CITY OF WATERBURY
NATURAL HAZARD PRE-DISASTER MITIGATION PLAN

CENTRAL NAUGATUCK VALLEY REGION

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Prepared For:

Council of Governments
Central Naugatuck Valley

Under a grant from the Federal Emergency Management Agency (FEMA) through the Connecticut Department of Environmental Protections (DEP)

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Waterbury Natural Hazard Pre-Disaster Mitigation Plan

Executive Summary

1. The primary goal of this hazard mitigation plan is to ***reduce the loss of or damage to life, property, infrastructure, and natural, cultural and economic resources from natural disasters.*** This includes the reduction of public and private damage costs. P. 1-3.

2. Many commissions and departments play a role in hazard mitigation, including the City Plan Commission, the Zoning Commission, the Zoning Board of Appeals, the Inland Wetland and Watercourses Commission, the Water Pollution Control Department, the Water Department, the Building Inspection Department, the Civil Preparedness Department, the Fire Department, the Police Department and the Public Works Department. P. 2-17.

3. The City considers its police, fire, medical, governmental, and major transportation facilities to be its most important critical facilities, for these are needed to ensure that emergencies are addressed while day-to-day management of the City continues. Day care facilities, convalescent homes, and educational institutions are often included as critical facilities as well as they are often used as shelters. P. 2-19.

4. A 24-inch pre-stressed concrete cylinder pipe (PCCP) is the primary water transmission main from the water treatment plant transmission line to the east side of Waterbury and provides public water supply and fire protection to thousands of people in Waterbury and Wolcott. In the past several years, the PCCP main has catastrophically failed in two locations, and other sections of the pipeline are likely to fail due to corrosion of the pre-stressing steel from the surrounding soil and groundwater which makes the entire main more susceptible to natural hazards, including the effects of flooding, freezing due to cold weather, earthquakes, and landslides. A broken pipe reduces the ability of both Waterbury and Wolcott to fight wildfires. P. 2-22, 2-23.

5. Inland flooding is the primary natural hazard that affects the City of Waterbury. P. 3-1

6. The City is looking into the purchase of database software which will maintain the City's complaint files (for the Public Works Department). P. 3-17. Ideally, this software will be compatible with permit tracking software that is being considered by the City Planning Department.

7. Given Waterbury's location in a river valley surrounded by steep slopes, rainfall collects quickly and has limited locations for storage, so proper conveyance of stormwater is important. Localized flooding and poor drainage often lead to icing issues in the winter (as discussed in Section 6.0). Localized nuisance flooding near steep slopes can lead to saturation of groundwater and possibly lead to landslides (as discussed in Section 8.0), which can damage critical utilities. P. 3-17 The Army Corps flood control projects have confined all but the most extreme flood events to the primary channel of the Naugatuck River. P. 3-18.

8. According to the COGCNV, nearly all of the 14,100 acres of developed land is served by the existing sanitary sewer system. In contrast, only about 3,400 acres of these acres are served by storm drainage systems according to the 1997 Drainage System Maps supplied by the COGCNV. Some storm sewers tie into the City sanitary sewers, reducing available carrying capacity. Storms that deliver rainfall amounts in excess of one inch can cause combined systems to back up into the street. The City is working on separation. P. 3-24.

9. Other stormwater issues include the fact that individual property owners can pave private driveways without a permit, increasing impervious surfaces without the City's knowledge. Also, much of the stormwater is handled via drainage swales; localized flooding is a major problem throughout the City under heavy rainfall conditions. Runoff on streets becomes sheet flow, flowing down roadways until it infiltrates in yards or reaches a down-gradient storm drain. The endpoints of the existing stormwater systems along the Naugatuck River

are not able to convey stormwater to the river when it is high, as the outflows become submerged. P. 3-24.

10. A comprehensive stormwater management plan is needed to define problem areas, create a maintenance schedule, and incorporate proposed runoff conditions from new and proposed developments into a watershed framework to demonstrate and understand the down-gradient effects of runoff. ……. On the other hand, several areas of the City (24 listed on Table 3-4) suffer such repeated drainage problems that the installation of a stormwater management *system* is warranted. P. 3-28.

11. The use of Geographic Information System (GIS) technology would greatly aid the identification and location of problem areas. P. 3-33.

12. The following *preventive* mitigation measures are recommended to reduce future flooding: increased cooperation between the above departments is necessary with regard to controlling growth and development in flood zones…… and a checklist should be developed that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to the proposed project. P. 3-34. The permit tracking software that is being considered by the City Planning Department should have such a checklist or built-in cross-notification function.

13. The City should consider outreach and education to prevent damage from inland nuisance flooding through property protection mitigation measures such as structural flood protection techniques (barriers, dry floodproofing, and wet floodproofing techniques). P. 3-34, 35.

14. Before an event, emergency services that would be appropriate mitigation measures for inland flooding include forecasting systems to provide information on the time of occurrence and magnitude of flooding; a system to issue flood warnings to the community and responsible officials; emergency protective measures, such as a section in the Emergency Operations Plan outlining procedures for the mobilization and position of staff, equipment,

and resources to facilitate evacuations and emergency flood-water control; and implementing emergency notification system which combines database and GIS mapping technologies to deliver outbound emergency notifications to geographic areas or specific groups of people. P. 3-35.

15. N*atural resource protection* mitigation measures are recommended to help prevent damage from inland and nuisance flooding including: the acquisition of additional open space properties; implementation of conservation objectives specified in the Plan of Conservation and Development, including the creation of greenways along the Naugatuck River and acquisition of land around water bodies; and continuation of the regulation of development in protected and sensitive areas. P. 3-37 Also, clear brush and growth that could possibly inhibit flood flows in the floodplain of the Mad River, especially in the Townline Road area at least once every three years. P. 3-39.

16. Specific *structural* mitigation measures recommended to prevent flood damage include: a comprehensive catch basin maintenance program; the installation and repair of curbing for areas listed in Table 3-3; the installation of stormwater systems for areas listed in Table 3-4; and repair of stormwater and drainage systems listed in Table 3-5. P. 3-38. Also, Continue to investigate reports of localized flooding problems to determine the cause and an appropriate solution and set milestones for eliminating recurring localized flooding areas; perform a drainage study of Great Brook that flows through underneath the Palace Theatre; perform an engineering study for the Mark Lane Landfill area and the Highland Metro North Railroad area; and other specific areas highlighted on page 3-40.

17. Other flood prevention measures include: Coordination with neighboring municipalities regarding new subdivisions that could impact properties within Waterbury (for upstream municipalities) and downstream of Waterbury; becoming a member of FEMA's Community Rating System; adopting a more comprehensive set of floodplain management regulations; amending the zoning and subdivision regulations to include detailed provisions for flood damage prevention; protecting new buildings constructed in flood prone areas to the highest

recorded flood level and design and graded them to shunt drainage away from the building; add appropriate regulations to the Land Subdivision Regulations to prevent non-permitted increases in impervious surfaces and require watershed-based engineering studies for new subdivisions or sizeable developments showing both the upstream and downstream drainage impacts; where possible, assist the "Map Mod" program to remap local flood prone areas and produce new regulatory floodplain maps using more exacting study techniques, including using more accurate contour information to map flood elevations provided with the FIRM; and implement outreach programs to educate citizens regarding Ordinances, Insurance, and other flood relevant issues. P. 3-39. Some of these recommendations can be implemented in conjunction with the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007.

18. Mitigation measures for winds, hail, tornadoes, and downbursts are: increase tree limb maintenance and inspections; continue outreach regarding dangerous trees on private property; continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas; continue the required compliance with the amended Connecticut Building Code for wind speeds; and make literature available during the permitting process regarding appropriate design standards.

19. For winter storms, the following recommendations are applicable to aspects of winter storms such as winds, snow, and ice: construct drainage improvements for reducing road icing; acquire additional funding for the small sand/salt storage facility; review fire and ambulance service area plans and identify areas which may be difficult to access during winter storm events; consider property acquisitions along Connecticut and Ohio Avenues to reduce the number of people potentially affected by the limited plowing services available in this neighborhood; continue to encourage two modes of egress into every neighborhood by the creation of through streets; and acquire GPS units for City vehicles and plowing contractors. P. 6-9.

20. Regarding earthquakes, people who live or work in non-reinforced masonry buildings, especially those built on filled land or unstable soils, are at the highest risk for injury, and Waterbury has a large number of masonry buildings. P. 7-3 Consider preventing residential development in areas of, on, above, or below steep slopes (slopes exceeding 30%) which also helps prevent landslides (the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 can assist here); add earthquakes to the list of hazards covered by the Emergency Operations Plan; and ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings. P. 7-6, 8-11.

21. Class C dams are high potential hazard dams that upon failure would result in loss of life and major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways with great economic loss. The five Class C dams in Waterbury are Cemetery Pond Dam, Scovill Pond Dam, East Mountain Reservoir Dam, Risdon Pond Dam, and Belleview Lake Dam. P. 9-3 Ensure that all Class C dams have up to date operation and maintenance plans. Perform or update the Dam Failure Analysis for each dam. The City should also make any necessary repairs to Pritchards Pond Dam to prevent further deterioration of the dam, and encourage development of an operation and maintenance plan for the Frost Road Pond Dam. P. 9-15.

22. The levee system in Waterbury is currently on the Army Corps of Engineers list of "Levees of Maintenance Concern" rated as "fair," a failing grade meaning that the levee system is not strong enough to properly withstand flooding conditions without necessary repairs. Designed to confine the 500-year flood to the Naugatuck River, the system's proper maintenance of this levee system is imperative. Failure of this levee system during an extreme flood could cause millions of dollars of damages in the City's industrial sector, specifically inside Waterbury Industrial Commons. If proper and required maintenance is not performed on this levee system, the Army Corps of Engineers may decertify it, meaning that property owners would be required to purchase flood insurance and rankings in the FEMA's Community Rating System would be reduced. It is therefore crucial for the Connecticut Department of

Environmental Protection to address the maintenance concerns in this levee system and performs the necessary repairs or alterations. P. 9-14.

23. Concerning wildfires, the Waterbury Water Department should continue to extend the public water supply systems into areas that require water for fire protection and identify and upgrade those portions of the public water supply systems that are substandard from the standpoint of adequate pressure and volume for fire-fighting purposes. The Public Works Department, working with the Fire Department, should explore innovative solutions to fire protection where conventional water systems are not available. P. 10-5.

1.0 INTRODUCTION

1.1 Background and Purpose

The term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. In the context of natural disasters, pre-disaster natural hazard mitigation is commonly defined as any sustained action that permanently reduces or eliminates long-term risk to people, property, and resources from natural hazards and their effects.

The primary purpose of a pre-disaster hazard mitigation plan (HMP) is to identify natural hazards and risks, existing capabilities, and activities that can be undertaken by a community or group of communities to prevent loss of life and reduce property damages associated with the identified hazards. This HMP is prepared specifically to identify hazards in the City of Waterbury, Connecticut ("Waterbury" or "City"). The HMP is relevant not only in emergency management situations, but also should be used within the City of Waterbury's land use, environmental, and capital improvement frameworks.

The Disaster Mitigation Act of 2000 (DMA), commonly known as the 2000 Stafford Act amendments, was approved by Congress and signed into law in October 2000, creating Public Law 106-390. The purposes of the DMA are to establish a national program for pre-disaster mitigation and streamline administration of disaster relief.

The DMA requires local communities to have a Federal Emergency Management Agency (FEMA)-approved mitigation plan in order to be eligible to receive post-disaster Hazard Mitigation Grant Program (HMGP) grants and Pre-Disaster Mitigation (PDM) program project grant funds. Once a community has a FEMA-approved hazard mitigation plan, the community is then eligible to apply for PDM project funds for mitigation activities.

The subject pre-disaster hazard mitigation plan was developed to be consistent with the requirements of the HMGP, PDM, and Flood Management Assistance (FMA) programs. These programs are briefly described below.

Pre-Disaster Mitigation (PDM) Program

The Pre-Disaster Mitigation program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through pre-disaster mitigation planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities. PDM funds should be used primarily to support mitigation activities that address natural hazards. In addition to providing a vehicle for funding, the PDM program provides an opportunity to raise risk awareness within communities.

Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.

Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist States and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities. Three types of grants are available under FMA. These are Planning, Project, and Technical Assistance grants.

1.2 Hazard Mitigation Goals

The primary goal of this hazard mitigation plan is to ***reduce the loss of or damage to life, property, infrastructure, and natural, cultural and economic resources from natural disasters.*** This includes the reduction of public and private damage costs. Limiting losses of and damage to life and property will also reduce the social, emotional, and economic disruption associated with a natural disaster.

Developing, adopting, and implementing this hazard mitigation plan is expected to:

- ***Increase access to and awareness of funding sources for hazard mitigation projects.*** Certain funding sources, such as the Pre-Disaster Mitigation Competitive Grant Program and the Hazard Mitigation Grant Program, will be available if the hazard mitigation plan is in place and approved.

- ***Identify mitigation initiatives to be implemented if and when funding becomes available.*** This HMP will identify a number of mitigation recommendations, which can then be prioritized and acted upon as funding allows.

- ***Connect hazard mitigation planning to other community planning efforts.*** This HMP can be used to guide Waterbury's development through inter-departmental and inter-municipal coordination.

- ***Improve the mechanisms for pre- and post-disaster decision making efforts.*** This plan emphasizes actions that can be taken now to reduce or prevent future disaster damages. If the actions identified in this plan are implemented, damage from future hazard events can be minimized, thereby easing recovery and reducing the cost of repairs and reconstruction.

- ***Improve the ability to implement post-disaster recovery projects*** through development of a list of mitigation alternatives ready to be implemented.

- ***Enhance and preserve natural resource systems.*** Natural resources, such as wetlands and floodplains, provide protection against disasters such as floods and hurricanes. Proper planning and protection of natural resources can provide hazard mitigation at substantially reduced costs.

- ***Educate residents and policy makers about natural hazard risk and vulnerability.*** Education is an important tool to ensure that people make informed decisions that complement the City's ability to implement and maintain mitigation strategies.

- ***Complement future Community Rating System efforts.*** Implementation of certain mitigation measures may increase a community's rating, and thus the benefits that it derives from FEMA. The City of Waterbury has never participated in the Community Rating System.

1.3 Identification of Hazards and Document Overview

As stated in Section 1.1, the term *hazard* refers to an extreme natural event that poses a risk to people, infrastructure, or resources. Based on a review of the Connecticut Natural Hazard Mitigation Plan and correspondence with local officials, the following have been identified as natural hazards that are most likely to affect the City of Waterbury:

- Inland Flooding
- Hurricanes and Tropical Storms
- Summer Storms (including lightning, hail, and heavy winds) and Tornadoes
- Winter Storms
- Earthquakes
- Landslides
- Dam Failure
- Wildfires

This document has been prepared with the understanding that a single *hazard effect* may be caused by multiple *hazard events*. For example, flooding may occur as a result of frequent heavy rains, a hurricane, or a winter storm. Thus, Appended Tables 1 and 2 provide summaries of the hazard events and hazard effects that impact the City of Waterbury, and include criteria for characterizing the locations impacted by the hazard, the frequency of occurrence of the hazards, and the magnitude or severity of the hazards.

Despite the causes, the effects of several hazards are persistent and demand high expenditures from the City. In order to better identify current vulnerabilities and potential mitigation strategies associated with other hazards, each hazard has been individually discussed in a separate chapter.

This document begins with a general discussion of the City of Waterbury's community profile, including the physical setting, demographics, development trends, governmental

structure, and sheltering capacity. Next, each chapter of this Plan is broken down into six or seven different parts. These are *Setting*; *Hazard Assessment*; *Historic Record*; *Existing Programs, Policies, and Mitigation Measures*; *Vulnerabilities and Risk Assessment*; and *Potential Mitigation Measures, Strategies, and Alternatives,* and if necessary, *a Summary of Recommendations.* These are described below.

- ***Setting*** addresses the general areas that are at risk from the hazard. General land uses are identified.

- ***Hazard Assessment*** describes the specifics of a given hazard, including general characteristics, and associated effects. Also defined are associated return intervals, probability and risk, and relative magnitude.

- ***Historic Record*** is a discussion of past occurrences of the hazard, and associated damages when available.

- ***Existing Programs, Policies, and Mitigation Measures*** gives an overview of the measures that the City of Waterbury is currently undertaking to mitigate the given hazard. These may take the form of ordinances and codes, structural measures such as dams, or public outreach initiatives.

- ***Vulnerabilities and Risk Assessment*** focuses on the specific areas at risk to the hazard. Specific land uses in the given areas are identified. Critical buildings and infrastructure that would be affected by the hazard are identified.

- ***Potential Mitigation Measures, Strategies, and Alternatives*** identifies mitigation alternatives, including those that may be the least cost effective or inappropriate for the City.

- ***Summary of Recommended Mitigation Measures, Strategies, and Alternatives*** provides a summary of the recommended courses of action for Waterbury that are included in the STAPLEE analysis described below.

This document concludes with a strategy for implementation of the Hazard Mitigation Plan, including a schedule, a program for monitoring and updating the plan, and a discussion of technical and financial resources.

1.4 Discussion of STAPLEE Ranking Method

To prioritize recommended mitigation measures, it is necessary to determine how effective each measure will be in reducing or preventing damage. A set of criteria commonly used by public administration officials and planners was applied to each proposed strategy. The method, called STAPLEE, stands for the "Social, Technical, Administrative, Political, Legal, Economic and Environmental" criteria for making planning decisions. The following questions were asked about the proposed mitigation strategies:

- **Social**: Is the proposed strategy socially acceptable to the City of Waterbury? Are there equity issues involved that would mean that one segment of the City is treated unfairly?
- **Technical**: Will the proposed strategy work? Will it create more problems than it will solve?
- **Administrative**: Can the City implement the strategy? Is there someone to coordinate and lead the effort?
- **Political**: Is the strategy politically acceptable? Is there public support both to implement and maintain the project?
- **Legal**: Is the City authorized to implement the proposed strategy? Is there a clear legal basis or precedent for this activity?

- **Economic**: What are the costs and benefits of this strategy? Does the cost seem reasonable for the size of the problem and the likely benefits?
- **Environmental**: How will the strategy impact the environment? Will the strategy need environmental regulatory approvals?

Each proposed mitigation strategy presented in this plan was evaluated and assigned a score (Good = 3, Average = 2, Poor = 1) based on the above criteria. An evaluation matrix with the total scores from each strategy can be found in Appendix A. After each strategy is evaluated using the STAPLEE method, it is possible to prioritize the strategies according to the final score. The highest scoring is determined to be of more importance, economically, socially, environmentally and politically and, hence, prioritized over those with lower scoring.

1.5 Documentation of the Planning Process

The City of Waterbury is a member of the Council of Governments of the Central Naugatuck Valley (COGCNV), the regional planning agency for Waterbury and twelve other member municipalities: Beacon Falls, Bethlehem, Cheshire, Middlebury, Naugatuck, Oxford, Prospect, Southbury, Thomaston, Watertown, Wolcott, and Woodbury. The Towns of Oxford, Watertown, and Woodbury have existing mitigation plans, and hazard mitigation plans are being concurrently developed for the municipalities of Cheshire, Prospect, and Wolcott.

Ms. Virginia Mason of the COGCNV coordinated the development of this Hazard Mitigation Plan. The COGCNV applied for the grant from FEMA through the Connecticut Department of Environmental Protection (DEP). The adoption of this plan in the City of Waterbury will also be coordinated by the COGCNV.

The following individuals from the City of Waterbury provided information, data, studies, reports, and observations; and were involved in the development of the Plan:

- Ms. Theresea Caldarone, Mayor's Office
- Mr. Adam Rinko, Waterbury Fire Department
- Mr. John Lawlor, Jr., Director of Public Works Department
- Mr. Mark Pronovost, P.E., City Engineer, Public Works Department
- Mr. Jim Sequin, AICP, City Planning Department
- Mr. Ken Skov, Waterbury Water Bureau
- Ms. Lynn McHale, Waterbury Water Pollution Control Department
- Ms. Sheila O'Malley, formerly of the Mayor's Office

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the Region, as well as to identify areas that should be prioritized for hazard mitigation. The following is a list of meetings and field reconnaissance that were held to develop this Hazard Mitigation Plan:

- ***A field inspection was performed May 16, 2006.*** Observations were made of numerous potential flooding and problem areas along the Mad River in the City.

- ***A field inspection was performed June 7, 2006.*** Observations were made of numerous flooded and storm-damaged areas in the City.

- ***A project initiation meeting was held June 26, 2006.*** This meeting addressed the scope of services necessary to develop this HMP. Initial input was provided by the project team.

- ***A project meeting with the Waterbury Fire Department contact was held October 10, 2006.*** Necessary documentation was collected, and problem areas within the City were discussed.

- ***A public information meeting was held November 16, 2006.*** Preliminary findings were presented and public comments solicited.

- ***A project meeting with the Waterbury Water Department contact was held December 8, 2006.*** Necessary documentation was collected, and problem areas within the City were discussed.

- ***A second public information meeting was held December 12, 2006.*** Preliminary findings were presented and public comments solicited.

- ***A project meeting with contacts from the Public Works Department, Mayor's Office, and Planning Department was held January 8, 2007.*** Necessary documentation was collected, and problem areas within the City were discussed.

- ***A project meeting with an additional contact from the Public Works Department was held January 22, 2007.*** Necessary documentation was collected, and problem areas within the City were discussed.

- ***A final project meeting with contacts from the Public Works Department was held August 16, 2007.*** The draft plan was reviewed.

While residents were invited to the public information meetings via newspaper, few attended. Residents were also encouraged to contact the COG with comments via newspaper articles. In addition, the president of the Waterbury Neighborhood Council, Mr. Joshua Angelus, was provided with a draft copy of the plan in an effort to collect additional feedback. The Waterbury Neighborhood Council is a nonprofit organization made up of the presidents and representatives of the eleven neighborhood associations of Waterbury. The Council strives to encourage citizen involvement in both neighborhood and city issues, to strengthen existing neighborhood organizations, and to foster the creation of new ones.

As another direct gauge of public interest, a thorough review of Public Works Department complaint files was undertaken (as explained in Section 3.3) to document problems of public concern. Finally, the Connecticut DEP was routinely briefed and consulted throughout the development process.

It is important to note that COGCNV manages the Central Naugatuck Valley Emergency Planning Committee. This committee has begun coordinating emergency services in the region. Fire, Police, EMS, Red Cross, emergency management directors, and other departments participate in these efforts. In June 2004, over 120 responders participated in the region's first tabletop exercise on biological terrorism. Area health directors, hospitals, and other health care professionals also meet monthly with the Health and Medical Subcommittee to share information, protocols, and training. Thus, local knowledge and experience gained through the Emergency Planning Committee activities has been transferred by the COGCNV to the pre-disaster mitigation planning process.

Additional opportunities for the public to review the Plan will be implemented in advance of the public hearing to adopt this plan, tentatively scheduled for the regular Board of Aldermen meeting in December 2007 or January 2008, contingent on receiving conditional approval from FEMA. This final draft of the plan will be posted on the City website and the COGCNV website to provide the opportunity for public review and comment. Notification of the opportunity to review the Plan on the websites will be posted in the local newspaper and forwarded to the Waterbury Neighborhood Council.

If any final plan modifications result from the comment period leading up to and including the Board of Aldermen meeting to adopt the plan, these will be submitted to FEMA as page revisions with a cover letter explaining the changes. It is not anticipated that any major modifications will occur at this phase of the project.

Appendix B contains copies of meeting minutes, field notes and observations, the public information meeting presentation, and other records that document the development of this Pre-Disaster Hazard Mitigation Plan, to date.

2.0 COMMUNITY PROFILE

2.1 Physical Setting

The City of Waterbury is located in New Haven County. It is bordered by the Towns of Watertown and Middlebury to the west, Thomaston and Plymouth to the north, Wolcott and Cheshire to the east, and Naugatuck and Prospect to the south. Refer to Figure 2-1 for a state location schematic and Figure 2-2 for a regional map.

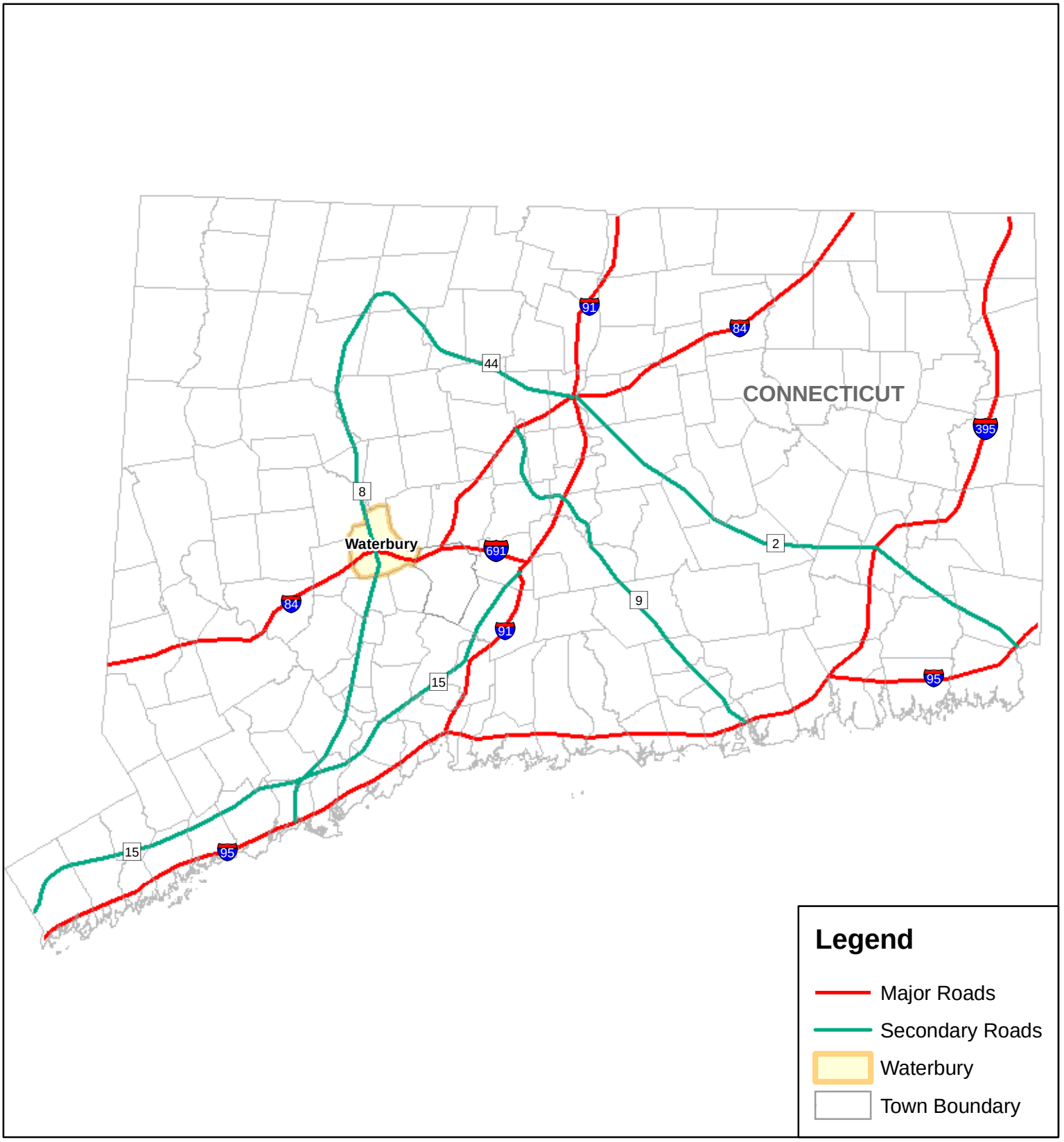
Waterbury is located on the I-84 corridor roughly midway between Hartford and Danbury, and is a major center of banking (including the Webster Bank Corporate Headquarters), as well as home to the Federal, State, and County courthouses. The City is the most developed community in the Central Naugatuck Valley Region.

As the location of numerous current and former industrial facilities, as well as three local colleges (University of Connecticut – Waterbury, Naugatuck Valley Community College, and Post University), two major hospitals (St. Mary's Hospital and The Waterbury Hospital) and many state and federal buildings, utility organizations, and major financial institutions, the City of Waterbury is vulnerable to a loss of life and property due to an array of hazards.

2.2 Existing Land Use

Waterbury encompasses 28.6 square miles. The City is characterized by a compact Central Business District surrounded by an industrial district and medium to high-density residential districts interspersed with mixed-use commercial corridors. Refer to Figure 2-3 for a map of generalized land use in the City of Waterbury.

Figure 2-1: Waterbury Location Map



Source:"Roads", GDT
"Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
January 2007

0 10 20 Miles

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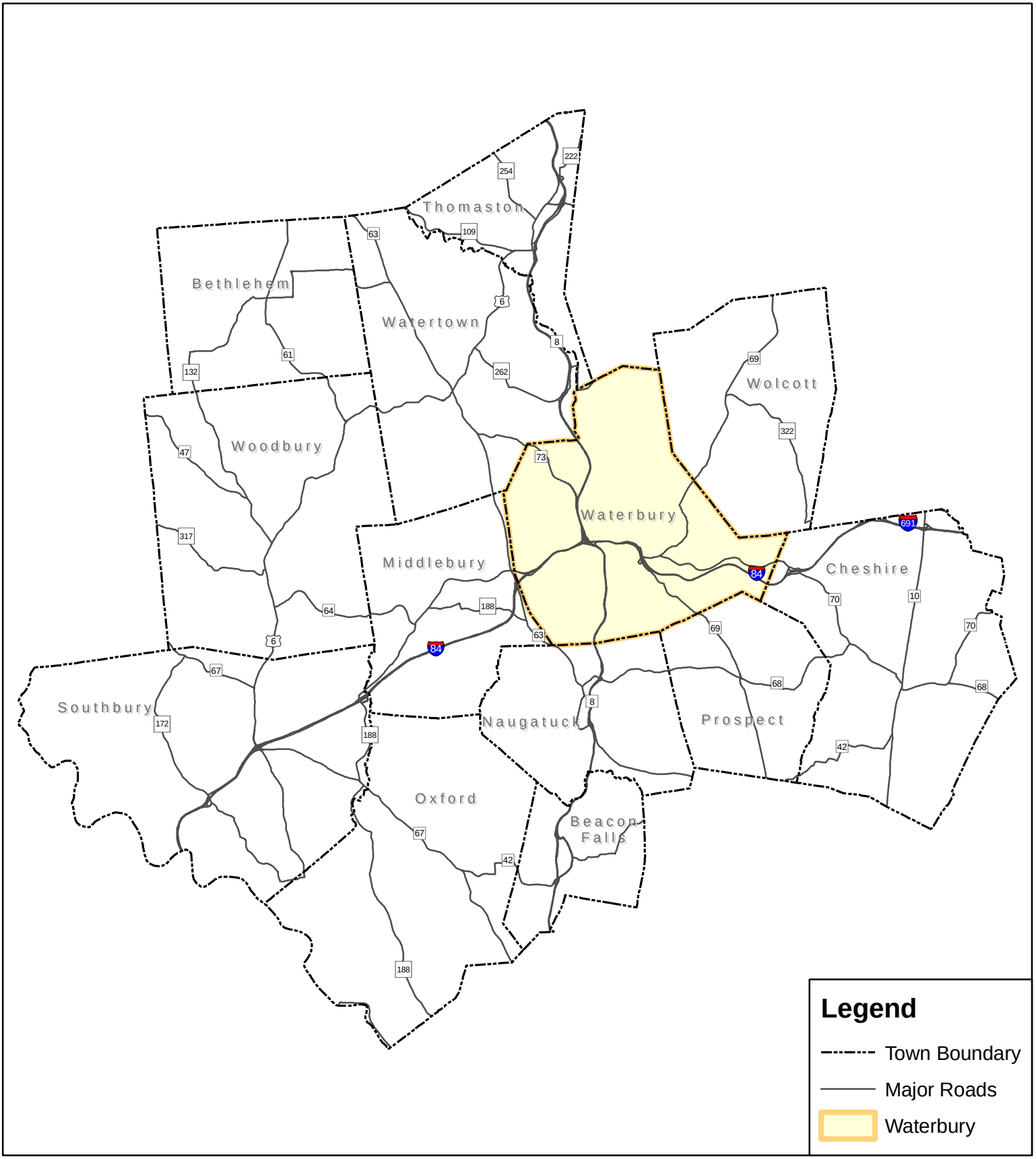
Figure 2-2: Waterbury in the CNVR



Source:"Roads", GDT
"Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
January 2007

0 2 4 Miles

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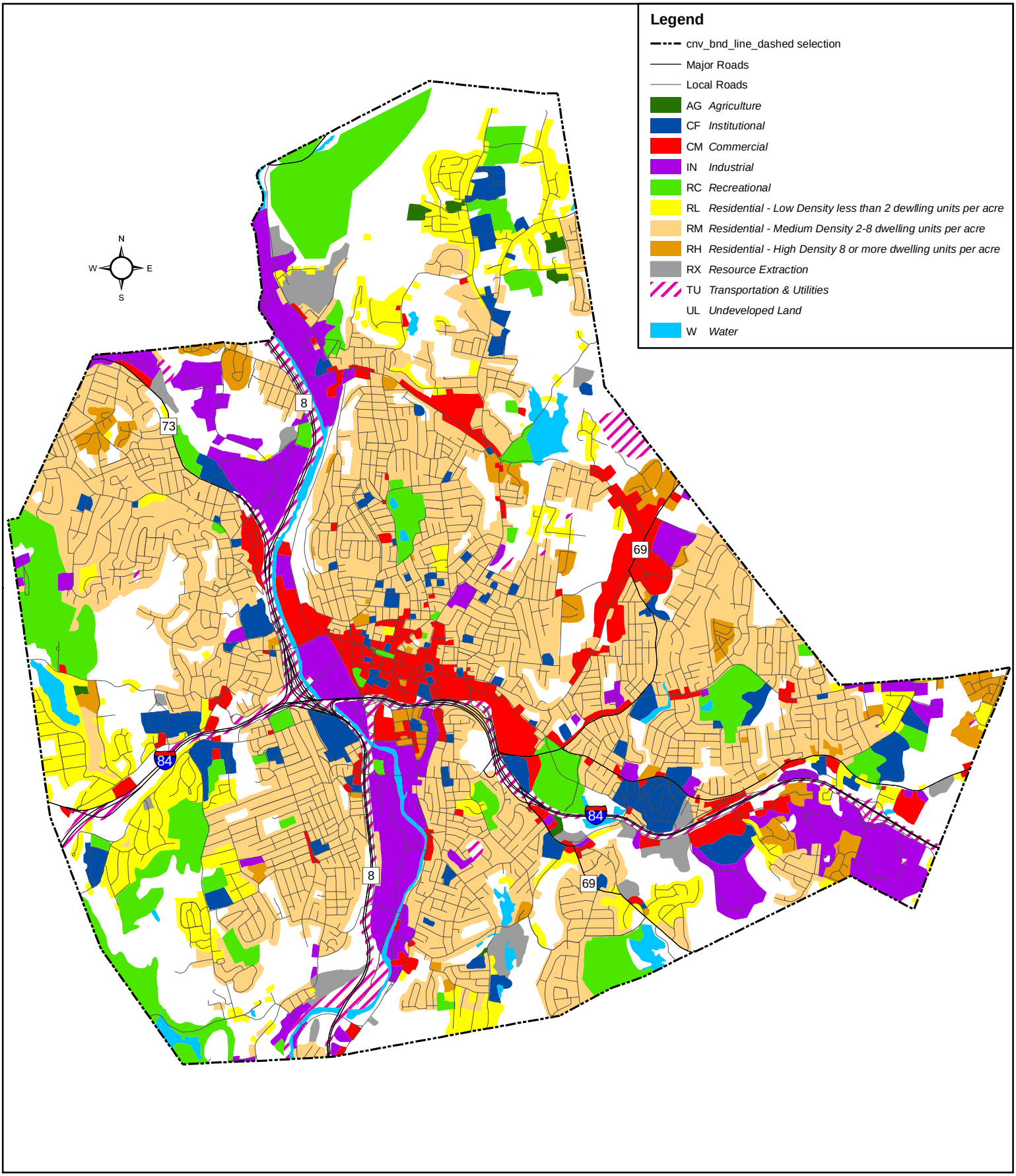
CENTRAL NAUGATUCK VALLEY

Figure 2-3: Waterbury Generalized Land Use



Source: "Roads", GDT
"Town Boundary", DEP
"Land Use", COGCNV

For general planning purposes only. Delineations may not be exact.

January 2007

0 0.5 1 Miles

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The CBD is located near the intersection of I-84 and Route 8. Sections of the City used predominantly for industrial purposes are largely located along the Naugatuck River, running from the north of the city to the south. An additional industrial district is located in the southeast part of the city. Medium-density residential areas surround the CBD and extend nearly to the city borders. In the northeast and southwest reaches of the city, topography limits development to small low-density residential neighborhoods surrounded by vacant land. Table 2-1 provides a summary of land use in Waterbury by area.

Table 2-1
Land Use by Area (acres)

Land Use	Area (acres)	Pct.
Residential - Medium Density	6377	34.4%
Vacant	4416	23.8%
Recreational	1526	8.2%
Industrial	1367	7.4%
Residential - Low Density	1354	7.3%
Commercial	1001	5.4%
Institutional	768	4.1%
Utilities/Transportation	631	3.4%
Residential - High Density	492	2.7%
Water	322	1.7%
Mining	256	1.4%
Agricultural	43	0.2%

Source: Council of Governments of the Central Naugatuck Valley, 2000

2.3 Geology

Geology is important to the occurrence and relative effects of natural hazards such as landslides and earthquakes. Thus, it is important to understand the geologic setting and variation of bedrock and surficial formations in Waterbury. The following discussion highlights Waterbury's geology at several regional scales.

In terms of North American bedrock geology, the City of Waterbury is located in the northeastern part of the Appalachian Orogenic Belt, also known as the Appalachian

Highlands. The Appalachian Highlands extend from Maine south into Mississippi and Alabama and were formed during the orogeny that occurred when the super-continent Pangea assembled during the late Paleozoic Era. The region is generally characterized by deformed sedimentary rocks cut through by numerous thrust faults.

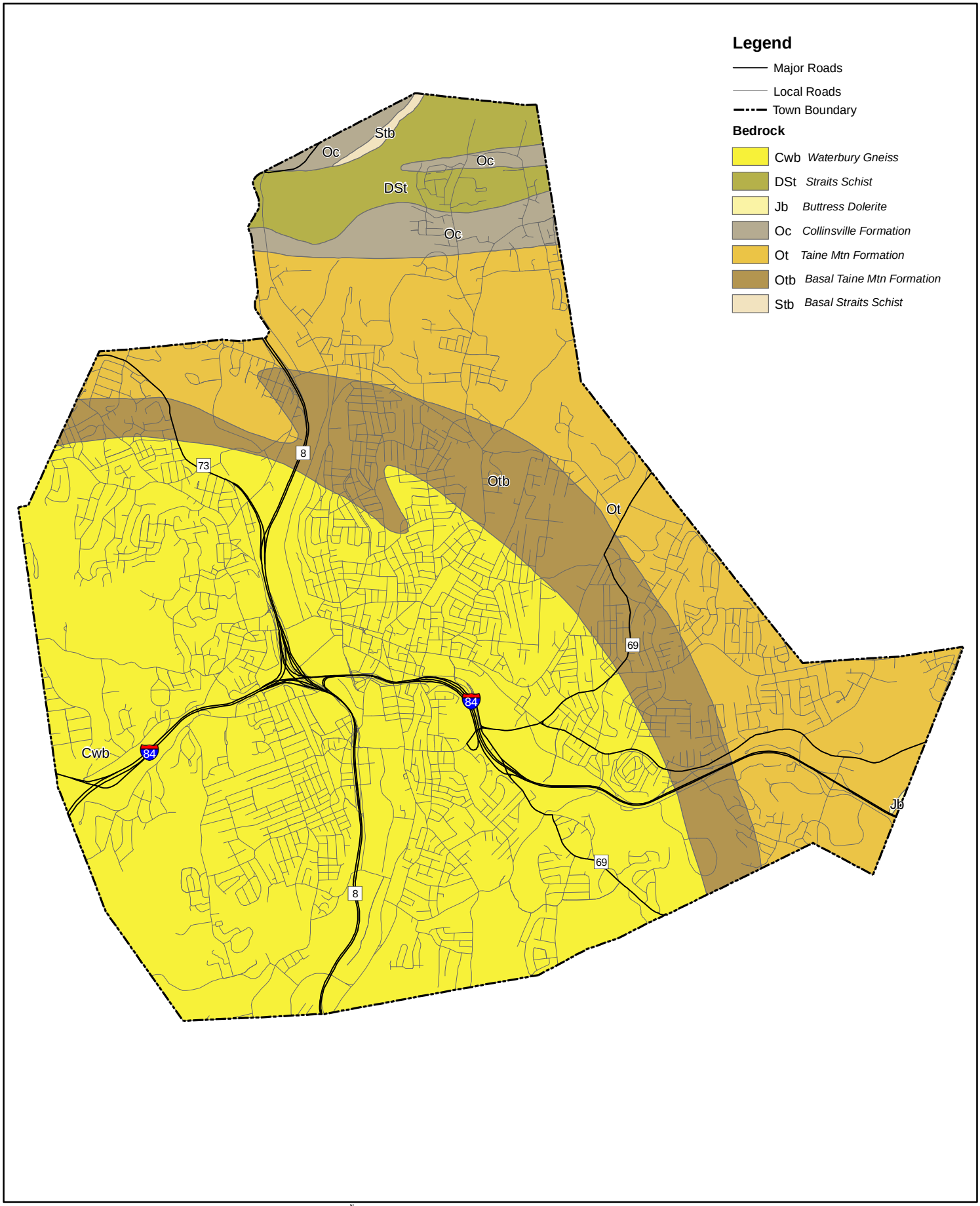
Regionally, in terms of New England bedrock geology the City of Waterbury lies within the geologic province known as the Eugeosyncline Sequence. The eugeosynclines consist of different sequences of lithologies more typical of deep marine environments. Eugeosynclinal rocks are typically more deformed, metamorphosed, and intruded by small to large igneous plutons.

Connecticut bedrock geology is comprised of several "terranes." Terranes are geologic regions that reflect the role of plate tectonics in Connecticut's natural history. The bedrock beneath the City of Waterbury is part of two terranes. The northern and eastern portions of Waterbury are underlain by the Iapetos Terrane, comprised of remnants of the Iapetos Ocean that existed before Pangaea was formed. This terrane formed when Pangaea was consolidated. The central, western, and southern portions of the City are underlain by the Proto-North American (Continental) Terrane, a displaced Iapetos Terrane.

The City of Waterbury's bedrock consists of three general lithologies: metamorphic granofels and amphibolites, volcanic igneous silicate gneiss, and metasedimentary and metaigneous schists. The bedrock intrusions trend northwest-southeast through the City. Refer to Figure 2-4 for a depiction of the bedrock geology in the City of Waterbury.

The central, western, and southern portions of the City are underlain by the Waterbury Gneiss formation. The Waterbury Gneiss is a gray to dark-gray, fine- to medium-grained schist and gneiss. The northern portion of Waterbury is underlain by formations such as the Collinsville Formation, the Straits Schist, and Basal Member of the Straits Schist, all silvery gray medium to coarse grained schists.

Figure 2-4: Waterbury Bedrock Geology



Source: "Roads", GDT
"Town Boundary", "Bedrock Geology", DEP
For general planning purposes only. Delineations may not be exact.
January 2007

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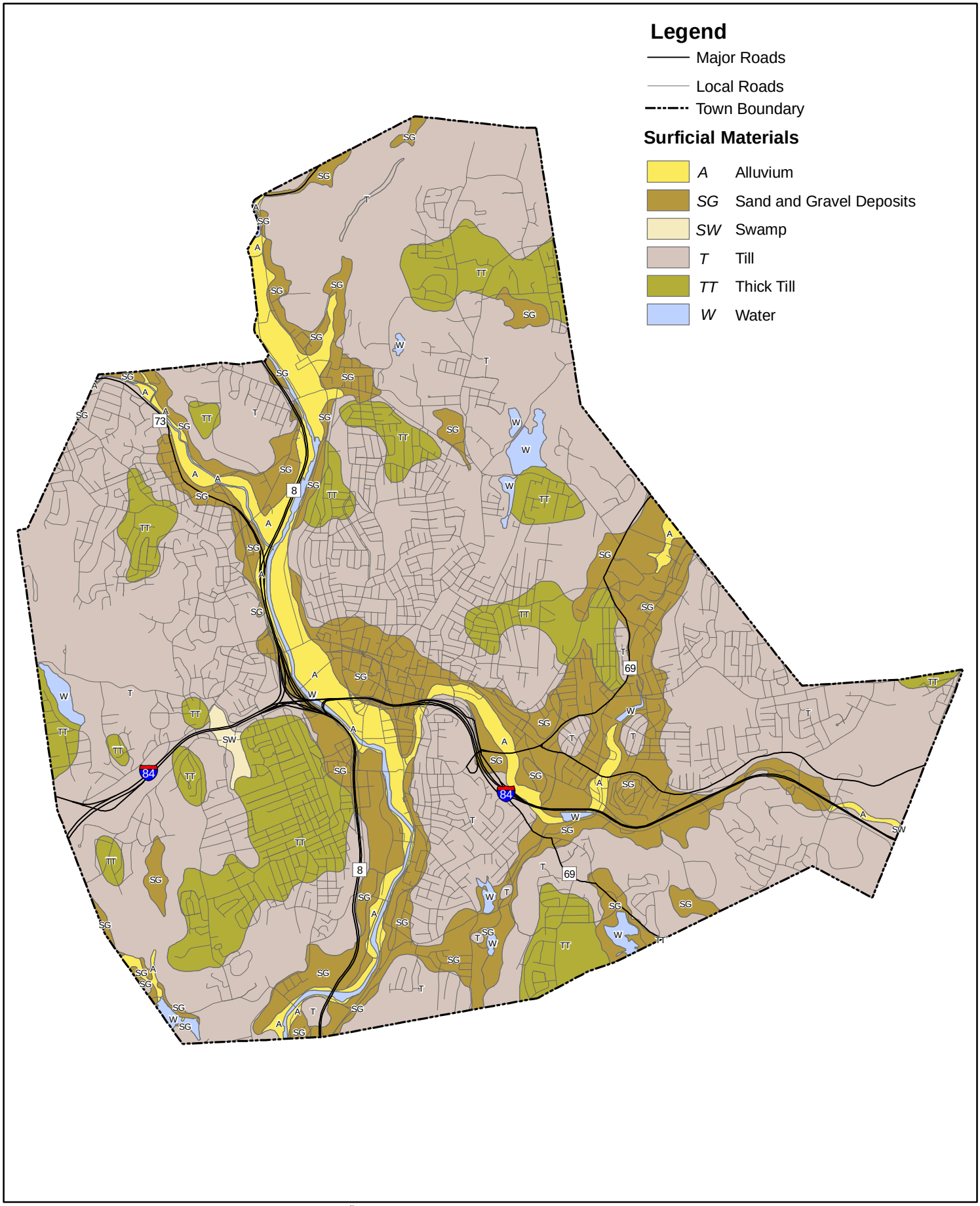
The remainder of the City is underlain by the Taine Mountain Formation and Basal Member of the Taine Mountain Formation, both gray granofels. In general, these formations strike northwest to southeast and dip approximately 60 degrees in a northeasterly direction, although exceptions occur. A review of geological data revealed an absence of fault lines in the City of Waterbury.

At least twice in the late Pleistocene, continental ice sheets moved across Connecticut. As a result, surficial geology of the City is characteristic of the depositional environments that occurred during glacial and postglacial periods. Refer to Figure 2-5 for a depiction of surficial geology.

A vast area of the City is covered by glacial till. Tills contain an unsorted mixture of clay, silt, sand, gravel, and boulders deposited by glaciers as a ground moraine. This area includes most of the upland areas of Waterbury, not in the vicinity of the Naugatuck and Mad Rivers. The remainder of the City consists primarily of stratified sand and gravel ("stratified drift") areas associated with the major rivers and brooks throughout the City. These deposits accumulated by glacial meltwater streams during the outwash period following the latest glacial recession.

With regard to soil types, over 50% of the City is mapped primarily by Udorthents urban land complex, and the majority of the remaining portion of the City is mapped as Charlton-Chatfield Complex, Canton and Charlton soils, Urban Land, Paxton-Urban Land Complex, Paxton and Montauk Soils, and Charlton-Urban Land Complex. The remainder of the City has soil types of consisting primarily of various silty and sandy loams. There may be minor areas of fill material along the Naugatuck River, but it is unlikely that such fill comprises a significant amount of land area in Waterbury.

Figure 2-5: Waterbury Surficial Geology



Source: "Roads", GDT
"Town Boundary", "Surficial Materials", DEP
For general planning purposes only. Delineations may not be exact.
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Udorthents are disturbed soils underlying urban and built up lands where the original soil type is no longer easily identified. Charlton-Chatfield Complex soils are primarily urban lands on top of deep, well-drained, hilly, and very rocky sandy loams. Canton and Charlton Soils are relatively level, rocky loams. Paxton Urban Land Complex soils are primarily urban lands consisting of a deep, well drained fine sandy loam. Paxton and Montauk soils are fine sandy loams. Finally, Charlton Urban Land Complex is a primarily urban area underlain by the rocky, hilly Charlton soil. In summary, the majority of the soils in Waterbury are rocky sandy and fine sandy loams generally associated with steeper slopes.

The presence of stratified drift present in the City is important for two reasons:

- With regard to inland flooding, areas of stratified materials are generally coincident with inland floodplains. This is because these materials were deposited at lower elevations by glacial streams, and these valleys later were inherited by the larger of our present-day streams and rivers. However, smaller glacial till watercourses can also cause flooding, such as occurs throughout Waterbury.

- The amount of stratified drift also has bearing on the relative intensity of earthquakes, as large areas of fine-grained sediment present special challenges during shaking as liquefaction may occur. The amount of stratified materials also affects the likelihood of landslides occurring in the community. These topics will be discussed in later sections.

2.4 Climate

Waterbury has an agreeable climate, characterized by moderate but distinct seasons. The average mean temperature is approximately 48 degrees, with summer temperatures in the mid-80s and winter temperatures in the upper 20s to mid-30s, Fahrenheit. Extreme conditions raise summer temperatures to near 100 degrees and winter temperatures to

below zero. Median snowfall is approximately 43 inches per year as averaged between the weather stations in Woodbury, Wolcott, and Hamden (NCDC, 2006). Median annual precipitation is 44 inches, which is spread evenly over the course of a year.

By comparison, average annual state-wide precipitation based on more than 100 years of record is nearly the same, at 45 inches. However, average annual precipitation in Connecticut has been increasing by 0.95 inches per decade since the end of the 19th century (Miller et. al., 2002; NCDC, 2005). Likewise, total annual precipitation in the City has increased over time. The continued increase in precipitation only heightens the need for hazard mitigation planning, as the occurrence of floods may change in accordance with the greater precipitation.

2.5 Drainage Basins and Hydrology

The City of Waterbury is divided by Naugatuck River, one of the largest rivers in Connecticut. Nearly all of the stream systems with drainage basins within Waterbury drain into the Naugatuck River, and while the floodplains and channels around the Naugatuck River within Waterbury are well developed, there are a number of impoundments which provide flood control both on the Naugatuck River and in its tributaries.

The City of Waterbury lies within drainage basins corresponding to the Ten Mile River, the Naugatuck River, Hancock Brook, Steele Brook, Beaver Pond Brook, Mad River, Fulling Mill Brook, and Hop Brook. These are described below.

Ten Mile River

A very small portion (4.11 acres, 0.01 square miles) of the Ten Mile River basin lies within the southeastern boundary of Waterbury, and this section is drained by Cuff Brook in Cheshire. The Ten Mile River basin makes up 0.02% of Waterbury's land area. This

river has its headwaters in Prospect and flows northeast across Cheshire, eventually draining into the Quinnipiac River near Milldale. In total, the Ten Mile River drains 20.261 square miles across Prospect, Waterbury, Cheshire, Wolcott, and Southington.

Naugatuck River

Most of the land area of Waterbury is part of the Naugatuck River Basin. This area measures 11.85 square miles and comprises 40% of the land area in Waterbury. The Naugatuck River originates near the City of Torrington and winds south almost 40 miles to meet the Housatonic River in Derby, giving it a total drainage area of 311.16 square miles. It is the only major river in the state whose headwaters are also contained within the boundaries of the state. The Naugatuck River was once well-known for its many defunct dams, although many have been removed.

The Naugatuck River flows south through Torrington, forming the southeastern municipal boundary with Harwinton. It then becomes the municipal boundary between Litchfield and Harwinton, and then flows through Thomaston until it becomes the southern part of the municipal boundary between Thomaston and Watertown. The Naugatuck River then approximates the corporate boundary between Watertown and Waterbury, entering Waterbury proper where State Route 8 crosses Waterbury's northern boundary.

The total drainage area of the Naugatuck River above Spruce Brook, which drains into the Naugatuck just as the river becomes the corporate boundary between Watertown and Waterbury, is 137.85 square miles. At the intersection of the Naugatuck River and the southern Waterbury city line, the drainage area of the Naugatuck River has increased to about 209 square miles. All of the major basins in Waterbury drain into the Naugatuck River and will be discussed in the following sections.

Several dams of note were located along the run of the Naugatuck River in Waterbury: the Chase Brass, Freight Street, Anaconda, and Platts Mills Dams. All have been removed.

Hancock Brook

Hancock brook has its headwaters in the City of Bristol and flows through Plymouth before entering the northern part of Waterbury, eventually joining with the Naugatuck River above Steele Brook. Hancock Brook drains 12.34 square miles before entering Waterbury and its drainage basin measures 3.05 square miles and comprises 10.51% of the land area within Waterbury, netting a total basin area of 15.39 square miles. The Hancock Pond Dam, the Lake Wequapauset Dam, and the Reidville Industrial Park Dam all impound waters in the basin of Hancock Brook in Waterbury, and the watershed is further impounded upstream on several lakes and ponds in Plymouth.

Steele Brook

Steele Brook has its headwaters in the hills of the Town of Watertown and flows east into the northwestern part of Waterbury, joining the Naugatuck River below Hancock Brook near the junction of State Route 8 and State Route 73. Steele Brook drains 14.98 square miles before entering Waterbury and its drainage basin measures 2.06 square miles and comprises 7.09% of the land area within Waterbury, netting a total basin area of 17.04 square miles. An unnamed dam lies on the lower reaches of Steele Brook in the vicinity of the Aurora Street bridge near the Naugatuck River, and there are other impoundments within Watertown as well.

Beaver Pond Brook

Beaver Pond Brook has its headwaters in Cheshire. It flows in a westerly direction into the southeastern part of Waterbury, being joined by Turkey Hill Brook and East

Mountain Brook before intersecting the Mad River at City Mills Ponds (Upper). The brook drains 3.53 square miles within the Waterbury, comprising 12.2% of the land area within Waterbury. In total, Beaver Pond Brook drains 5.58 square miles including area in the municipalities of Wolcott, Cheshire, Prospect, and Waterbury.

While there are no dams of note along the reach of Beaver Pond Brook, there are dams on its tributaries: Waterbury Reservoir Dam #2 on the Waterbury / Prospect Reservoir in Prospect, which flows into Turkey Hill Brook; the East Mountain Reservoir Dam above East Mountain Brook; and Daigle Pond Dam on Daigle / DeBishop Pond which also outlets into East Mountain Brook.

Mad River

The Mad River has its headwaters just north of Cedar Swamp Pond in the City of Bristol. It flows in a south and southwestern direction through the Town of Wolcott and into Waterbury, where it turns northwest before turning back southwest and emptying into the Naugatuck River. The Mad River drains a total area of 15.8 square miles at the confluence of the Mad River and Old Tannery Brook at the Waterbury corporate boundary. Within the city of Waterbury, the Mad River drains a total area of 8.60 square miles, comprising 29.68% of the total land area of Waterbury. In total, the Mad River drains 25.93 square miles. The river is heavily impounded with 21 dams of note within its drainage basin, and many of these are privately-owned.

Upon entering the City of Waterbury, the Mad River drains to the south, entering into Cemetery Pond and exiting through the Cemetery Pond Dam. It is next joined by Beaver Pond Brook at City Mills Ponds (Upper). After draining just south into Scoville Pond and exiting through the Scoville Pond Dam, the Mad River flows northwest into Brass Pond and through the John Dees Pond Dam before turning back to the southwest near St. Mary's Hospital and draining into the Naugatuck River about 3,000 feet southeast of the Route 8 and Interstate 84 interchange.

Fulling Mill Brook

A very small part (10.52 acres, 0.02 square miles) of southern Waterbury lies within the Fulling Mill Brook watershed. This brook has its headwaters in central Prospect near Brewster Pond. Fulling Mill Brook flows west across Prospect into Naugatuck and is joined by Cold Spring Brook near Union City. Just west of the confluence of Cold Spring Brook and Fulling Mill Brook, Fulling Mill Brook joins the Naugatuck River, draining a total land area of 5.38 square miles.

Hop Brook

Hop Brook has its source in the swamps just north of Great Hill in the Town of Middlebury. The brook meanders through Middlebury in an east / southeast direction eventually entering Hop Brook Lake. Wooster Brook from the north and Shattuck Brook from the southwest also drain into Hop Brook Lake, which lies on the Middlebury and Waterbury corporate boundary. The lake is impounded on its southeastern end by the Hop Brook Flood Control Dam in Waterbury near the Waterbury and Naugatuck corporate boundary. The outflow from this dam drains south into Naugatuck and flows southeast across Naugatuck to enter the Naugatuck River just south of Fulling Mill Brook.

In total, Hop Brook drains a total of 17.40 square miles across the Towns of Woodbury, Middlebury, Watertown, Waterbury, and Naugatuck. The watershed area of Hop Brook to the Hop Brook Flood Control Dam is 16.05 square miles. About 3.41 square miles of this watershed lies within the limits of Waterbury, comprising 11.77% of Waterbury's total land area.

2.6 Population and Demographic Setting

The total CNV Region population as indicated in the 2000 Census is 272,594 persons. The total land area is 309 square miles, yielding a regional population density of 882 persons per square mile. Waterbury has the highest population density with 3,757 individuals per square mile; Bethlehem has the lowest population density with 177 individuals per square mile (Table 2-2).

Table 2-2
Population Density by Municipality, Region and State, 2000

Municipality	Total Population	Land Area (square miles)	Population Density
Beacon Falls	5,246	9.77	537
Bethlehem	3,422	19.36	177
Cheshire	28,543	32.90	868
Middlebury	6,451	17.75	363
Naugatuck	30,989	16.39	1,891
Oxford	9,821	32.88	299
Prospect	8,707	14.32	608
Southbury	18,567	39.05	475
Thomaston	7,503	12.01	625
Waterbury	107,271	28.55	3,757
Watertown	21,661	29.15	743
Wolcott	15,215	20.43	745
Woodbury	9,198	36.46	252
CNV Region	272,594	309.02	882
Connecticut	3,405,565	4844.80	703

Source: United States Census Bureau, 2000 Census of Population and Housing, Summary File 1

Waterbury is the fifth most populous city in Connecticut, with an estimated population of 109,154 in 2004. However, Waterbury is the only municipality in the Region that lost population from 1990-2000; over half of the other municipalities in the region grew by more than 10% during that same timeframe. Annual growth of 0.7% is expected until the year 2009. The city is the seventh most densely populated municipality in the state.

According the 2000 Census of Population and Housing from the United States Census Bureau, the median value of owner-occupied housing in the city of Waterbury was $101,300, which is lower than the statewide median value of $166,900.

Waterbury has substantial populations of people who are elderly, linguistically isolated, and/or disabled. These are depicted by census block on Figures 2-6, 2-7, and 2-8. The populations with these characteristics have numerous implications for hazard mitigation, as they may require special assistance or different means of notification before disasters occur. These will be addressed as needed in subsequent sections.

2.7 Governmental Structure

The City of Waterbury is governed by a Mayor-Aldermen form of government, according to the City Charter revised most recently in 2004. The Mayor is the Chief Executive Officer and oversees the actions of all City Departments, while the fifteen members of the Board of Aldermen act as the legislative body for the city. These two bodies serve and are elected together for two-year terms. Waterbury is the judicial seat of the region, housing Federal, State, and County courthouses.

In addition to Board of Aldermen and the Mayor, there are numerous boards, commissions and committees providing input and direction to city administrators. Also, there are a number of City departments providing municipal services and day-to-day administration. Many of these commissions and departments may play a role in hazard mitigation, including the City Plan Commission, the Zoning Commission, the Zoning Board of Appeals, the Inland Wetland and Watercourses Commission, the Water Pollution Control Department, the Water Bureau, the Building Inspection Department, the Fire Department, the Police Department, and the Public Works Department.

Figure 2-6: Waterbury Elderly Population

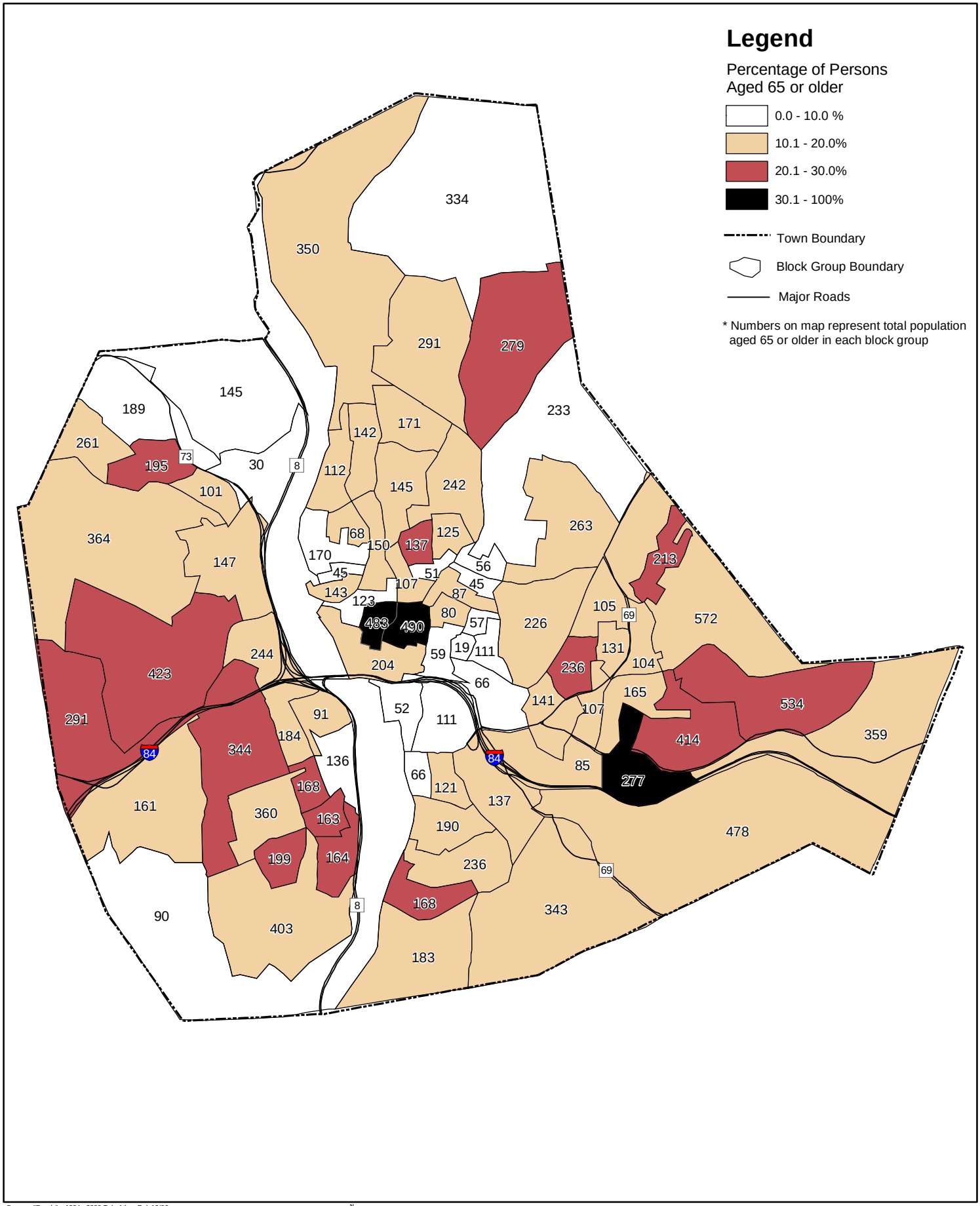
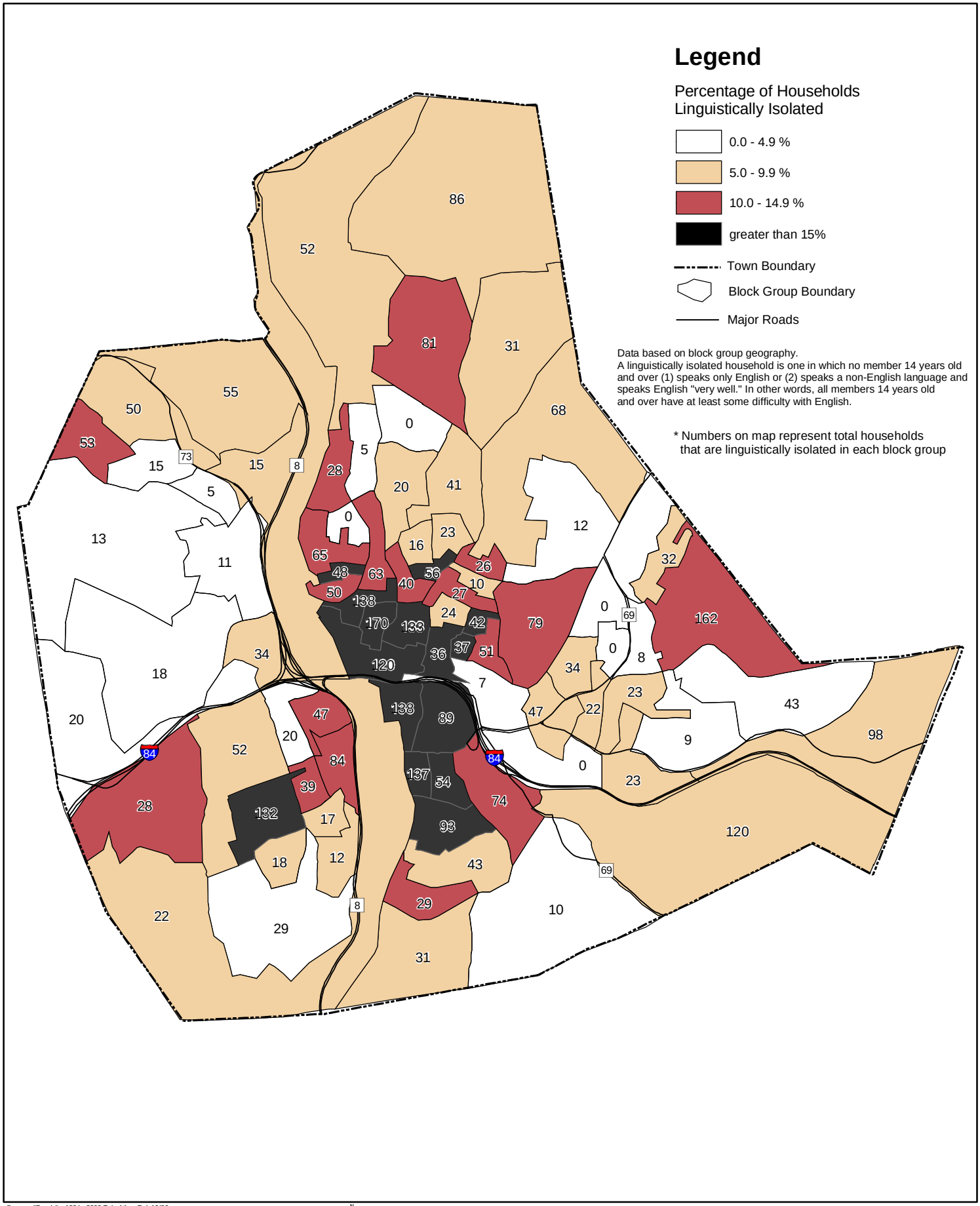


Figure 2-7: Waterbury Linguistically Isolated Households



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", DEP
"Linguistically Isolated", "Block Groups", 2000 Census
For general planning purposes only. Delineations may not be exact.
October 2007

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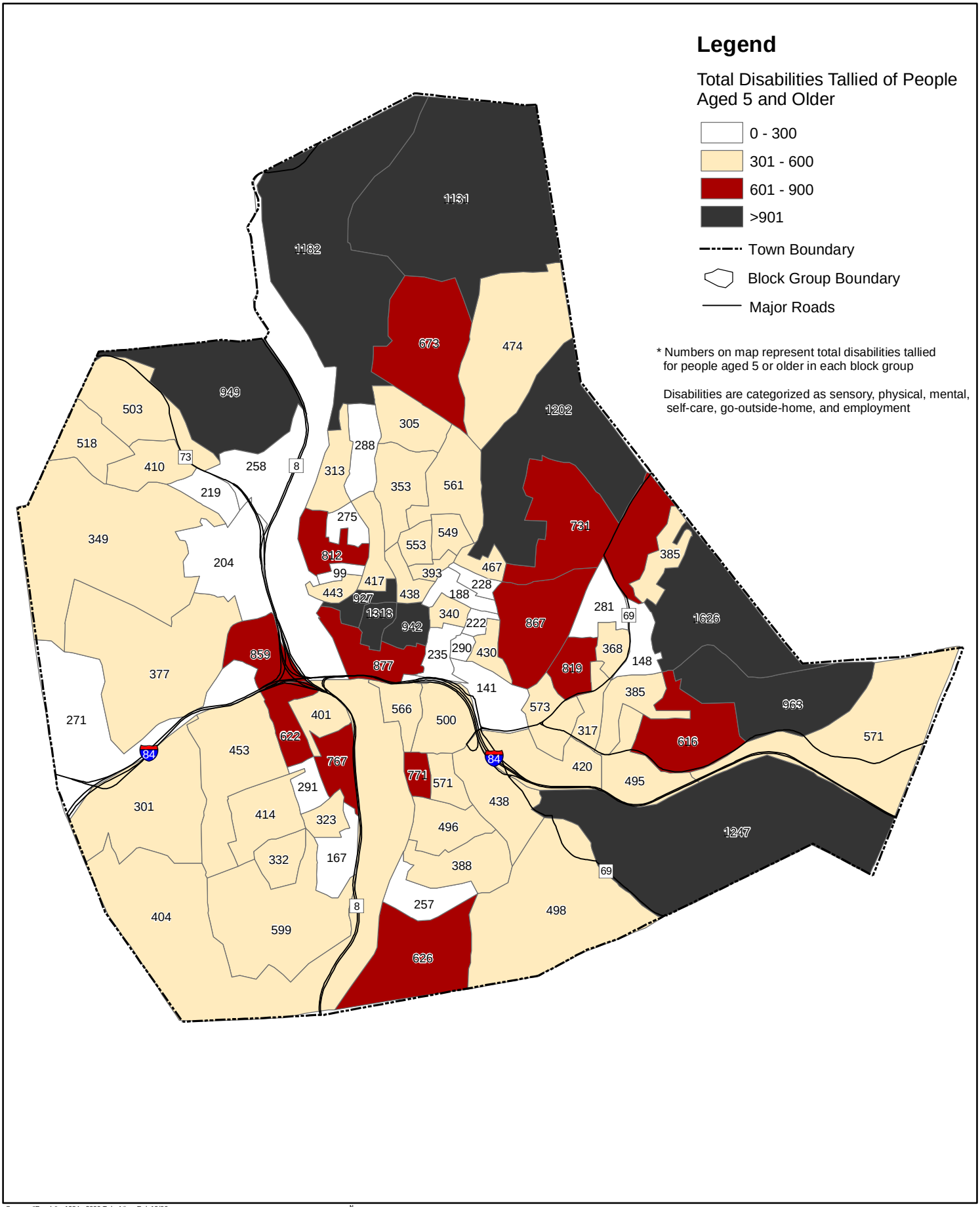
Figure 2-8: Waterbury Disabilities Map



Complaints related to City maintenance issues are logged by the Citizen Services Center and the Public Works Department. These complaints are usually received via phone, fax, mail, or email and are recorded using standardized paper forms and logged in a collection of binders in the Public Works office. Some complaints have also been recorded on "Trak-It" complaint forms. The complaints are categorized by the first letter of the street of occurrence and remain in the binders until the investigation and remediation surrounding the individual complaint is concluded.

An electronic complaint tracking system would greatly expedite the filing process and allow areas of concern to be easily entered into a GIS database. Such information could be used for City planning purposes and for prioritizing areas needing significant construction or rehabilitation projects. Approximately $10,000 has been appropriated in the 2008 budget towards the purchase and training of personnel in such a system. Ideally, this software will be compatible with permit tracking software that is being considered by the City Planning Department.

2.8 Development Trends

Waterbury has a rich industrial history. Although early settlers to the Waterbury area in the late 1600s found the location difficult for habitation due to its poor soils and annual floods, the brass industry took off in the late 1700s. Nicknamed "The Brass City," Waterbury began making brass and eventually diversified into clock-making by the mid-1800s. The east end of Waterbury was at one time featured over two million square feet of brass manufacturing floor area located in over 90 buildings. A flood in 1955 led to the deaths of approximately 20 Waterbury citizens and property damage totaling $50 million. Brass manufacturing in the city began to decline in the mid-20th century, and the last operating brass mill was closed in the 1970s. Today, government offices, hospitals and retail make up the bulk of Waterbury's economic base.

Immigrants working in the brass mills took residence in boarding houses within walking distance of the factories. Typical structures were two- to four-story walkups; and the most prevalent style, the three-decker with three stacked porches, characterize much of Waterbury's core residential area.

Based on the City's 2005 update of its Plan of Conservation and Development, Waterbury has adopted the following objectives as guidelines for future development:

- Decrease impervious coverage through changes in zoning regulations;
- Increase open space, in particular through opening access to riverfront areas;
- Decrease residential density through the creation of an RS-12 zone;
- Increase the diversity of uses in commercial districts;
- Limit the locations where heavy and high-impact industrial can be developed; and
- Preserve the City's historic building stock and neighborhoods through zoning.

As of January 2007, about 2,200 new housing units in single-family homes, condominiums and apartments had been proposed or permitted but not yet built, posing a potential strain on the City's infrastructure. In particular, recent development pressures in Waterbury are characterized by interest in subdividing large properties and building multiple condominium or apartment buildings. In the interest of adopting the guidelines recommended in the Plan of Conservation and Development that would entail more strict building regulations, a one-year moratorium has been enacted restricting subdivision of properties in areas zoned for multi-family developments. In addition, a Land Use Regulations/Engineering Standards Revision Project commenced in autumn 2007 to address some of these problems.

2.9 Critical Facilities and Sheltering Capacity

The City considers its police, fire, medical, public works, governmental, and major transportation facilities to be its most important critical facilities, for these are needed to

ensure that emergencies are addressed while day-to-day management of the City continues. Day-care facilities and convalescent homes are included with critical facilities, as these house populations of individuals that would require special assistance during an emergency. Educational institutions are often included in critical facilities as well, as these are often used as shelters.

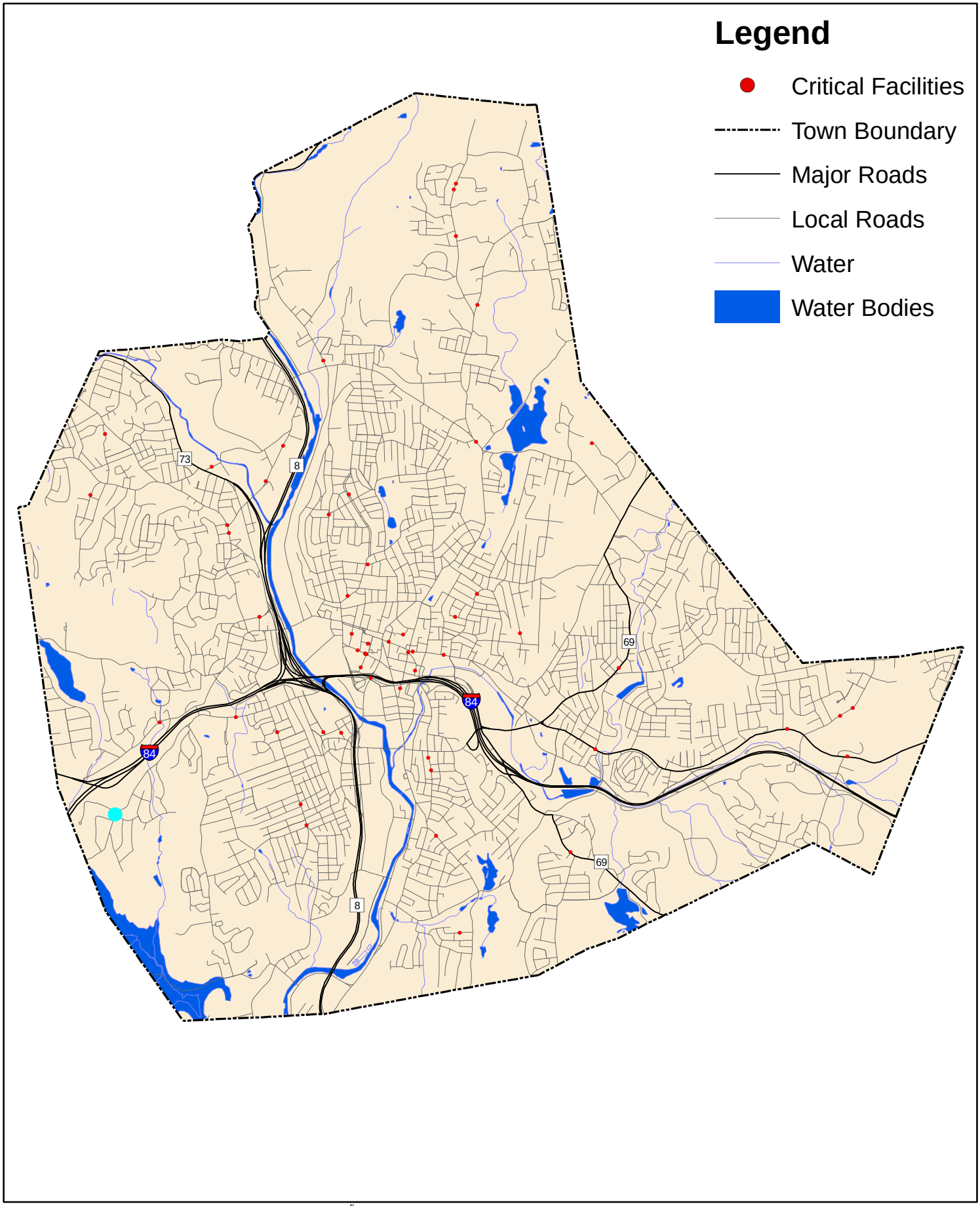
A map of critical facilities by number is shown in Figure 2-9, and the associated list of critical facilities is provided in Table 2-3. Shelters, water system infrastructure, and transportation facilities are described in more detail below.

Shelters

Emergency shelters are also considered to be an important subset of critical facilities, as they are needed most in emergency situations. Waterbury has designated the three high school facilities, Crosby High School, Kennedy High School and Wilby High School, as their primary emergency shelters. Each facility can provide bedding for 150 people. Each facility has good accessibility and the three schools are evenly distributed throughout the city so that residents can quickly access the facility nearest them.

These buildings have been designated as public shelter facilities by meeting specific American Red Cross guidelines. Amenities and operating costs of the designated shelters including expenses for food, cooking equipment, emergency power services, bedding, etc., are the responsibilities of the community and generally are not paid for by the American Red Cross. In Waterbury, the Police and Fire Departments staff the shelters.

Figure 2-9: Waterbury Critical Facilities



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", "Hydrography", DEP
"Critical Facilities", COGCNV
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October 2007

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Table 2-3
Critical Facilities in Waterbury

Map #	Type	Name	Address	In Floodplain?
1	Assisted Living	Abbott Terrace	44 Abbott Terrace	No
2	Assisted Living	Health Center of Greater Waterbury	177 Whitewood Road	No
3	Assisted Living	Mattatuck Health Care Facility	9 Cliff Street	No
4	Emer. Ops.	Office of Emergency Management	236 Grand Street	No
5	Fire Dept	Engine 1, Engine 9 and Truck 2	1979 North Main Street	No
6	Fire Dept	Engine 10, Truck 1	26 Field Street	No
7	Fire Dept	Engine 11	740 Highland Avenue	No
8	Fire Dept	Engine 2, Truck 3	519 East Main Street	No
9	Fire Dept	Engine 4	823 Baldwin Street	No
10	Fire Dept	Engine 5	1956 East Main Street	No
11	Fire Dept	Engine 6	431 Willow Street	No
12	Fire Dept	Engine 7	315 Walnut Street	No
13	Fire Dept	Engine 8	197 Bunker Hill Avenue	No
14	Fire Dept	Waterbury Fire Dept. Headquarters	235 Grand Street	No
15	Hospital	Saint Mary's Hospital	56 Franklin Street	No
16	Hospital	Waterbury Hospital	64 Robbins Street	No
17	Library	Silas Bronson Library	267 Grand Street	No
18	Police Station	Waterbury Police Dept	255 E Main Street	No
19	Police Station	Waterbury Police Dept Annex	240 Bank Street	No
20	Public Works	Public Works at City Hall Annex	26 Kendrick Street	No
21	Public Works	Highway	51 East Aurora Street	No
22	Public Works	Central vehicle maintenance	181 East Aurora	No
23	Public Works	Refuse Transfer facility	Mark Lane	No
24	School	B. W. Tinker Elementary School	809 Highland Avenue	No
25	School	Barnard School	11 Draher Street	No
26	School	Brooklyn School	29 John Street	No
27	School	Bucks Hill Elementary School	330 Bucks Hill Road	No
28	School	Bunker Hill School	170 Bunker Hill Avenue	No
29	School	Carrington Elementary School	24 Kenmore Avenue	No
30	School	Crosby High School	300 Pierpont Rd	No
31	School	Driggs Elementary School	77 Woodlawn Terrace	No
32	School	F J Kingsbury School	220 Columbia Boulevard	No
33	School	Gilmartin Elementary School	107 Wyoming Avenue	No
34	School	H S Chase School	40 Woodtick Road	No
35	School	Hopeville Elementary School	2 Cypress Street	No
36	School	Kaynor Technical School	43 Tompkins Street	No
37	School	Kennedy High School	422 Highland Ave.	No
38	School	Maloney Magnet School	233 South Elm Street	No
39	School	Margaret M. Generali School	3196 East Main Street	No
40	School	Michael F Wallace Middle School	3465 East Main Street	No
41	School	Naugatuck Valley Community College	750 Chase Parkway	No
42	School	North End Middle School	534 Bucks Hill Rd.	No
43	School	Post University	800 Country Club Road	No
44	School	Regan Elementary School	2780 North Main Street	No
45	School	Rotella School	380 Pierpont Road	No
46	School	Sprague Elementary School	1443 Thomaston Avenue	No

Table 2-3 (Continued)
Critical Facilities in Waterbury

Map #	Type	Name	Address	In Floodplain?
47	School	State Street School	35 State Street	No
48	School	UConn Waterbury Campus	99 East Main Street	No
49	School	Walsh Elementary School	55 Dikeman Street	No
50	School	Washington Elementary School	685 Baldwin Street	No
51	School	Waterbury Arts Magnet School	16 South Elm Street	No
52	School	Wendell L Cross Elementary School	1255 Hamilton Avenue	No
53	School	West Side Middle School	483 Chase Pkwy.	No
54	School	Wilby High School	568 Bucks Hill Rd.	No
55	School	Woodrow Wilson Elementary School	235 Birch Street	No
56	City Office	Waterbury City Hall	235 Grand Street	No
57	City Office	Waterbury City Offices	236 Grand Street	No
58	City Office	Waterbury City Offices	26 Kendrick Avenue	No

Source: Council of Governments of the Central Naugatuck Valley, City of Waterbury

In case of a power outage, it is anticipated that up to 20% of the population would relocate, although not all of those relocating would necessary utilize the shelter facilities. Many communities only intend to use these facilities on a temporary basis for providing shelter until hazards such as hurricanes diminish. Regionally-located mass care facilities operated and paid for by the American Red Cross may be available during recovery operations when addition sheltering services are necessary.

As a feature of its emergency response program, Waterbury has GPS capabilities to locate incoming cell phone calls as part of its Enhanced 911. Enhanced 911 improves the effectiveness and reliability of wireless 911 calls by having wireless service providers inform the 911 operator of the wireless telephone number of the caller, and the origin of the call within a 50 to 300 meter radius. This technology allows emergency services to provide a faster response to wireless callers.

The Central Naugatuck Valley Council of Governments is investigating the possibilities of instituting an emergency notification system in the area to further enhance emergency response. It is important to note that effective January 1, 2008, the City of Waterbury will be in the southeast portion of Region 5 of the Connecticut Emergency Medical

Service regions. Thus, it is important that Waterbury institute emergency notification systems compatible with those of Region 5 and with those of Cheshire (Region 2) to the east. Region 5 will contain most of the COGCNV municipalities.

As a means of evacuating the area, Waterbury has convenient access to nearby towns on the following state routes that function as major transportation arteries: Route 8, I-691 and I-84. In an emergency situation, the police department is responsible for designating the specific evacuation routes to be used as appropriate. According to City personnel, this policy provides the City with the flexibility to deal with specific incidents as they occur.

Public Works Department

The Public Works Department is a critical municipal department related to hazard mitigation because it maintains, repairs, and constructs stormwater systems and roadways. The Department is responsible for maintaining stormwater systems for proper drainage and flood mitigation, as well as clearing snow and ice and maintaining access for emergency vehicles.

The Public Works Department currently utilizes four facilities listed in Table 2-3. Consolidation of Public Works facilities is believed to be an important goal for the City of Waterbury as it would allow for a better, more coordinated response to disasters. This is one of the priority recommendations of the subject Plan.

Likewise, the Public Works Department believes that establishment of working intermunicipal agreements with other public works departments in nearby communities would allow for sharing of resources when disasters affect one community more than others. This Plan therefore recommends that these types of agreements be pursued.

Public Water System

Water service is a critical component of hazard mitigation, especially in regards to fighting wildfires. It is also necessary for everyday residential, commercial, and industrial use. According to the City of Waterbury Plan of Conservation and Development, approximately 99% of the properties in the City are served by the Waterbury Water Department. In addition, the department sells water to water utilities in Wolcott, Middlebury, and Watertown.

A 24-inch pre-stressed concrete cylinder pipe (PCCP) is the primary water transmission main from the water treatment plant transmission line to the east side of Waterbury. At the east end of the main, a 24-inch transmission line splits and runs south to the Benefit Street water tank, and a 16-inch transmission line continues to the east, ultimately providing water for the interconnection with the Town of Wolcott. The PCCP transmission main therefore provides public water supply and fire protection to thousands of people in Waterbury and Wolcott.

In the past several years, the PCCP main has catastrophically failed in two locations: twice at the 24-inch west end near the intersection of Waterville Street and Faber Avenue, and once at the 16-inch east end between Industry Lane and Route 69. A condition assessment of the pipe revealed that other sections of the pipeline were likely to fail due to corrosion of the pre-stressed wire from the surrounding soil and groundwater. The corroded condition of the pre-stressed wire causes the entire main to be more susceptible to natural hazards, including the effects of flooding, freezing due to cold weather, earthquakes, and landslides. A broken pipe reduces the ability of both Waterbury and Wolcott to fight wildfires. The effects of particular natural hazards on this pipe will be discussed further in subsequent sections.

Sanitary Sewer System

Sanitary waste collection and treatment are critical components of hazard mitigation, as these functions are often impaired during storms that produce heavy rainfall and/or during flood events. This underscores the importance of controlling stormwater to keep it out of the sanitary sewer system.

Nearly all of the developed land in the City of Waterbury (more than 14,000 acres) is served by the existing sanitary sewer system. In contrast, only about 3,400 acres of land in Waterbury are served by stormwater drainage systems. The Public Works Department is working to update the stormwater sewer system, while the Water Pollution Control Authority is working to update the sanitary sewer system.

Separation of the sanitary and stormwater systems is typically coordinated between the Public Works Department and the Water Pollution Control Authority in order to prioritize the areas that need improvements most. The sanitary sewer system is designed to handle 80 million gallons per day (mgd) but has experienced in excess of 100 mgd during events such as the June 2006 and April 2007 storms described in this Plan, due to the combined sanitary and stormwater systems. Continued separation of the sewer systems is one of the priority recommendations of the subject Plan.

Transportation

Waterbury has many one-way and dead-end streets. Such streets restrict egress and can cause serious transportation jams when those one-way roads are closed, as can occur from the effects of natural hazards (wind blowing down trees, flooding, etc.).

Three bridges spanning the Mad River are currently on the capital improvement lists. The East Liberty Bridge and the East Main Street bridge both need repairs. In addition, the bridge deck at Sharon Road will be redesigned and constructed. These projects will

be prioritized in the 2008-2012 budgets because safe bridges are necessary for public transportation and egress to critical facilities.

3.0 INLAND FLOODING

3.1 Setting

According to FEMA, most municipalities in the United States have at least one clearly recognizable flood-prone area around a river, stream, or large body of water. These areas are outlined as Special Flood Hazard Areas (SFHA) and delineated as part of the National Flood Insurance Program (NFIP). Flood-prone areas are addressed through a combination of floodplain management criteria, ordinances, and community assistance programs sponsored by the NFIP and individual municipalities.

Many communities also have localized flooding areas outside the SFHA. These floods tend to be shallower and chronically reoccur in the same area due to a combination of factors. Such factors include ponding, poor drainage, inadequate storm sewers, clogged culverts or catch basins, sheet flow, obstructed drainageways, sewer backup, or overbank flooding from small streams.

Inland flooding is the primary natural hazard that affects the City of Waterbury. The primary drainage basins in Waterbury are the Naugatuck River, Hancock Brook, Steele Brook, Beaver Pond Brook, Mad River, Fulling Mill Brook, and Hop Brook. A thorough discussion of these drainage areas is included in Section 2.5. While the severity of flooding damage is usually considered limited except in extreme cases, the frequency of occurrence of flooding in Waterbury is considered likely to highly likely depending on the source of the flooding. Only a few areas are impacted by overflow from the major river and brook systems with any regularity, and these areas are generally limited to areas adjacent to the rivers. Localized nuisance flooding along tributaries and roadways is a chronic problem that affects the entire City, resulting from insufficient or poorly maintained drainage systems and other factors.

3.2 Hazard Assessment

Flooding represents the most common and costly natural hazard in Connecticut. The state typically experiences floods in the early spring due to snowmelt and in the late summer/early autumn due to frontal systems and tropical storms, although localized flooding caused by thunderstorm activity can be significant. Flooding can occur as a result of other natural hazards, including hurricanes, summer storms, and winter storms. Flooding can also occur as a result of dam failure, which is discussed in Section 9.0, and may also cause landslides and slumps in affected areas.

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the base flood for purposes of floodplain management. This flood has a one percent chance of being equaled or exceeded each year, and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than one year are considered. Similarly, a 500-year flood has a 0.2 percent chance of occurring in a given year. The 500-year floodplain indicates areas of moderate flood hazard.

Floodplains are lands along watercourses that are subject to periodic flooding; floodways are those areas within the floodplains that convey floodwaters. Floodways are subject to water being carried at relatively high velocities and forces. The floodway fringe contains those areas of the 100-year floodplain that are outside the floodway and are subject to inundation but do not convey the floodwaters.

Flooding presents several safety hazards to people and property. Floodwaters also cause massive damage to the lower levels of buildings, destroying business records, furniture, and other sentimental papers and artifacts. In addition, floodwaters can prevent emergency and commercial egress by blocking streets, deteriorate municipal drainage systems, and divert municipal staff and resources.

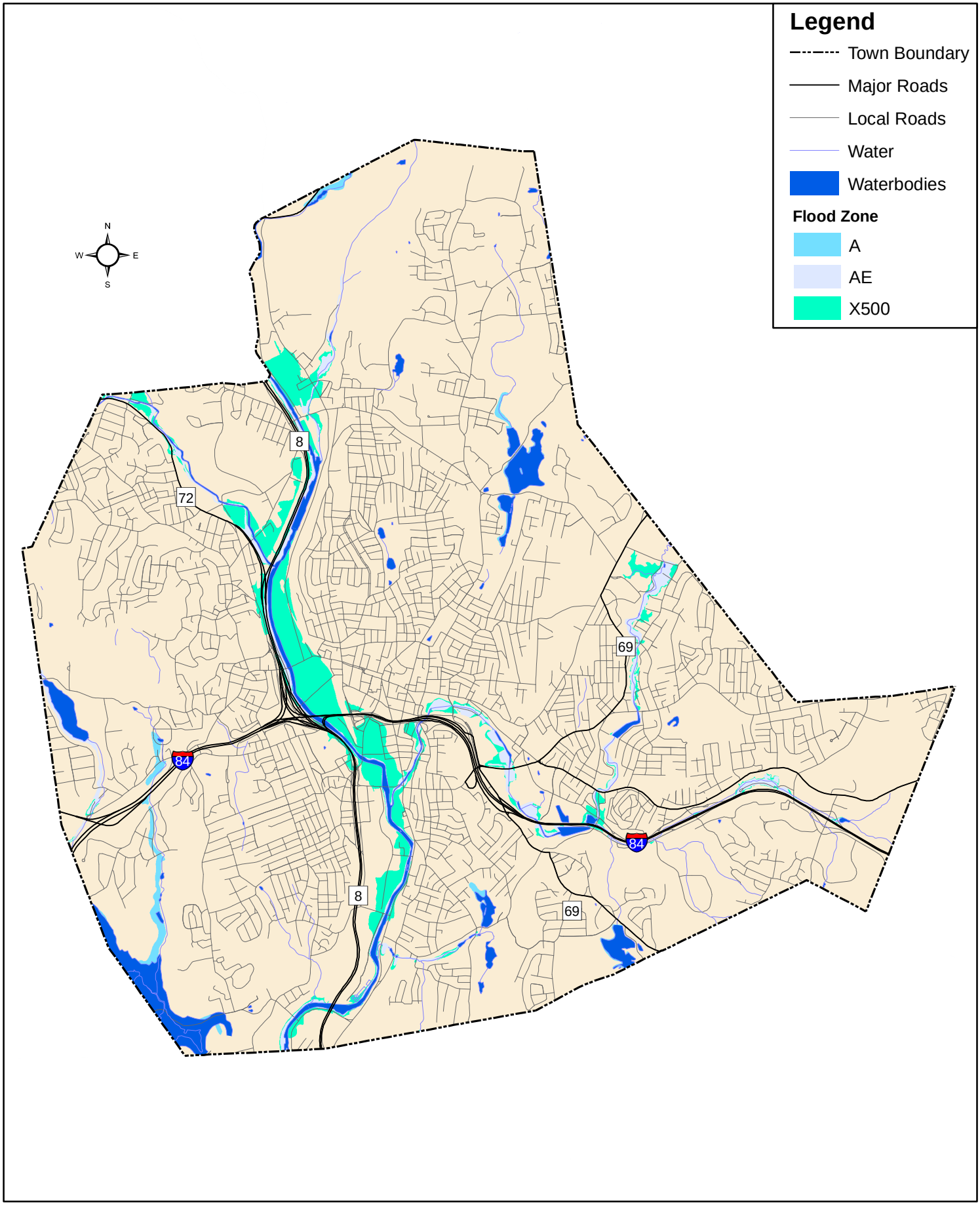
Furthermore, damp conditions trigger the growth of mold and mildew in flooded buildings, contributing to allergies, asthma, and respiratory infections. Snakes and rodents are forced out of their natural habitat and into closer contact with people, and ponded water following a flood provides a breeding ground for mosquitoes. Gasoline, pesticides, and other aqueous pollutants can be carried into areas and buildings by flood waters and soak into soil, building components, and furniture.

SFHAs in Waterbury are delineated on Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS). These maps demonstrate areas within Waterbury that are vulnerable to flooding. The FIRMs were published on November 1, 1979. The FIS was originally published in May of 1979. Refer to Figure 3-1 for the areas of Waterbury susceptible to flooding based on FEMA flood zones. Table 3-1 describes the various zones depicted on the FIRM panels for Waterbury.

Table 3-1
FIRM Zone Descriptions

Zone	Description
A	An area inundated by 100-year flooding, for which no base flood elevations (BFEs) have been determined.
AE	An area inundated by 100-year flooding, for which BFEs have been determined.
Area Not Included	An area that is located within a community or county that is not mapped on any published FIRM.
X	An area that is determined to be outside the 100- and 500-year floodplains.
X500	An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 100-year flooding.

Figure 3-1: FEMA Flood Zones in Waterbury



Source:"Roads", GDT
"Hydrography", "Flood Zone", "Town Boundary", DEP
For general planning purposes only. Delineations may not be exact.
January 2007

Miles
0 0.5 1

COUNCIL OF GOVERNMENTS
CENTRAL NAUGATUCK VALLEY

In some areas of Waterbury, flooding occurs from heavy rains with a much higher frequency than those mapped by FEMA. This nuisance flooding occurs from heavy rains with a much higher frequency than 100-year and 500-year events, and often in different areas than those depicted on the FIRM panels. These frequent flooding events occur in areas with insufficient drainage; where conditions may cause flashy, localized flooding; and where poor maintenance may exacerbate drainage problems. These areas are discussed in Sections 3.3 and 3.5.

During large storms, the recurrence interval level of a flood discharge on a tributary tends to be greater than the recurrence interval level of the flood discharge on the main channel downstream. In other words, a 500-year flood event on a tributary may only contribute to a 50-year flood event downstream. This is due to the distribution of rainfall and the greater hydraulic capacity of the downstream channel to convey floodwaters. For example, while the 1955 floods (See Section 3.3 below) have been estimated to be a 50- to 500-year flood across all streams in Connecticut, the floods were less than 10-year flood events on the Quinnipiac River in Wallingford. Dams and other flood control structures can also reduce the magnitude of peak flood flows, as has occurred on the Naugatuck River since the flood controls were installed by the Army Corps.

The recurrence interval level of a precipitation event also generally differs from the recurrence interval level of the associated flood. For example, on April 16, 1996, six inches of rain fell in 18 hours in New Haven County. This was classified as a greater than 50-year frequency storm, but caused an approximately 25-year flood event on the Quinnipiac River in Wallingford. According to the National Climatic Data Center (NCDC), this flood event caused $1.5 million in property damage in New Haven County.

Another example would be of tropical storm Floyd in 1999, which caused rainfall on the order of a 250-year event while flood frequencies were slightly greater than a 10-year event on the Naugatuck River in Beacon Falls. Flood events can also be mitigated or

exacerbated by in-channel and soil conditions, such as low or high flows, or a deep or shallow water table, as can be seen in the following historic record.

FEMA commenced the Flood Map Modernization program for New Haven County, Connecticut in August 2007. The "Map Mod" program will result in an updated comprehensive FIS report for New Haven County and one FIRM. It is anticipated that the Map Mod program will enable a more accurate representation of floodplains in Waterbury, including those along the Mad River and other areas where inaccuracies are suspected in the current set of maps. However, the Map Mod program will not re-establish flood elevations along the Naugatuck River, the Mad River, or any other river where dam removals have occurred and/or flood control measures are in place.

3.3 Historic Record

In every season of the year throughout its recorded history, the City of Waterbury has experienced various degrees of flooding. Melting snow combined with early spring rains have caused frequent spring flooding. Numerous flood events have occurred in late summer to early autumn resulting from storms of tropical origin moving northeast along the Atlantic coast. Winter floods result from the occasional thaw, particularly during years of heavy snow, or periods of rainfall on frozen ground. Other flood events have been caused by excessive rainfalls upon saturated soils, yielding greater than normal runoff.

Notable historic floods occurred along the Naugatuck River in November 1927, March 1936, September 1938, January 1949, and August and October 1955. In terms of damage to the City of Waterbury, the most severe of these was due to Hurricane Diane in August 1955. Peak daily flows along the Naugatuck River were gauged by the USGS to be 53,400 cubic feet per second (cfs) in Thomaston and 106,000 cfs in Beacon Falls, equivalent of a greater than 500-year flood event on the Naugatuck River. This hurricane is the storm of record for both stations.

Hurricane Diane resulted in a devastating loss of property and life throughout the Naugatuck River basin. The heavily industrial and commercial sectors bordering the Naugatuck River in Waterbury experienced flooding at the first or second story levels, causing approximately 20 deaths and over $50 million (1955) in industrial and municipal damage before taking into account private and commercial losses, business payrolls, and cleanup and rehabilitation efforts. The October 1955 flood was also significant, but the October losses were lower because the August storm eliminated most of the damageable property.

After the floods of 1955, the United States Army Corps of Engineers constructed two major flood control projects along the Naugatuck River that protect the City from flooding. The first is a local protection project consisting of channel improvements, a floodwall, and a protective dike in the Waterville section of the City. According to FEMA, this project confines the 500-year flood and protects the major industrial area in the City.

The Army Corps of Engineers also constructed six flood control dams along the Naugatuck River upstream of Waterbury resulting in a significant reduction in possible flood levels along the river. These dams and levees are discussed in greater detail in Section 9. This project also lowered the level of the river bed in some reaches of the Naugatuck River in Waterbury and partially channelized others, allowing safe passage of flood flows along most of the river in the City.

The following are descriptions of additional, more recent examples of floods in and around the City of Waterbury as described in the NCDC Storm Events Database, and based on correspondence with municipal officials.

- January 15, 1999: A combination of heavy rain falling on frozen ground, snow and ice melting, and partially clogged storm drains caused widespread flash flooding of

low-lying and poor drainage areas across Fairfield and New Haven Counties. Waterbury experienced significant widespread street and basement flooding.

- September 16, 1999: Torrential record rainfall (five to ten inches) produced by Tropical Storm Floyd caused widespread urban, small stream, and river flooding. Fairfield County was declared a disaster area, along with Litchfield and Hartford Counties. Initial cost estimates for damages to the public sector was $1.5 million for those three counties. These estimates do not account for damages to the private sector and is based on information provided by the Connecticut Office of Emergency Management. Serious wide-spread flooding of low-lying and poor drainage areas resulted in the closure of many roads and basement flooding across Fairfield, New Haven, and Middlesex Counties.

- September 17, 2005: Strong thunderstorms swept across the state, with heavy winds, frequent lightning, and torrential rains causing flash flooding of streets. Several residents of Waterbury complained of flooding problems caused primarily due to inadequate drainage.

- October 2005: Although the consistent rainfall of October 7-15, 2005 caused flooding and dam failures in most of Connecticut (most severely in northern Connecticut), the precipitation intensity and duration was such that only minor flooding occurred in Waterbury.

- April 22-23, 2006: A sustained heavy rainfall caused streams to overtop their banks and drainage systems to fail throughout New Haven County. Rainfall amounts of approximately eight inches occurred in Waterbury, and stream stages were believed to approximate the ten-year recurrence interval.

- April 15-16, 2007: A powerful spring nor'easter caused heavy rains of five inches and severe flooding throughout Connecticut. Severe flooding of the Mad River affected

residents of Woodtick Road (including evacuation of 45 condominium units) and Sharon Road.

An investigation into the complaint binders stored at the Public Works Department revealed that a significant amount of complaints have been logged regarding poor drainage. Such complaints involve needed maintenance for City-owned culverts and drainage systems and surface runoff occurring from private homeowners onto City streets and other private yards. These types of complaints highlight the need for adequate drainage and a comprehensive drainage plan to protect down-gradient properties from the runoff generated by up-gradient development. A review of these complaint logs is included in Appendix B.

June 2, 2006 Storm

The storm of June 2, 2006 caused such widespread damage across the City that it deserves special attention in this plan. According to the NCDC, rainfall from slow-moving thunderstorms caused flash flooding across parts of Northern New Haven County during the late afternoon and early evening. Up to eight inches of rainfall occurred in less than six hours time in Waterbury, causing flooding, power outages, and landslides. Numerous roads were washed out and many water rescues were necessary.

The extent of the flooding prompted the Waterbury Mayor to declare a state of emergency. The hardest hit areas in Waterbury were Highland Avenue, Watertown Avenue, South Main Street, and Charles Street. Damage estimates by the City were over $4 million, with most of the damage occurring in older neighborhoods with insufficient drainage systems.

In response to this disaster, the City of Waterbury commissioned A-N Consulting Engineers, Inc. to identify potential causes and remediation costs which occurred as a

result of storm damage. Highlights of flooding and poor drainage-related damage are listed below.

- Highland Metro North at the stilling basin west of the Metro North mainline where the Highland Avenue storm drainage system outfalls: Excessive stormwater overwhelmed a retention embankment, causing the embankment to fail and sending a torrent of debris-laden water downstream. The debris flow washed out a box culvert and undermined the railroad.

- Mark Lane facility: Excessive stormwater combined with a lack of stormwater controls caused erosion damage at the closed landfill.

- South End Landfill near Lower Highland Avenue: Excessive stormwater combined with a lack of stormwater controls caused erosion damage at the closed landfill.

- Madison Street at intersection of Southview Street: These streets form a right angle intersection 45 feet above South Main Street. The storm drainage system was overwhelmed, causing pipe leakage which saturated the embankment and resulted in the washout of material and ponding of water in the intersection. This led to the collapse of the nearby hillside leading to South Main Street, exposing and damaging sanitary sewer, storm drainage, and natural gas pipelines.

- Bank Street at Fifth Street: Water and debris overloaded the drainage system and overflowed into the street, causing damage to the pavement and manholes.

- Chipman Street near Old Colony Drive: The volume of storm water in Sled Haul Brook exceeded the capacity of the 36-inch reinforced concrete pipe (RCP) cross culvert, and water topped the road causing damage to the guard rails and pavement.

- East Mountain Road from Pearl Lake Road to Peach Orchard Road: The volume of storm water exceeded the capacity of the gutters of the road, causing scour and erosion and damage to pavement, road shoulder, and embankment.

- Hamilton Avenue east of Prospect Road: The clogged catch basins were not equipped to handle the volume of water and overflowed, causing damage to pavement and manholes and eroding the sides of the road.

- Robbins Street off West Main Street: Pavement on Robbins Street bubbled off the ground due to underflow, affecting egress to Waterbury Hospital.

Numerous areas of the City experienced flooding related damages to curbing and pavement and erosion damages to yards and driveways abutting the streets. These areas were included in the A-N Consulting Engineers damage assessment and are summarized alphabetically in Table 3-2.

Table 3-2
Other Areas Damaged by Runoff from June 2, 2006 Storm

1. Alberta Street	15. Highland Av. North of Highview St.
2. America Street	16. Karen Avenue
3. Arden Road	17. Long Hill Road
4. Bank Street	18. North Walnut Street
5. Bellewood Avenue	19. Peach Street
6. Bristol Avenue	20. Pear Street
7. Calumet Street	21. Piedmont Street
8. Carriage Drive	22. Ridgefield Avenue
9. Country Club Road	23. Robbins Street
10. Division Street	24. Robinwood Road
11. Fiske Street	25. Rosario Drive
12. Glen Street	26. Saint Jean Street
13. Greenmount Terrace	27. Tree Hill Road
14. Hamilton Av. West of Prospect Rd.	28. Woodland Avenue

Additional areas reported as damaged during the June 2, 2006 storm by City personnel or confirmed through field inspections by MMI include:

- Highland Avenue was damaged by Sled Haul Brook when it jumped its culvert and followed its historical course rather than staying under the road. The culvert was not designed for the storm intensity experienced, and the culvert backed up from flooding and debris.

- An unnamed tributary to Hopeville Pond Brook flowing under Jersey Street backed up through a catch basin. It is believed that the amount of runoff, coupled with debris, backed up the culvert and forced the water up to the street. The water then proceeded to run down Jersey Street toward Pearl Lake Road. A review of the historical USGS topographical maps revealed that this stream was not recorded on the maps in 1892 or 1904, but was shown flowing under Jersey Street in 1951 and 1955.

Aside from the geographic areas of storm damage described above, damage to the sanitary sewer system also is believed to have occurred. Significant amounts of debris entered the system, and portions of the system will need to be cleaned to remove the debris.

3.4 Existing Programs, Policies, and Mitigation Measures

The City of Waterbury has limited regulations regarding floodplain management. According to the City of Waterbury Plan of Conservation and Development, development within floodplains and wetlands has typically been restricted in light of the environmental costs and the human hazard that development in these sensitive lands pose. After the floods of 1955, Waterbury's General Plan of 1959 sought to limit new commercial and industrial buildings within set floodplain encroachment lines. That Plan also recommended that new residential development be prohibited from floodplain areas.

Following the adoption of the 1959 General Plan, the Army Corps of Engineers established flood control dams, levees, and detention reservoirs along the Naugatuck River, eliminating most of the flooding concerns. Today, the 100-year flood zone comprises a small area of Waterbury, and the limited flooding along the Naugatuck River and Mad River corridors is perceived as minimal and not requiring significant regulation.

In general, developments in floodplains are regulated during the zoning and land subdivision application processes. The City has several regulations, codes, and ordinances preventing encroachment and development near floodways. Regulations, codes, and ordinances that apply to flood hazard mitigation include:

- ***Earth Excavation and Related Activity*** (Section 5.14-8 (h) of Waterbury Zoning Regulations). This regulation instructs the City Plan commission to consider any negative impacts of the project to adjoining properties (including potential flooding), to traffic, to the quality of surface or ground water, to future zoning (for fill projects), to potential erosion and sedimentation problems, and whether the activity would be consistent with the City's Plan of Conservation and Development.

- ***Development Plans*** (Section 7.45-2 (f) of Waterbury Zoning Regulations). This regulation states that all development plans must be accompanied by a topographic map with two-foot contours and show existing wooded areas, watercourses, wetlands, flood hazard areas, rock outcrops and other significant physical features.

- ***Drainage*** (Section 5.30 of Waterbury Land Subdivision Regulations). This regulation states that applicants must provide for the disposition of surface water run-off that may exist either previously to, or as a result of, the subdivision. Such drainage facilities shall be large enough to accommodate potential runoff from the entire upstream drainage area, inside and outside the subdivision, under conditions of maximum development permitted by the zoning regulations.

- ***General Design – Streams and Natural Features*** (Section 5.34 of Waterbury Land Subdivision Regulations). The City Plan Commission may require recreational or scenic easements along streams or major natural features.

- ***Activities Requiring Permit*** (Section 4.3 of Waterbury Inland Wetlands and Watercourses Agency Regulations). All activities in wetlands or watercourses involving filling, excavation, dredging, clear cutting, grading, or any other alteration or use of a wetland or watercourse requires a permit from the Inland Wetlands & Watercourses Agency.

- ***Required Information for Significant Activity*** (Section 7.5 (g) of Waterbury Inland Wetlands and Watercourses Agency Regulations). Applications require the inclusion of mitigation measures which reduce the impact of a proposed activity, including: Plans or actions which 1) avoid destruction or diminution or wetland or watercourse functions, recreational uses and natural habitats, 2) which prevent flooding, degradation of water quality, erosion and sedimentation and obstruction or drainage, or 3) which otherwise safeguard water resources.

In terms of new developments, the City of Waterbury primarily mitigates flood damage and flood hazards by restricting building activities inside flood-prone areas. All existing watercourses are to be impacted minimally or not at all while maintaining the existing flood carrying capacity. These regulations rely primarily on the FEMA defined 100-year flood elevations to determine flood areas. Any development which may potentially impact a watercourse, as defined as being a "significant impact activity" in Section 2.1 of the Inland Wetlands and Watercourses Regulations, must be approved by the Inland Wetlands and Watercourses Agency before being approved by the zoning board.

The intent of these regulations is to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas of the City of Waterbury by the establishment of standards designed to:

- Protect human life and public health;
- Minimize expenditure of money for costly flood control projects;
- Minimize the need for rescue and relief efforts associated with flooding;
- Ensure that purchasers of property are notified of special flood hazards;
- Ensure that all land approved for subdivision shall have proper provisions for water, drainage, and sewerage and in areas contiguous to brooks, rivers, or other bodies of water subject to flooding, and that proper provisions be made for protective flood control measures;
- Ensure that property owners are responsible for their actions;
- Ensure the continued eligibility of owners of property in Waterbury for participation in the National Flood Insurance Program.

The City Engineer instructs subdivision applicants to perform drainage analyses for both the upstream and the downstream areas, but this is not an official regulation. Such an analysis would be more straightforward if there was a comprehensive stormwater management plan in place that a new regulation could refer to for such activities. This would help applicants understand and demonstrate how their projects would fit into the overall stormwater management scenario.

As noted in Section 2.8, a one-year moratorium went into effect in January 2007 preventing new subdivisions and multiple residential buildings on a single property. This moratorium is designed to give the City time to draft and adopt more restrictive development regulations called for the in the 2005 Plan of Conservation and Development, and also to give the City time to study the impacts of the pending applications in regards to City water service, sewer service, and public works. The possible implication of these developments on the drainage capacity of existing stormwater management systems is a concern. The Land Use Regulations/Engineering Standards Revision Project that began in autumn 2007 will attempt to address some of these problems.

Several structural projects in the City of Waterbury currently mitigate flood damage. In addition to the Army Corps of Engineers levees, dams, and detention basins described above, there are several dams within the City of Waterbury that regulate flow along the Naugatuck River and the Mad River. These dams are outlined in Section 9.0. Also, many brooks and streams have riprap along the sides to prevent bank erosion.

In addition, several structural projects are currently approved through the Public Works Department capital budget to prevent localized flooding or to maintain existing flood controls. These projects are summarized below:

- Division Street Drainage Design and Construction: Division Street is a moderately well-traveled road that has several catch basins feeding a 12-inch to 24-inch storm drainage pipe underneath the street. Drainage flow proceeds to the west. This drainage system was unable to convey the June 2, 2006 storm and backed up, causing erosion to occur in the shoulder areas.

- Great Brook Rehabilitation: Great Brook is the outflow from Great Brook Reservoir in the Long Hill section of the City. It flows south through the City Mills Playground and flows into an underground culvert near the intersection of Division Street and Robinson Street. This culvert brings Great Brook underneath the City, eventually daylighting at West Liberty Street above its confluence with the Naugatuck River. A reach of this culvert runs underneath the Palace Theatre on East Main Street. There are concerns that this culvert is deteriorating and an existing conditions and capacity study is proposed with any necessary construction to follow.

- Mad River Brush Clearing: The City is looking for additional funding to help clear brush in the floodplain and floodway of the Mad River to reduce growth inhibiting flood flows. This is especially important in the Townline Road and Sharon Road area where the topography is very flat and where significant flooding occurred as recently

as April 2007 during the spring nor'easter. This is proposed to be a recurring budget item.

- Progress Lane Culvert Repair: An unnamed tributary to Beaver Pond Brook flows under Progress Lane in the southeastern section of the City. A culvert failure in 2005 closed this road to through traffic. The culvert was recently repaired to ensure safe conveyance of flows.

- Sharon Road Bridge Design and Construction: This very wide bridge over the Mad River is in good condition but is very low to the water. Sharon Road is a heavily traveled thru-street but the existing bridge is only designed to convey the 10-year flood. The bridge was not overwhelmed during any of the spring 2006 storms although minor flooding occurred in the surrounding neighborhood. The April 2007 nor'easter caused significant flooding of the surrounding neighborhoods. The City is currently considering different proposals regarding this bridge, although it is expected that increasing the capacity will not reduce flooding as the area is entirely within the floodplain. Instead, the bridge could be improved to facilitate access during flooding.

- Trumpet Brook Watershed Study and Reconstruction: Clough Brook, locally known as Trumpet Brook, flows east-northeast through the Bunker Hill section of Waterbury and is a tributary to Steele Brook. Numerous problems related to backyard flooding and poor drainage in the area of the brook are occurring, so culvert upgrades are planned. Several private detention ponds need rehabilitation and maintenance along this brook, and the City would like to get additional funding to acquire easements so the city can do maintenance.

The City is looking into the purchase of database software which will maintain the City's complaint files. The "Trak-It" database will facilitate the processing and prioritization of Public Works Department projects in the future. Ideally, this software will be compatible with permit tracking software that is being considered by the City Planning Department.

3.5 Vulnerabilities and Risk Assessment

This section discusses specific areas at risk to inland flooding within the City. The three types of areas considered include (1) the major river systems, (2) tributaries, and (3) areas of localized nuisance flooding.

Given Waterbury's location in a river valley surrounded by steep slopes, rainfall collects quickly and has limited locations for storage, so proper conveyance of stormwater is important. In addition, poor drainage can cause additional impacts associated with other natural hazards. For example, localized flooding and poor drainage often lead to icing issues in the winter (as discussed in Section 6.0), and localized nuisance flooding near steep slopes can lead to saturation of groundwater and possibly lead to landslides (as discussed in Section 8.0).

3.5.1 Major Rivers

The City of Waterbury lies within the Naugatuck River Valley. Thus, all of the outlets for stormwater collection within the City of Waterbury are the Naugatuck River and its tributaries (Mad River, Steele Brook, Hancock Brook, and Great Brook). Routine large scale flooding from storms is not an issue within the City. This is primarily due to the fact that the Naugatuck and Mad rivers are heavily flood controlled throughout their reaches, both within Waterbury and upstream. Notable areas at risk of flooding along the Naugatuck and Mad Rivers include the areas described below.

Naugatuck River

The Army Corps flood control projects have confined all but the most extreme flood events to the primary channel of the Naugatuck River. Only one location has a repeated history of flooding. Specifically, overbank flooding occurs infrequently and temporarily

near the Wastewater Treatment Plant on South Main Street. This is a minor issue that causes little damage in the surrounding area.

Mad River

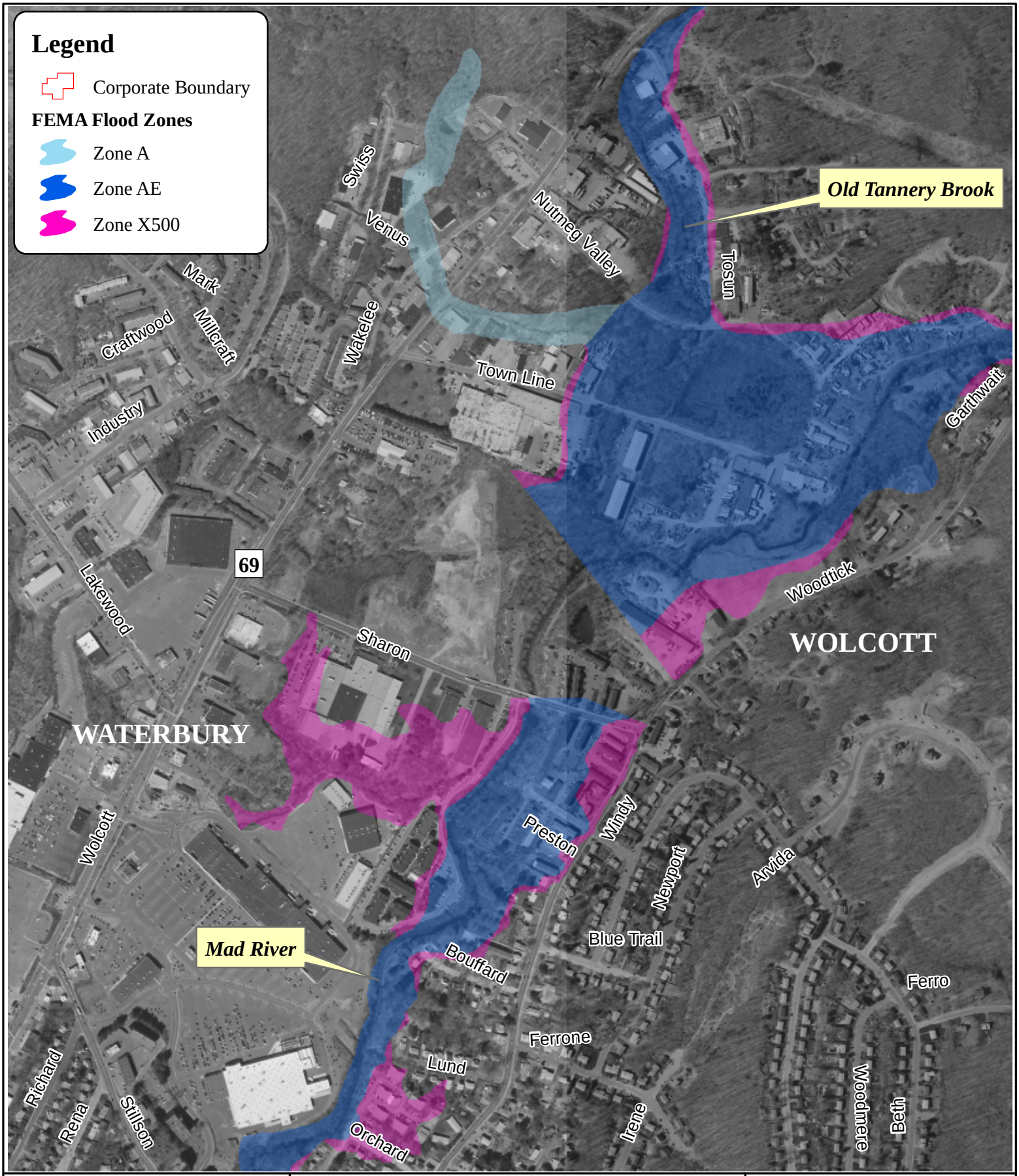
Condominiums and apartments are clustered in the floodplain of the Mad River upstream and downstream of Sharon Road. This area has a history of repeated flooding. Refer to Figure 3-2 for a depiction of this area.

The condominiums at the northwest corner of the river and the road lie several feet above the river elevation. The River's Edge apartment complex, located at the southeast corner of the river and the road, has expansive common areas that were partly underwater following the June 2, 2006 storm, and some of the paved areas were close to the water elevation. Most recently, a powerful spring nor'easter of April 15-16, 2007 caused severe flooding of the Mad River corridor, affecting residents of Woodtick Road (including evacuation of 45 condominium units) and Sharon Road.

Flooding along the Mad River occurs elsewhere, as well. In spring 2006, flooding occurred in the area of Maybury Circle off Southmayd Road.

Other Major Streams

Few flooding problems were reported along Steele Brook or Hancock Brook. However, beaver dams along Steele Brook have caused flood damage to surrounding properties recently.



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Mad River Study Area

LOCATION: **Waterbury, CT**

MMI#: 2937-01
MXD: H:\wtby3-2sharonrd.mxd
SOURCE: CLEAR, CT DEP

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Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: June 2007
SCALE: 1:8,000

SHEET: Figure 3-2

3.5.2 Tributary Streams

Flashy conditions along smaller streams can be a problem. Some of the troublesome smaller streams include Beaver Pond Brook, Little Brook, Trumpet Brook, Great Brook, Beaver Pond Brook, Sled Haul Brook, and Hopeville Pond Brook and its tributaries (including Pritchards Pond). These streams are described below.

Beaver Pond Brook

The area of Beaver Pond Brook near Interstate 84 is believed to experience drainage and flooding problems, although few complaints have been received due to the non-residential nature of the neighborhood.

Little Brook

Little Brook is a tributary to Great Brook which drains the Fulton Park ponds. It flows underground into a culvert at Hopkins Street and intersects with the Great Brook culvert underneath Brook Street near the Palace Theatre. The culvert at the corner of Bishop Street and Grove Street backed up due to a debris clog during the September 17, 2005 storm, so proper maintenance of this culvert system is important.

Great Brook

As described above in Section 3.4, there are concerns about the structural integrity and capacity of this below-grade culvert throughout its reach in Waterbury. In particular, the reach of the culvert near Brown Street and Water Street reportedly needs maintenance and a structural integrity study.

Hopeville Pond Brook and Tributaries

Several areas in the Hopeville Pond Brook watershed were revealed to be insufficient in regards to conveying heavy stormwater discharges. Refer to Figure 3-3 for a depiction of this area. Edgewood Avenue and Edgewater Street are very flat and near the level of Pritchards Pond, contributing to poor drainage in that area. Beaver dams along Hopeville Pond Brook have caused flood damage to surrounding properties recently.

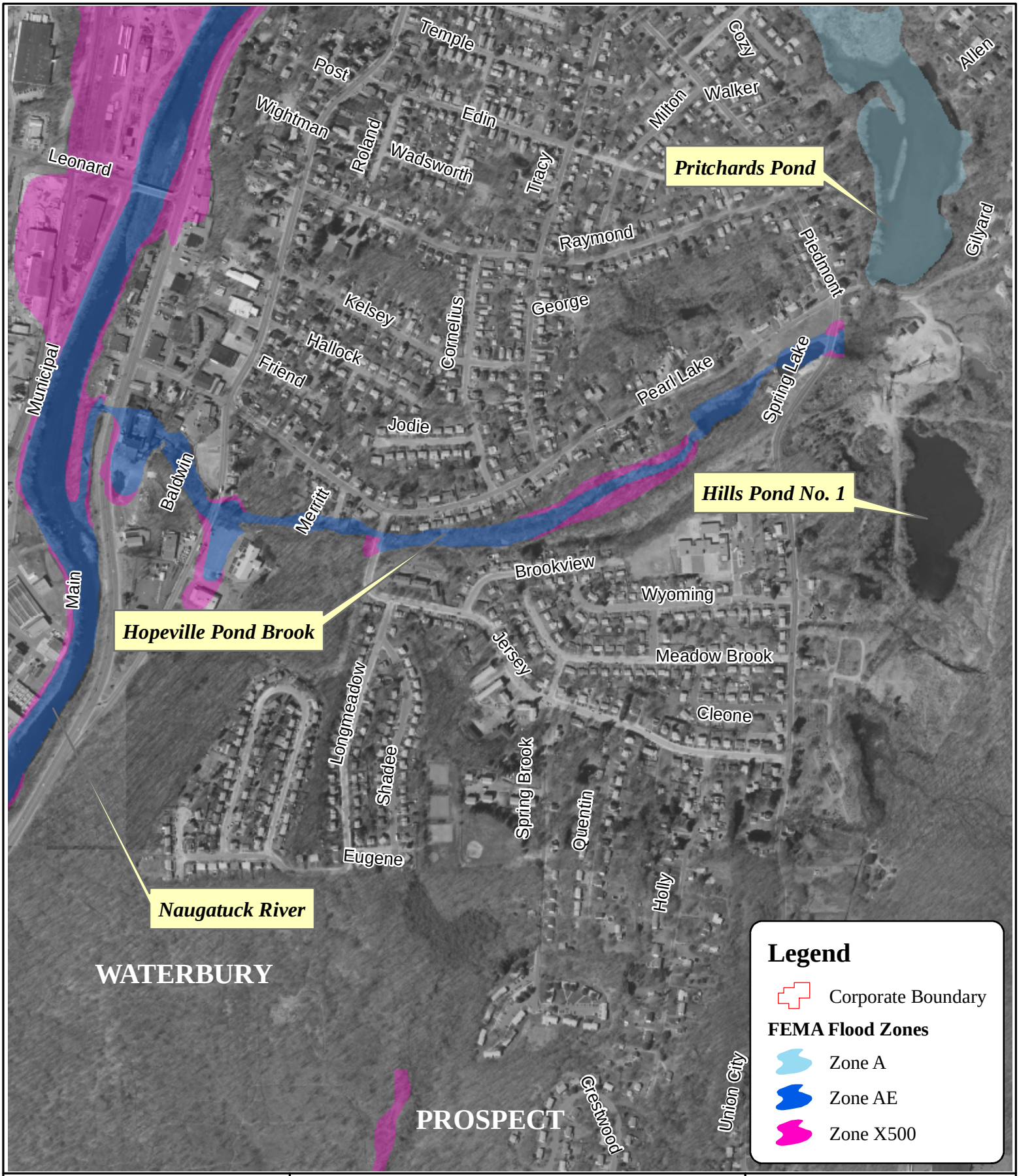
An unnamed tributary to Hopeville Pond Brook running under Jersey Street was insufficient to convey the June 2, 2006 storm, and the stream backed up through a culvert on Jersey Street. In addition, poor drainage to a stream running parallel to East Mountain Road allowed a good deal of sheet flow down East Mountain Road, causing erosion and slumping during the same storm. The road had to be closed following that storm.

Sled Haul Brook

As described in Section 3.3.1, culverts running under Chipman Avenue and Highland Avenue were insufficient to convey flood flow in Sled Haul Brook during the June 2, 2006 storm.

Trumpet Brook

This corridor of this brook has experienced several problems with backyard flooding and poor drainage throughout its reach, as described in Section 3.4. Refer to Figure 3-4 for a depiction of the Trumpet Brook corridor.



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Hopeville Pond Brook Study Area

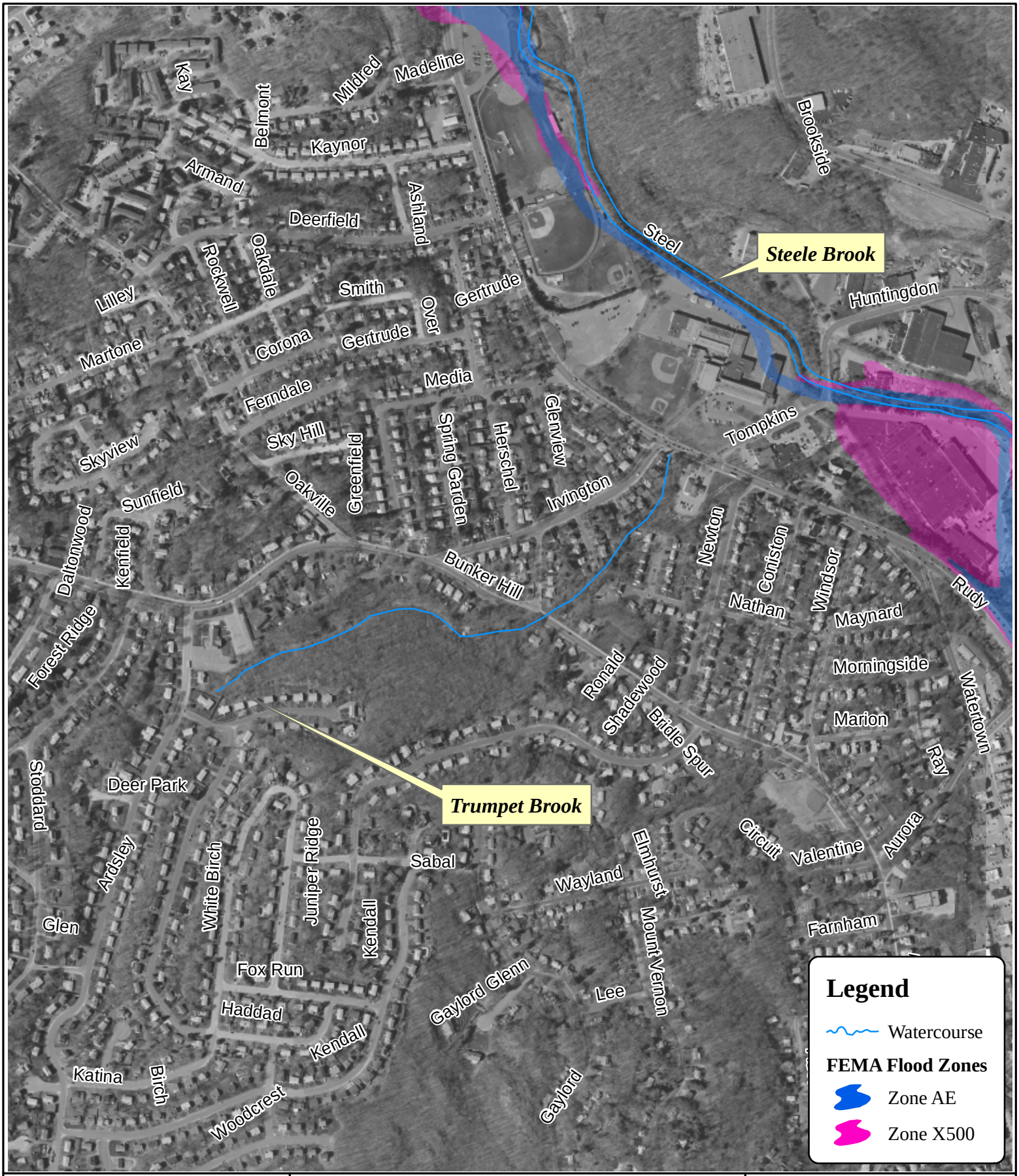
LOCATION: **Waterbury, CT**

MMI#: 2937-01
MXD: H:\wtby3-3hopeville.mxd
SOURCE: CLEAR, CT DEP

Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: June 2007
SCALE: 1:8,000

SHEET: Figure 3-3



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Trumpet Brook Study Area

LOCATION: Waterbury, CT

MMI#: 2937-01
MXD: H:\wtby3-4trumpet.mxd
SOURCE: CLEAR, CT DEP

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Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: June 2007
SCALE: 1:8,000

SHEET: Figure 3-4

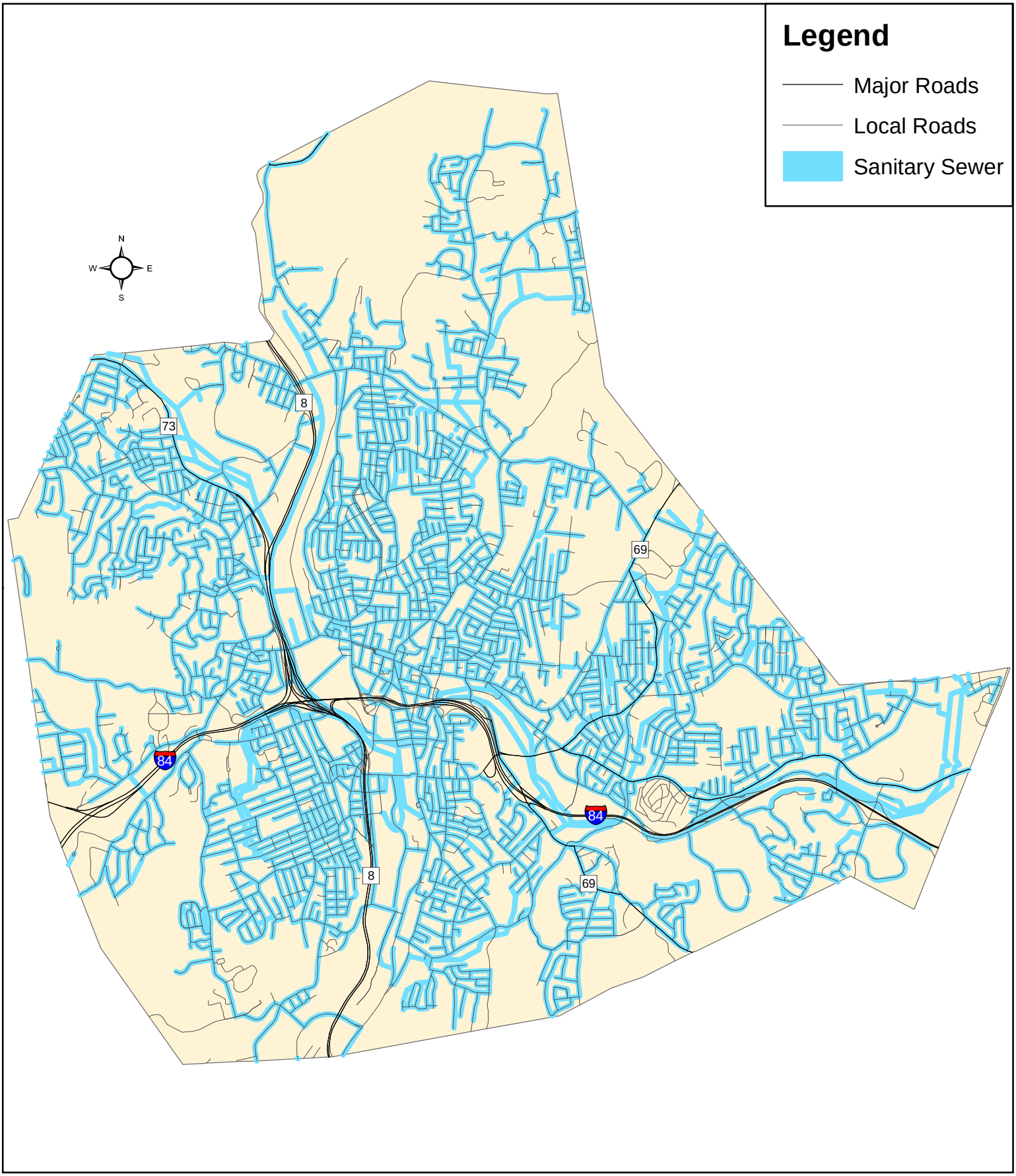
3.5.3 Problem Areas Related to Localized Flooding

The infrastructure of the City of Waterbury has a difficult time handling stormwater runoff for several reasons:

- Most significantly, much of the City is not served by storm drainage systems. This problem is described in the following paragraphs.
- Much of the topography of the City includes steep slopes and a shallow glacial till water table that decreases infiltration and increases runoff velocity.
- Residents encroach onto stream channels and detention basins in their yards, sometimes dumping in or otherwise altering watercourses and storage basins.
- Individual property owners can pave private driveways and make certain changes without permits, increasing impervious surfaces without the City's knowledge.
- The endpoints of the existing stormwater systems along the Naugatuck River are not able to convey stormwater to the river when it is high, as the outflows become submerged.
- The sanitary sewer system is designed to handle 80 mgd but has experienced in excess of 100 mgd during events such as the June 2006 and April 2007 storms, due to the combined sanitary and stormwater systems.

As indicated above, the existing stormwater collection system is limited in its coverage area. According to the COGCNV, there are approximately 14,100 acres of developed land in the City. Nearly all of this developed land is served by the existing sanitary sewer system, as depicted on Figure 3-5 and Figure 3-6. In contrast, only about 3,400 acres of land in Waterbury are served by storm drainage systems according to the 1997 Drainage System Maps supplied by the COGCNV.

Figure 3-5: Sanitary Sewer System in Waterbury



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", DEP
"Sewer System", Waterbury

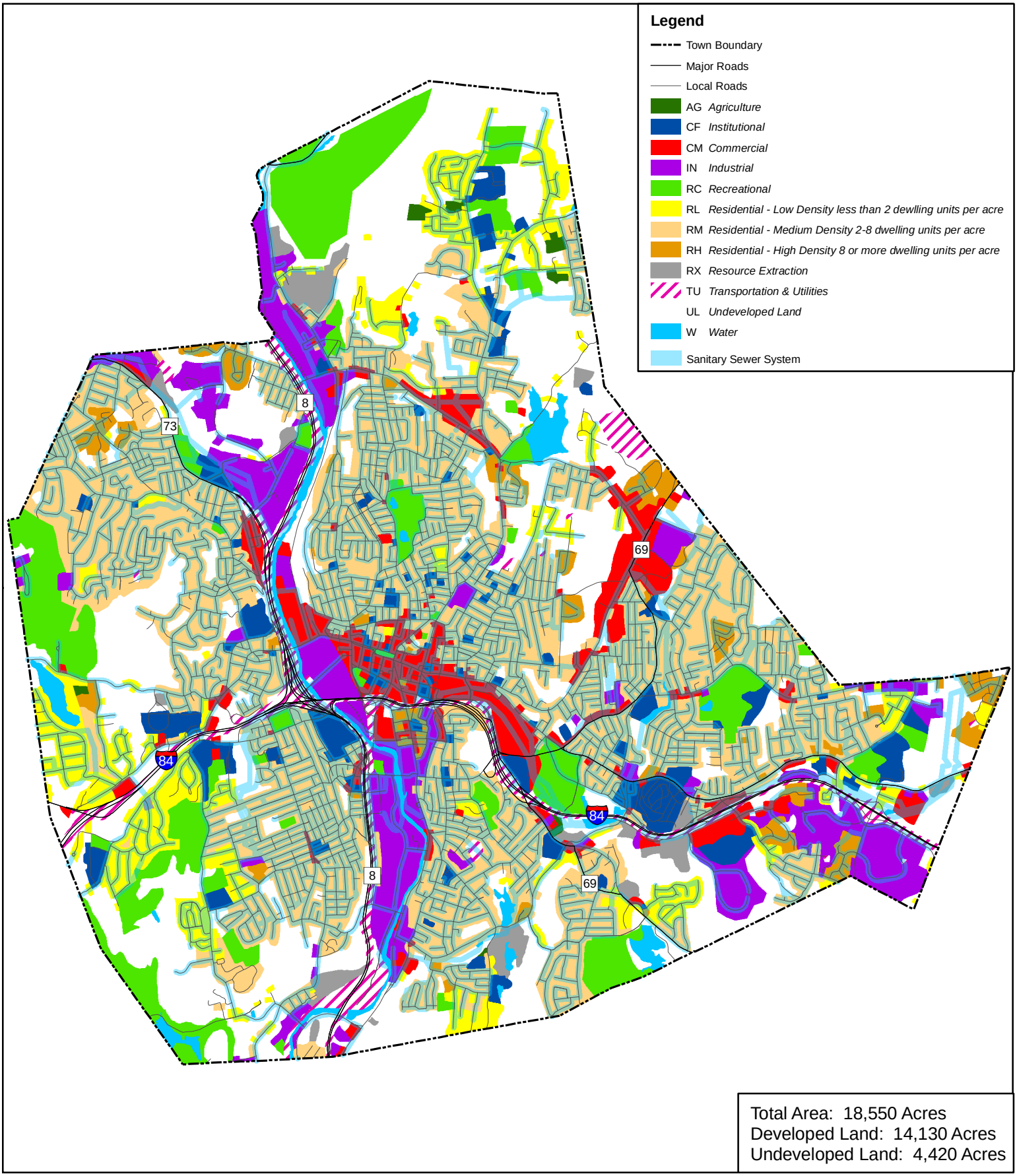
For general planning purposes only. Delineations may not be exact.

January 2007

0 0.5 1 Miles

COUNCIL OF GOVERNMENTS
CENTRAL NAUGATUCK VALLEY

Figure 3-6: Waterbury Sanitary Sewer System and Land Use



Source: "Roads", GDT
"Town Boundary", DEP
"Land Use", COGCNV
"Sanitary Sewer", Waterbury

For general planning purposes only. Delineations may not be exact.

January 2007

N
W E
S

0 0.5 1 Miles

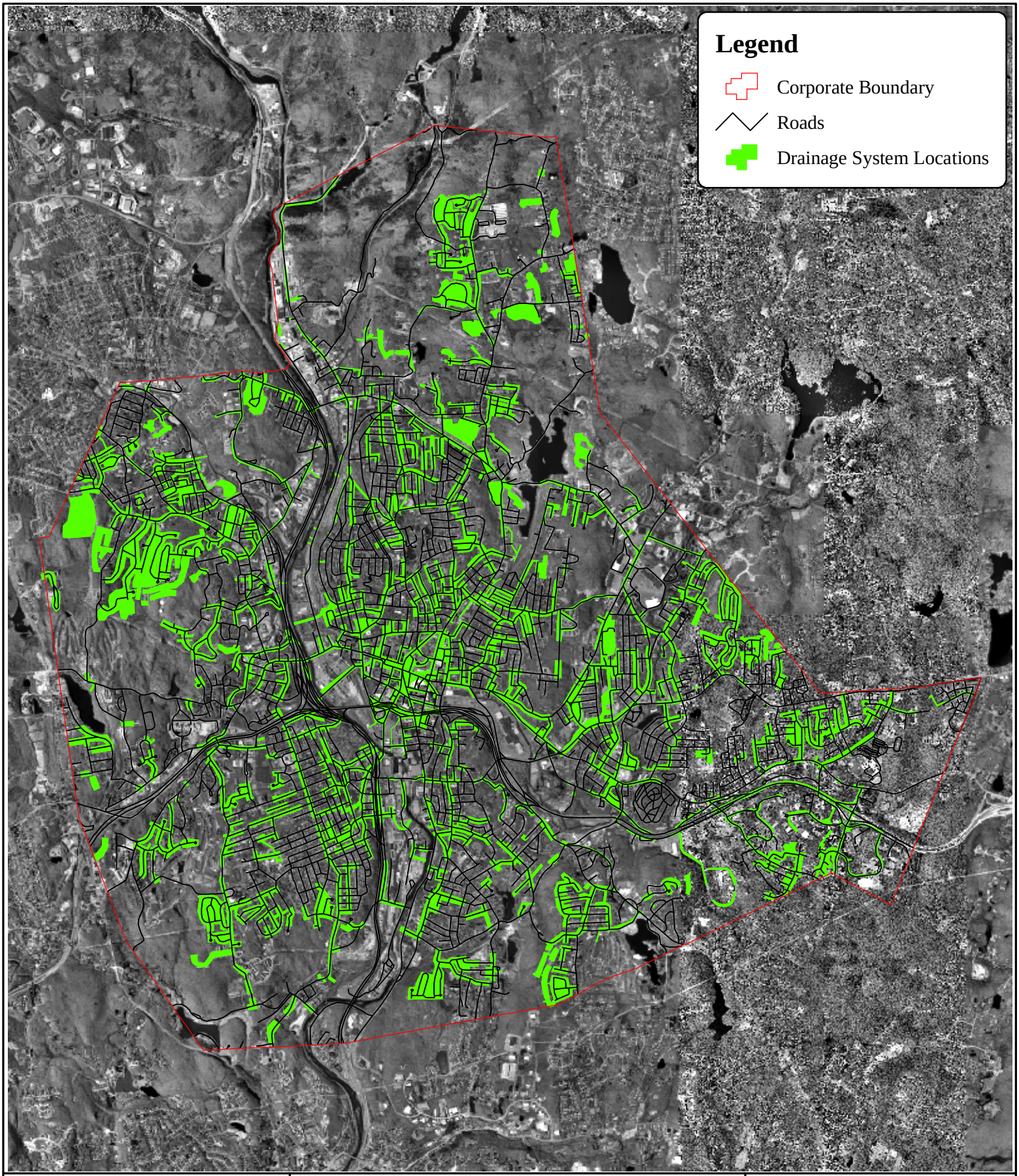
COUNCIL OF GOVERNMENTS
CENTRAL NAUGATUCK VALLEY

The systems on these maps are simplified in Figure 3-7. As much of the stormwater is handled via drainage swales, localized flooding is a major problem throughout the City under heavy rainfall conditions. Runoff on streets becomes sheet flow, flowing down roadways until it infiltrates in yards or reaches a down-gradient storm drain. This sheet flow causes erosion along roadways and in yards. Some storm sewers tie into the City sanitary sewers, reducing available carrying capacity.

A comprehensive stormwater management plan is needed to define problem areas, create a maintenance schedule, and incorporate proposed runoff conditions from new and proposed developments into a watershed framework to demonstrate and understand the down-gradient effects of runoff.

The Public Works Department is working to update the stormwater sewer system, while the Water Pollution Control Authority is working to update the sanitary sewer system. The Public Works Department currently performs repairs and upgrades to the stormwater system as needed, but is restricted in funding. The lack of a comprehensive plan means that sometimes individual projects can patch the local-scale problem but fail to correct the overall watershed-scale problem. Separation of the sanitary and stormwater systems needs to be coordinated between the Public Works Department and the Water Pollution Control Authority in order to prioritize the areas that need improvements most.

Numerous areas of the City suffer repeated water damages to curbing, sidewalks, and pavement during heavy rainfalls. A few priority areas are listed in Table 3-3. While the areas noted in Table 3-3 do not necessarily require drainage systems, such systems would alleviate future erosion problems.



1997 Drainage System Map

LOCATION: Waterbury, CT

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MMI#: 2937-01
MXD: H:\wtbystormsewers.mxd
SOURCE: COGCNV, DEP

N

Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: Oct. 2007
SCALE: 1:60,000

SHEET: Figure 3-7

Table 3-3
Areas Needing Curbing Repair/Installation or Sidewalk Repair Due to Repeated Water Damage

1. Amity Street	5. East Main Street near Silver Street
2. Boyden Street	6. Gaylord Drive
3. Brookview Avenue	7. Highland Drive
4. Columbia Boulevard	8. Reid Street

References:
1. A-N Consulting Engineers, Inc., 2006, *Damage Assessment Report for the Extreme Rainfall Event that Occurred June 2, 2006 Within the City of Waterbury*.
2. Public works complaint logs and files.

On the other hand, several areas of the City suffer such repeated drainage problems that the installation of a stormwater management system is warranted. These vulnerable areas have been confirmed with City personnel and are outlined in Table 3-4.

Table 3-4
Areas Needing Stormwater Management Systems

Street Name	Comment
1. Arline Drive*	Poor drainage
2. Bank Street near Congress Street	High slopes, one-way streets, and multiple flooding occurrences per year; it will be challenging and expensive to construct a culvert beneath Route 8
3. Bank Street near Fifth Street	
4. Baldwin Avenue	Street runoff floods private property
5. Blanchard Street*	Water ponds on the road and ices in winter
6. Campfield Road*	Runoff from yards tends to pond on roadway
7. Chambers Street	Excessive erosion to the street, gutters
8. Charles Street near Fourth Street	Seepage floods the street
9. Colby Avenue* (a "paper" street)	Local road used by children to access Crosby High School. The area washed out and is continuing to erode, preventing egress
10. Corby Avenue	This area is very flat with poor drainage
11. Fiske Street	Water ponds on the street
12. Gem Drive	Repeated driveway flooding
13. George Street	Runoff ponds on streets and in nearby yards
14. Hillhouse Road*	Drainage problems flood private home, driveway, and cellar
15. John Street	Floods three times per year due to poor drainage
16. Lakeside Boulevard East	Water pools and ices in winter
17. Meriline Avenue	Poor drainage
18. Mountain View Drive*	Seepage ices road in winter

Table 3-4 (Continued)
Areas Needing Stormwater Management Systems

Street Name	Comment
19. North Walnut Street*	Drainage needed to prevent further occurrence of sinkholes
20. Rockledge Drive	Seepage ices road in winter
21. Rose Street*	Low point in road causes poor drainage
22. Sunnyside Ave. near Bunker Hill	Heavy runoff affects this neighborhood
23. Woodstock Road	Local flooding due to poor drainage
24. Wooster Avenue	Stormwater damaging driveway, yard

References:

1. A-N Consulting Engineers, Inc., 2006, *Damage Assessment Report for the Extreme Rainfall Event that Occurred June 2, 2006 Within the City of Waterbury.*

2. Public works complaint logs and files.

*Denotes an existing or proposed capital improvement project for fiscal years 2007-2011.

In addition, several areas with existing stormwater management systems are either in need of maintenance or are now insufficient to convey required storm discharges. These areas are outlined in Table 3-5.

Table 3-5
Areas Needing Stormwater Management System Improvements or Maintenance

Street Name	Comment
1. Brook Street near Scovill St	Two deteriorating catch basins need replacement; related flooding of nearby basements
2. Calumet Street near Columbia Blvd.	September 2005 rainstorm backed up catch basins and sent debris flow in front of #16 and eroded side
3. Cooke Street near Adam St. & Grove St.	Flooding occurred during the September 2005 rainstorm due to the clogging of the Little River culvert with debris
4. Division Street*	This drainage system is undersized (see Section 3.4)
5. East Main Street near Fairlawn Ave.	Catch basins are insufficient to handle parking lot runoff
6. Grandview Avenue*	Insufficient drainage system overflows causing erosion
7. Grove Street	Washed out due to clogging of Little River culvert
8. Hans Avenue	Insufficient drainage causes icing in winter
9. Highview Street	Insufficient stormwater management system
10. Jersey Street near Pearl Lake Rd	Culvert clogged during June 2006 storm, backing up into Jersey Street
11. Progress Lane*	2005 storm drainage failure closed road to traffic
12. St. Jean Street below Greenmount	Insufficient drainage system on a high slope road

Table 3-5 (Continued)
Areas Needing Stormwater Management System Improvements or Maintenance

Street Name	Comment
13. Robbins Street	Insufficient drainage system on primary egress to Waterbury Hospital
14. West Main Street	Insufficient drainage system near Douglas Ave. and Park Road results in repetitive basement flooding of Saint Mary's Physical Medicine & Rehabilitation Center.
15. Westwood Avenue	Insufficient drainage system near Devonwood Drive
16. Woodhaven Street	Insufficient drainage system causes nearby flooding

References:
1. A-N Consulting Engineers, Inc., 2006, *Damage Assessment Report for the Extreme Rainfall Event that Occurred June 2, 2006 Within the City of Waterbury.*
2. Public works complaint logs and files.
*Denotes an existing or proposed capital improvement project for fiscal years 2007-2011.

Separation of sanitary and stormwater systems is also necessary and should coincide with any repairs related to items in Tables 3-4 and 3-5.

Finally, other areas of the City with drainage concerns not directly related to the above categories include:

- Bishop Street has been affected by sinkholes that may be related to the underground Little Brook culvert.

- A potential subdivision between Pearl Lake Road and Purdy Road could exacerbate localized flooding in an area with steep slopes that is known to have drainage issues.

3.6 Potential Mitigation Measures, Strategies, and Alternatives

A number of measures can be taken to reduce the impact of a flood event. These include measures that prevent increases in flood losses by managing new development, measures that reduce the exposure of existing development to flood risk, and measures to preserve and restore natural resources. These are listed below under the categories of *prevention*,

property protection, *structural projects*, *public education and awareness*, *natural resource protection*, and *emergency services*.

*3.6.1 **Prevention***

Prevention of damage from flood losses often takes the form of floodplain regulations and redevelopment policies. These are usually administered by building, zoning, planning, and/or code enforcement offices through capital improvement programs and through zoning, subdivision, and wetland ordinances.

It is important to promote coordination among the various departments that are responsible for different aspects of flood mitigation. Coordination and cooperation among departments should be reviewed every few years as specific responsibilities and staff changes.

Municipal departments should identify areas for acquisition to maintain flood protection. Acquisition of heavily damaged structures after a flood may be an economical and practical means to accomplish this. Policies can also include the design and location of utilities to areas outside of flood hazard areas, and the placement of utilities underground.

Planning and Zoning: Zoning ordinances should regulate development in flood hazard areas. Flood hazard areas should reflect a balance of development and natural areas.

Floodplain Development Regulations: Development regulations encompass subdivision regulations, building codes, and floodplain ordinances.

Site plan and new subdivision regulations should include the following:

- Requirements that every lot have a buildable area above the flood level;

- Construction and location standards for the infrastructure built by the developer, including roads, sidewalks, utility lines, storm sewers, and drainage ways; and
- A requirement that developers dedicate open space and flood flow, drainage, and maintenance easements.

Building codes should ensure that the foundation of structures will withstand flood forces and that all portions of the building subject to damage are above or otherwise protected from flooding.

Floodplain ordinances should at minimum follow the requirements of the National Flood Insurance Program for subdivision and building codes. These could be included in the ordinances for zoning and building codes, or could be addressed in a separate ordinance.

According to the FEMA, communities are encouraged to use different, more accurate base maps to expand upon the FIRMs published by FEMA. This is because many FIRMs were originally created using United States Geological Survey quadrangle maps with 10-foot contour intervals, but most municipalities today have contour maps of one or two-foot intervals that show more recently constructed roads, bridges, and other anthropologic features. Another approach is to record high-water marks and establish those areas inundated by a recent severe flood to be the new regulatory floodplain.

Adoption of a different floodplain map is allowed under NFIP regulations as long as the new map covers a larger floodplain than the FIRM. Reductions in floodplain area can only be accomplished through revised FEMA-sponsored engineering studies or Letters of Map Change (LOMC). It should be noted that the community's map will not affect the current FIRM or alter the SFHA used for setting insurance rates or making map determinations; it can only be used by the community to regulate floodplain areas. The FEMA Region I office has more information on this topic; contact information can be found in Section 12.

Stormwater Management Policies: Development and redevelopment policies to address the prevention of flood losses must include effective stormwater management policies. Developers should be required to build detention and retention facilities where basin maintenance can be ensured. Infiltration can be enhanced to reduce runoff volume, including the use of swales, infiltration trenches, vegetative filter strips, and permeable paving blocks. Generally, post-development stormwater should not leave a site at a rate higher than under pre-development conditions.

Standard engineering practice is to avoid the use of detention measures if the project site is located in the lower one-third of the overall watershed. The effects of detention are least effective and even detrimental if used at such locations because of the delaying effect of the peak discharge from the site that typically results when detention measures are used. By detaining stormwater in close proximity of the stream in the lower reaches of the overall watershed, the peak discharge from the site will occur later in the storm event, which will more closely coincide with the peak discharge of the stream, thus adding more flow during the peak discharge during any given storm event. Due to its geography, Waterbury contains a range of upper to lower portions of watersheds. Developers should be required to demonstrate whether detention or retention will be the best management practice for stormwater at specific sites in regards to the position of each project site in the surrounding watershed.

Drainage System Maintenance: An effective drainage system must be continually maintained to ensure efficiency and functionality. Maintenance should include programs to clean out blockages caused by overgrowth and debris. Culverts should be monitored, and repaired and improved when necessary. The use of Geographic Information System (GIS) technology would greatly aid the identification and location of problem areas.

Education and Awareness: Other prevention techniques include the promotion of awareness of natural hazards among citizens, property owners, developers, and local

officials. Technical assistance for local officials, including workshops, can be helpful in preparation for dealing with the massive upheaval that can accompany a severe flooding event. Research efforts to improve knowledge, develop standards, and identify and map hazard areas will better prepare a community to identify relevant hazard mitigation efforts.

The City of Waterbury *Inland Wetlands & Watercourses Agency* administers the wetland regulations whereas the *City Plan Commission* administers the Zoning and Subdivision regulations. The wetlands regulations are not directly used to regulate floodplain development; this mainly occurs as part of the *City Plan Commission* review. The *Building Department* is charged with ensuring that development follows the floodplain management regulations. The City Engineer often meets with applicants to provide site plan guidance.

Based on the above guidelines and the existing roles of the Inland Wetlands & Watercourses Agency and the City Plan Commission, the following *preventive* mitigation measures are recommended:

- Increased cooperation between the above departments is necessary with regard to controlling growth and development in flood zones. This will provide a system of checks and balances to ensure that development leads to flood-resistant structures and reduces risk to people.

- A checklist should be developed that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to the proposed project. This will streamline the permitting process and ensure maximum education of a developer or applicant. This list could be provided to an applicant at any City department. The list of regulations and ordinances in Section 3.4 can be used as a starting point for a checklist. The permit tracking software that is being considered

by the City Planning Department should have such a checklist or built-in cross-notification function.

3.6.2 Property Protection

Steps should be taken to protect existing public and private properties. Non-structural measures for public property protection include acquisition and relocation of properties at risk for flooding, purchase of flood insurance, and relocating valuable belongings above flood levels to reduce the amount of damage caused during a flood event.

Structural flood protection techniques applicable to property protection include the construction of barriers, dry floodproofing, and wet floodproofing techniques. Barriers include levees, floodwalls, and berms, and are useful in areas subject to shallow flooding. These structural projects are discussed in Section 3.6.6 below. Dry floodproofing refers to the act of making areas below the flood level water-tight. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents should be either permanently closed or covered with removable shields. Flood protection should only be two to three feet above the top of the foundation because building walls and floors cannot withstand the pressure of deeper water.

Wet floodproofing should only be used as a last resort. Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Furniture and electrical appliances should be moved away from advancing floodwaters.

All of the above *property protection* mitigation measures may be useful for City of Waterbury residents to prevent damage from inland and nuisance flooding. The City should consider outreach and education in these areas.

3.6.3 Emergency Services

A pre-disaster natural hazard mitigation plan addresses actions that can be taken before a disaster event. In this context, emergency services that would be appropriate mitigation measures for inland flooding include:

- Forecasting systems to provide information on the time of occurrence and magnitude of flooding;
- A system to issue flood warnings to the community and responsible officials;
- Emergency protective measures, such as a section in the Emergency Operations Plan outlining procedures for the mobilization and position of staff, equipment, and resources to facilitate evacuations and emergency flood-water control; and
- Implementing an emergency notification system that combines database and GIS mapping technologies to deliver outbound emergency notifications to geographic areas; or specific groups of people, such as emergency responder teams.

Based on the above guidelines, a number of specific proposals for improved *emergency services* are recommended to prevent damage from inland and nuisance flooding. These are common to all hazards in this plan, and are listed in Section 11.1.

3.6.4 Public Education and Awareness

The objective of public education is to provide an understanding of the nature of flood risk, and the means by which that risk can be mitigated on an individual basis. Public information materials should encourage individuals to be aware of flood mitigation techniques, including discouraging the public from changing channel and detention basins in their yards, and dumping in or otherwise altering watercourses and storage basins. Individuals should be made aware of drainage system maintenance programs and other methods of mitigation. The public should also understand what to expect when a hazard event occurs, and the procedures and time frames necessary for evacuation.

Based on the above guidelines, a number of specific proposals for improved *public education* are recommended to prevent damage from inland and nuisance flooding. These are common to all hazards in this plan, and are listed in Section 11.1.

3.6.5 Natural Resource Protection

Floodplains can provide a number of natural resources and benefits, including storage of flood waters, open space and recreation, water quality protection, erosion control, and preservation of natural habitats. Retaining the natural resources and functions of floodplains can not only reduce the frequency and consequences of flooding, but also minimize stormwater management and non-point pollution problems. Through natural resource planning, these objectives can be achieved at substantially reduced overall costs.

Measures for preserving floodplain functions and resources typically include:

- Adoption of floodplain regulations to control or prohibit development that will alter natural resources;
- Development and redevelopment policies focused on resource protection;
- Information and education for both community and individual decision-makers; and
- Review of community programs to identify opportunities for floodplain preservation.

Measures for restoring diminished or destroyed resources and functions provide for re-establishment of an environment in which these functions can again operate. Measures that involve improving the natural condition of areas or restoring them to their previous natural state include development of land reuse policies focused on resource restoration and review of community programs to identify opportunities for floodplain restoration.

Based on the above guidelines, the following specific *natural resource protection* mitigation measures are recommended to help prevent damage from inland and nuisance flooding:

- Pursue the acquisition of additional open space properties.
- Selectively pursue conservation objectives specified in the Plan of Conservation and Development, including the creation of greenways along the Naugatuck River and acquisition of land around waterbodies.
- Continue to regulate development in protected and sensitive areas, including steep slopes, wetlands, and floodplains.

3.6.6 Structural Projects

Structural projects include the construction of new structures or modification of existing structures (e.g. floodproofing) to lessen the impact of a flood event. Stormwater controls such as drainage systems, detention dams and reservoirs, and culverts should be employed to lessen floodwater runoff. On-site detention can provide temporary storage of stormwater runoff. Barriers such as levees, floodwalls, and dikes physically control the hazard to protect certain areas from floodwaters. Channel alterations can be made to confine more water to the channel and accelerate flood flows. Care should be taken when using these techniques to ensure that problems are not exacerbated in other areas of the impacted watersheds. Individuals can protect property by raising structures, and constructing walls and levees around structures.

Based on the above guidelines, the following specific *structural* mitigation measures are recommended to prevent damage from inland and nuisance flooding:

- Perform a comprehensive Stormwater System study that encompasses the entire City of Waterbury.
- Institute a comprehensive catch basin maintenance program.

- Continue to separate and update the storm and sanitary sewer systems where the Public Works Department and Water Pollution Control Department agree that it is a priority.
- Consider installation and repair of curbing for areas listed in Table 3-3.
- Consider installation of stormwater systems for areas listed in Table 3-4.
- Repair stormwater and drainage systems listed in Table 3-5.

3.7 Summary of Potential Mitigation Measures, Strategies, and Alternatives

The proposed mitigation strategies for addressing inland and nuisance flooding are listed below.

Prevention

- Streamline the permitting process and ensure maximum education of a developer or applicant. Develop a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to the proposed project. This list could be provided to an applicant at any City department. The permit tracking software that is being considered by the City Planning Department should have such a checklist or built-in cross-notification function.
- Coordinate with neighboring municipalities regarding new subdivisions that could impact properties within Waterbury (for upstream municipalities) and downstream of Waterbury.
- Consider becoming a member of FEMA's Community Rating System.
- Adopt a more comprehensive set of floodplain management regulations. The Zoning and Land Subdivision Regulations should be amended to include detailed provisions for flood damage prevention. Applicants should be required to demonstrate compliance with these regulations. New buildings constructed in flood prone areas should be protected to the highest recorded flood level, regardless of being in a SFHA, and designed and graded to shunt drainage away from the building.

- Add appropriate regulations to the Code of Ordinances, Zoning Ordinance, and the Land Subdivision Regulations to 1) prevent non-permitted increases in impervious surfaces and 2) require watershed-based engineering studies for new subdivisions or sizeable developments showing both the upstream and downstream drainage impacts.
- Utilize the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 to assist with implementation of the above recommendations.
- When possible, assist with the Map Mod program to ensure an appropriate update to the Flood Insurance Study, Flood Insurance Rate Maps, and Flood Boundary and Floodway Maps, particularly for the Mad River. The current incarnation of FEMA mapping is almost 30 years old and is outdated.
- After Map Mod has been completed, consider restudying local flood prone areas and produce new local-level regulatory floodplain maps using more exacting study techniques, including using more accurate contour information to map flood elevations provided with the FIRM.
- Implement outreach programs to educate citizens regarding Ordinances, Insurance, and other flood relevant issues.

Property & Natural Resource Protection

- Clear brush and growth that could possibly inhibit flood flows in the floodplain of the Mad River, especially in the Townline Road area where the topography is very flat. This should be a recurring item taking place at least once every three years.
- Purchase private land in the 100-year floodplain and convert to greenways, parks, or other non-residential, non-commercial, or non-industrial use.
- Selectively pursue conservation objectives listed in the Plan of Conservation and Development, including the creation of greenways.
- Continue to regulate development in protected and sensitive areas.
- Pursue the acquisition of additional municipal open space properties inside SFHAs.

Structural Projects

- Commission a comprehensive City-wide stormwater management system study. This study should include a culvert and catch basin maintenance and replacement schedule and include mathematical models that developers can use to compare existing to proposed conditions. Update this Study with a minimum frequency of every five years.
- Continue to investigate reports of localized flooding problems to determine the cause and an appropriate solution. Set milestones for eliminating recurring localized flooding areas.
- Implement an electronic complaint tracking system to maintain a computerized database of calls received by the City. Ensure that this software will be compatible with permit tracking software that is being considered by the City Planning Department.
- Perform a drainage study of Great Brook, including a structural analysis of the box culvert that Great Brook flows through underneath the Palace Theatre. Construct improvements as outlined by the engineering study.
- Perform an engineering study for the Mark Lane Landfill area and the Highland Metro North Railroad area. Both of these areas were heavily damaged by the June 2, 2006 storm. Mitigation measures are required to properly protect these areas from future disasters.
- Install a drainage system along Division Street.
- Conduct Trumpet Brook watershed study and reconstruction.
- Evaluate capacities of East Main Street and East Liberty Street bridges over the Mad River and reconstruct if necessary.
- Conduct a study to prioritize areas for separation of sanitary and stormwater systems.
- Continue to separate and update the storm and sanitary sewer systems according to the priority worked out in the study and agreed upon by Public Works and Water Pollution Control Departments.
- Consider installation and repair of curbing for areas listed in Table 3-3.

- Consider installation of stormwater systems for areas listed in Table 3-4.
- Repair stormwater and drainage systems listed in Table 3-5.

In addition, mitigation strategies important to all hazards are described in Section 11.1

4.0 HURRICANES AND TROPICAL STORMS

4.1 Setting

Hazards associated with tropical storms and hurricanes include winds, heavy rains, and inland flooding. While only some of the areas of Waterbury are susceptible to flooding damage caused by hurricanes, wind damage can occur anywhere in the City. Hurricanes therefore have the potential to affect any area within the City of Waterbury. A hurricane striking Waterbury is considered a possible event in any given year that could cause critical damage to the City and its infrastructure (Appended Table 2).

4.2 Hazard Assessment

Hurricanes are a class of tropical cyclones which are defined by the National Weather Service as non-frontal, low pressure large scale systems that develop over tropical or subtropical water and have definite organized circulations. Tropical cyclones are categorized based on the speed of the sustained (1-minute average) surface wind near the center of the storm. These categories are: Tropical Depression (winds less than 39 mph), Tropical Storm (winds 39-74 mph, inclusive) and Hurricanes (winds at least 74 mph).

The geographical areas affected by tropical cyclones are called tropical cyclone basins. The Atlantic tropical cyclone basin is one of six in the world and includes much of the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. The official Atlantic hurricane season begins on June 1 and extends through November 30 of each year, although occasionally hurricanes occur outside this period.

Inland Connecticut is vulnerable to hurricanes despite moderate hurricane occurrences when compared with other areas within the Atlantic Tropical Cyclone basin. Since hurricanes tend to weaken within 12 hours of landfall, inland areas are less susceptible to

hurricane wind damages than coastal areas in Connecticut; however, the heaviest rainfall often occurs inland. Therefore, inland areas are most vulnerable to inland flooding along roadways, lakes, and streams during a hurricane.

A hurricane Watch is an advisory for a specific area stating that a hurricane poses a threat to coastal and inland areas. Individuals should keep tuned to local television and radio for updates. A hurricane Warning is then issued when the dangerous effects of a hurricane are expected in the area within 24 hours.

The Saffir / Simpson Scale

The Saffir / Simpson Hurricane Scale, which has been adopted by the National Hurricane Center, categorizes hurricanes based upon their intensity, and relates this intensity to damage potential. The Scale uses the sustained surface winds (1-minute average) near the center of the system to classify hurricanes into one of five categories. The Saffir / Simpson scale is provided below.

- **Category 1:** Winds 74-95 mph (64-82 kt or 119-153 km/hr). Storm surge generally 4-5 ft above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs, coastal road flooding, and minor pier damage. Hurricane Diane was a Category 1 hurricane when it made landfall in North Carolina in 1955, and weakened to a tropical storm before reaching the Connecticut shoreline. Hurricane Agnes of 1971 was a Category 1 hurricane when it hit Connecticut, and Hurricanes Allison of 1995 and Danny of 1997 were Category 1 hurricanes at peak intensity.

- **Category 2:** Winds 96-110 mph (83-95 kt or 154-177 km/hr). Storm surge generally 6-8 feet above normal. Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal

and low-lying escape routes flood two to four hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings. Hurricane Bonnie of 1998 was a Category 2 hurricane when it hit the North Carolina coast, Hurricane Georges of 1998 was a Category 2 hurricane when it hit the Florida Keys and the Mississippi Gulf Coast, and Hurricane Bob was a Category 2 hurricane when it made landfall in southern New England and New York in August of 1991.

- **Category 3:** Winds 111-130 mph (96-113 kt or 178-209 km/hr). Storm surge generally 9-12 ft above normal. Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water three to five hours before arrival of the center of the hurricane. Flooding near the coast destroys smaller structures with larger structures damaged by battering from floating debris. Terrain continuously lower than five feet above mean sea level may be flooded inland eight miles (13 km) or more. Evacuation of low-lying residences within several blocks of the shoreline may be required.

  The Great New England Hurricane of 1938 was a Category 3 hurricane when it hit New York and southern New England. The Great Atlantic Hurricane of 1944 was a Category 3 hurricane when it made landfall in North Carolina, Virginia, New York, and southern New England. Hurricane Carol of 1954 was a Category 3 hurricane when it struck Connecticut, New York, and Rhode Island. Hurricane Connie of 1955 was a Category 3 hurricane when it made landfall in North Carolina. Hurricane Gloria of 1985 was a Category 3 hurricane when it made landfall in North Carolina and New York, and weakened to a Category 2 hurricane before reaching Connecticut. Hurricanes Roxanne of 1995 and Fran of 1996 were Category 3 hurricanes at landfall on the Yucatan Peninsula of Mexico and in North Carolina, respectively. Hurricane Katrina of August 2005 was a Category 3 hurricane when it struck Louisiana and Mississippi, Hurricane Rita of September 2005 reached Category 3 when it struck

Louisiana, and Hurricane Wilma of October 2005 was a Category 3 hurricane when it made landfall in southwestern Florida.

- **Category 4:** Winds 131-155 mph (114-135 kt or 210-249 km/hr). Storm surge generally 13-18 ft above normal. More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water three to five hours before arrival of the center of the hurricane. Major damage to lower floors of structures near the shore. Terrain lower than 10 ft above sea level may be flooded requiring massive evacuation of residential areas as far inland as six miles (10 km).

  Hurricane Donna of 1960 was a Category 4 hurricane when it made landfall in southwestern Florida, and weakened to a Category 2 hurricane when it reached Connecticut. Hurricane Luis of 1995 was a Category 4 hurricane while moving over the Leeward Islands. Hurricanes Felix and Opal of 1995 also reached Category 4 status at peak intensity.

- **Category 5:** Winds greater than 155 mph (135 kt or 249 km/hr). Storm surge generally greater than 18 ft above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water three to five hours before arrival of the center of the hurricane. Major damage to lower floors of all structures located less than 15 ft above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles (8-16 km) of the shoreline may be required.

Hurricane Andrew was a Category 5 hurricane when it made landfall in southeastern Florida in 1992. Hurricane Mitch of 1998 was a Category 5 hurricane at peak intensity over the western Caribbean. Hurricane Gilbert of 1988 was a Category 5 hurricane at peak intensity and is one of the strongest Atlantic tropical cyclones of record.

Table 4-1 lists the hurricane characteristics mentioned above as a function of category, as well as the expected central pressure.

Table 4-1
Hurricane Characteristics

Category	CENTRAL PRESSURE		WIND SPEED		SURGE Feet	Damage Potential
	Millibars	Inches	MPH	Knots		
1	>980	>28.9	74-95	64-83	4-5	Minimal
2	965-979	28.5-28.9	96-110	84-96	6-8	Moderate
3	945-964	27.9-28.5	111-130	97-113	9-12	Extensive
4	920-644	27.2-27.9	131-155	114-135	13-18	Extreme
5	<920	<27.2	>155	>135	>18	Catastrophic

The Saffir / Simpson Hurricane Scale assumes an average, uniform coastline for the continental United States and was intended as a general guide for use by public safety officials during hurricane emergencies. It does not reflect the effects of varying localized bathymetry, coastline configuration, astronomical tides, barriers or other factors that may modify surge heights at the local level during a single hurricane event. For inland communities such as the City of Waterbury, the coastline assumption is not applicable.

According to Connecticut's Natural Hazard Mitigation Plan, a moderate Category 2 hurricane is expected to strike Connecticut once every ten years, whereas a Category 3 or Category 4 hurricane is expected before the year 2040. These frequencies are based partly on the historic record, described in the next section.

4.3 Historic Record

Through research efforts by NOAA's National Climate Center in cooperation with the National Hurricane Center, records of tropical cyclone occurrences within the Atlantic Cyclone Basin have been compiled from 1851 to present. These records are compiled in NOAA's Hurricane database (HURDAT), which contains historical data in the process of being reanalyzed to current scientific standards, as well as the most current hurricane data. During HURDAT's period of record, 29 hurricanes and 67 tropical storms have passed within a 150 mile radius of Newport, Rhode Island.

Since 1900, eight direct hits and two hurricanes that did not make landfall (but passed close to the shoreline) were recorded along the Connecticut coast, of which there were four Category 3, two Category 2, and two Category 1 hurricanes (two of the ten struck Connecticut before the Saffir / Simpson scale was developed). Of the four Category 3 hurricanes, two occurred in September and two occurred in August.

The most devastating hurricane to strike Connecticut, and believed to be the strongest hurricane to hit New England in recorded history, was believed to be a Category 3 hurricane. Dubbed the "Long Island Express of September 21, 1938", this name was derived from the unusually high forward speed of the hurricane, estimated to be 70 mph. The hurricane made landfall at Long Island, New York and moved quickly northward over Connecticut into northern New England.

The majority of damage was caused from storm surge and wind damage. Surges of 10 to 12 feet were recorded along portions of the Long Island and Connecticut Coast, and heavy winds flattened forests, destroyed nearly 5,000 cottages, farms, and homes, and damaged an estimated 15,000 more throughout New York and southern New England. Overall, the storm left an estimated 700 dead and caused physical damages in excess of $300 million (1938 United States dollars (USD)).

The "Great Atlantic Hurricane" hit the Connecticut coast in September 1944. This Category 3 hurricane brought rainfall in excess of six inches to most of the state and rainfall in excess of eight to ten inches in Fairfield County. Most of the wind damage from this storm occurred in southeastern Connecticut.

Another Category 3 hurricane, Hurricane Carol, struck in August of 1954 shortly after high tide and produced storm surges of 10 to 15 feet in southeastern Connecticut. Rainfall amounts of six inches were recorded in New London, and wind gusts peaked at over 100 mph. Near the coast, the combination of strong winds and storm surge damaged or destroyed thousands of buildings, and the winds toppled trees that left most of the eastern part of the state without power. Overall damages were estimated at $461 million (1954 USD), and 60 people died as a direct result of the hurricane. Western Connecticut was largely unaffected by Hurricane Carol due to the compact nature of the hurricane.

The following year, back-to-back hurricanes Connie and Diane caused torrential rains and record-breaking floods in Connecticut. Hurricane Connie was a declining tropical storm when it hit Connecticut in August of 1955, producing heavy rainfall of four to six inches across the state. The saturated soil conditions exacerbated the flooding caused by Diane five days later, a Category 1 hurricane and the wettest tropical cyclone on record for the Northeast. Diane produced 14 inches of rain in a 30-hour period, causing destructive flooding conditions along nearly every major river system in the state. The Mad and Still Rivers in Winsted, the Naugatuck River, the Farmington River, and the Quinebaug River in northeastern Connecticut caused the most damage. The flood waters caused over 100 deaths, left 86,000 unemployed, and caused an estimated $200 million in damages (1955 USD). For comparison, the total property taxes levied by all Connecticut municipalities in 1954 amounted to $194.1 million.

More recently, flooding and winds associated with hurricanes have caused extensive shoreline erosion and related damage. In September of 1985, hurricane Gloria passed over the coastline as a Category 2 hurricane. The hurricane struck at low tide, resulting

in low to moderate storm surges along the coast. The storm produced up to six inches of rain and heavy winds which damaged structures and uprooted trees. Over 500,000 people suffered significant power outages. Hurricane Bob, a Category 2 hurricane making landfall in 1991, caused storm surge damage along the Connecticut coast, but was more extensively felt in Rhode Island and Massachusetts. Heavy winds were felt across eastern Connecticut with gusts up to 100 mph recorded, and the storm was responsible for six deaths in the state. Total damage in southern New England was approximately $1.5 billion (1991 USD).

The most recent tropical cyclone to hit Connecticut was tropical storm Floyd in 1999. Floyd is the storm of record in the Connecticut Natural Hazard Mitigation Plan and is discussed in more detail in Section 3.3. Tropical Storm Floyd caused power outages throughout New England and at least one death in Connecticut.

4.4 Existing Programs, Policies, and Mitigation Measures

Existing mitigation measures appropriate for inland flooding have been discussed in previous sections. These include ordinances, codes, and regulations that have been enacted to minimize flood damage. In addition, various structures exist to protect certain areas, including, levees, dams, and riprap.

Wind loading requirements are addressed through the state building code. The Connecticut Building Code was amended in 2005 and adopted with an effective date of December 31, 2005. The new code specifies the design wind speed for construction in all the Connecticut municipalities, with the addition of split zones for some towns. For example, for towns along the Merritt Parkway such as Fairfield and Trumbull, wind speed criteria are different north and south of the Parkway in relation to the distance from the shoreline. Effective December 31, 2005, the design wind speed for Waterbury is 90 miles per hour.

Tall and older trees and branches may fall during heavy wind events, potentially damaging structures, utility lines, and vehicles. The Waterbury Public Works Department approaches residents on a case-by-case basis if branches appear to be hazardous. Otherwise, it performs roadside tree maintenance, and Connecticut Light & Power performs trimming near power lines as well. According to Section 5.27 of the Waterbury Land Subdivision Regulations, the City policy is for utilities in new subdivisions to be located underground whenever possible. This helps to mitigate wind-related and other natural hazard-related damages.

The primary shelters in the City of Waterbury are the three high schools, with additional shelters being churches and elementary schools as necessary. As discussed in Section 2.9, evacuation routes are determined on a case by case basis by members of the Police Department. The City relies on radio and television to spread information on the location and availability of shelters. Prior to severe storm events, the City ensures that warning/notification systems and communication equipment is working properly, and prepares for the possible evacuation of impacted areas.

4.5 Vulnerabilities and Risk Assessment

It is generally believed that New England is long overdue for another major hurricane strike. According to the State of Connecticut Natural Hazard Mitigation Plan, a moderate Category 2 storm is expected to strike the state once per decade. The City of Waterbury is less vulnerable to hurricane damage than coastal towns in Connecticut because it does not need to deal with the effects of storm surge.

The City of Waterbury is vulnerable to hurricane damage from wind and flooding, and from any tornadoes accompanying the storm. Areas of known and potential flooding problems are discussed in Section 3.0, and tornadoes are discussed in Section 5.0. The entire City is also vulnerable to wind damage. Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. Debris such as signs, roofing material,

and small items left outside become flying missiles in hurricanes. Extensive damage to trees, towers, aboveground and underground utility lines (from uprooted trees), and fallen poles cause considerable disruption for residents. Streets may be flooded or blocked by fallen branches, poles, or trees, preventing egress. Downed power lines can also start electrical fires, so adequate fire protection is important.

As the residents and businesses of the State of Connecticut become more dependent on the internet and mobile communications, the impact of hurricanes on commerce will continue to increase. A major hurricane has the potential of causing complete disruption of power and communications for up several weeks, rendering electronic devices and those that rely on utility towers and lines inoperative. According to the Connecticut DEP, this is a significant risk which can not be quantitatively estimated.

As the City of Waterbury is not affected by storm surge, hurricane sheltering needs have not been calculated by the Army Corps of Engineers for the City. It is assumed that sheltering need will be based upon areas damaged within the City. Under limited emergency conditions, a high percentage of evacuees will seek shelter with friends or relatives rather than go to established shelters. During extended power outages, it is believed that only 10% to 20% of the affected population of Waterbury will relocate.

4.6 Potential Mitigation Measures, Strategies, and Alternatives

Many potential mitigation measures for hurricanes include those appropriate for inland flooding. These were presented in Section 3.0. However, hurricane mitigation measures must also address the effects of heavy winds that are inherently caused by hurricanes. Mitigation for wind damage is therefore emphasized in the subsections below.

4.6.1 Prevention

Although hurricanes and tropical storms cannot be prevented, a number of methods are available to continue preventing damage from the storms, and perhaps to mitigate damage. The following actions have been identified as potential preventive measures:

- Continue City-wide tree limb inspection and maintenance programs to ensure that the potential for downed power lines is diminished.
- Continue location of utilities underground in new developments or as related to redevelopment.
- Continue to review the Emergency Operations Plan for the City and update when necessary.

4.6.2 Property Protection

Potential mitigation measures include designs for hazard-resistant construction and retrofitting techniques. These may take the form on increased wind and flood resistance, as well as the use of storm shutters over exposed glass and the inclusion of hurricane straps to hold roofs to buildings. Compliance with the amended Connecticut Building Code for wind speeds is necessary. Literature should be made available to developers during the permitting process regarding these design standards.

4.6.3 Public Education and Awareness

The public should be made aware of evacuation routes and available shelters. A number of specific proposals for improved *public education* are recommended to prevent damage and loss of life during hurricanes. These are common to all hazards in this plan, and are listed in Section 11.1.

4.6.4 Emergency Services

The Emergency Operation Plan of the City of Waterbury includes guidelines and specifications for communication of hurricane warnings and watches, as well as for a call for evacuation. The public needs to be made aware in advance of a hurricane event of evacuation routes and the locations of public shelters. In addition, Waterbury emergency personnel should identify and prepare additional facilities for evacuation and sheltering needs. The City should also review its mutual aid agreements and update as necessary to ensure help is available as needed.

4.6.5 Structural Projects

Structural projects for wind damage mitigation are not possible.

4.7 Summary of Potential Mitigation Measures, Strategies, and Alternatives

Recommendations included in Section 3.6 for the mitigation of inland flooding are also pertinent to mitigating tropical storm or hurricane related flooding. Recommendations for mitigation of hurricane and tropical storm winds include the following:

- Increase tree limb maintenance and inspections on public property;
- Continue outreach to residents warning of dangerous trees on their properties; and
- Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.

In addition, important recommendations that apply to all hazards are listed in Section 11.1.

5.0 SUMMER STORMS AND TORNADOES

5.1 Setting

Like hurricanes and winter storms, summer storms and tornadoes have the potential to affect any area within the City of Waterbury. Furthermore, because these types of storms and the hazards that result (flash flooding, wind, hail, and lightning) might have limited geographic extent, it is possible for a summer storm to harm one area within the City without harming another. The entire City of Waterbury is therefore susceptible to summer storms (including heavy rain, flash flooding, wind, hail, and lightning) and tornadoes.

Based on the historic record, it is considered highly likely that a summer storm that includes lightning will impact the City of Waterbury each year, although lightning strikes have a limited effect. Strong winds and hail are considered likely to occur during such storms but also generally have limited effects. A tornado is considered a possible event each year that could cause significant damage to a small area.

5.2 Hazard Assessment

Heavy wind (including tornadoes and downbursts), lightning, heavy rain, hail, and flash floods are the primary hazards associated with summer storms. Inland flooding and flash flooding caused by heavy rainfall was covered in Section 3.0 of this plan and will not be discussed in detail here.

Tornadoes

Tornadoes are spawned by certain thunderstorms. The Fujita scale was accepted as the official classification system for tornado damage for many years following its publication

in 1971. The Fujita scale rated the intensity of a tornado by examining the damage caused by the tornado after it has passed over a man-made structure. The scale ranked tornadoes using the now-familiar notation of F0 through F5, increasing with wind speed and intensity. The following graphic of the Fujita scale is provided by FEMA. A description of the scale follows in Table 5-1.

Fujita Tornado Scale

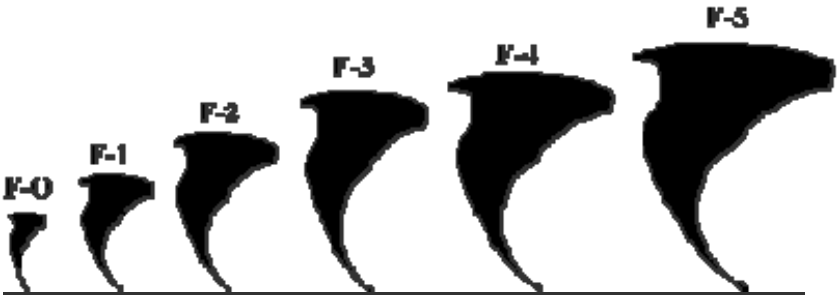


Table 5-1
Fujita Scale

F-Scale Number	Intensity	Wind Speed	Type of Damage Done
F0	Gale tornado	40-72 mph	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards.
F1	Moderate tornado	73-112 mph	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	Significant tornado	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	Severe tornado	158-206 mph	Roof and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted
F4	Devastating tornado	207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated

Table 5-1 (Continued)
Fujita Scale

F-Scale Number	Intensity	Wind Speed	Type of Damage Done
F5	Incredible tornado	261-318 mph	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
F6	Inconceivable tornado	319-379 mph	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 winds that would surround the F6 winds. Missiles, such as cars and refrigerators, would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies.

The Enhanced Fujita Scale was released by NOAA for implementation on February 1, 2007. According to the NOAA web site, the Enhanced Fujita Scale was developed in response to a number of weaknesses to the Fujita Scale that were apparent over the years, including the subjectivity of the original scale based on damage, the use of the worst damage to classify the tornado, the fact that structures have different construction depending on location within the United States, and an overestimation of wind speeds for F3 and greater. The Enhanced F-scale is still a set of wind estimates based on damage. Its uses three-second gusts estimated at the point of damage based on a judgment of eight levels of damage to 28 specific indicators. Table 5-2 relates the Fujita and enhanced Fujita scales.

Table 5-2
Enhanced Fujita Scale

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	*Fastest 1/4-mile (mph)*	*3 Second Gust (mph)*	*EF Number*	*3 Second Gust (mph)*	*EF Number*	*3 Second Gust (mph)*
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

The historic record of tornadoes is discussed in Section 5.3. The pattern of occurrence in Connecticut is expected to remain unchanged, according to the Connecticut DEP Natural Hazard Mitigation Plan (2004). The highest relative risk for tornadoes in the state will continue to be in the Hartford and New Haven Counties. The City of Waterbury, being in New Haven County, is therefore at a relatively higher risk of tornadoes compared to the rest of the state.

Lightning

Lightning is a circuit of electricity that occurs between the positive and negative charges within the atmosphere or between the atmosphere and the ground. In the initial stages of development, air acts as an insulator between the positive and negative charges. However, when the potential between the positive and negative charges becomes too great, a discharge of electricity (lightning) occurs.

In-cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom. Cloud to cloud lightning occurs between the positive charges near the top of the cloud and the negative charges near the bottom of a second cloud. Cloud to ground lightning is the most dangerous. In summertime, most cloud to ground lightning occurs between the negative charges near the bottom of the cloud and positive charges on the ground.

According to NOAA's National Weather Service, lightning reportedly kills an average of 80 people per year in the United States, in addition to an average of 300 lightning injuries per year. Only 15 lightning-related fatalities occurred in Connecticut between 1959 and 2005. Most lightning deaths and injuries occur outdoors, with 45% of lightning casualties occurring in open fields and ballparks, 23% under trees, and 14% involving water activities.

Thunderstorms occur 18 to 35 days each year in Connecticut. In general, thunderstorms in Connecticut are more frequent in the western and northern parts of the state, and less frequent in the southern and eastern parts. Although lightning is usually associated with thunderstorms, it can occur on almost any day. The likelihood of lightning strikes in the Waterbury area is very high during any given thunderstorm, although no single area of the City is at higher risk of lightning strikes.

Downbursts

A downburst is a severe localized wind blasting down from a thunderstorm. They are more common than tornadoes in Connecticut. These "straight line" winds are distinguishable from tornadic activity by the pattern of destruction and debris. Depending on the size and location of these events, the destruction to property may be significant. Downbursts may be categorized as microbursts (affecting an area less than 2.5 miles in diameter) or macrobursts (affecting an area at least 2.5 miles in diameter).

It is difficult to find statistical data regarding frequency of downburst activity. However, downburst activity is, on occasion, mistaken for tornado activity in Connecticut, indicating that it is a relatively uncommon yet persistent hazard. The risk to the City of Waterbury is believed to be moderate for any given year. Downburst activity in New Haven County is believed to have occurred most recently on May 16, 2007.

Hail

Hailstones are chunks of ice that grow as updrafts in thunderstorms keep them in the atmosphere. Most hailstones are smaller in diameter than a dime, but stones weighing more than a pound have been recorded. While crops are the major victims of hail, it is also a hazard to vehicles and property.

Hailstorms typically occur in at least one part of Connecticut each year during a severe thunderstorm. As with thunderstorms, hailstorms are more frequent in the northwest and western portions of the state, and less frequent in the southern and eastern portions. The likelihood of one hailstorm occurring in Waterbury is moderate in any given year.

5.3 Historic Record

The National Climatic Data Center (NCDC) lists 10 tornado events in New Haven County since 1950. This includes one F4 rated tornado, two F3 rated tornadoes, and three F2 rated tornadoes. Property damages from tornados in the county totaled approximately $280 million. Table 5-3 lists the tornado events for New Haven County.

Table 5-3
Tornado Events in New Haven County Since 1950

Date	Fujita Tornado Scale	Property Damage	Wind Speed
October 24, 1955	F2	$3,000	113 – 157 mph
August 29, 1959	F-	$0	Unknown
May 24, 1962	F3	$2,500,000	158 – 206 mph
July 29, 1971	F3	$250,000	158 – 206 mph
September 18, 1973	F2	$0	113 – 157 mph
July 28, 1982	F1	$3,000	73 – 112 mph
July 10, 1989	F2	$25,000,000	113 – 157 mph
July 10, 1989	F4	$250,000,000	207 – 260 mph
May 29, 1995	F-	$10,000	Unknown
May 29, 1995	F1	$50,000	73 – 112 mph
July 23, 1995	F0	$0	40 – 72 mph
July 3, 1996	F1	$2,000,000	73 – 112 mph
May 31, 2002	F0	$0	40 – 72 mph

A limited selection of summer storm damage in the area, taken from the NCDC Storm Events database, is listed below:

- May 24, 1962 – A F3 tornado touched down on the western side of Waterbury and moved east across the City, causing $2.5 million in damages.
- July 29, 1971 – A F3 tornado touched down in Waterbury near the Route 8 and Interstate 84 interchange, causing $250 thousand in damages.
- July 10, 1989 – A F2 tornado touched down in Waterbury near the City center and moved in an east-northeast direction for three miles, causing $25 million in damages.
- May 11, 1996 – A line of severe thunderstorms produced high winds that knocked down trees and power lines in Waterbury.
- July 3, 1996 – An F1 tornado touched down in the vicinity of Wilby High School with a path length of about 0.3 miles and a path width of approximately 100 yards. The tornado destroyed a tool shed and then moved northeast across the school's football field. It blew down the scoreboard, destroyed a set of bleachers, and scattered both over a half-mile away. The tornado next did serious damage to the roof of the school building and blew out several windows. Early damage estimates for Wilby High School were on the order of $1 million. The tornado lifted just northeast of the school and later touched down in Wolcott.
- January 18, 1999 – Thunderstorms and heavy showers occurred ahead of an approaching cold front, causing a brief period of high winds and torrential rain. Lightning struck the house at 64Keefe Street in Waterbury, leaving a burn mark on the back of the house. A 42 year old man working in the garage suffered second-degree burns on his hands from the strike.
- March 3, 1999 – Lightning struck and ignited a fire that destroyed a three-story garage near Lakewood Park.
- July 24, 1999 – A severe thunderstorm produced high winds that downed trees and power lines in Waterbury.

- May 18, 2000 - As a line containing severe thunderstorms swept southeast across the region, it produced damaging wind gusts, "mainly" small hail (less than 3/4-inch in diameter), heavy rain and lightning. Peak wind gusts were measured at 70 mph at The Connecticut Weather Center in Danbury. Spotters reported downed trees, tree limbs, and wires in Bethel, Waterbury, Stratford and Hamden.
- June 16, 2002 – A severe thunderstorm produced large hail and damaging wind gusts throughout northern Fairfield, northern New Haven, and northern Middlesex Counties. Three-quarter-inch hail was reported in Waterbury.
- May 28, 2003: A short line of severe thunderstorms produced hail up to the size of a penny in Waterbury.
- August 20, 2004 – An intense severe thunderstorm produced golfball-sized hail and very strong wind gusts in Waterbury. The storm downed several trees, some of which fell on cars and blocked roads.
- August 21, 2004 – Trees and wires were downed by thunderstorm winds in Waterbury and Cheshire. In Cheshire, power lines fell on a house. Three miles northeast of Waterbury, a tree fell onto a truck.
- May 31, 2005 – As thunderstorms moved across the state, lightning struck and injured two people: one in Waterbury and one in Stonington.
- August 3, 2006 – A cluster of severe thunderstorms moved east across Southern Connecticut. High winds downed trees and power lines in Waterbury.
- May 16, 2007 – Downburst activity in New Haven County was caused by a severe thunderstorm system moving through Connecticut.

5.4 Existing Programs, Policies, and Mitigation Measures

Warning is the primary method of existing mitigation for tornadoes and summer storm-related hazards. A ***severe thunderstorm watch*** is issued by the National Weather Service when the weather conditions are such that a severe thunderstorm (damaging winds 58 miles per hour or more, or hail three-fourths of an inch in diameter or greater) is likely to develop. A ***severe thunderstorm warning*** is issued when a severe thunderstorm has been

sighted or indicated by weather radar. Tables 5-4 and 5-5 list the National Oceanic and Atmospheric Administration (NOAA) Watches and Warnings, respectively, as pertaining to actions to be taken by emergency management personnel in connection with summer storms and tornadoes.

Table 5-4
NOAA Weather Watches

Weather Condition	Meaning	Actions
Severe Thunderstorm	Severe thunderstorms are possible in your area.	Notify personnel, and watch for severe weather.
Tornado	Tornadoes are possible in your area.	Notify personnel, and be prepared to move quickly if a warning is issued.
Flash Flood	It is possible that rains will cause flash flooding in your area.	Notify personnel to watch for street or river flooding.

Table 5-5
NOAA Weather Warnings

Weather Condition	Meaning	Actions
Severe Thunderstorm	Severe thunderstorms are occurring or are imminent in your area.	Notify personnel and watch for severe conditions or damage (i.e. downed power lines and trees. Take appropriate actions listed in city emergency plans.
Tornado	Tornadoes are occurring or are imminent in your area.	Notify personnel, watch for severe weather and ensure personnel are protected. Take appropriate actions listed in emergency plans.
Flash Flood	Flash flooding is occurring or imminent in your area.	Watch local rivers and streams. Be prepared to evacuate low-lying areas. Take appropriate actions listed in emergency plans.

Aside from warnings, several other methods of mitigation for wind damage, tornadoes, lightning, and hail are employed in Waterbury. Continued location of utilities underground is an important method of reducing damage to utilities and the resulting loss

of services. The Connecticut Building Codes include guidelines for Wind Load Criteria that are specific to each municipality, as explained in Section 4.0. The building codes also address the proper grounding of structures to reduce lightning damage. In addition, specific mitigation measures address debris removal and tree trimming.

In the City of Waterbury, the local electric utility (Connecticut Light & Power) is responsible for tree branch removal and maintenance above and near power lines. In addition, all new developments in Waterbury must place utilities underground wherever possible. The Public Works Department has the responsibility of maintaining trees on municipal property. The Department is responsible for trimming over roadways, and staff routinely monitor for downed tree limbs during storms. The City also approaches residents on a case-by-case basis when trees and branches on their property look hazardous.

Municipal responsibilities relative to tornado mitigation and preparedness include:

- Developing and disseminating emergency public information and instructions concerning tornado safety, especially guidance regarding in-home protection and evacuation procedures, and locations of public shelters.
- Identify and designate appropriate shelter space in the community that could potentially withstand tornado impact.
- Periodically test and exercise tornado response plans.
- Put emergency personnel on standby at tornado 'watch' stage.

5.5 Vulnerabilities and Risk Assessment

The central and southern portions of the United States are at higher risk for lightning and thunderstorms than is the northeast. However, more deaths from lightning occur on the East Coast than elsewhere, according to FEMA. Lightning-related fatalities have declined in recent years due to increased education and awareness.

Most thunderstorm damage is caused by straight-line winds exceeding 100 mph. Straight-line winds occur as the first gust of a thunderstorm or from the downburst from a thunderstorm, and have no associated rotation. Waterbury is susceptible to damage from high winds due to its heavily treed landscape in outlying areas, older buildings, and high residential density.

Heavy winds can take down trees near power lines, leading to the start of electrical fires. Such fires can be extremely dangerous during the summer months during drought conditions. Most downed power lines in Waterbury are detected quickly and any associated fires are quickly extinguished. However, it is important to have adequate water supply for fire protection to ensure this level of safety is maintained.

5.6 Potential Mitigation Measures, Strategies, and Alternatives

Both the FEMA and the NOAA websites contain valuable information regarding preparing for and protecting oneself during a tornado, as well as information on a number of other natural hazards. This information is available at:

FEMA
http://www.fema.gov/library/prepandprev.shtm.

NOAA
http://www.nssl.noaa.gov/NWSTornado/

Available information from FEMA includes:

- Design and construction guidance for community shelters.

- Recommendations to better protect from tornado damage for your business, community, and home. This includes construction and design guidelines for business and homes, as well as guidelines for creating and identifying shelters.
- Ways to better protect property from wind damage.
- Ways to protect property from flooding damage.
- Construction of safe rooms within homes.

NOAA information includes a discussion of family preparedness procedures and the best physical locations during a storm event. Although tornadoes pose a legitimate threat to public safety, their occurrence is considered too infrequent to justify the construction of tornado shelters. Residents should be encouraged to purchase a NOAA weather radio containing an alarm feature.

The implementation of an emergency notification system would be beneficial in warning residents of an impending tornado. A community warning system that relies on radios and television is less effective at warning residents during the night when the majority of the community is asleep. This fact was evidenced most recently by the severe storm which struck Lake County, Florida on February 2, 2007. This powerful storm that included several tornadoes stuck at about 3:15 AM. According to National Public Radio, local broadcast stations had difficultly warning residents due to the lack of listeners and viewers and encouraged those awake to telephone warnings into the affected area.

The City of Waterbury owns two golf courses and several parks. The City is interested in developing an early warning system to warn the users of these facilities of impending dangerous summer storms including heavy wind, lightning and/or hail.

Specific mitigation steps that can be taken to prevent property damage and protect property are given below.

Prevention

- Continue or increase tree limb inspection programs to ensure that the potential for downed power lines is minimized.
- Continue to place utilities underground.

Property Protection

- Require compliance with the amended Connecticut Building Code for wind speeds.
- Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards.

5.7 Summary of Potential Mitigation Measures, Strategies, and Alternatives

The following actions are recommended to mitigate for winds, hail, tornadoes, and downbursts:

- Increase tree limb maintenance and inspections.
- Continue outreach regarding dangerous trees on private property.
- Develop an early-warning system to alert residents in municipally-owned parks and golf courses that heavy wind, hail, and/or lightning is possible.
- Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.
- Continue to require compliance with the amended Connecticut Building Code for wind speeds.
- Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards.

In addition, important recommendations that apply to all hazards are listed in Section 11.1.

6.0 WINTER STORMS

6.1 Setting

Similar to summer storms and tornadoes, winter storms have the potential to affect any area of the City of Waterbury. However, unlike summer storms, winter events and the hazards that result (wind, snow, and ice) have more widespread geographic extent. The entire City of Waterbury is susceptible to winter storms. In general, winter storms are considered highly likely to occur each year, and the hazards that result (nor'easter winds, snow, and blizzard conditions) are expected to have a significant effect over a large area of the City.

6.2 Hazard Assessment

This section focuses on those effects commonly associated with winter storms, including those from blizzards, ice storms, heavy snow, freezing rain and extreme cold. Most deaths from winter storms are indirectly related to the storm, such as from traffic accidents on icy roads and hypothermia from prolonged exposure to cold. Damage to trees and tree limbs and the resultant downing of utility cables are a common effect of these types of events. Secondary effects include loss of power and heat.

According to the National Weather Service, approximately 70% of winter deaths related to snow and ice occur in automobiles, and approximately 25% of deaths occur from people being caught in the cold. In relation to deaths from exposure to cold, 50% are people over 60 years old, 75% are male, and 20% occur in the home.

The classic winter storm in New England is the nor'easter, which is caused by a warm moist, low pressure system moving up from the south colliding with a cold, dry high pressure system moving down from the north. Severe winter storms can produce an array

of hazardous weather conditions, including heavy snow, blizzards, freezing rain and ice pellets, and extreme cold. The National Weather Service defines a blizzard as having winds over 35 mph with snow and blowing snow reducing visibility to near zero.

Connecticut experiences at least one severe winter storm every five years, although a variety of small and medium snow and ice storms occur nearly every winter. The likelihood of a nor'easter occurring in any given winter is therefore considered high, and the likelihood of other winter storms occurring in any given winter is very high.

The Northeast Snowfall Impact Scale (NESIS) was developed by Paul Kocin and Louis Uccellini (Kocin and Uccellini, 2004) and is used by NOAA to characterize and rank high-impact Northeast snowstorms. These storms have large areas of snowfall accumulations of ten inches and above. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm's societal impacts.

NESIS values are calculated within a geographical information system (GIS). The aerial distribution of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. Table 6-1 presents the NESIS categories, their corresponding NESIS values, and a descriptive adjective.

Table 6-1
NESIS Categories

Category	NESIS Value	Description
1	1—2.499	Notable
2	2.5—3.99	Significant
3	4—5.99	Major
4	6—9.99	Crippling
5	10.0+	Extreme

6.3 Historic Record

According to the NCDC, there have been 87 snow and ice events in the State of Connecticut between 1993 and 2006, causing over $18 million in damages. Notably, heavy snow in December 1996 caused $6 million in property damage. Snow removal and power restoration for a winter storm event spanning March 31 and April 1, 1997 cost $1 million. On March 5, 2001, heavy snow caused $5 million in damages, followed by another heavy snow event four days later that caused an additional $2 million in damages. The last documented winter storm event that qualified as a blizzard occurred in January of 1996. These events were recorded for various counties throughout the state.

With regard to major winter nor'easters, seven have occurred in Connecticut during the past 30 years (in 1979, 1983, 1988, 1992, 1996, 2003, and 2006). The 1992 nor'easter, in particular, caused the third-highest tides ever recorded in Long Island Sound and damaged 6,000 coastal homes. Inland areas received up to four feet of snow. Winter storm Ginger in 1996 caused over two feet of snow and shut down the State of Connecticut for 24 hours. The nor'easter which occurred on February 12 and 13, 2006 resulted in 18 to 24 inches of snow across Connecticut and was rated on NESIS as a Category 3 "Major" storm across the northeast. This storm ranked 20th out of 33 major winter storms ranked by NESIS for the northeastern United States since 1956.

Catastrophic ice storms are less frequent in Connecticut than the rest of New England due to the close proximity of the warmer waters of the Atlantic Ocean and Long Island Sound. The most severe ice storm in Connecticut on record was Ice Storm Felix on December 18, 1973. This storm resulted in two deaths and widespread power outages throughout the state. An ice storm in November of 2002 that hit Litchfield and western Hartford Counties resulted in $2.5 million in public sector damages.

6.4 Existing Programs, Policies, and Mitigation Measures

Existing programs applicable to inland flooding and wind are the same as those discussed in Sections 3.0 and 4.0. Programs that are specific to winter storms are generally those related to preparing plows, sand and salt trucks; tree-trimming to protect power lines; and other associated snow removal and response preparations.

As it is almost guaranteed that winter storms will occur annually in Connecticut, it is important for municipalities to budget fiscal resources towards snow management. The City ensures that all warning/notification and communications systems are ready before a storm, and ensures that appropriate equipment and supplies are in place and in good working order. The City also prepares for the possible evacuation and sheltering of some populations which could be impacted by the upcoming storm (especially the elderly and special needs persons).

Snow removal is mainly subcontracted in Waterbury. The state plows Routes 8, 69, 73, and Interstate 84. In addition, the City has currently approved capitol budget funding in the 2007-2010 budget for road de-icing safety improvements, and a small sand/salt storage facility in the City.

The City of Waterbury Land Subdivision Regulations discourages the creation of cul-de-sacs whenever a feasible connection to a through street can be created. This policy presents residents and emergency personnel with two means of egress into neighborhoods

in the City, ensuring that residents will not be cut off from critical facilities during times of need.

Although the City's geography prevents a prioritization of plowing routes due to the many dead-end streets and meandering arterials, the City is zoned into plowing districts and the subcontractors in each district can respond to individual needs within their districts. This procedure has worked in the past and is proposed for future winter storms.

6.5 Vulnerabilities and Risk Assessment

As mentioned for summer storms, the heavily treed landscape in outlying areas in close proximity to densely populated residential areas in the City poses problems in relation to blizzard condition damage. Tree limbs and some building structures may not be suited to withstand high wind and snow loads. Ice can damage or collapse power lines, render steep gradients impassable for motorists, undermine foundations, and cause "flood" damage from ice freezing water pipes in basements.

In addition, winter storms present additional problems for motorists all over the state. As the population of Connecticut and its dependence on transportation continues to increase, the vulnerability of the state to winter storms also increases. There is a high propensity for traffic accidents during heavy snow and even light icing events. Roads may become impassable, inhibiting the ability of emergency equipment to reach trouble spots and the accessibility to medical and shelter facilities. Stranded motorists, especially senior and/or handicapped citizens, are at particularly high risk of injury or death during a blizzard. After a storm, snow piled on the sides of roadways can inhibit line of sight and reflect a blinding amount of sunlight, making driving difficult. When coupled with slippery road conditions, poor sightlines and heavy glare create dangerous driving conditions.

Road icing is a major problem in Waterbury. The shallow water table contributes to the icing of roads in several areas through a combination of frequent seepage, a lack of

infiltration, and poor or absent drainage systems. These ice-prone areas are listed in Tables 6-2 and 6-3.

Table 6-2
Roadways Prone to Significant Icing in Winter

Street Name	Reason
1. Aldur Street	Icing due to poor drainage
2. Blanchard Street*	Road has no storm drains. Ice ponds on roads and in yards in winter. Repeated freeze/thaw creates uneven ice and treacherous walking/driving conditions
3. Campfield Road*	Road has no storm drains. Runoff from private property pools on roadway and freezes in winter
4. East Main Street near Silver St.	Deteriorated sidewalk contributes to icing problems at this intersection
5. East Mountain Road west of Pineridge Road	Icing due to poor drainage
6. Fiske Street	Icing due to poor drainage
7. Gem Drive	Road ices and floods driveways
8. Hans Avenue near Bradley Avenue & Arnold Street	Icing due to poor drainage
9. Lakeside Boulevard East	Chronic icing due to lack of a drainage system
10. Mountain View Drive*	Road has no storm drains. Groundwater seeping into the roadway freezes in winter
11. North Walnut Street*	Groundwater seepage ices the roadway. Needs a curtain drain near #154
12. Ohio Avenue	Technically a "paper" street, the steep slope prevents this road and Connecticut Avenue from being plowed. Three houses are affected by limited emergency and public service egress in the winter.
13. Rockledge Drive	Road has no storm drains. Groundwater seepage causes icing of road in winter
14. Traverse Street at Hope Street	Groundwater seepage on Hope Street causes icing on both roads in winter
15. Waterville Street	Icing due poor drainage
16. Westridge Drive	Water flowing down the street causes icing problems.

*Denotes an existing or proposed capital improvement project for fiscal years 2007-2011.

Table 6-3
Roadways Prone to Icing Based on Sanding List, 2007

Town Plot Area	
Esther Avenue	Greenmount Terrace
Wesley Street	Bank Street
Ernest Avenue	St. Jean Street
Arnold Street	Malmalick Avenue
Nichols Drive	Country Club Road to Oronoke Road
South Leonard Street	Highview Street
North End Area	
Lamont Street	Boyden Street
Fiske Street	Bucks Hill Road
Heola Street	Waverly Street
Waterville Street	North Walnut Street
Lincoln Street	Griggs Street
Willow Street	
South End Area	
Springbrook Road	
West End Area	
Clough Road	Lakeside Blvd East
Cardinal Lane	Maplewood Street
Oakville Avenue	Douglas Avenue
East End Area	
Harland Avenue	Rockledge Drive
Hamilton Avenue	

Freezing conditions in the upper levels of the soil can also cause shallow utility lines to stress or breaks to occur in water transmission lines. Such breaks can cause a reduction in the availability of public water supply and fire fighting capability. The loss of fire fighting capability can be dangerous during winter storms when electrical fires can start as a result of roof collapses and power line breaks due to ice damage. Upper soil freezing and thawing can cause frost heave, contributing to the disintegration of sidewalks and impeding pedestrian egress along the sides of streets and potentially to and from critical facilities. A notable example of this type of damage is on the sidewalk along Boyden Street.

Drifting snow is not as large a problem in Waterbury as other areas, but it still occurs. This problem is mitigated through municipally subcontracted plowing efforts.

6.6 Potential Mitigation Measures, Strategies, and Alternatives

Potential mitigation measures for flooding caused by nor'easters include those appropriate for flooding. These were presented in Section 3.6. Winter storm mitigation measures must also address blizzard, snow, and ice hazards. These are emphasized below. Note that structural projects are generally not applicable to hazard mitigation for wind, blizzard, snow, and ice hazards.

6.6.1 Prevention

Cold air, wind, snow, and ice can not be prevented from impacting any particular area. Thus, mitigation should be focused on property protection and emergency services (discussed below) and prevention of damage as caused by breakage of tree limbs.

Previous recommendations for tree limb inspections and maintenance in Sections 4.0 and 5.0 are thus applicable to winter storm hazards, as well. As mentioned previously, utilities in Waterbury should continue to be placed underground where possible. This can occur in connection with new development and also in connection with redevelopment work. Underground utilities cannot be damaged by heavy snow, ice, and winter winds.

6.6.2 Property Protection

Property can be protected during winter storms through the use of shutters, storm doors, and storm windows. Where flat roofs are used on structures, snow removal is important as the heavy load from collecting snow may exceed the bearing capacity of the structure. Heating coils may be used to remove snow from flat roofs, and pipes should be adequately insulated to protect against freezing and bursting. All of these recommendations should apply to new construction, although they may also be applied to

existing buildings during renovations. Finally, as recommended in previous sections, compliance with the amended Connecticut Building Code for wind speeds is necessary.

6.6.3 Public Education and Awareness

The public is typically more aware of the hazardous effects of snow, ice, and cold weather than they are with regard to other hazards discussed in this plan. Nevertheless, people are still stranded in automobiles, get caught outside their homes in adverse weather conditions, and suffer heart failure while shoveling during each winter in Connecticut. Public education should therefore focus on safety tips and reminders to individuals about how to prepare for cold and icy weather, including stocking homes, preparing vehicles, and taking care of themselves during winter storms.

6.6.4 Emergency Services

Emergency services personnel and departments such as Police and Fire should identify areas which may be difficult to access during winter storm events and devise contingency plans to continue servicing those areas during moderate storms.

GPS units should be considered for use in all City vehicles and subcontracted plowing vehicles in order to enable rapid dispatch and/or re-routing to areas that need assistance. Ideally, the GPS units would be available to all vehicle operators when they check in at the Public Works facility.

Available shelters should also be advertised and their locations known to the public prior to a storm event. Finally, mutual aid agreements with surrounding municipalities should be reviewed and updated as necessary to ensure help will be available when needed.

6.7 Summary of Potential Mitigation Measures, Strategies, and Alternatives

Most of the recommendations in Sections 3.6 for mitigating flooding are suitable for mitigation of flooding caused by nor'easters. These are not repeated in this subsection. The following recommendations are applicable to other aspects of winter storms such as winds, snow, and ice:

- Construct drainage improvements for reducing road icing.
- Acquire additional funding for the sand/salt storage facility.
- Consider property acquisitions along Connecticut and Ohio Avenues to reduce the number of people potentially affected by the limited plowing services available in this neighborhood.
- Increase tree limb maintenance and inspections.
- Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.
- Continue to encourage two modes of egress into every neighborhood by the creation of through streets.
- Provide education and outreach materials to property owners on how to protect property through the use of shutters and storm windows, the importance of removing snow from flat roofs, and the importance of insulating pipes adequately to protect from freezing and bursting.
- Purchase GPS units for City vehicles and subcontracted plowing vehicles.

In addition, important recommendations that apply to all hazards are listed in Section 11.1.

7.0 EARTHQUAKES

7.1 Setting

The entire City of Waterbury is susceptible to earthquakes. However, even though earthquakes have the potential to affect any place in the City, the effects may be felt differently in some areas based on the type of geology. In general, earthquakes are considered a hazard that is unlikely to occur, but that may cause significant effects to a large area of the City.

7.2 Hazard Assessment

An earthquake is a sudden rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. Earthquakes can cause buildings and bridges to collapse, disrupt gas, electric and phone lines, and often cause landslides, flash floods, fires, avalanches, and tsunamis. Earthquakes can occur at any time without warning.

The underground point of origin of an earthquake is called its focus; the point on the surface directly above the focus is the epicenter. The magnitude and intensity of an earthquake is determined by the use of the Richter scale and the Mercalli scale, respectively.

The Richter scale defines the magnitude of an earthquake. Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of earthquake waves recorded on instruments which have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value recorded by a seismograph, which record the varying amplitude of ground oscillations.

The magnitude of an earthquake is determined from the logarithm of the amplitude of recorded waves. Being logarithmic, each whole number increase in magnitude represents a tenfold increase in measured strength. Earthquakes with a magnitude of about 2.0 or less are usually called micro-earthquakes, and are generally only recorded locally. Earthquakes with magnitudes of 4.5 or greater are strong enough to be recorded by seismographs all over the world.

The effect of an earthquake on the Earth's surface is called the intensity. The Modified Mercalli Intensity Scale consists of a series of key responses such as people awakening, movement of furniture, damage to chimneys, and total destruction. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It is an arbitrary ranking based on observed effects.

The following is an abbreviated description of the 12 levels of Modified Mercalli intensity from the United States Geological Survey.

I. Not felt except by a very few under especially favorable conditions.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.

IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.

VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rail bent.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.

XII. Damage total. Lines of sight and level are destroyed. Object thrown in the air.

Unlike seismic activity in California, earthquakes in Connecticut are not associated with specific known faults. Instead, earthquakes with epicenters in Connecticut are referred to as being intra-plate activity. Bedrock in Connecticut - and New England in general - is highly capable of transmitting seismic energy; thus, the area impacted by an earthquake in Connecticut can be four to 40 times greater than that of California. In addition, population density is up to 3.5 times greater in Connecticut than in California, potentially putting a greater number of people at risk.

The built environment in Connecticut includes old, non-reinforced masonry that is not seismically designed. Those who live or work in non-reinforced masonry buildings, especially those built on filled land or unstable soils are at the highest risk for injury due to the occurrence of an earthquake. In particular, Waterbury has a large number of masonry buildings.

7.3 Historic Record

According to the USGS Earthquake Hazards Program, Connecticut is a region of very minor seismic activity. This assessment is based on lack of historical and instrumental reports of strong earthquakes. However, earthquakes do occur in this region. The New England states regularly register seismic events.

There were 137 recorded earthquakes in Connecticut between 1598 and 1990. The most severe earthquake in Connecticut's history occurred at East Haddam on May 16, 1791. Stone walls and chimneys were toppled during this quake. In October 1845, an Intensity V earthquake occurred in Bridgeport. An Intensity V earthquake would be a 4.3 on the Richter scale. Another Intensity V earthquake was reported in Stamford in March of 1953. All other seismic activity in Connecticut has ranked less than Intensity V. Recent earthquake activity has been recorded near New Haven in 1988, 1989, and 1990 (2.0, 2.8, and 2.8 in magnitude, respectively), in Greenwich in 1991 (3.0 magnitude), and on Long Island in East Hampton, New York in 1992.

7.4 Existing Programs, Policies, and Mitigation Measures

The Connecticut Building Codes include design criteria for buildings specific to municipality, as adopted by the Building Officials and Code Administrators (BOCA). These include the seismic coefficients for building design in the City of Waterbury. The City has adopted these codes for new construction and they are enforced by the City Building Department. Due to the infrequent nature of damaging earthquakes, land use policies in the City of Waterbury do not address earthquake hazards.

7.5 Vulnerabilities and Risk Assessment

According to the USGS, Connecticut is at a low risk for experiencing a damaging earthquake. The USGS has determined that the State of Connecticut has a 10% chance that at some point in a 50-year period an earthquake would cause peak acceleration (ground shaking) values of 4% to 8% of the force of gravity. To appreciate why these values of ground shaking are expressed as a percentage of the force of gravity, note that it requires more than 100% of the force of gravity to throw objects up in the air.

In terms of felt effects and damage, ground motion at the level of several percent of gravity corresponds to the threshold of damage to buildings and houses (an earthquake intensity of approximately V). For comparison, reports of "dishes, windows and doors disturbed" corresponds to an intensity of about IV, or about 2% of gravity. Reports of "some chimneys broken" correspond to an intensity of about VII, or about 10% to 20% of gravity. According to the USGS National Seismic Hazard Mapping Project, an earthquake impacting the City of Waterbury has a 2% chance of exceeding a peak acceleration of 14-16% of the force of gravity in a 50-year period.

According to the State of Connecticut Department of Emergency Management, the chance that a damaging earthquake of magnitude 5.0 or greater will occur within the state in any one year is 5%. The odds of an earthquake of magnitude 6.0 are about one in 300 each year. Therefore, the City of Waterbury is unlikely to experience a damaging earthquake in any given year. This belief is reinforced by the historical record presented in Section 7.3.

Surficial earth materials behave differently in response to seismic activity. Unconsolidated materials such as sand and artificial fill can amplify the shaking associated with an earthquake. In addition, artificial fill material has the potential for liquefaction. Liquefaction is a phenomenon in which the strength and stiffness of a soil are reduced by earthquake shaking or other rapid loading. It occurs in soils at or near

saturation, especially the finer textured soils. When liquefaction occurs, the strength of the soil decreases and the ability of soil to support building foundations or bridges is reduced. Increased shaking and liquefaction can cause greater damage to buildings and structures, and a greater loss of life.

As explained in Section 2.3, portions of the City of Waterbury are underlain by sand and gravel. Figure 2-5 depicts surficial materials in the City. Structures in these areas are at increased risk from earthquakes due to amplification of seismic energy and/or collapse. The best mitigation for future development in areas of sandy material may be application of the most stringent building codes, or possibly the prohibition of certain types of new construction. The areas that are not at increased risk during an earthquake due to unstable soils are the areas in Figure 2-5 underlain by glacial till.

Areas of steep slopes can collapse during an earthquake, creating landslides. Seismic activity can also break utility lines, such as water mains, electric and telephone lines, and stormwater management systems. Dam failure can also pose a significant threat to developed areas during an earthquake. For this Plan, dam failure has been addressed separately in Section 9.0.

7.6 Potential Mitigation Measures, Strategies, and Alternatives

As earthquakes are difficult to predict and can affect the entire City of Waterbury, potential mitigation can only include adherence to building codes, education of residents, and adequate planning. The following potential mitigation measures have been identified:

- Consider preventing residential development in areas of, on, above, or below steep slopes (slopes exceeding 30%) [the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 may assist with implementation of this recommendation].

- Continue to require adherence to the state building codes.
- Consider adding earthquakes to the list of hazards covered by the Emergency Operations Plan.
- Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs to municipal buildings.

In addition, important recommendations that apply to all hazards are listed in Section 11.1.

8.0 LANDSLIDES

8.1 Setting

The word "landslide" is a general term for most types of landforms and processes involving the downslope movement of soil and rock materials. Landslides have many causes, but most involve earth materials with low shear strength, high ground-water saturation, an interruption of the slope by natural causes or human activities, or a combination of the above.

There are several areas of the City of Waterbury at risk for landslides, as described below. The City of Waterbury has many areas where the topography is extremely steep. Landslides occasionally occur in these areas due to human activities or groundwater saturation. Debris from landslides can flow or move beyond the bottom of the slope, or may impact utilities, resulting in the effects of the landslide being felt in a wider area. In general, the occurrence of landslides and land subsidence is considered possible in any given year, with the potential to cause critical damage to a geographically small area.

8.2 Hazard Assessment

According to the United States Department of Agriculture (USDA), landslides occur in all 50 States, causing $1 to 2 billion in damage and more than 25 fatalities on average each year. Landslides pose serious threats to highways and structures that support fisheries, tourism, timber harvesting, mining, and energy production. Landslides commonly accompany other major natural disasters, such as earthquakes and floods, exacerbating relief and reconstruction efforts. Expanded development onto less desirable slopes and soils has increased the incidence of landslide disasters.

According to the USDA, there are two primary causes for slope failure or landslides. One involves an uneven distribution of weight on a slope. Adding weight to the top of a slope (fill, a structure, tall trees, soil saturation, etc.) or removing weight at the toe of a slope (excavation, erosion, drainage, landslide, etc.) causes the weight on the slope to be uneven and thus often results in slope failure. The second cause of slope failure is typically the wetting of a weak layer that is inclined at the same angle as the ground surface. Water can reduce the strength and lubricate the layer, allowing the upper block of wet soil to slide down the slope. A variation of this cause is the accumulation of water on a soil or rock layer with a low permeability rate. The water can saturate the layers above the water restriction, adding weight to the upper layers. The water on top of the restrictive layer can also reduce the shear strength of the soil and lubricate any failure planes, causing a slope failure.

Landslides are common throughout the Appalachian region and New England. The greatest hazard in these areas is from sliding of clay-rich soils. Landslides are hazardous to life and property both in the landslide itself and in the areas where the landslide material is deposited. While some landslides are stable and unlikely to move again; others can be reactivated by basal undercutting, such as that caused by stream erosion or by excavation. Excavation for road construction can be particularly hazardous. Movement can also recur because of increased ground-water pressure, such as that induced by the removal of forest cover or the diversion of drainage water.

According to the USDA, the following locations are generally prone to landslides:

- Existing old landslides;
- Steep slopes or the base of slopes;
- Areas in or at the base of minor drainage hollows;
- The base or top of an old fill slope or steep cut slope;
- Areas where part of the natural slope is interrupted; and
- Developed hillsides where leach field septic systems are used.

Numerous areas of the City of Waterbury are built on steeply sloping terrain. Such areas have the potential for a landslide to develop, especially when the terrain is characterized by poorly draining soils or served by an inadequate drainage system. Most landslides in the City of Waterbury develop due to heavy rainfall saturating the upper parts of the soil with groundwater, although there are some that develop due to poor excavation practices. Therefore, the likelihood of a naturally-induced landslide occurring in Waterbury is believed to be possible for any given year, as only the most severe of rain events will potentially trigger a landslide, slump, or slope failure.

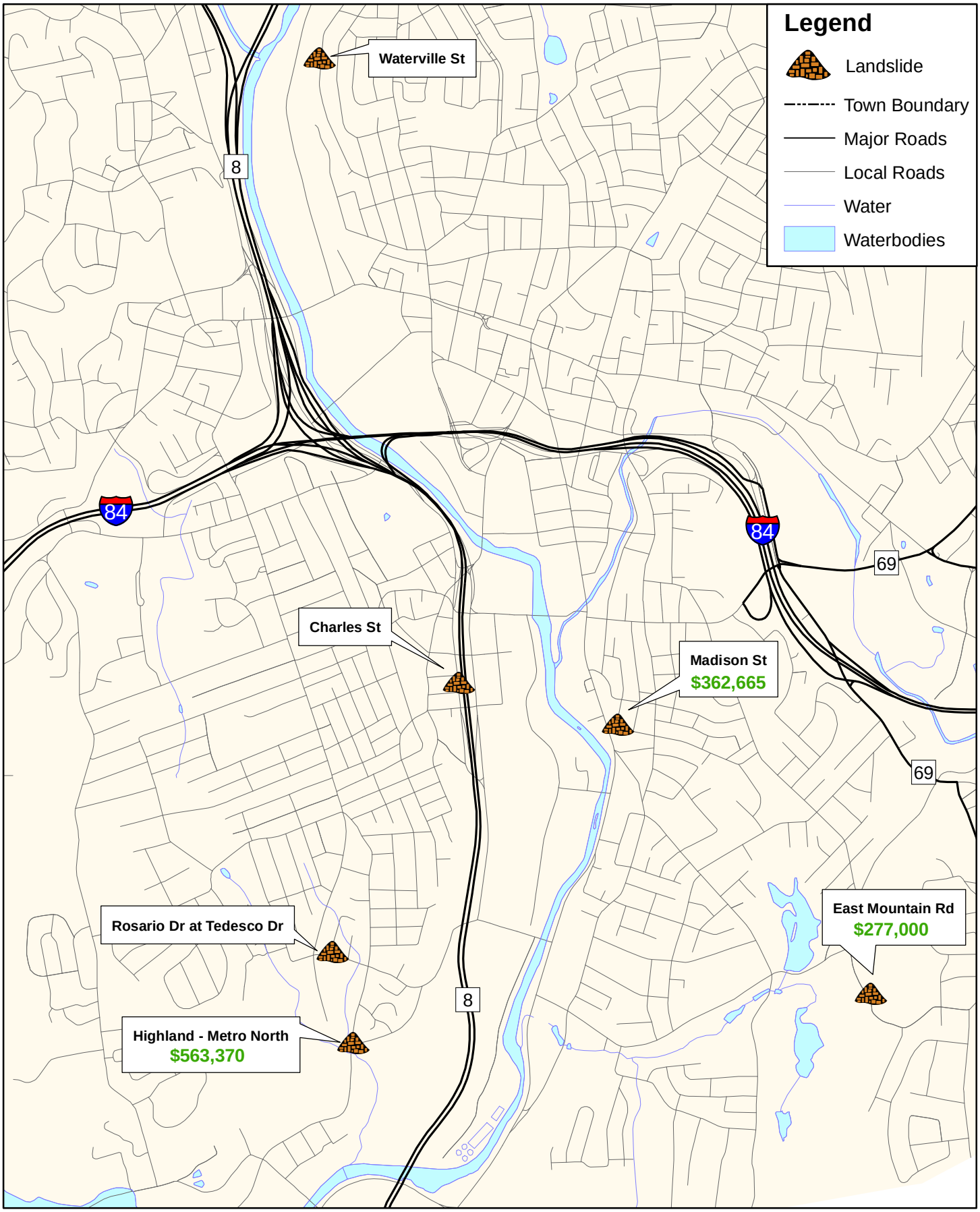
8.3 Historic Record

Minor and major landslides have occurred throughout the City. Despite steep slopes existing throughout Waterbury, the topography is generally stable. Landslides in the City tend to occur as a result of extreme rainfall or as a result of human activities. Recent examples of landslides in the City are provided in this section.

One notable example of a landslide due to human activities is visible on Waterville Street. Waterville Street overlooks the east side of the Naugatuck River just northwest of the City center. Construction activities in the 1990s occurring at the toe of the slope below Waterville Street compromised the natural grade of the 50 to 75 foot high hill, resulting in a collapse. Part of Waterville Street later collapsed as well, and the road is currently a one-way street. This street is now considered a potential landslide area.

The extreme rain event that occurred on June 2, 2006, described in detail in Section 3.0, caused many slopes to fail throughout the City with varying amounts of damage. These incidents are described below and depicted in Figure 8-1 along with the Waterville Street landslide:

Figure 8-1: Recent Landslides in Waterbury



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06
"Hydrography", DEP
"Landslides", DAR City of Waterbury
For general planning purposes only. Delineations may not be exact.
March 2007

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- Charles Street – One of the two 18-foot high stone walls lining the backyard at 22 Charles Street crumbled under the weight of floodwaters. The second wall collapsed about two hours later, crashing through the porch of 26 Fourth Street. This area reportedly had as much as three feet of floodwaters. Deep patches of mud were also recorded in the Brooklyn neighborhood around Fourth Street.

- East Mountain Road. While approaching the end of the road from the west along Pearl Lake Road, an excessive amount of water was observed crossing downhill along the side of Pearl Lake Road. This water was crossing from the north end of East Mountain Road, and the road was closed with a barricade. A brief reconnaissance of the road was undertaken, and a severe condition was observed where a landslide/gully had caused the road to fail. Potholes and sinkholes were scattered in various nearby locations. While this area is not in a mapped floodplain or floodway, it appears that a small watercourse (an unnamed tributary to Hopeville Pond Brook) flowing from the east caused this damage.

- Rosario and Tedesco Drive – Thick layers of silt and debris flowed into the intersection, prompting removal with a backhoe and truck. Damage may have been caused by an unnamed tributary to the Naugatuck River backing up a cross culvert under Tedesco Drive. This backup caused heavy erosion and a subsequent mudflow.

- Southview Street – A new storm drainage system had been installed the previous October when Madison Street and Southview Street were connected. It was overwhelmed and washed out. The hill next to a house on Southview Street gave way in a matter of minutes during the storm. Jersey barriers, mud, and rock cascaded down the hill burying a 40-foot section of the road with about three feet of debris. It pushed a car from the north side of South Main Street against a building on the other side. The torrent of earth, rock, and water severed the gas main on both sides of the cleft carved into the hill. Yankee Gas Company officials responded immediately to

cap the breaks there and in one other location. An abandoned car was almost completely buried in the employee parking lot of Shaker's Chrysler Jeep on South Main Street.

- Highland Avenue at Highview Street: An extreme amount of stormwater concentrated in a depression on the north side of an abandoned railroad siding embankment located to the southeast of this intersection. The embankment likely had a catastrophic failure as the water level neared the top. A further description of downgradient damage is included in Section 3.3 under the description of events impacting Highland Metro North.

- Willow Street: Although the portion of Clowes Terrace above this area was abandoned many years ago, eliminating the active pressure on the slope, the retaining wall and accompanying slope continue to erode.

8.4 Existing Programs, Policies, and Mitigation Measures

Landslide prevention programs, policies, or mitigation measures are not outlined in the regulations governing zoning, land use, or development plans in the City of Waterbury. However, the Zoning regulations consider areas with greater than 10% slopes to be areas definable as open space. Landslides, slumps, and retaining wall failures that occur on private properties are considered to be the responsibility of the property owners. When such failures occur on municipal property or affects City utilities, then the Public Works Department is in charge of repairs.

The damage dealt by the June 2, 2006 storm has for the most part either been patched or completely repaired, and the reconstruction of Waterville Street is on the Capital budget schedule for 2007-2012. The continuing efforts of the City to identify problem areas and repair or replace damaged infrastructure can be classified as existing mitigation.

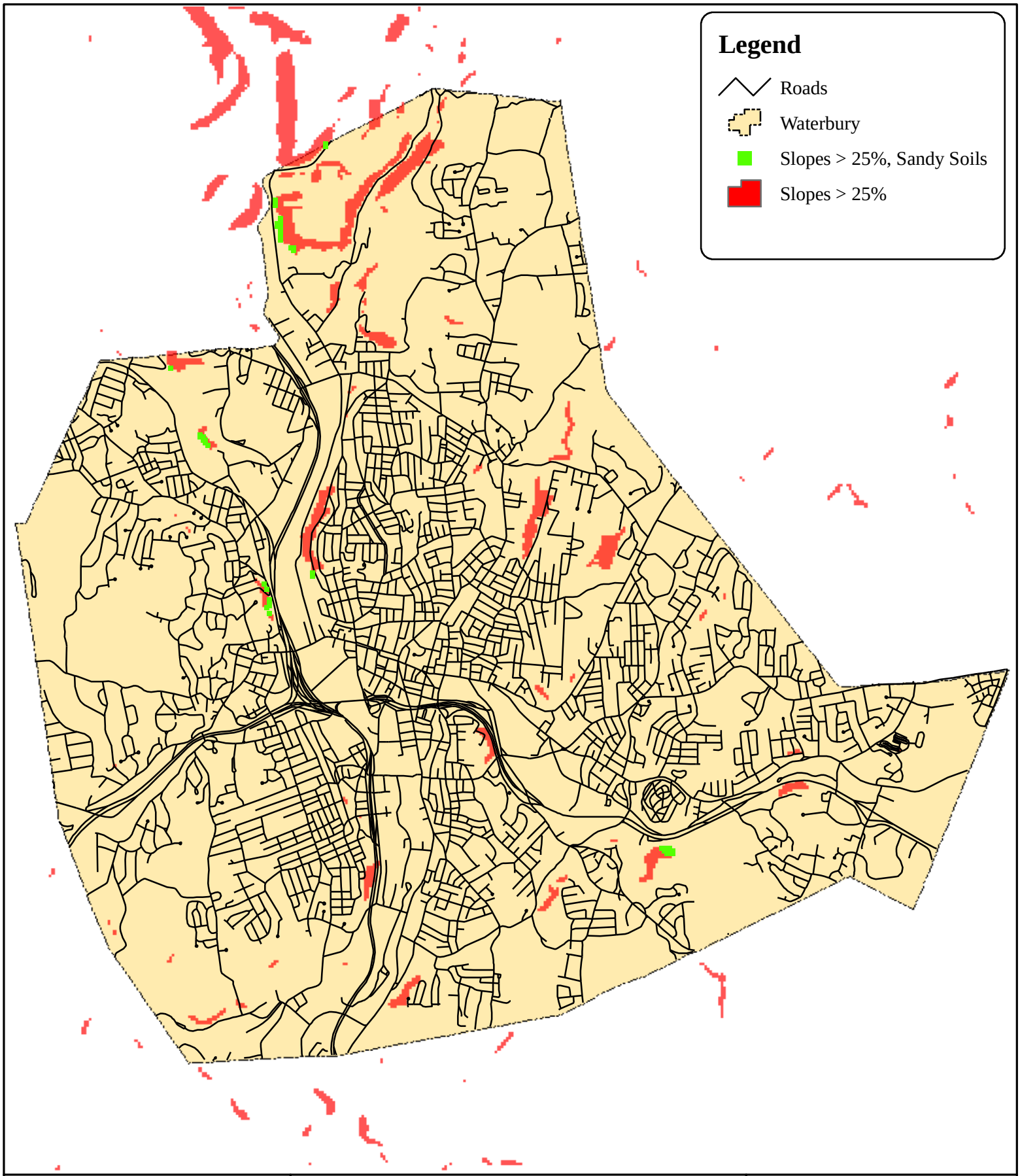
8.5 Vulnerabilities and Risk Assessment

As noted in Section 8.2, the overall likelihood of a landslide occurring in the City of Waterbury is considered to be low for any given year. Although direct landslide damage generally impacts only a small area on and at the base of the slope that has failed, utilities damaged by a landslide can have more of a widespread impact. Therefore, it is important for the City of Waterbury to identify areas that are prone to slope failure and restrict development, clearing and excavation activities in order to mitigate damages at those locations.

As noted above, the City of Waterbury has many areas of steep slopes. Figure 8-2 depicts areas of the City which have slopes greater than 25% and sandy surficial materials. These areas have a higher probability of slope failure compared to the rest of the City. An outline of these areas is provided below:

- The slope south of and above Kukas Lane in southeastern Waterbury;
- Areas above Watertown Avenue north of Waterbury Hospital;
- Sections below the southern part of Waterville Street;
- Several areas above Thomaston Avenue in northern Waterbury;
- Areas above Spruce Brook Road in the Mattatuck State Forest near the Plymouth town line;
- An undeveloped area north of Steele Brook above the abandoned railroad line; and
- A small area east of Denver Place near the Watertown town line.

Recall from Section 8.2 that landslides and slumps do not always occur near watercourses. In areas where the drainage network is comprised only of sheet flow, roadways can act as watercourses and break apart. When construction activities undermine the natural grade of a hill, the hillside can collapse as occurred on Waterville Street.



Areas of Steep and Sandy Slopes

LOCATION: Waterbury, CT

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MMI#: 2937-01
MXD: H:\8-2_slopes.mxd
SOURCE: DEP Bulletin No.40

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Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: April 2007
SCALE: 1:57,000

SHEET: Figure 8-2

As discussed in Section 2.9, deterioration of the PCCP running eastward through the City has rendered it more susceptible to damage from natural hazards. The 24-inch and 16-inch PCCP mains travel through several areas of steep slopes. As shown in Figure 8-3, the two western water main breaks occurred in an area of greater than 25% slopes, and the eastern occurred in an area of greater than 20% slope. In addition, other areas of the pipe are also in high slope areas. As this pipe provides public water supply and fire protection to thousands of people in two municipalities, this water main is a critical piece of infrastructure vulnerable to landslides and earthquakes.

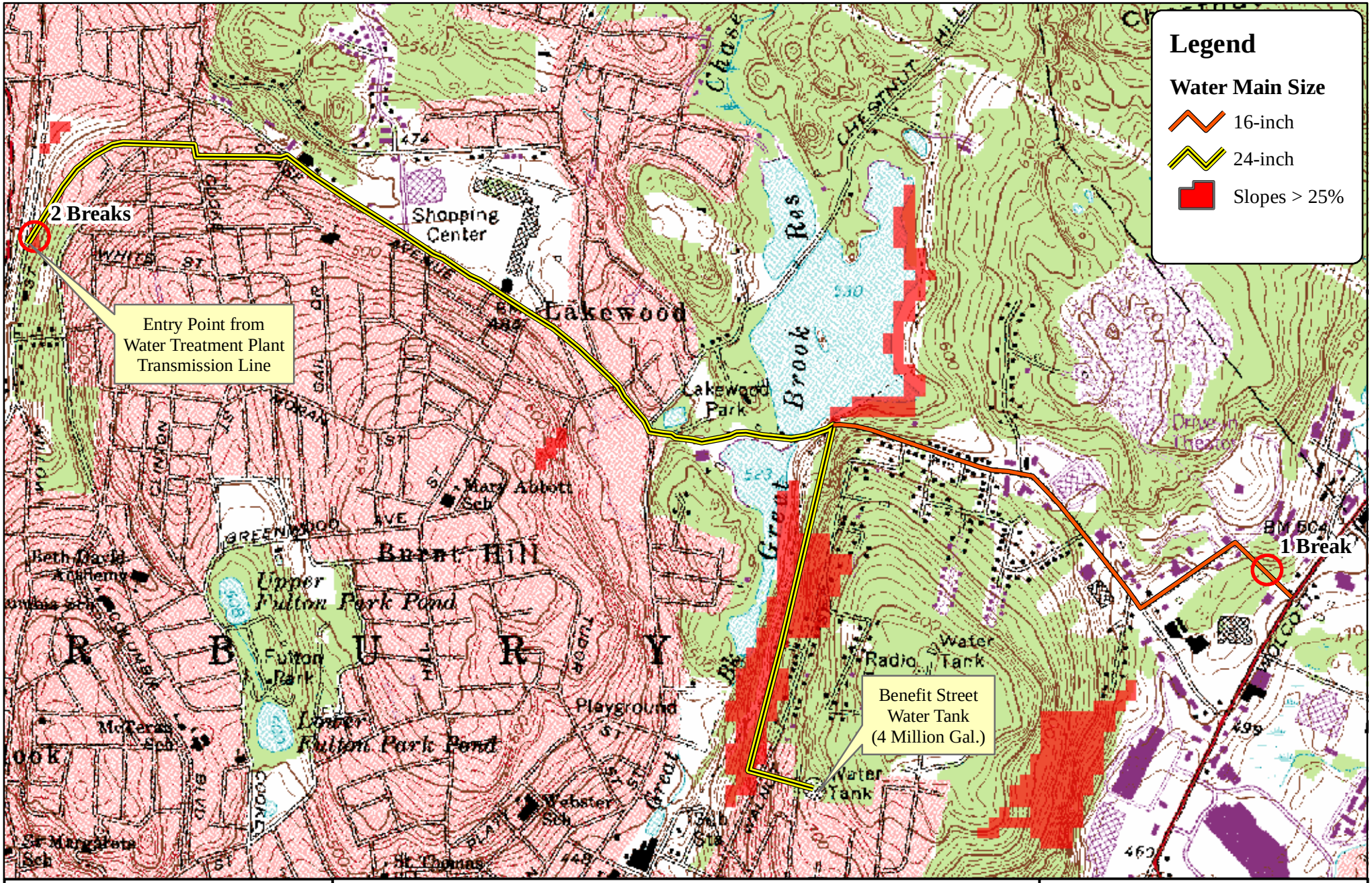
Insufficient or poorly installed drainage systems can also lead to landslides in high slope areas, as occurred at Southview Street, Highland Avenue, and East Mountain Road. Oversizing drainage structures, wherever possible, may help mitigate the results of such systems being overwhelmed. The expansion of the City drainage network would also help in this regard.

8.6 Potential Mitigation Measures, Strategies, and Alternatives

The extreme rainfall events that can lead to landslides in the City of Waterbury cannot be prevented. However, human activities that develop or undermine steep slopes can be regulated to prevent landslide damage. A discussion of various mitigation measures is included below.

8.6.1 Prevention

Heavy rainfall cannot be prevented from falling onto a certain area. However, in an area of steep slopes, a properly designed drainage system can prove beneficial for mitigating landslides. Areas of steep slopes should be a consideration for where the City of Waterbury expands its drainage network and should be discussed in any comprehensive stormwater management plan that the City may implement.



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Locations of Recent Water Main Breaks

Location: Waterbury, CT

MMI#: 2937-01
MXD: H:\watermain.mxd
Source: DEP Bulletin No.40

N

Waterbury Pre-Disaster Natural Hazard Mitigation Plan

Date: April 2007

Scale: 1:15,000

Sheet: Figure 8-3

Damage from landslides can be prevented by restricting development in landslide-prone areas. The City should consider adopting regulations restricting development on slopes of 25% or greater, and should restrict excavation and clearing activities on lands above such slopes. The City should also consider restricting development in the sandy, high slope areas outlined in Figure 8-3.

In addition, the USDA offers the following guidelines regarding development in areas where landslides are a concern that could be considered by regulatory agencies in Waterbury:

- Avoid steep slopes or areas with noticeable mass movement when selecting a building site;
- Watch for naturally wet areas with seeps and springs that might indicate water problems;
- Slope stability decreases as water moves into the soil. Do not allow surface waters to saturate a sloping soil. Springs, seeps, roof runoff, gutter downspouts, septic systems, and poorly graded sites can all result in ponding or surface runoff that often increase the risk of landslides;
- Properly locate diversion channels to help redirect runoff away from areas disturbed during construction. Runoff should be channeled and water from roofs and downspouts piped to stable areas at the bottom of slopes;
- Seek professional assistance in selecting the appropriate type and location of a septic system. Septic systems located in fill material can saturate soil and increase the risk of landslides;
- Note unusual cracks or bulges at the soil surface. These might be typical signs of soil movement that may lead to slope failure;
- Landslides are less likely to occur on sites where disturbance has been minimized. Alter the natural slope of the building site as little as possible during construction. Never remove soil from the toe or bottom of the slope or add soil to the top of the slope. Seek professional assistance before earth-moving begins; and

- Trees develop extensive root systems that are very useful in slope stabilization and also lower the ground water table. Remove as few trees and other vegetation as possible. Trees and other kinds of permanent plant cover should be established as rapidly as possible and maintained to reduce the risks of erosion and landslides.

8.6.2 Property Protection

Individual property owners should be encouraged to have their retaining walls inspected by a professional engineer skilled in such structures to determine their susceptibility to failure. The City should also determine areas which are on or below steep slopes that could be impacted by a landslide and encourage the property owners to develop emergency plans.

8.6.3 Public Education and Awareness

Landslides do not occur frequently enough in Waterbury to be a major concern. Still, the public should be instructed on identifying warning signs indicating possible landslide conditions. According to the USDA, these signs include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before;
- New cracks or unusual bulges in the ground, street pavements, or sidewalks;
- Soil moving away from foundations;
- Ancillary structures, such as decks and patios, tilting and/or moving relative to the main house;
- Tilting or cracking of concrete floors and foundations;
- Broken water lines and other underground utilities;
- Leaning or offset telephone poles, trees, retaining walls, or fences; and
- Sticking doors and windows and visible open spaces indicating jambs and frames out of plumb.

8.6.4 Emergency Services

The City should continue to encourage through-streets over dead end streets. Two modes of egress reduces the risk that residents can be cut off from critical facilities should a landslide block or collapse an entire street. In addition, the City should consider connecting dead ends through to other streets where possible.

Utility providers should be made aware of landslide prone areas. Emergency teams associated with each utility should be prepared to control breaks and reroute service when possible so that larger areas are not affected. This service is especially important for water, electrical, and telephone service. Sanitary sewer service affected by landslides should be rerouted or controlled as soon as possible to prevent septic conditions in down-gradient soils.

8.7 Summary of Potential Mitigation Measures, Strategies, and Alternatives

The following recommendations are applicable to mitigating landslide occurrence in the City of Waterbury:

- Direct the property owner to reconstruct that portion of the slope that jeopardizes Waterville Street and restore a proper angle to the slope below to prevent future landslides.
- Secure pre-disaster mitigation funding for replacing the 24-inch and 16-inch water transmission mains servicing the eastern part of Waterbury and Wolcott. Consider relocating parts of the transmission main to areas of less severe slope.
- Consider implementing regulations restricting construction on 25% or greater slopes and restricting excavation and clearing activities above such slopes.

- Consider preventing new development in sandy areas with steep slopes as outlined in Figure 8-3.
- Consider adopting or codifying some or all of the USDA guidelines in Section 8.6.1 to regulate development in areas of steep slopes.
- Consider preserving areas of steep slopes as protected open space through acquisition or modified zoning.
- Continue to encourage through streets over dead-end streets.
- Ensure that local utility providers are aware of landslide potential and have responder teams ready to repair damage to their utilities caused by landslides.
- Make education and outreach materials available at the Building Department regarding how to identify potential landslide areas as outlined in Section 8.6.3.
- Consider expanding and over-sizing drainage systems in the vicinity of steep slopes.
- Encourage private property owners to have their retaining walls inspected by a professional structural engineer.

In addition, important recommendations that apply to all hazards are listed in Section 11.1.

9.0 DAM FAILURE

9.1 Setting

Dam failures can be triggered suddenly, with little or no warning, by other natural disasters such as floods and earthquakes. Dam failures often occur during flooding when the dam breaks under the additional force of floodwaters. In addition, dam failure can cause a chain reaction where the sudden release of floodwaters causes the next dam downstream to fail. With 28 registered dams and potentially several other minor dams in the City, dam failure can occur almost anywhere in Waterbury. While flooding from a dam failure generally has a limited geographic extent, the effects are potentially catastrophic. Fortunately, a major dam failure is considered only a possible natural hazard event in any given year (Appended Table 2).

9.2 Hazard Assessment

The Connecticut DEP administers the statewide Dam Safety Program, and designates a classification to each state-registered dam based on its potential hazard.

- *Class AA* dams are negligible hazard potential dams that upon failure would result in no measurable damage to roadways, land and structures, and negligible economic loss.
- *Class A* dams are low hazard potential dams that upon failure would result in damage to agricultural land and unimproved roadways, with minimal economic loss.
- *Class BB* dams are moderate hazard potential dams that upon failure would result in damage to normally unoccupied storage structures, damage to low volume roadways, and moderate economic loss.

- *Class B* dams are significant hazard potential dams that upon failure would result in possible loss of life, minor damage to habitable structures, residences, hospitals, convalescent homes, schools, and the like, damage or interruption of service of utilities, damage to primary roadways, and significant economic loss.
- *Class C* dams are high potential hazard dams that upon failure would result in loss of life and major damage to habitable structures, residences, hospitals, convalescent homes, schools, and main highways with great economic loss.

This section deals with only with the possible effects of failure of Class C dams. Failure of a class C dam has the potential for loss of life and property damage totaling millions of dollars.

Approximately 27 registered dams are located in the City of Waterbury, of which one is Class AA, 14 are Class A, two are Class BB, three are Class B, five are Class C, and three are undefined. These are listed in Table 9-1.

Table 9-1
Dams Registered with the DEP in the City of Waterbury

Number	Name	Class
15101	Traceys Pond Dam	-
15102	Cemetery Pond Dam	C
15104	East Mountain Reservoir Dam	C
15105	Pritchards Pond Dam	BB
15106	Risdon Pond Dam	C
15107	Cable Pond Dam	BB*
15108	Murphy Lake Dam	BB*
15109	Lake Wequapauset Dam	B
15110	Chain Pond Dam	A
15113	Great Brook Reservoir Dam	BB
15114	Belleview Lake Dam	C
15116	Unnamed Dam North of Vine Street	A
15117	Industrial Pond Dam	A
15118	Griggs Street Pond Dam	A
15119	Park Pond Dam	A
15120	Daigle Pond Dam	A
15121	Hills Pond Dam #1	A
15122	Pearl Lake Dam	A

Table 9-1 (Continued)
Dams Registered with the DEP in the City of Waterbury

Number	Name	Class
15123	Spring Lake Dam	A
15125	Game Club Lake Dam	A
15126	13th Hole Pond Dam	A
15127	Unnamed Dam on Whelton Brook at Waterbury Country Club	A
15128	Hancock Pond Dam	A
15129	Unnamed Dam on Steele Brook Upstream of East Aurora Street	A
15130	Frost Road Pond Dam	AA
15131	Hop Brook Flood Control Dam	-
15132	Reidville Industrial Park Dam	-

*Formerly Class B, but have been recently reclassified as not being significant hazard dams

The four Class C dams in Waterbury are Cemetery Pond Dam, East Mountain Reservoir Dam, Risdon Pond Dam, and Belleview Lake Dam, all depicted on Figure 9-1.

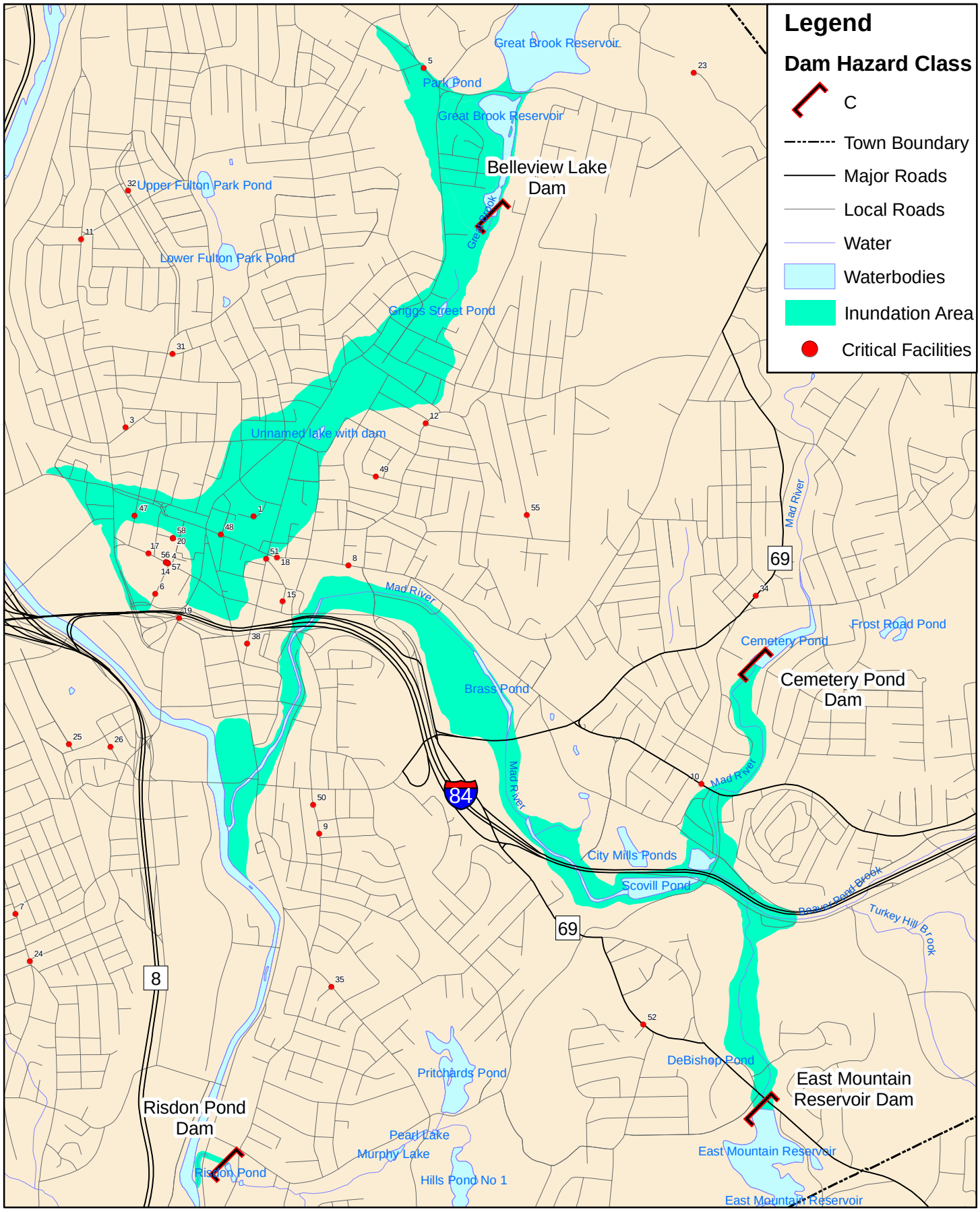
9.3 Historic Record

Approximately 200 notable dam and reservoir failures occurred worldwide in the twentieth century. More than 8,000 people died in these disasters. The following are the two most catastrophic dam failures in Connecticut recent history:

- 1963: Failure of the Spaulding Pond Dam in Norwich caused six deaths and $6 million in damage.
- 1982: Failure of the Bushy Hill Pond Dam in Deep River caused $50 million in damages.

More recently, the Connecticut DEP reported that the sustained heavy rainfall from October 7 to 15, 2005 caused two dam failures, four partial breaches, and damage to four other dams throughout the State. These are summarized in Table 9-2.

Figure 9-1: High Hazard Dams in Waterbury



Source:"Roads", GDT
"Hydrography", "Dams", "Town Boundary", DEP
"Inundation Area", USACE. Mad River Dam. Phase I Inspection Program Report National Dam Inspection Program, January 1980.
City of Waterbury Bureau of Water. East Mountain Dam Report. September 1989, revised February 1991.
City of Waterbury. Emergency Operations Plan. Great Brook Reservoir and Bellevue Lake Dams, Waterbury, Connecticut. July 1998.

Miles
0 0.25 0.5

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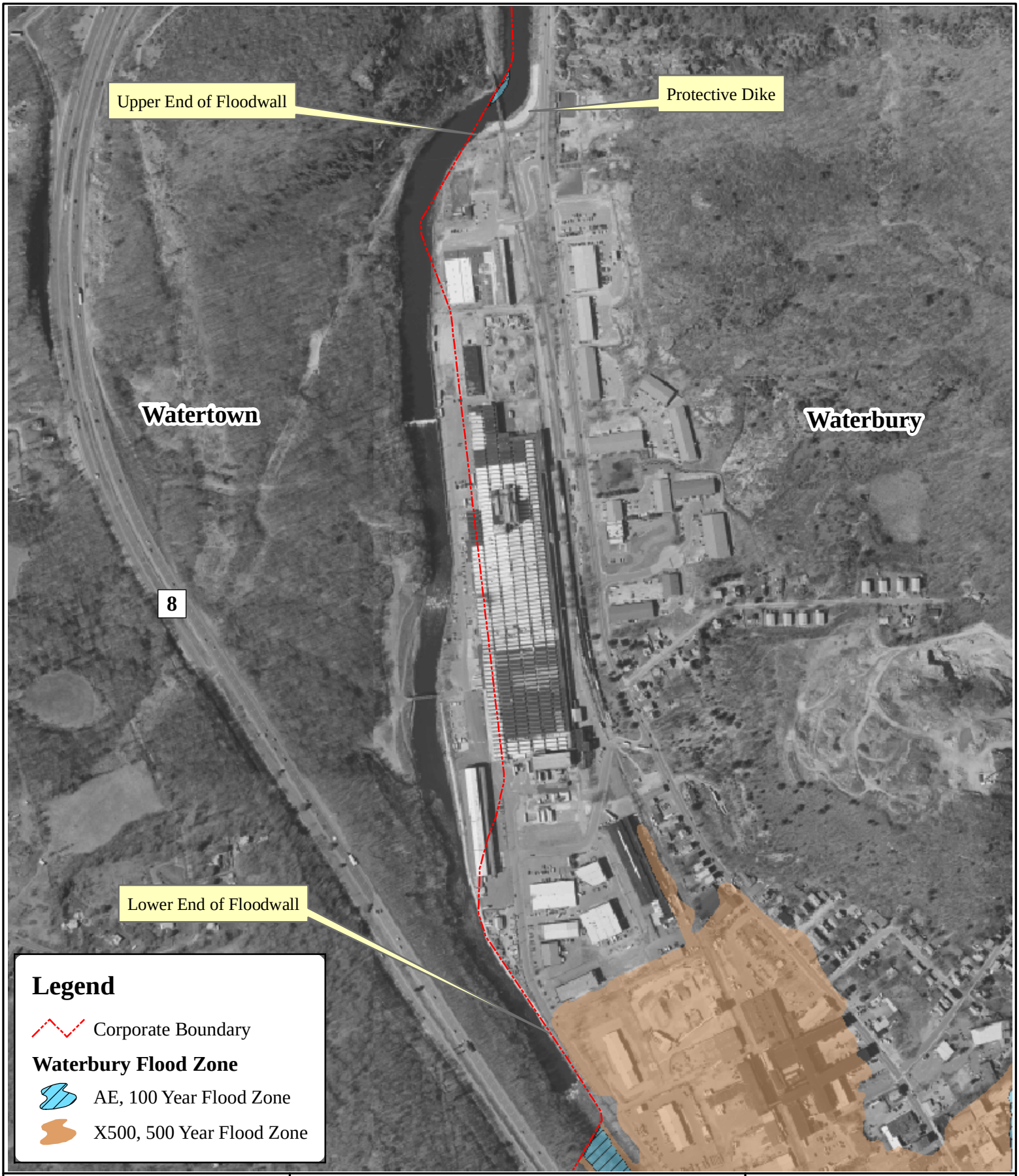
For general planning purposes only. Delineations may not be exact. January 2007

Table 9-2
Dams Damaged Due to Flooding from October 2005 Storms

Number	Name	Location	Class	Damage Type	Ownership
-----	Somerville Pond Dam	Somers	--	Partial Breach	DEP
4701	Windsorville Dam	East Windsor	BB	Minor Damage	Private
10503	Mile Creek Dam	Old Lyme	B	Full Breach	Private
-----	Staffordville Reservoir #3	Union	--	Partial Breach	CT Water Co.
8003	Hanover Pond Dam	Meriden	C	Partial Breach	Meriden
-----	ABB Pond Dam	Bloomfield	--	Minor Damage	Private
4905	Springborn Dam	Enfield	BB	Minor Damage	DEP
13904	Cains Pond Dam	Suffield	A	Full Breach	Private
13906	Schwartz Pond Dam	Suffield	BB	Partial Breach	Private
14519	Sessions Meadow Dam	Union	BB	Minor Damage	DEP

Several dams are located along the Naugatuck River both in and upstream of the City of Waterbury. The Naugatuck River and Mad River were formerly utilized for industrial water supply, serving copper and brass mills in and around Waterbury from the middle of the 19th century until the 1980's. During this time a series of low "run-of-the-river" dams diverted a portion of the river flow to various canals and pipes. As the mills closed, the dams fell into disrepair.

After the floods of 1955, the United States Army Corps of Engineers constructed two major flood control projects along the Naugatuck River which protect the City from flooding. The first is a local protection project consisting of channel improvements, a floodwall, and a protective dike in the Waterville section of the City on the Waterbury-Watertown boundary. This area is depicted on Figure 9-2. According to FEMA, this project confines the 500-year flood and protects the major industrial area in the City. The Army Corps of Engineers also constructed six flood control dams along the Naugatuck River upstream of Waterbury resulting in a significant reduction in possible flood levels along the river. This local protection project is owned and maintained by the Connecticut Department of Environmental Protection.



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2004 Aerial Photograph of Levee System

LOCATION: Waterbury & Watertown, CT

MMI#: 2937-01
MXD: H:\levee.mxd
SOURCE: DEP, CLEAR

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Waterbury Pre-Disaster Natural Hazard Mitigation Plan

DATE: April 2007
SCALE: 1:7,000

SHEET: Figure 9-2

Historically, the Naugatuck River has had degraded water quality due to the influence of industrial and municipal wastewater. As a result, removing the dilapidated dams to restore fish passage and habitat was not considered until the 1990's when tertiary treatment was enacted at the Waterbury Sewage Treatment Plant. All of the Naugatuck River dams in Waterbury have now been removed in order to provide fish passage. The dams removed along the Naugatuck River are summarized in Table 9-3 below.

Table 9-3
Dams Removed Along the Naugatuck River in Waterbury

Name	Height	Length	Removed
Anaconda Dam	11 feet	327 feet	1999
Platts Mill Dam	10 feet	231 feet	1999
Freight Street Dam	4 feet	158 feet	1999
Chase Brass Dam	6 feet	180 feet	2004

Along the Mad River, the City of Waterbury formed a breach in Scovill Reservoir Dam in 1995 to lower its storage capacity, and completely removed the John Dees Pond Dam that was formerly below Wolcott Street. Additionally, Risdon Pond Dam, a dam on Hopeville Pond Brook, was breached to lower the head by 16 feet in 1985.

Major dam failures have not occurred in the City of Waterbury. However, minor failures and breaches have occurred on several dams. Two such examples include the Frost Road Pond Dam (Class AA) upstream of Frost Road and Circular Avenue, and Pritchards Pond Dam (Class BB) near Pearl Lake Road.

According to information available at the Public Works Department, a partial breach was made to lower the head behind the Frost Road Pond Dam following flooding problems in 1980. The lack of proper maintenance over the next 26 years allowed trash and natural debris to accumulate in the breach, allowing the dam to regain most of its storage capacity. The breach was reopened by floodwaters during the June 2, 2006 storm, causing some flooding damage downstream. As for Pritchards Pond Dam, as of August

2005 the Public Works Department listed the dam as being in need of repair due to minor seepage concerns.

9.4 Existing Programs, Policies, and Mitigation Measures

The dam safety statues are codified in Section 22a-401 through 22a-411 inclusive of the Connecticut General Statutes. Sections 22a-409-1 and 22a-409-2 of the Regulations of Connecticut State Agencies, have been enacted which govern the registration, classification, and inspection of dams. Dams must be registered by the owner with the DEP, according to Connecticut Public Act 83-38.

Dam Inspection Regulations require that over 600 dams in Connecticut must be inspected annually. The DEP currently prioritizes inspections of those dams which pose the greatest potential threat to downstream persons and properties. Dams found to be unsafe under the inspection program must be repaired by the owner. Depending on the severity of the identified deficiency, an owner is allowed reasonable time to make the required repairs or remove the dam. If a dam owner fails to make necessary repairs to the subject structure, the DEP may issue an administrative order requiring the owner to restore the structure to a safe condition and may refer noncompliance with such an order to the Attorney General's Office for enforcement. As a means of last resort, the DEP Commissioner is empowered by statute to remove or correct, at the expense of the owner, any unsafe structures which present a clear and present danger to public safety.

Owners of Class C dams are required to maintain emergency operations plans. The City of Waterbury is responsible for maintaining such plans for the East Mountain Reservoir Dam and Belleview Lake Dam. According to the DEP, the Risdon Pond Dam and Cemetery Pond Dam (a.k.a. Homestead Avenue Dam) are privately owned. It is believed that the owners maintain emergency plans, but they are not on file with the DEP.

The City of Waterbury has a levee system along its boundary with Watertown on the Naugatuck River. This levee system consists of channel improvements, a floodwall, and a protective dike. The system confines the 500-year flood and protects a major industrial area of the City. In addition, there are several dams upstream of Waterbury along the Naugatuck River that collectively mitigates flood flows.

Several dam removals have been performed in the City of Waterbury that had the secondary result of mitigating downstream hazards associated with dam failure. These include the Naugatuck River main stem dams and the John Dees Pond Dam discussed in Section 9.3. Other dams in the City have been breached to reduce the hazard of dam failure, such as the Scovill Pond Dam and the Risdon Pond Dam. These dams are discussed in Section 9.5 below. In addition, a run-of-the-river dam is proposed to be removed upstream in Thomaston.

9.5 Vulnerabilities and Risk Assessment

By definition, failure of Class C dams may cause catastrophic loss of life and property. Of the four Class C dams in the City of Waterbury, a failure on the East Mountain Reservoir Dam or the Belleview Lake Dam would present the highest hazard to the City in terms of damage to life and property. The four Class C dams, the Army Corps dams upstream of Waterbury, and the Waterbury/Watertown levee system are discussed in the risk assessment below. Inundation areas associated with dam failures are included on Figure 9-1.

Belleview Lake Dam

Belleview Lake is owned and operated by the City of Waterbury. The USGS name for this Lake is Great Brook Reservoir. It covers a surface area of approximately 73 acres and outflows into Great Brook. Belleview Lake Dam is an ashlar masonry gravity

structure built sometime before 1880. The dam was repaired as recently as 1998 to allow safe passage of the probable maximum flood.

The area downstream of Belleview Lake is a major residential and commercial sector of the City. As Great Brook flows through an underground culvert throughout most of its length in Waterbury, a dam failure would quickly exceed the capacity of the culvert and water would flood up through catch basins into several areas of the City. Due to the high probability of downstream damage to life and property should this structure fail, proper maintenance of this historical structure is critical.

Several critical facilities have the potential to be inundated should Belleview Lake Dam fail. These critical facilities are identified by their map number on Figure 9-1. These include the Abbott Terrace assisted living facility at 44 Abbott Terrace (Map #1), the Fire Department containing Engines 1 and 9 and Truck 2 at 1979 North Main Street (Map #5), State Street School at 35 State Street (Map #47), and the University of Connecticut Waterbury campus at 99 East Main Street (Map # 48).

Cemetery Pond Dam

Cemetery Pond is a small impoundment located in the run of the Mad River near the Fair Lawn section of Waterbury. It covers a surface area of approximately six acres. The pond gets its name from being adjacent to Pine Grove Cemetery. Cemetery Pond Dam is also known as the Homestead Avenue Dam or the Mad River Dam. The dam is a concrete-faced stone masonry structure with a downstream earthen embankment. A sewer interceptor was installed through the dam in 1986 and the DEP has a record of maintenance being performed at that time.

The area downstream of Cemetery Pond Dam is significantly developed with areas of residential, commercial, and industrial use. A failure of this dam would send a torrent of water downstream into the former Scovill (City Mills) Pond, where the Scovill Pond Dam

has already been breached. Flooding conditions would likely occur all the way downstream to the Naugatuck River. As a Class C Dam, it is important that the owner of the dam and the DEP continue to review this dam for potential structural issues to mitigate possible damage to life and property.

East Mountain Reservoir Dam

East Mountain Reservoir is an approximately 36 acre impoundment located on the Waterbury and Prospect municipal boundary. The reservoir is owned by the City of Waterbury and was formerly used as a surface water supply reservoir by the Waterbury Water Department. The East Mountain Reservoir has been formally abandoned and will never again be used as a water supply. Currently, the reservoir is used for recreational fishing and flood control. Outflow from this reservoir is known as East Mountain Brook as described in Section 2.5.

The East Mountain Reservoir Dam is an earth embankment with a concrete core wall originally built in the late 1800's. The structure of the dam was repaired as recently as 1999, and the DEP has an emergency operations plan, an operation and maintenance manual, and a dam failure analysis study on file from 1998.

According to the dam failure analysis, a failure of this dam would be catastrophic for the highly developed commercial, industrial, and residential areas downstream. The initial impact area would be Route 69 and East Mountain Road, which would be inundated to a depth of 14 feet within seconds. Interstate 84 would receive peak inundation of two to eight feet, and floodwaters of 5 feet to 15 feet would affect areas near the Mad River from City Mills Ponds downstream to East Liberty Street. Proper maintenance of this dam is imperative to prevent such a disaster.

Risdon Pond Dam

Risdon Pond is a small, privately owned impoundment along the run of Hopeville Pond Brook near South Baldwin Street and the Naugatuck River. The impoundment is maintained by a dam fashioned from an earthen embankment reinforced by stone masonry. Below Risdon Pond Dam, Hopeville Pond Brook flows underneath what appears to be an abandoned industrial building and South Main Street before emptying into the Naugatuck River.

It is believed that a failure of this dam would have the potential to undermine the foundation of this industrial building and part of South Main Street. Consequently, the DEP requested the elevation of the spillway lowered by 16.7 feet in 1985. As a result, Risdon Pond is now approximately one-third of its former size one-half acre size. It is unlikely that a failure of this dam would have the same destructive potential it formerly did. Nevertheless, it is still a Class C dam and the owner and the DEP should strive to ensure that this dam is properly maintained.

Flood Control Dams Upstream of Waterbury

The six Army Corps of Engineers flood control dams of the Naugatuck River upstream of Waterbury are currently maintained by the Corps and are in excellent condition. The Corps maintains dam failure analysis plans for these dams. While a dam failure at one of these locations has the potential to cause downstream flooding damages, much of the flooding impact would occur upstream of Waterbury. Therefore, it is believed that Waterbury is at a lower risk of receiving severe flooding damage should any of these dams fail.

Waterbury/Watertown Levee System

When the Army Corps of Engineers commenced its flood control improvements, the topography of the river banks along the Naugatuck River in Waterbury allowed the lowering and widening of the riverbed. Therefore, the levee system in this area contains fewer dikes and shorter floodwall heights than in upstream municipalities. As a result, there are few flooding problems directly related to out-of-bank conditions along the Naugatuck River. This was noted in Sections 3.3 and 3.5.

The levee system in Waterbury is currently on the Army Corps of Engineers list of "Levees of Maintenance Concern." Currently, the Corps has this levee system rated as "fair," which is a failing grade. This rating means that the levee system is not strong enough to properly withstand flooding conditions without necessary repairs.

As this levee system is designed to confine the 500-year flood to the Naugatuck River, proper maintenance of this levee system is imperative. Failure of this levee system during an extreme flood could cause millions of dollars of damages in the City's industrial sector, specifically inside Waterbury Industrial Commons. In addition, businesses and residents in the lower parts of the Waterville section of Waterbury could be inundated. A levee failure associated with an extreme flood event could take this sector of the City by surprise, resulting in multiple deaths.

If proper and required maintenance is not performed on this levee system, the Army Corps of Engineers may decertify it. Decertification means that property owners protected by the levee would be required to purchase flood insurance, and communities participating in FEMA's Community Rating System would find their ranking reduced. Despite the heavy flood controls along the Naugatuck River, it is still possible that a powerful series of storms could cause this levee system to fail. It is therefore crucial that the Connecticut DEP completes its review of the maintenance concerns in this levee

system and performs the necessary repairs or alterations to maintain the system's certified status.

According to City personnel, the DEP is currently updating the Operations and Maintenance Plan for the levee system and is addressing the concerns of the ACOE. The City of Waterbury has agreed to take on very limited duties in the case of a flood. The City and the State will be entering into a Memorandum of Understanding to outline these very limited obligations.

9.6 Potential Mitigation Measures, Strategies, and Alternatives

The Dam Safety Section of the DEP Inland Water Resources Division is charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. The existing statutes require that permits be obtained to construct, repair, or alter dams, and that existing dams be registered and periodically inspected to assure that their continued operation does not constitute a hazard to life, health, or property.

The City of Waterbury should work in conjunction with private dam owners and the Connecticut DEP to ensure that all dams in the City are in safe and functional working order. In this regard, having a written operation and maintenance plan for all dams is essential. This is especially important for Class C dams. There also are other preventive mitigation strategies suggested for the Class C dams in the City of Waterbury, as described below:

- Ensure that all Class C dams have up to date emergency operations plans.
- Ensure that all Class C dams have up to date operation and maintenance plans.
- Perform or update the Dam Failure Analysis for each dam. This is of particular importance for Belleview Lake Dam, and should be performed in conjunction with the Great Brook structural integrity analysis described in Section 3.0.

- Depending on the results of the updated Dam Failure Analyses, consider requesting that DEP reclassify the hazard potential of Risdon Pond Dam and Scovill Pond Dam. These dams have had their hydraulic head significantly reduced by lowering and breaching.
- Petition FEMA to commission a new study of the Mad River to reestablish 100-year flood heights. The current incarnation of FEMA mapping is almost 30 years old and is outdated. The partial breach of the dam at Scovill Pond has likely lowered flood heights in that area. Such a study would prove useful for future bridge repairs similar to those currently approved in the capitol budget for the Mad River.

The levee system in Waterbury is also important. Currently, the ACOE has these levees rated as "fair," which is a failing grade. The Connecticut DEP should conduct a levee failure analysis outlining in detail the area of impact should the levee fail at the level of the 100-year and 500-year flood, and should conduct an engineering study to determine specific mitigation and rehabilitation strategies that can be implemented to restore this levee system to a passing grade. A similar study was conducted recently in the City of Torrington, Connecticut in connection with its ACOE levee system.

The City should make any necessary repairs to Pritchards Pond Dam to prevent further deterioration of the dam. This is being considered as part of the Pearl Lake Road reconstruction project.

The City should encourage the owner to prepare an operation and maintenance plan for the Frost Road Pond Dam. This will help ensure that proper maintenance is performed to keep the dam properly breached. As an alternative, the City could work with the owner to commission an engineering study considering the removal of this dam altogether.

In addition, several suggested potential mitigation strategies are applicable to all hazards in this plan. These are outlined in the Section 11.1.

10.0 WILDFIRES

10.1 Setting

The ensuing discussion about wildfires is focused on the undeveloped wooded, shrubby, or grassland areas of Waterbury, along with low-density suburban type development found at the margins of these areas known as the wildland interface. Structural fires in higher density areas of the City are not considered.

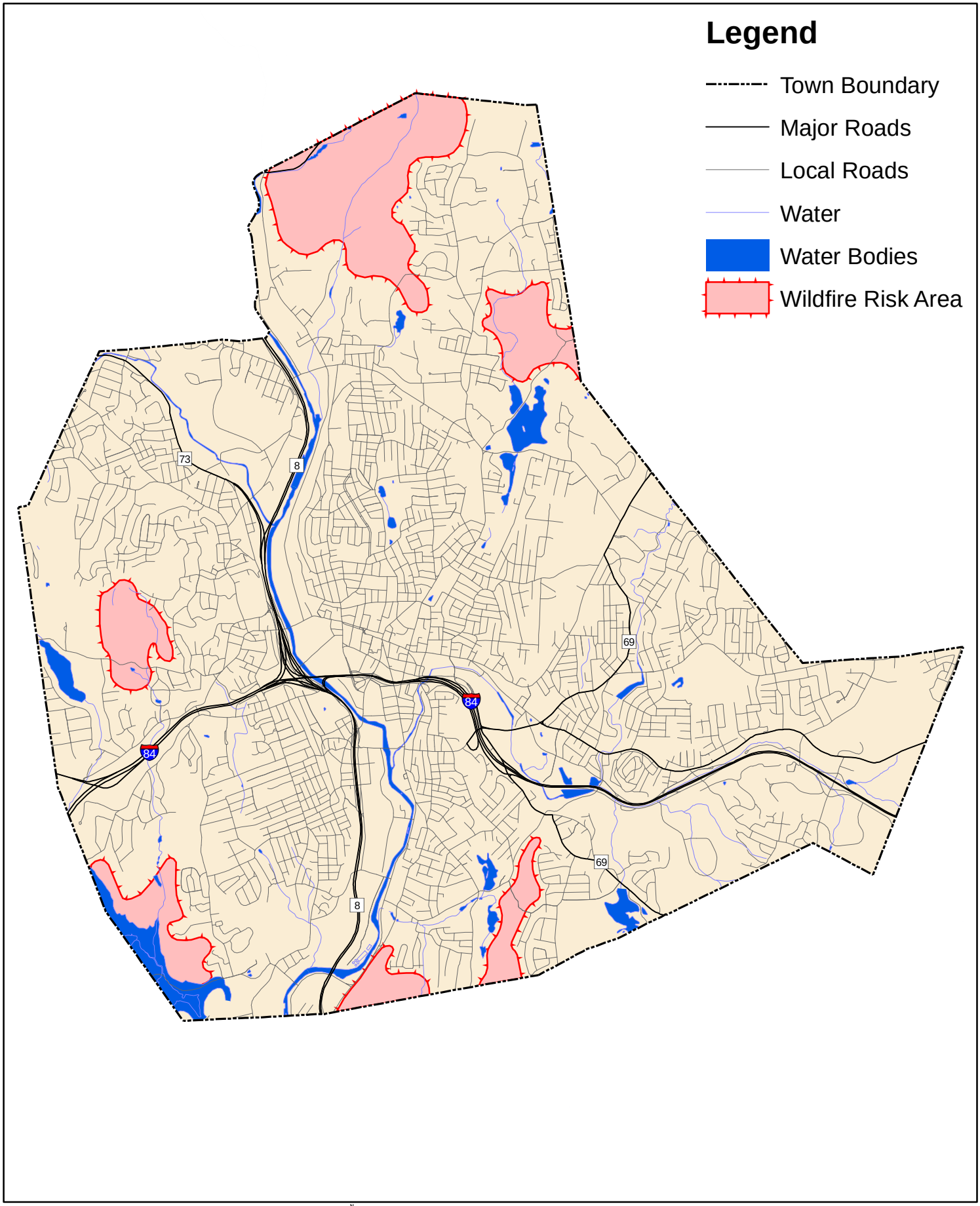
The City of Waterbury is a low-risk area for wildfires. Wildfires are of particular concern in wooded areas and other areas with poor access for fire-fighting equipment. Figure 10-1 presents a wildfire risk area with associated acreages for the City of Waterbury. Hazards associated with wildfires include property damage and loss of habitat. Wildfires are considered a likely event each year, but should they occur are generally contained to a small range with limited damage to non-forested areas.

10.2 Hazard Assessment

Wildfires are well-defined by the Massachusetts Hazard Mitigation Plan as being "highly destructive, uncontrollable fires." Although the term brings to mind images of tall trees engulfed in flames, wildfires can occur as brush and shrub fires, especially under dry conditions. Wildfires are also known as "wildland fires."

Nationwide, humans have caused approximately 90% of all wildfires in the last decade. Accidental and negligent acts include unattended campfires, sparks, burning debris, and irresponsibly discarded cigarettes. The remaining 10% of fires are caused mostly by lightning.

Figure 10-1: Waterbury Wildfire Risk Areas



Source: "Roads", c1984 - 2006 Tele Atlas, Rel. 10/06.
"Town Boundary", "Hydrography", DEP
"Critical Facilities", "Wildfire Areas", COGCNV
For general planning purposes only. Delineations may not be exact.
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Nevertheless, wildfires are also a natural process, and their suppression is now recognized to have created a larger fire hazard, as live and dead vegetation accumulates in areas where fire has been prevented. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently, federal, state and local agencies are committed to finding ways, such as prescribed burning to reintroduce fire into natural ecosystems, while recognizing that fire fighting and suppression are still important.

Connecticut has a particular vulnerability to fire hazards where urban development and wildland areas are in close proximity. The "wildland/urban interface" is where many such fires are fought. Wildland areas are subject to fires because of weather conditions and fuel supply. An isolated wildland fire may not be a threat, but the combined effect of having residences, businesses, and lifelines near a wildland area causes increased risk to life and property. Thus, a fire that might have been allowed to burn itself out with a minimum of fire fighting or containment in the past must now be fought to prevent fire damage to surrounding homes and commercial areas, as well as smoke threats to health and safety in these areas.

10.3 Historic Record

Connecticut enacted its first state-wide forest fire control system in 1905, when the state was largely rural with very little secondary growth forest. By 1927, the state had most of the statutory foundations for today's forest fire control programs and policies in place, such as the State Forest Fire Warden system, a network of fire lookout towers and patrols, and regulations regarding open burning. The severe fire weather in the 1940's prompted the state legislature to join the Northeastern Interstate Forest Fire Protection Compact with its neighbors in 1949. Today, most of Connecticut's forested areas are secondary growth forests. According to the Connecticut DEP, forest has reclaimed over 500,000 acres of what was farmland in 1914.

The technology used to combat wildfires has significantly improved since the early 20th century. An improved transportation network, coupled with advances in firefighting equipment, communication technology, and training, has improved the ability of firefighters to minimize damage due to wildfires in the state.

According to the USDA Forest Service Annual Wildfire Summary Report for 1994 through 2003, an average of 600 acres per year in the United States was burned by wildfires. In general, the fires are small and detected quickly, with most wildfires being contained to less than 10 acres in size. The number one cause of wildfires is arson, with about half of all wildfires being intentionally set.

Traditionally, the highest forest fire danger in Connecticut occurs in the spring from mid-March to mid-May. The worst wildfire year in Connecticut since 1994 occurred during the extremely hot and dry summer of 1999. Over 1,733 acres of Connecticut burned in 345 separate wildfires, an average of about five acres per fire. Only one wildfire occurred between 1994 and 2003 that burned over 300 acres, and a wildfire in 1986 in the Mattatuck State Forest in the nearby Town Watertown burned 300 acres.

10.4 Existing Programs, Policies, and Mitigation Measures

Existing mitigation for wildland fire control is typically focused on Fire Department training and maintaining an adequate supply of equipment. The City has a brush truck capable of accessing remote fires, and several pumpers carry extra lines of hose to supplement the range of this truck.

Unlike wildfires on the west coast of the United States where the fires are allowed to burn toward development and then stopped, the Waterbury Fire Department goes to the fires. This proactive approach is believed to be effective for controlling wildfires. The fire department has some water storage capability, but primarily relies on the City water

system. Most of the City has water service that includes hydrants for fire protection. The availability of water speeds the containment time for most fires occurring in the City.

The DEP Forestry Division uses the rainfall data recorded by the Automated Flood Warning system (see Section 3.4) to compile forest fire probability forecasts. This allows the Division and local municipalities to monitor the drier areas of the state in an effort to reduce forest fire risk.

The City Land Subdivision Regulations encourage through streets in new developments, increasing the amount of egress available to the fire department for combating wildfires. However, Inland Wetland Regulations sometimes cause a conflicting pattern of street development, with a loss of egress where wetlands are located.

Finally, the City Fire Department has an inventory of industrial facilities containing substantial wood construction in order to mitigate the spread of fires.

10.5 Vulnerabilities and Risk Assessment

Wildfires can occur anywhere and at any time in undeveloped or lightly developed areas. The extensive forests and fields covering the state are prime locations for a wildfire. In many areas, structures and subdivisions are built abutting forest borders, creating areas of particular vulnerability. Wildfires are more common in rural areas than in developed areas, as most fires in populated areas are quickly noticed and contained. The likelihood of a severe wildfire developing is lessened by the vast network of water features in the state, which create natural breaks likely to stop the spread of a fire. During long periods of drought, these natural features may dry up, increasing the vulnerability of the state to wildfires.

According to the Connecticut DEP, the actual forest fire risk in Connecticut is low due to several factors. First, the overall incidence of forest fires is very low. Secondly, as the

wildfire/forest fire prone areas become fragmented due to development, the local fire departments have increased access to those neighborhoods for fire fighting equipment. Finally, trained fire fighters at the local and state levels are readily available to fight fires in the state, and inter-municipal cooperation on such occurrences is common.

Based on the historic record presented in Section 10.3, most wildfires in Connecticut are relatively small. In the drought year of 1999, the average wildfire burned five acres in comparison to the most extreme wildfire recorded in the past 20 years that burned 300 acres. Given the large water service area in the City and long-standing mutual aid assurances the City Fire Department has with neighboring communities, it is believed that these average and severe values are applicable to the City as well.

The wildfire risk areas presented in Figure 10-1 were defined as being contiguous wooded areas greater than 50 acres in size without access to public water service. These areas are generally near the northern, western, and southern corporate boundaries and each area borders residential sections of the City. Therefore, residents on the outskirts of these risk areas are the most vulnerable to fire, heat, and smoke effects of wildfires.

Despite having a large amount of forest/urban interface, the overall risk of wildfires occurring in the City of Waterbury is also considered to be low. Such fires fail to spread far due speed of detection and strong fire response. The majority of the City is served by the Waterbury Water Department, so a large amount of water pressure is available for fire fighting equipment. As stated above, the creation of through streets increases the range of fire fighting and emergency equipment, and increased public awareness has further mitigated the risk.

Recall from Figure 2-7, Figure 2-8, and Figure 2-9 that significant elderly, linguistically isolated, and disabled populations reside in the City of Waterbury. In comparing these figures with the wildfire risk areas presented in Figure 10-1, it is possible that up to 20% of the population in a wildfire impact area could consist of the elderly, up to 10% could

consist of linguistically isolated households, and numerous people with disabilities could reside in wildfire impact areas. Thus, it is important for the Waterbury Fire Department to be prepared to assist these special populations during a wildfire emergency.

Recall from Section 2.9 that an important 24" to 16" PCCP runs west-east through the City. A break in this water main could leave thousands without public water supply and firefighting water, not only for urban fires but also for wildland fires. Furthermore, the Town of Wolcott relies on the Waterbury Water Department, and this water main in particular, for much of its firefighting water. Wolcott is less developed than the City of Waterbury and is at a higher risk for wildfires because of its rural nature.

10.6 Potential Mitigation Measures, Strategies, and Alternatives

Potential mitigation measures for wildfires include a mixture of prevention, education, and emergency planning. Although educational materials are available through the Fire Department, they should be made available at other municipal offices as well. Education of homeowners on methods of protecting their homes is far more effective than trying to steer growth away from potential wildfire areas, especially given that the available land that is environmentally appropriate for development may be forested.

Water system improvements are an important class of potential mitigation for wildfires. The following recommendations could be implemented to mitigate fire risk:

- The Waterbury Water Department should continue to extend the public water supply systems into areas that require water for fire protection.
- The Waterbury Water Department should identify and upgrade those portions of the public water supply systems that are substandard from the standpoint of adequate pressure and volume for fire-fighting purposes.
- Innovative solutions to fire protection should be explored where it is not feasible to extend a conventional water system. One example of a fire protection solution would

be the use of fire ponds. This task would be best designated to the Public Works Department.

Other potential mitigation strategies for wildfires include:

- Continue to promote inter-municipal cooperation in fire fighting efforts;
- Ensure personnel are prepared to provide assistance to a possibly significant number of elderly, linguistically isolated, and/or disabled populations;
- Continue to support public outreach programs to increase awareness of forest fire danger and how to use common fire fighting equipment;
- Continue to review subdivision applications to ensure new neighborhoods and driveways are properly sized to allow access of emergency vehicles;
- Where possible, ensure that adherence to Inland Wetland Regulations does not result in a loss of egress due to truncation of roads at wetlands;
- Provide outreach programs including tips on how to property manage burning on private property;
- Patrol City-owned open space and parks to prevent campfires;
- Distribute copies of a booklet such as "Is Your Home Protected from Wildfire Disaster? – A Homeowner's Guide to Wildfire Retrofit" when developers and homeowners pick up or drop off applications in the Building Department;
- Enforce regulations and permits for open burning; and
- Continue to place utilities underground.

In addition, specific recommendations that apply to all hazards are listed in Section 11.1.

11.0 RECOMMENDATIONS

11.1 Additional Recommendations

Recommendations that are applicable to two, three, or four hazards were discussed in the applicable subsections of Sections 3.0 through 10.0. For example, placing utilities underground is a recommendation for hurricane, summer storm, winter storm, and wildfire mitigation. A remaining class of recommendations is applicable to all hazards, because it includes recommendations for improving public safety and planning for emergency response. Instead of repeating these recommendations in section after section of this Plan, these are described herein.

Informing and educating the public about how to protect themselves and their property from natural hazards is essential to any successful hazard mitigation strategy. The Local Emergency Planning personnel or commission should be charged with the creation and/or dissemination of informational pamphlets and guides to public locations such as libraries, post offices, senior centers, and City Hall. One such guide entitled "Are You Ready? An In-Depth Guide to Citizen Preparedness," co-published by the American Red Cross, NOAA, and FEMA provides useful information regarding fire, flooding, heat waves, hurricanes, thunderstorms, tornadoes, and winter storms. Other useful guides should include, at a minimum, the following subjects:

- Food, water, and other disaster supplies
- Creating a family disaster plan
- Disaster preparation for people with disabilities and other special needs
- Helping children cope with disaster
- Helping adults cope with disaster-related stress

A community warning system that relies on radios and television is less effective at warning residents during the night when the majority of the community is asleep. Thus, the implementation of an emergency notification system would be beneficial in warning residents of an impending hazard. In addition, the City Emergency Operations Plan should continue to reviewed and updated regular basis, at least once annually.

In addition, several pages should be added to the City website regarding emergency planning and shelter locations so that the public can prepare family emergency plans within the framework of the Waterbury emergency procedures.

Finally, as explained in Section 2.9, consolidation of Public Works facilities is believed to be an important goal for the City of Waterbury as it would allow for a better, more coordinated response to disasters. Moving the functions of the four existing facilities to once centralized facility, located outside a flood zone and along a disaster-resistant roadway or travel route, would enable the City of Waterbury to better respond to natural disasters.

Likewise, the Public Works Department should develop working intermunicipal agreements with other public works departments in nearby communities. This would allow for sharing of resources when disasters affect one community more than others.

11.2 Summary of Specific Recommendations

Recommendations have been presented throughout this document in individual sections as related to each natural hazard. This section lists specific recommendations of the Plan without any priority ranking. Recommendations that span multiple hazards are only reprinted once in this section under the most appropriate hazard event. Refer to the matrix in Appendix A for recommendations with scores based on the STAPLEE methodology described in Section 1.0.

Inland Flooding

Prevention

- Streamline the permitting process and ensure maximum education of a developer or applicant. Develop a checklist that cross-references the bylaws, regulations, and codes related to flood damage prevention that may be applicable to the proposed project. This list could be provided to an applicant at any City department. The permit tracking software that is being considered by the City Planning Department should have such a checklist or built-in cross-notification function.
- Coordinate with neighboring municipalities regarding new subdivisions that could impact properties within Waterbury (for upstream municipalities) and downstream of Waterbury.
- Consider becoming a member of FEMA's Community Rating System.
- Adopt a more comprehensive set of floodplain management regulations. The Zoning and Land Subdivision Regulations should be amended to include detailed provisions for flood damage prevention. Applicants should be required to demonstrate compliance with these regulations. New buildings constructed in flood-prone areas should be protected to the highest recorded flood level, regardless of being in a SFHA, and designed and graded to shunt drainage away from the building.
- Add appropriate regulations to the Code of Ordinances, Zoning Ordinance, and the Land Subdivision Regulations to 1) prevent non-permitted increases in impervious surfaces and 2) require watershed-based engineering studies for new subdivisions or sizeable developments showing both the upstream and downstream drainage impacts.
- Utilize the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 to assist with implementation of the above recommendations.
- When possible, assist with the Map Mod program to ensure an appropriate update to the Flood Insurance Study, Flood Insurance Rate Maps, and Flood Boundary and

Floodway Maps, particularly for the Mad River. The current incarnation of FEMA mapping is almost 30 years old and is outdated.

- After Map Mod has been completed, consider restudying local flood prone areas and produce new local-level regulatory floodplain maps using more exacting study techniques, including using more accurate contour information to map flood elevations provided with the FIRM.
- Implement outreach programs to educate citizens regarding Ordinances, Insurance, and other flood relevant issues.

Property & Natural Resource Protection

- Clear brush and growth that could possibly inhibit flood flows in the floodplain of the Mad River, especially in the Townline Road area where the topography is very flat. This should be a recurring item taking place at least once every three years.
- Purchase private land in the 100-year floodplain and convert to greenways, parks, or other non-residential, non-commercial, or non-industrial use.
- Selectively pursue conservation objectives listed in the Plan of Conservation and Development, including the creation of greenways.
- Continue to regulate development in protected and sensitive areas.
- Pursue the acquisition of additional municipal open space properties inside SFHAs.

Structural Projects

- Commission a comprehensive City-wide stormwater management system study. This study should include a culvert and catch basin maintenance and replacement schedule and include mathematical models that developers can use to compare existing to proposed conditions. Update this Study with a minimum frequency of every five years.

- Continue to investigate reports of localized flooding problems to determine the cause and an appropriate solution. Set milestones for eliminating recurring localized flooding areas.
- Implement an electronic complaint tracking system to maintain a computerized database of calls received by the City. Ensure that this software will be compatible with permit tracking software that is being considered by the City Planning Department.
- Perform a drainage study of Great Brook, including a structural analysis of the box culvert that Great Brook flows through underneath the Palace Theatre. This could be coordinated with a dam failure analysis for Belleview Lake Dam, recommended below under the "Dam Failure" heading. Construct improvements as outlined by the engineering study.
- Perform an engineering study for the Mark Lane Landfill area and the Highland Metro North Railroad area. Both of these areas were heavily damaged by the June 2, 2006 storm. Mitigation measures are required to properly protect these areas from future disasters.
- Install a drainage system along Division Street.
- Perform Trumpet Brook watershed study and reconstruction.
- Evaluate capacities of East Main Street and East Liberty Street bridges over the Mad River and reconstruct if necessary.
- Conduct a study to prioritize areas for separation of sanitary and stormwater systems.
- Continue to separate and update the storm and sanitary sewer systems according to the priority worked out in the study and agreed upon by Public Works and Water Pollution Control Departments.
- Consider installation and repair of curbing for areas listed in Table 3-3.
- Consider installation of stormwater systems for areas listed in Table 3-4.
- Repair stormwater and drainage systems listed in Table 3-5.

Damage Related to Hurricanes, Summer Storms, and Winter Storms

- Increase tree limb maintenance and inspections.
- Continue outreach regarding dangerous trees on private property.
- Develop an early-warning system to alert residents in municipally-owned parks and golf courses that lightning is possible.
- Continue to require that utilities be placed underground in new developments and pursue funding to place them underground in existing developed areas.
- Continue to require compliance with the amended Connecticut Building Code for wind speeds.
- Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards.

Winter Storms

- Construct improvements for reducing road icing.
- Acquire additional funding for the sand/salt storage facility.
- Consider property acquisitions along Connecticut and Ohio Avenues to reduce the number of people potentially affected by the limited plowing services available in this neighborhood.
- Continue to encourage two modes of egress into every neighborhood by the creation of through streets.
- Provide education and outreach materials to property owners on how to protect property through the use of shutters and storm windows, the importance of removing snow from flat roofs, and the importance of insulating pipes adequately to protect from freezing and bursting.
- Purchase GPS units for City vehicles and subcontracted plowing vehicles.

Earthquakes

- Consider preventing residential development in areas of, on, above, or below steep slopes (slopes exceeding 30%) [the Land Use Regulations/Engineering Standards Revision Project that commenced in autumn 2007 may assist with implementation of this recommendation].
- Continue to require adherence to the state building codes.
- Consider adding earthquakes to the list of hazards covered by the Emergency Operations Plan.
- Ensure that municipal departments have adequate backup facilities in case earthquake damage occurs.

Landslides

- Direct the property owner to reconstruct that portion of the slope that jeopardizes Waterville Street and restore a proper angle to the slope below to prevent future landslides.
- Secure pre-disaster mitigation funding for replacing the 24-inch and 16-inch water transmission mains servicing the eastern part of Waterbury and Wolcott. Consider relocating parts of the transmission main to areas of less severe slope.
- Consider implementing regulations restricting construction on 25% or greater slopes and restricting excavation and clearing activities above such slopes.
- Consider preventing development in sandy areas with steep slopes as outlined in Figure 8-3.
- Consider adopting some or all of the USDA guidelines listed in Section 8.1 to regulate development in areas of steep slopes.
- Consider preserving areas of steep slopes as protected open space through acquisition or modified zoning.
- Ensure that local utility providers are aware of landslide potential and have responder teams ready to repair damage to their utilities caused by landslides.

- Have education and outreach materials available at the Building Department regarding how to identify potential landslide areas
- Consider expanding and over-sizing drainage systems in the vicinity of steep slopes.
- Encourage private property owners to have their retaining walls inspected by a professional structural engineer.

Dam Failure

- Continue to require or conduct regular inspections of all Class C dams, with upkeep and maintenance as required for keeping such dams in safe and functional order.
- Consider implementing City inspections of municipally-owned Class A, AA, B, and BB dams.
- Work with the DEP to ensure that all Class C dams have up to date emergency operations plans and dam failure analyses. Have copies of these documents available at the City Hall for public viewing.
- Ensure that all Class C dams have up to date operation and maintenance plans
- Perform or update the dam failure analysis for each dam. This is of particular importance for Belleview Lake Dam, and should be performed in conjunction with the Great Brook structural integrity analysis described in Section 3.
- Depending on the results of the updated dam failure analyses, consider requesting that DEP reclassify the hazard potential of Risdon Pond Dam and Scovill Pond Dam. These dams have had their hydraulic head significantly reduced by lowering and partial breaching.
- Petition FEMA to commission a new study of the Mad River to reestablish 100-year flood heights. The current incarnation of FEMA mapping is almost 30 years old and is outdated. The partial breach of the dam at Scovill Pond has likely lowered flood heights in that area. Such a study would prove useful for future bridge repairs similar to those currently approved in the capitol budget for the Mad River.

- Ensure that Connecticut DEP conducts a levee failure analysis outlining in detail the area of impact should the Waterbury local protection project fail at the level of the 100-year and 500-year flood.
- Ensure that the Connecticut DEP performs any and all repairs and maintenance necessary to restore the Army Corps levee system to fully certified status.
- Encourage the owner to prepare an operation and maintenance plan for Frost Road Pond Dam to help ensure that the hydraulic head behind the dam is not raised by debris clogged in the breach.
- Consider working with the owner to commission an engineering study concerning the total removal of Frost Road Pond Dam.
- Perform any necessary repairs to Pritchards Pond Dam to return the dam to safe working order. These repairs may be implemented as part of the Pearl Lake Road reconstruction project.

Wildfires

- The Waterbury Water Department should continue to extend the public water supply systems into areas within growth boundaries that require water for fire protection.
- The Waterbury Water Department should identify and upgrade those portions of the public water supply systems that are substandard from the standpoint of adequate pressure and volume for fire-fighting purposes.
- Innovative solutions to fire protection should be explored where it is not feasible to extend a conventional water system. One example of a fire protection solution would be the use of fire ponds.
- Continue to promote inter-municipal cooperation in fire fighting efforts;
- Ensure personnel are prepared to provide assistance to a possibly significant number of elderly, linguistically isolated, and/or disabled populations;
- Continue to support public outreach programs to increase awareness of forest fire danger and how to use common fire fighting equipment;

- Distribute copies of a booklet such as "Is Your Home Protected from Wildfire Disaster? – A Homeowner's Guide to Wildfire Retrofit" when developers and homeowners pick up or drop off applications in the Building Department;
- Continue to review subdivision applications to ensure new neighborhoods and driveways are properly sized to allow access of emergency vehicles;
- Where possible, ensure that adherence to Inland Wetland Regulations does not result in a loss of egress due to truncation of roads at wetlands;
- Provide outreach programs including tips on how to properly manage burning on private property;
- Patrol City-owned open space and parks to prevent unauthorized campfires; and
- Enforce regulations and permits for open burning.

11.3 Sources of Funding

The following sources of funding and technical assistance may be available for the priority projects listed above. Funding requirements and contact information is given in Section 12.0.

Flood Mitigation

- FEMA Flood Mitigation Assistance (FMA) Program – *grants for pre-disaster flood hazard mitigation planning and projects.*
- U.S. Army Corps of Engineers – 50*/50 match funding for floodproofing and flood preparedness projects.*
- U.S. Department of Agriculture – *financial assistance to reduce flood damage in small watersheds and to improve water quality.*
- CT Department of Environmental Protection – *assistance to municipalities to solve flooding and dam repair problems through the Flood and Erosion Control Board Program.*

Hurricane Mitigation

- FEMA State Hurricane Program - *financial and technical assistance to local governments to support mitigation of hurricanes and coastal storms.*
- FEMA Hurricane Program Property Protection – *grants to hurricane prone states to implement hurricane mitigation projects.*

General Hazard Mitigation

- FEMA Hazard Mitigation Grant Program (HMGP) – *funding for hazard mitigation projects following a presidentially-declared disaster.*
- FEMA Pre-Disaster Mitigation Grant Program (PDM) – *funding for hazard mitigation projects on a nationally competitive basis.*
- Americorps – *teams may be available to assist with landscaping projects such as surveying, tree planting, restoration, construction, and environmental education.*

Wildfire Mitigation

- Assistance to Firefighters Grant Program – *Provides pre-disaster grants to organizations such as fire departments that are recognized for expertise is fire prevention and safety programs.*

Erosion Control and Wetland Protection

- U.S. Department of Agriculture – *technical assistance for erosion control.*
- CT Department of Environmental Protection – *assistance to municipalities to solve beach erosion problems through the Flood and Erosion Control Board Program.*
- North American Wetlands Conservation Act Grants Program – *funding for projects that support long term wetlands acquisition, restoration, and/or enhancement. Requires a 1-to-1 funds match.*

12.0 PLAN IMPLEMENTATION

12.1 Implementation Strategy and Schedule

The Council of Governments of the Central Naugatuck Valley is authorized to update this hazard mitigation plan as described below, coordinate its adoption with the City of Waterbury, and guide it through the FEMA approval process.

As individual recommendations of the hazard mitigation plan are implemented, they must be implemented by the municipal departments that oversee these activities. The Public Works Department and its Bureau of Engineering will primarily be responsible for developing and implementing selected projects, although other departments such as Water Pollution Control and City Planning will oversee or jointly oversee some projects. Appendix A incorporates an implementation strategy and schedule, detailing the responsible department and anticipated time frame for the specific recommendations listed throughout this document.

Upon adoption, the Plan will be made available to all relevant City departments and agencies as a planning tool to be used in conjunction with existing documents. It is expected that revisions to other City plans and regulations, such as the Plan of Conservation and Development, department annual budgets, and the Zoning and Subdivision Regulations, will reference this plan and its updates. The Office of the Mayor will be responsible for ensuring that the actions identified in this plan are incorporated into ongoing City planning activities, and that the information and requirements of this plan are incorporated into existing planning documents within five years from the date of adoption or when other plans are updated, whichever is sooner.

The Office of the Mayor will be responsible for assigning appropriate City officials to update the Plan of Conservation and Development, Zoning Regulations, Subdivision

Regulations, Wetlands Regulations, and Emergency Operations Plan to include the provisions in this plan. Should a general revision be too cumbersome or cost prohibitive, simple addendums to these documents will be added that include the provisions of this plan. The Plan of Conservation and Development and the Emergency Operations Plan are the two documents most likely to benefit from the inclusion of the Plan in the City's library of planning documents.

Finally, information and projects in this planning document will be included in annual budget and capital improvement plans as part of implementing the projects recommended in this plan. This will primarily include the annual budget and capital improvement projects lists maintained and updated by the Public Works Department and City Engineer.

12.2 Progress Monitoring and Public Participation

The Office of the Mayor will be the party responsible for monitoring the successful implementation of the Plan as part of its oversight of all municipal departments. Such monitoring may include periodic reports to the COG regarding certain projects, meetings, site visits, and telephone calls as befits the project being implemented. The Council of Governments of the Central Naugatuck Valley will coordinate an annual meeting for review and evaluation of the plan. Participants in this review may include representatives of the departments listed in Section 12.1.

Matters to be reviewed at this meeting will include a review of the goals and objectives of the original plan, a review of hazards or disasters that occurred during the preceding year, a review of the mitigation activities that have been accomplished to date, a discussion of reasons that implementation may be behind schedule, and recommendations for new projects and revised activities. The meeting will be conducted in October or November, at least two months before the annual application cycle for pre-disaster grants (applications are typically due in January of any given year). This will enable a list of

possible projects to be circulated for City Departments to review, with sufficient time for developing an application.

Continued public involvement will be sought regarding the monitoring, evaluating, and updating of the Plan. Public input will be solicited through community meetings and input to web-based information gathering tools. Public comment on changes to the Plan may be sought through posting of public notices, and notifications posted to the website of the Council of Governments of the Central Naugatuck Valley, as well as of the City of Waterbury.

12.3 Updating the Plan

The Council of Governments of the Central Naugatuck Valley will update the hazard mitigation plan if a consensus to do so is reached by the Board of Aldermen and Mayor and a request is presented to the Council of Governments of the Central Naugatuck Valley, or at least once every five years. A committee will be formed consisting of representatives of many of the same departments solicited for input to this plan. In addition, local business leaders, community and neighborhood group leaders, relevant private and non-profit interest groups, and the eight neighboring municipalities will be invited to participate, including the following:

- The Central Naugatuck Valley Emergency Planning Committee, managed by the COGCNV;
- The Waterbury Neighborhood Council (the council's mission was described in Section 1.5);
- Naugatuck River Watershed Association;
- Town of Cheshire Public Works Department and Planning Department;
- Town of Wolcott Local Emergency Planning Commission (LEPC);
- Town of Prospect Mayor's Office;

- Town of Naugatuck (key department to be determined; hazard mitigation plan development is scheduled for 2008);
- Town of Middlebury (key department to be determined; hazard mitigation plan development is scheduled for 2008);
- Town of Watertown Emergency Management Department;
- Town of Thomaston (key department to be determined; hazard mitigation plan development is scheduled for 2008);
- Town of Plymouth Public Works Department and Land Use Department; and
- The University of Connecticut Waterbury Campus, Department of Urban and Community Studies.

Updates may include deleting recommendations as projects are completed, adding recommendations as new hazard impacts arise, or modifying hazard vulnerabilities as land use changes. In addition, the list of shelters and critical facilities should be updated as necessary, or at least every five years.

12.4 Technical and Financial Resources

This Section is comprised of a list of resources to be considered for technical assistance and potentially financial assistance for completion of the actions outlined in this plan. This list is not all-inclusive and is intended to be updated as necessary.

Federal Resources

Federal Emergency Management Agency
Region I
99 High Street, 6th floor
Boston, MA 02110
(877) 336-2734
http://www.fema.gov/

Mitigation Division

The Mitigation Division is comprised of three branches that administer all of FEMA's hazard mitigation programs. The **Risk Analysis Branch** applies planning and engineering principles to identify hazards, assess vulnerabilities, and develop strategies to manage the risks associated with natural hazards. The **Risk Reduction Branch** promotes the use of land use controls and building practices to manage and assess risk in both the existing built developments and future development areas in both pre- and post-disaster environments. The **Risk Insurance Branch** mitigates flood losses by providing affordable flood insurance for property owners and by encouraging communities to adopt and enforce floodplain management regulations.

FEMA Programs administered by the Risk Analysis Branch include:

- *Flood Hazard Mapping Program*, which maintains and updates National Flood Insurance Program maps;
- *National Dam Safety Program*, which provides state assistance funds, research, and training in dam safety procedures;
- *National Hurricane Program*, which conducts and supports projects and activities that help protect communities from hurricane hazards; and
- *Mitigation Planning*, a process for states and communities to identify policies, activities, and tools that can reduce or eliminate long-term risk to life and property from a hazard event.

FEMA Programs administered by the Risk Reduction Branch include:

- *Hazard Mitigation Grant Program (HMGP)*, which provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration;
- *Flood Mitigation Assistance Program (FMA)*, which provides funds to assist states and communities to implement measures that reduce or eliminate long-term risk of flood damage to structures insurable under the National Flood Insurance Program;
- *Pre-Disaster Mitigation Grant Program (PDM)*, which provides program funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event;

- *Severe Repetitive Loss Program (SRL)*, which provides funding to reduce or eliminate the long-term risk of flood damage to "severe repetitive loss" structures insured under the National Flood Insurance Program;
- *Community Rating System (CRS)*, a voluntary incentive program under the National Flood Insurance Program that recognizes and encourages community floodplain management activities; and
- *National Earthquake Hazards Reduction Program (NEHRP)*, which in conjunction with state and regional organizations supports state and local programs designed to protect citizens from earthquake hazard.

The Risk Insurance Branch oversees the *National Flood Insurance Program (NFIP)*, which enables property owners in participating communities to purchase flood insurance. The NFIP assists communities in complying with the requirements of the program and publishes flood hazard maps and flood insurance studies to determine areas of risk.

FEMA also can provide information on past and current acquisition, relocation, and retrofitting programs, and has expertise in many natural and technological hazards. FEMA also provides funding for training state and local officials at Emergency Management Institute in Emmitsburg, Maryland.

The Mitigation Directorate also has in place several *Technical Assistance Contracts (TAC)* that support FEMA, States, territories, and local governments with activities to enhance the effectiveness of natural hazard reduction program efforts. The TACs support FEMA's responsibilities and legislative authorities for implementing the earthquake, hurricane, dam safety, and floodplain management programs. The range of technical assistance services provided through the TACs varies based on the needs of the eligible contract users and the natural hazard programs. Contracts and services include:

- *The Hazard Mitigation Technical Assistance Program (HMTAP) Contract*-supporting post-disaster program needs in cases of large, unusual, or complex projects; situations where resources are not available; or where outside technical assistance is determined to be needed. Services include environmental and biological assessments, benefit/cost analyses, historic preservation assessments, hazard identification, community planning, training, and more.

- *The Wind and Water Technical Assistance Contract (WAWTAC)*-supporting wind and flood hazards reduction program needs. Projects include recommending mitigation measures to reduce potential losses to post-FIRM structures, providing mitigation policy and practices expertise to States, incorporating mitigation into local hurricane program outreach materials, developing a Hurricane Mitigation and Recovery exercise, and assessing the hazard vulnerability of a hospital.

- *The National Earthquake Technical Assistance Contract (NETAC)* – supporting earthquake program needs. Projects include economic impact analyses of various earthquakes, vulnerability analyses of hospitals and schools, identification of and

training on non-structural mitigation measures, and evaluating the performance of seismically rehabilitated structures, post-earthquake.

Response & Recovery Division

As part of the National Response Plan, this division provides information on dollar amounts of past disaster assistance including Public Assistance, Individual Assistance, and Temporary Housing, as well as information on retrofitting and acquisition/relocation initiatives. The Response & Recovery Division also provides mobile emergency reponse support to disaster areas, supports the National Disaster Medical System, and provides urban search and rescue teams for disaster victims in confined spaces.

The division also coordinates federal disaster assistance programs. The Public Assistance Grant Program (PA) that provides 75% grants for mitigation projects to protect eligible damaged public and private non-profit facilities from future damage. 100% "minimization" grants are available through the Individuals and Family Grant Program. The Hazard Mitigation Grant Program and the Fire Management Assistance Grant Program are also administered by this division.

Computer Sciences Corporation
New England Regional Insurance Manager
Bureau and Statistical Office
(781) 848-1908
http://www.csc.com/

A private company contracted by the Federal Insurance Administration as the National Flood Insurance Program Bureau and Statistical Agent, CSC provides information and assistance on flood insurance, including handling policy and claims questions, and providing workshops to leaders, insurance agents, and communities.

Small Business Administration
360 Rainbow Boulevard South, 3rd Floor
Niagara Falls, NY 14303
800-659-2955
http://www.sba.gov/

SBA has the authority to "declare" disaster areas following disasters that affect a significant number of homes and businesses, but that would not need additional assistance through FEMA. (SBA is triggered by a FEMA declaration, however.) SBA can provide additional low-interest funds (up to 20% above what an eligible applicant would "normally" qualify for) to install mitigation measures. They can also loan the cost of bringing a damaged property up to state or local code requirements. These loans can

be used in combination with the new "mitigation insurance" under the NFIP, or in lieu of that coverage.

Environmental Protection Agency
Region I
1 Congress Street, Suite 1100
Boston, MA 02114-2023
(888) 372-7341

Provides grants for restoration and repair, and educational activities, including:

- *Capitalization Grants for State Revolving Funds*: Low interest loans to governments to repair, replace, or relocate wastewater treatment plans damaged in floods. Does not apply to drinking water or other utilities.

- *Clean Water Act Section 319 Grants*: Cost-share grants to state agencies that can be used for funding watershed resource restoration activities, including wetlands and other aquatic habitat (riparian zones). Only those activities that control non-point pollution are eligible. Grants are administered through the CT DEP, Bureau of Water Management, Planning and Standards Division.

U.S. Department of Housing and Urban Development
1 Corporate Center, 19th Floor
Hartford, CT 06103-3220
(860) 240-9700
http://www.hud.gov/

The U.S. Department of Housing and Urban Development offers *Community Development Block Grants (CDBG)* to communities with populations greater than 50,000, who may contact HUD directly regarding CDGB. One program objective is to improve housing conditions for low and moderate income families. Projects can include acquiring flood prone homes or protecting them from flood damage. Funding is a 100% grant; can be used as a source of local matching funds for other funding programs, such as FEMA's "404" Hazard Mitigation Grant Program. Funds can also be applied toward "blighted" conditions, which is often the post-flood condition. A separate set of funds exists for conditions that create an "imminent threat." The funds have been used in the past to replace (and redesign) bridges where flood damage eliminates police and fire access to the other side of the waterway. Funds are also available for smaller municipalities through the State Administered CDBG program participated in by the State of Connecticut.

U.S. Army Corps of Engineers
Institute for Water Resources
7701 Telegraph road
Alexandria, VA 22315
(703) 428-8015
http://www.iwr.usace.army.mil/

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under the Floodplain Management Services Program (FPMS). Various flood protection measures such as beach re-nourishment, stream clearance and snagging projects, floodproofing, and flood preparedness are funded on a 50/50 matching basis by Section 22 planning Assistance to States program. They are authorized to relocate homes out of the floodplain if it proves to be more cost effective than a structural flood control measure.

U.S. Department of Commerce
National Weather Service
Northeast River Forecast Center
445 Myles Standish Blvd.
Taunton, MA 02780
(508) 824-5116
http://www.nws.noaa.gov/

The National Weather Service prepares and issues flood, severe weather, and coastal storm warnings. Staff hydrologists can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

U.S. Department of the Interior
National Park Service
Steve Golden, Program Leader
Rivers, Trails, & Conservation Assistance
15 State Street
Boston, MA 02109
(617) 223-5123
http://www.nps.gov/rtca/

The National Park Service provides technical assistance to community groups and local, state, and federal government agencies to conserve rivers, preserve open space, and develop trails and greenways, as well as identify non-structural options for floodplain development.

U.S. Fish and Wildlife Service
New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
(603) 223-2541
http://www.fws.gov/

The U.S. Fish and Wildlife Service provide technical and financial assistance to restore wetlands and riparian habitats through the North American Wetland Conservation Fund and Partners for Wildlife programs. It also administers the *North American Wetlands Conservation Act Grants Program*, which provides matching grants to organizations and individuals who have developed partnerships to carry out wetlands projects in the United States, Canada, and Mexico. Funds are available for projects focusing on protecting, restoring, and/or enhancing critical habitat.

U.S. Department of Agriculture
Natural Resources Conservation Service (formerly SCS)
Connecticut Office
344 Merrow Road, Suite A
Tolland, CT 06084-3917
(860) 871-4011

The Natural Resources Conservation Service provides technical assistance to individual land owners, groups of landowners, communities, and soil and water conservation districts on land-use and conservation planning, resource development, stormwater management, flood prevention, erosion control and sediment reduction, detailed soil surveys, watershed/river basin planning and recreation, and fish and wildlife management. Financial assistance is available to reduce flood damage in small watersheds and to improve water quality. Financial assistance is available under the Emergency Watershed Protection Program; the Cooperative River Basin Program; and the Small Watershed Protection Program.

Regional Resources

Northeast States Emergency Consortium
1 West Water Street, Suite 205
Wakefield, MA 01880
(781) 224-9876
http://www.serve.com/NESEC/

The Northeast States Emergency Consortium (NESEC) develops, promotes, and coordinates "all-hazards" emergency management activities throughout the Northeast. NESEC works in partnership with public and private organizations to reduce losses of

life and property. They provide support in areas including interstate coordination and public awareness and education, along with reinforcing interactions between all levels of government, academia, non-profit organizations, and the private sector.

State Resources

Connecticut Department of Economic and Community Development
505 Hudson Street
Hartford, CT 06106-7106
(860) 270-8000
http://www.ct.gov/ecd/

The Connecticut Department of Economic and Community Development administers HUD's State CDBG Program, awarding smaller communities and rural areas grants for use in revitalizing neighborhoods, expanding affordable housing and economic opportunities, and improving community facilities and services.

Connecticut Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3706
http://www.dep.state.ct.us/
The Connecticut DEP includes several divisions with various functions related to hazard mitigation:

Bureau of Water Management, Inland Water Resources Division - This division is generally responsible for flood hazard mitigation in Connecticut, including administration of the National Flood Insurance Program. Other programs within the division include:

- *National Flood Insurance Program State Coordinator*: Provides flood insurance and floodplain management technical assistance, floodplain management ordinance review, substantial damage/improvement requirements, community assistance visits, and other general flood hazard mitigation planning.

- *State Hazard Mitigation Officer (shared role with the Department of Emergency Management and Homeland Security)*: Hazard mitigation planning and policy; oversight of administration of the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program.

- *Flood Warning and Forecasting Service*: Prepares and issues flood, severe weather, and coastal storm warnings. Staff engineers and forecaster can work with communities on flood warning issues and can give technical assistance in preparing flood warning plans.

- *Flood & Erosion Control Board Program*: Provides assistance to municipalities to solve flooding, beach erosion and dam repair problems. Certain non-structural measures that mitigate flood damages are also eligible. Funding is provided to communities that apply for assistance through a Flood & Erosion Control Board on a non-competitive basis.

- *Stream Channel Encroachment Line Program*: Similar to the NFIP, this state regulatory program places restrictions on the development of floodplains along certain major rivers. This program draws in environmental concerns in addition to public safety issues when permitting projects.

- *Inland Wetlands and Watercourses Management Program*: Provides training, technical and planning assistance to local Inland Wetlands Commissions, reviews and approves municipal regulations for localities.

- *Dam Safety Program*: Charged with the responsibility for administration and enforcement of Connecticut's dam safety laws. Permits the construction, repair or alteration of dams, dikes or similar structures and maintains a registration database of all known dams statewide. This program also operates a statewide inspection program.

- *Rivers Restoration Grant Program*: Administers funding and grants under the Clean Water Act involving river restoration, and reviews and provides assistance with such projects.

Bureau of Water Management - Planning and Standards Division - Administers the Clean Water Fund and many other programs directly and indirectly related to hazard mitigation including the Section 319 non-point source pollution reduction grants and municipal facilities program which deals with mitigating pollution from wastewater treatment plants.

Office of Long Island Sound Programs (OLISP) - Administers the Coastal Area Management Act (CAM) program and Long Island Sound License Plate Program.

Connecticut Department of Emergency Management and Homeland Security
25 Sigourney Street, 6th Floor
Hartford, CT 06106-5042
(860) 256-0800
http://www.ct.gov/demhs/

DEMHS is the lead agency responsible for emergency management. Specifically, responsibilities include emergency preparedness, response & recovery, mitigation, and an extensive training program. DEMHS is the state point of contact for most FEMA grant

and assistance programs. DEMHS administers the Earthquake and Hurricane programs described above under the FEMA resource section. Additionally, DEMHS operates a mitigation program to coordinate mitigation throughout the state with other government agencies.

Connecticut Department of Public Safety
1111 Country Club Road
Middletown, CT 06457
(860) 685-8441
http://www.ct.gov/dps/

Office of the State Building Inspector **-** The Office of the State Building Inspector is responsible for administering and enforcing the Connecticut State Building Code, and is also responsible for the municipal Building Inspector Training Program.

Connecticut Department of Transportation
2800 Berlin Turnpike
Newington, CT 06131-7546
(860) 594-2000
http://www.ct.gov/dot/

The Department of Transportation administers the federal Intermodal Surface Transportation Efficiency Act (ISTEA) that includes grants for projects which promote alternative or improved methods of transportation. Funding through grants can often be used for projects with mitigation benefits such as preservation of open space in the form of bicycling and walking trails. CT DOT is also involved in traffic improvements and bridge repairs which could be mitigation related.

Private and Other Resources

The Association of State Floodplain Managers (ASFPM)
2809 Fish Hatchery Road
Madison, WI 53713
(608) 274-0123
http://www.floods.org/

ASFPM is a professional association of state employees that assist communities with the NFIP with a membership of over 1,000. ASFMP has developed a series of technical and topical research papers, and a series of Proceedings from their annual conferences. Many "mitigation success stories" have been documented through these resources, and provide a good starting point for planning.

Institute for Business & Home Safety
4775 East Fowler Avenue
Tampa, FL 33617
(813) 286-3400
http://www.ibhs.org/

A non-profit organization put together by the insurance industry to research ways of reducing the social and economic impacts of natural hazards. The Institute advocates the development and implementation of building codes and standards nationwide and may be a good source of model code language.

Multidisciplinary Center for Earthquake Engineering and Research (MCEER)
University at Buffalo
State University of New York
Red Jacket Quadrangle
Buffalo, New York 14261
(716) 645-3391
http://mceer.buffalo.edu/

A source for earthquake statistics, research, engineering and planning advice.

The National Association of Flood & Stormwater Management Agencies (NAFSMA)
1301 K Street, NW, Suite 800 East
Washington, DC 20005
(202) 218-4122
http://www.nafsma.org

NAFSMA is an organization of public agencies who strive to protect lives, property, and economic activity from the adverse impacts of stormwaters by advocating public policy, encouraging technology, and conducting educational programs. NAFSMA is a voice in national politics on water resources management issues concerning stormwater management, disaster assistance, flood insurance, and federal flood management policy.

National Emergency Management Association (NEMA)
P.O. Box 11910
Lexington, KY 40578
(859)-244-8000
http://www.nemaweb.org/

A national association of state emergency management directors and other emergency management officials. The NEMA Mitigation Committee is a strong voice to FEMA in

shaping all-hazard mitigation policy in the nation. NEMA is also an excellent source of technical assistance.

Natural Hazards Center
University of Colorado at Boulder
482 UCB
Boulder, CO 80309-0482
(303) 492-6818
http://www.colorado.edu/hazards/

The Natural Hazards Center includes the Floodplain Management Resource Center, a free library and referral service of the ASFPM for floodplain management publications. The Natural Hazards Center is located at the University of Colorado in Boulder. Staff can use keywords to identify useful publications from the more than 900 documents in the library.

New England Flood and Stormwater Managers Association, Inc. (NEFSMA)
C/o MA DEM
100 Cambridge Street
Boston, MA 02202

NEFSMA is a non-profit organization made up of state agency staff, local officials, private consultants and citizens from across New England. NEFSMA sponsors seminars and workshops and publishes the NEFSMA News three times per year to bring the latest flood and stormwater management information from around the region to its members.

Volunteer Organizations - Volunteer organizations including the American Red Cross, the Salvation Army, Habitat for Humanity, Interfaith, and the Mennonite Disaster Service are often available to help after disasters. Service Organizations such as the Lions Club, Elks Club, and the Veterans of Foreign Wars are also available. Habitat for Humanity and the Mennonite Disaster Service provide skilled labor to help rebuild damaged buildings while incorporating mitigation or floodproofing concepts. The office of individual organizations can be contacted directly, or the FEMA Regional Office may be able to assist.

Flood Relief Funds - After a disaster, local businesses, residents and out-of-town groups often donate money to local relief funds. They may be managed by the local government, one or more local churches, or an ad hoc committee. No government disaster declaration is needed. Local officials should recommend that the funds be held until an applicant exhausts all sources of public disaster assistance, allowing the funds to be used for mitigation and other projects than cannot be funded elsewhere.

Americorps – Americorps is the recently installed National Community Service Organization. It is a network of local, state, and national service programs that connects volunteers with nonprofits, public agencies, and faith-based and community organizations to help meet our country's critical needs in education, public safety, health, and the environment. Through their service and the volunteers they mobilize, AmeriCorps members address critical needs in communities throughout America, including helping communities respond to disasters. Some states have trained Americorps members to help during flood-fight situations, such as by filling and placing sandbags.

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APPENDED TABLES

Appended Table 1
Hazard Event Ranking

Each hazard may have multiple effects; for example, a hurricane causes high winds and inland flooding.
Some hazards may have similar effects; for example, hurricanes and earthquakes may cause dam failure.

Natural Hazards	Location	Frequency of Occurrence	Magnitude / Severity	Rank
	1 = small **2 = medium** **3 = large**	**0 = unlikely** **1 = possible** **2 = likely** **3 = highly likely**	**1 = limited** **2 = significant** **3 = critical** **4 = catastrophic**	
Winter Storms	3	3	2	8
Hurricanes	3	1	3	7
Summer Storms and Tornadoes	2	3	2	7
Landslides	2	2	2	6
Earthquakes	3	0	2	5
Wildfires	1	1	1	3

Location

1 = small	isolated to specific area during one event
2 = medium	mulitple areas during one event
3 = large	significant portion of the town during one event

Frequency of Occurrence

0 = unlikely	less than 1% probability in the next 100 years
1 = possible	between 1 and 10% probability in the next year; or at least one chance in next 100 years
2 = likely	between 10 and 100% probability in the next year; or at least one chance in next 10 years
3 = highly likely	near 100% probability in the next year

Magnitude / Severity

1 = limited	injuries and/or illnesses are treatable with first aid; minor "quality of life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%
2 = significant	injuries and / or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%
3 = critical	injuries and / or ilnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%
4 = catastrophic	multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

Frequency of Occurrence, Magnitude / Severity, and Potential Damages based on historical data from NOAA National Climatic Data Center

Appended Table 2
Hazard Effect Ranking

Some effects may have a common cause; for example, a hurricane causes high winds and inland flooding.
Some effects may have similar causes; for example, hurricanes and nor'easters both cause heavy winds.

Natural Hazard Effects	Location	Frequency of Occurrence	Magnitude / Severity	Rank
	1 = small **2 = medium** **3 = large**	**0 = unlikely** **1 = possible** **2 = likely** **3 = highly likely**	**1 = limited** **2 = significant** **3 = critical** **4 = catastrophic**	
Snow	3	3	2	8
Flooding from Poor Drainage	3	3	1	7
Nor'Easter Winds	3	2	2	7
Blizzard	3	2	2	7
Hurricane Winds	3	1	3	7
Riverine & Floodplain Flooding	2	2	2	6
Flooding from Dam Failure	1	1	4	6
Ice	2	2	2	6
Thunderstorm and Tornado Winds	2	2	2	6
Destruction from landslides	2	2	2	6
Shaking	3	0	2	5
Lightning	1	3	1	5
Falling Trees/Branches	2	2	1	5
Hail	1	2	1	4
Fire/Heat	1	1	1	3
Smoke	1	1	1	3

Location

1 = small isolated to specific area during one event
2 = medium mulitple areas during one event
3 = large significant portion of the town during one event

Frequency of Occurrence

0 = unlikely less than 1% probability in the next 100 years
1 = possible between 1 and 10% probability in the next year; or at least one chance in next 100 years
2 = likely between 10 and 100% probability in the next year; or at least one chance in next 10 years
3 = highly likely near 100% probability in the next year

Magnitude / Severity

1 = limited injuries and/or illnesses are treatable with first aid; minor "quality of life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%

2 = significant injuries and / or illnesses do not result in permanent disability; shutdown of several critical facilities for more than one week; property severely damaged <25% and >10%

3 = critical injuries and / or ilnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged <50% and >25%

4 = catastrophic multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

Frequency of Occurrence, Magnitude / Severity, and Potential Damages based on historical data from NOAA National Climatic Data Center

APPENDIX A
STAPLEE MATRIX

Strategies Listed by Primary Report Section for Waterbury	Responsible Department[1]	Schedule A. Ongoing B. 2007-2012 C. 2012-2017 D. 2017-2022	Associated Report Sections								Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services	STAPLEE Criteria *Good = 3, Average =2, and Poor = 1*							
			Inland Flooding	Hurricanes	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Landslides	Dam Failure	Wildfires		Socially acceptable?	Technically feasible?	Administratively workable?	Politically acceptable?	Can it be legally implemented?	Economically beneficial?	Environmentally beneficial?	**STAPLEE Sum of Scores**
ALL HAZARDS																			
Consolidate Public Works facilities in one location	Public Works	C	x	x	x	x	x	x	x	x	6	3	3	3	3	3	3	3	**21**
Develop intermunicipal agreements with other public works departments	Public Works	B	x	x	x	x	x	x	x	x	6	3	3	3	3	3	3	3	**21**
Dissemination of informational pamphlets regarding natural hazards to public locations	OEM	B	x	x	x	x	x	x	x	x	1,2,5	3	3	3	3	3	3	3	**21**
Implementation of an emergency notification system	OEM	B	x	x	x	x	x	x	x	x	1,2,5	3	3	3	2	3	2	3	**19**
Continue to review and update Emergency Operations Plan, at least once annually	OEM	A	x	x	x	x	x	x	x	x	1, 6	3	3	3	3	3	3	3	**21**
Add pages to City website regarding emergency planning, shelter locations, and general emergency preparedness	OEM	B	x	x	x	x	x	x	x	x	1, 5, 6	3	3	3	3	3	3	3	**21**
INLAND FLOODING																			
<u>Prevention</u>																			
Streamline the permitting process to ensure maximum education of developer or applicant	City Planning	B	x	x	x	x	x	x		x	1	3	2	2	3	3	3	3	**19**
Coordinate with neighboring municipalities regarding developments that could impact properties within Waterbury	Mayor, City Planning	B,C,D	x	x	x				x		1	3	1	1	3	2	3	2	**15**
Consider becoming a member of FEMA's Community Rating System	Mayor	B	x	x	x						1	2	3	3	3	3	2	1	**17**
Coordinate with neighboring municipalities regarding developments that could impact properties downstream of Waterbury	Mayor, City Planning	B,C,D	x	x	x				x		1	2	1	1	2	2	1	1	**10**
Adopt a more comprehensive set of Floodplain Management regulations	City Planning	B	x	x	x						1	2	3	3	3	3	2	2	**18**
Require new buildings constructed in floodprone areas to be protected to the highest recorded flood level, regardless of SFHA	City Planning	B	x	x	x						1, 2	2	2	3	3	3	2	1	**16**
Require new buildings to be designed to shunt drainage away from the building	City Planning	B	x	x	x	x					1, 2	3	3	3	3	3	3	1	**19**
Prohibit non-permitted increases in impervious surfaces	City Planning	B	x	x	x						1	1	2	1	1	2	1	3	**11**
Require watershed-based engineering studies for sizeable developments demonstrating upstream and downstream drainage effects	City Planning	B	x	x	x				x		1	2	2	3	3	3	3	2	**18**
Utilize the Land Use Regulations/Engineering Standards Revision Project to assist with implementation of the above recommendations	City Planning	B	x	x	x						1	3	3	3	2	3	3	3	**20**
When possible, assist with the Map Mod program to ensure an appropriate update to the FIS, FIRM, and Floodway Maps	Public Works	B	x	x	x				x		1, 2	3	3	3	3	3	3	3	**21**
After Map Mod has been completed, consider restudying local flood areas to produce local-level regulatory floodplain maps with greater topographic detail	Public Works	B	x	x	x				x		1, 2	2	3	2	2	2	3	1	**15**
Implement outreach programs to educate citizens regarding ordinances, insurance, and other flood-related issues	City Planning	B	x	x	x						1, 5	3	3	3	3	3	2	1	**18**
<u>Property and Natural Resource Protection</u>																			
Pursue the acquisition of additional open space properties within SFHAs	Mayor	B,C,D	x	x	x				x		2, 3	3	2	2	3	3	3	3	**19**
Selectively pursue conservation objectives listed in the Plan of Conservation and Development, including the creation of greenways	Mayor	B,C,D	x	x	x						3	3	2	2	3	3	2	3	**18**
Continue to regulate development in protected and sensitive areas	City Planning	A	x	x	x		x	x	x	x	3	2	3	3	2	3	2	3	**18**
Purchase private land in the 100-year floodplain and set it aside as greenways, parks, or other non-residential, non-commercial, or non-industrial use	Mayor	B,C,D	x	x	x						2, 3	3	1	2	3	3	2	3	**17**
Clear brush and growth in the floodplain of the Mad River that could possibly inhibit flood flows at least every three years	Public Works	B,C,D	x	x	x				x	x	1, 3	3	3	3	3	2	3	1	**18**
<u>Structural Projects</u>																			
Commission a City-wide Stormwater Management System Study containing drainage models useful to developers, and update every five years	Public Works	B,C,D	x	x	x	x			x		1, 4	3	3	3	3	3	3	1	**19**
Create and implement a culvert and catch basin inspection, maintenance and cleaning schedule	Public Works	B,C,D	x	x	x	x					1, 4	2	3	3	2	3	3	1	**17**
Continue to investigate reports of localized flooding problems to determine cause and appropriate solution, and set goals for eliminating recurrences	Public Works	A	x	x	x						2, 4	3	3	2	3	3	3	1	**18**
Implement an electronic complaint tracking system to maintain a computerized database of all calls received by the City	Public Works	B	x	x	x	x					1	3	3	3	3	3	2	1	**18**
Perform a drainage study of Great Brook, including a structural analysis of the box culvert running under the Palace Theatre, and repair as needed	Public Works	B	x	x	x				x		4	3	3	3	3	3	3	1	**19**
Perform engineering studies for the Mark Lane Landfill and the Highland Metro North Railroad areas outlining how to better protect these areas	Public Works	B	x	x	x			x			4	3	3	3	3	3	3	2	**20**
Install a drainage system along Division Street	Public Works	B	x	x	x	x					4	3	3	3	3	3	3	1	**19**
Conduct the proposed Trumpet Brook watershed study and reconstruction	Public Works	B	x	x	x						4	3	3	3	3	3	2	2	**19**
Evaluate capacities of East Main Street and East Liberty Street bridges over the Mad River and reconstruct if necessary	Public Works	B	x	x	x				x		4	3	3	3	3	3	2	3	**20**
Conduct a study to prioritize areas for separation of sanitary and stormwater systems.	Public Works	B	x	x	x						4	3	3	3	3	3	2	3	**20**
Continue to separate and update the storm and sanitary sewer systems according priority agreed upon by Public Works and Water Pollution Control	Public Works	A	x	x	x						4	3	3	3	3	3	2	3	**20**
Consider installation and repair of curbing (ref. Table 3-3)	Public Works	A	x	x	x	x					4	3	3	3	3	3	2	2	**19**
Consider installation of stormwater systems for (ref. Table 3-4)	Public Works	A	x	x	x	x					4	3	3	3	3	3	2	2	**19**
Repair stormwater and drainage systems (ref. Table 3-5)	Public Works	A	x	x	x	x					4	3	3	3	3	3	2	2	**19**

Strategies Listed by Primary Report Section for Waterbury	Responsible Department[1]	Schedule A. Ongoing B. 2007-2012 C. 2012-2017 D. 2017-2022	Associated Report Sections								Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services	STAPLEE Criteria *Good = 3, Average =2, and Poor = 1*							
			Inland Flooding	Hurricanes	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Landslides	Dam Failure	Wildfires		Socially acceptable?	Technically feasible?	Administratively workable?	Politically acceptable?	Can it be legally implemented?	Economically beneficial?	Environmentally beneficial?	**STAPLEE Sum of Scores**
DAMAGE RELATED TO HURRICANES, SUMMER STORMS, AND WINTER STORMS																			
Increase tree limb inspections and maintenance, especially along evacuation routes, and ensure minimum potential for downed power lines	Public Works	B		x	x	x	x				1	3	2	2	3	3	3	2	**18**
Continue to require that utilities be placed underground in new developments and pursue funding to move them underground in existing areas	City Planning	A	x	x	x	x			x	x	2	3	2	2	3	3	3	2	**18**
Develop early warning system for lightning at municipally-owned parks and golf courses	OEM	C			x						5, 6	3	2	3	3	3	1	1	**16**
Continue to require compliance with the amended Connecticut Building Code for wind speeds	City Planning	A		x	x	x					2	2	3	3	3	3	3	1	**18**
Provide for the Building Department to make literature available during the permitting process regarding appropriate design standards	City Planning	B		x	x	x	x			x	2, 5	3	3	3	3	3	3	1	**19**
Continue outreach regarding dangerous trees on private property	Public Works	A		x	x	x	x				1, 5	3	3	3	3	3	3	1	**19**
WINTER STORMS																			
Provide educational materials to property owners regarding using shutters, storm windows, pipe insulators, and removing snow from flat roofs	OEM	B		x	x	x					2, 5	3	3	3	3	3	3	1	**19**
Provide educational materials with safety tips and reminders regarding cold weather	OEM	B				x					1, 5	3	3	3	3	3	3	1	**19**
Construct improvements for reducing road icing	Public Works	B				x					1	3	3	3	3	3	2	1	**18**
Acquire additional funding for a new sand/salt storage facility	Public Works	B				x					1	3	3	3	3	3	1	1	**17**
Consider property acquisitions along Connecticut & Ohio Avenues to reduce number of people affected by the limited plowing & emergency services	Mayor	A	x	x	x	x	x	x		x	1, 6	2	3	2	2	2	3	3	**17**
Continue to encourage two modes of egress into every neighborhood and the creation of through streets	City Planning	A	x	x	x	x	x	x	x	x	1, 6	3	3	3	3	3	3	1	**19**
Purchase GPS units for City vehicles and subcontracted plowing vehicles	Mayor	B	x	x	x	x					6	3	3	3	3	3	3	3	**21**
EARTHQUAKES																			
Consider preventing residential development in areas on or below steep slopes (slopes exceeding 30%)	City Planning	B					x	x			1	2	3	3	3	3	3	3	**20**
Continue to require adherence to the state building codes	City Planning	A		x	x	x	x				2	2	3	3	3	3	3	1	**18**
Consider adding earthquakes to the list of hazards specifically identified in the EOP	OEM	B					x				6	3	3	3	3	3	3	1	**19**
Ensure that municipal departments have adequate backup facilities (power generation, heat, water, etc.) in case earthquake damage occurs	Public Works	B		x	x	x	x				1, 6	3	2	2	3	2	2	1	**15**
LANDSLIDES																			
Reconstruct Waterville Street and restore a proper angle to the slope to prevent future landslides	Public Works	B						x			1	3	3	3	3	3	3	3	**21**
Secure pre-disaster mitigation funds for replacing and possibly relocating the 24-inch and 16-inch water mains in the eastern part of the City	Water Department	B					x	x		x	1, 2, 4, 6	3	3	3	3	2	3	2	**19**
Consider regulations restricting construction on 25% or greater slopes and restricting excavation and clearing activities above such slopes	City Planning	B						x			1, 5	2	3	3	2	3	1	3	**17**
Consider restricting development in sandy areas with steep slopes, as outlined in Figure 8-3	City Planning	B						x			1, 3	2	3	3	2	3	1	3	**17**
Consider adopting some or all of the USDA guidelines in Section 8.1 for regulation of development on steep slopes	City Planning	B						x			1, 4, 5	2	3	3	2	3	1	3	**17**
Consider preserving municipal areas of steep slopes as protected open space	City Planning	B						x			1, 3	3	3	3	3	3	2	3	**20**
Ensure local utility providers are aware of landslide potential and have responder teams on call to repair damage caused by landslides	City Planning	B						x			5, 6	3	3	3	3	3	3	1	**19**
Have education and outreach materials available at the building department regarding the identification of potential landslide areas	City Planning	B						x			1, 5	3	3	3	3	3	2	3	**20**
Consider expanding and over-sizing the drainage network in the vicinity of steep slopes	Public Works	C	x	x	x	x		x			4	3	2	3	3	2	2	1	**16**
Encourage private property owners to have their retaining walls inspected by a professional structural engineer and repaired if necessary	OEM	B						x			2	2	3	2	3	3	2	2	**17**

Strategies Listed by Primary Report Section for Waterbury	Responsible Department[1]	Schedule A. Ongoing B. 2007-2012 C. 2012-2017 D. 2017-2022	Associated Report Sections								Category 1. Prevention 2. Property Protection 3. Natural Resource Prot. 4. Structural Projects 5. Public Information 6. Emergency Services	STAPLEE Criteria *Good = 3, Average =2, and Poor = 1*							
			Inland Flooding	Hurricanes	Summer Storms and Tornadoes	Winter Storms	Earthquakes	Landslides	Dam Failure	Wildfires		Socially acceptable?	Technically feasible?	Administratively workable?	Politically acceptable?	Can it be legally implemented?	Economically beneficial?	Environmentally beneficial?	**STAPLEE Sum of Scores**
DAM FAILURE																			
Continue to require or conduct regular inspections of all Class C dams and perform or require upkeep and maintenance as needed	Public Works	A	x						x		2, 4	3	3	3	3	3	3	3	**21**
Consider implementing City inspections of Class A, AA, B, and BB dams	Mayor	B	x						x		2, 4	2	3	2	2	1	3	3	**16**
Work with the Connecticut DEP to ensure that the owners of Class C dams have up to date EOPs and Dam Failure Analyses for each dam	Mayor	B	x						x		1	3	3	3	3	3	3	3	**21**
Have copies of the Class C dam EOPs and Dam Failure Analyses on file at the Town Hall for public viewing	Mayor	B							x		5	3	3	3	3	3	1	1	**17**
Ensure that all Class C dams have up to date operation and maintenance plans	Mayor	B							x		1	3	3	3	3	3	3	2	**20**
Perform or update the Dam Failure Analysis for each dam, especially for Belleview Lake Dam	Public Works	B							x		1	3	3	3	3	3	3	1	**19**
Petition FEMA to commission a new study of the Mad River to reestablish 100-year flood heights.	Public Works	B	x	x	x				x		1, 2	3	3	1	3	2	3	3	**18**
Depending on the results of the updated Dam Failure Analyses, request DEP reclassify the hazard potential of Ridson Pond and Scovill Pond Dams	Mayor	B							x		1	3	3	3	3	3	1	1	**17**
Assist CT DEP in performing a levee failure analysis outlining in detail the area of impact should the levee fail at the level of the 100- and 500-year flood	Public Works	B							x		1	3	3	3	3	3	3	1	**19**
Ensure CT DEP performs all necessary repairs and maintenance to the Waterbury/Watertown levee system to restore it to fully certified status	Public Works	B							x		4	3	3	3	3	3	3	1	**19**
Encourage owner to prepare an operations/maintanence plan for Frost Road Pond Dam, including schedule for addressing the partial breach	Public Works	B							x		2, 6	3	3	3	3	3	2	1	**18**
Encourage owner to commission engineering study considering the removal of Frost Road Pond Dam	Public Works	C							x		4	1	3	3	2	2	2	2	**15**
Conduct any necessary repairs to Pritchards Pond Dam to restore it to fully functional status	Public Works	B							x		4	3	3	3	3	3	3	2	**20**
WILDFIRES																			
Continue to have the Waterbury Water Department extend the public water supply systems into areas requiring water for fire protection	Water Department	A			x					x	2, 4, 6	3	2	3	3	3	3	2	**19**
Continue to have the Waterbury Water Department identify and upgrade any portions of the water system that are substandard for fire protection	Water Department	A								x	2, 6	3	3	3	3	3	3	1	**19**
Explore other fire protection solutions when water main extensions are not feasible, such as the use of fire ponds	Water Department	A			x					x	2, 6	3	2	3	3	3	3	2	**19**
Continue to promote inter-municipal cooperation in fire-fighting efforts	Fire Dept.	A			x					x	6	3	3	3	3	3	3	3	**21**
Ensure personnel are prepared to provide assistance to a possibly significant number of elderly, linguistically isolated, and/or disabled populations	Fire Dept.	A	x	x	x	x	x	x	x	x	6	3	2	3	3	3	2	1	**17**
Continue to support public outreach programs to increase awareness of forest fire danger and how to use common fire fighting equipment	OEM / Fire Dept.	A								x	5	3	3	3	3	3	3	3	**21**
Distribute copies of "Is Your Home Protected from Wildfire Disaster?" booklet in the Building Department	City Planning	B								x	2, 5	3	3	2	3	3	1	3	**18**
Continue to review subdivision applications to ensure proper access for emergency vehicles	OEM	A	x	x	x	x	x		x	x	1, 6	3	3	3	3	3	1	3	**19**
Ensure that adherence to Inland Wetland Regulations does not result in a loss of egress due to truncation of roads at wetlands	City Planning	B	x	x	x	x	x	x	x	x	1, 6	2	3	2	2	3	3	2	**17**
Provide outreach programs that include tips on how to properly manage burning and campfires on private property	Fire Dept.	B								x	5	3	3	3	3	3	3	3	**21**
Patrol City-owned open space and parks to prevent campfires	Police Dept.	B								x	1	2	2	2	3	3	2	3	**17**
Enforce regulations and permits for open burning	Police Dept.	B								x	1, 3	2	2	2	3	3	3	3	**18**

[1]Notes
OEM = Office of Emergency Management

APPENDIX B
DOCUMENTATION OF PLAN DEVELOPMENT

APPENDIX B
PREFACE

An extensive data collection, evaluation, and outreach program was undertaken to compile information about existing hazards and mitigation in the City of Waterbury, as well as to identify areas that should be prioritized for hazard mitigation. Documentation of this process is provided within the following sets of meeting minutes and field reports.

COGCNV field notes
Field inspection on May 16, 2006.
Notes typed June 5, 2006
Scott Bighinatti

Connecticut experienced a period of heavy rains from May 12 to the 16, 2006. On May 16, 2006, Jim MacBroom and David Murphy outlined several sites of interest in the Towns of Cheshire and Wolcott and the City of Waterbury that may have experienced flooding in the past. These sites were visited on May 16, 2006 and photographed. The sequence of photography is listed below:

Camera #1:

1. Ten Mile Brook at Route 70, Cheshire, upstream
2. Ten Mile Brook at Route 70, Cheshire, downstream
3. Willow Brook at Cornwall Ave., Cheshire, upstream
4. Willow Brook at Cornwall Ave., Cheshire, downstream
5. Error shot
6. Mill River at Mansion Road, Cheshire, upstream
7. Mill River at Mansion Road, Cheshire, downstream
8. Mill River at Forest Lane, Cheshire, upstream
9. Mill River at Forest Lane, Cheshire, downstream
10. Mill River at Fawn Drive, Cheshire, upstream
11. Mill River at Fawn Drive, Cheshire, downstream
12. Mill River at Cook Hill Rd, Cheshire, upstream
13. Mill River at Cook Hill Rd, Cheshire, downstream
14. Honeypot Brook at East Gate Drive, Cheshire, upstream
15. Honeypot Brook at East Gate Drive, Cheshire, downstream
16. Honeypot Brook at Country Club Rd, Cheshire, upstream
17. Honeypot Brook at Country Club Rd, Cheshire, upstream weir
18. Honeypot Brook at Country Club Rd, Cheshire, downstream
19. Honeypot Brook at Riverside Drive, Cheshire, upstream
20. Honeypot Brook at Riverside Drive, Cheshire, downstream
21. Quinnipiac River at Blacks Rd, Cheshire, upstream
22. Quinnipiac River at Blacks Rd, Cheshire, upstream floodplain
23. Quinnipiac River at Blacks Rd, Cheshire, downstream
24. Quinnipiac River at Quinnipiac Park, Cheshire
25. Quinnipiac River at Route 322, Southington, upstream
26. Quinnipiac River at Route 322, Southington, downstream
27. Ten Mile River at West Johnson Ave., Cheshire, downstream

Camera #2:

1. Ten Mile River at West Johnson Ave., Cheshire, upstream
2. Unnamed Stream at Schoolhouse Rd, Cheshire, upstream
3. Unnamed Stream at Schoolhouse Rd, Cheshire, downstream
4. Unnamed Stream at end of Grandview Court, Cheshire

5. Judd Brook at Knotter Drive, Cheshire, downstream
6. Judd Brook at Knotter Drive, Cheshire, upstream
7. Hitchcock Lake Brook at College Place, Wolcott, upstream
8. Hitchcock Lake Brook at College Place, Wolcott, downstream
9. Todd Lake at Central Ave., Wolcott
10. Lily Brook at Todd Rd, Wolcott, upstream
11. Lily Brook at Todd Rd, Wolcott, downstream (scoured wingwall)
12. Lily Brook at Todd Rd, Wolcott, downstream
13. Scoville Reservoir Lower Dam, Nichols Rd, Wolcott
14. Lily Brook at Woodtick Rd, Wolcott, downstream
15. Lily Brook at Woodtick Rd, Wolcott, upstream
16. Old Tannery Brook at Nutmeg Valley St., Wolcott, upstream
17. Old Tannery Brook at Nutmeg Valley St., Wolcott, downstream
18. Chestnut Hill Reservoir Spillway, Lyman Road, Wolcott
19. Chestnut Hill Reservoir Outflow (Old Tannery Brook), Lyman Road, Wolcott
20. Old Tannery Brook at Tosun Road, Wolcott, upstream #1
21. Old Tannery Brook at Tosun Road, Wolcott, upstream #2
22. Old Tannery Brook at Tosun Road, Wolcott, sliding barricade
23. Old Tannery Brook at Tosun Road, Wolcott, downstream
24. Old Tannery Brook at Nutmeg Valley St., Wolcott, water over road area
25. Mad River at Sharon Road, Waterbury, downstream #1
26. Mad River at Sharon Road, Waterbury, upstream
27. Mad River at Sharon Road, Waterbury, downstream #2

These notes follow the sequence of photography above.

a) Ten Mile Brook at Route 70, Cheshire – The bridge in this area appears more than sufficient for flood flows. The high water mark can be seen in shot 1 and far below the bottom of the bridge. There is riprap upstream and downstream of the bridge to reinforce the banks. There was some evidence of high water downstream bending plants.

b) Willow Brook at Cornwall Avenue, Cheshire – There are three circular culverts under this bridge. The recent rain event filled 60-70% of the culvert at the high water mark.

c) Mill River at Madison Road, Cheshire – This bridge is fairly recent and provides clearance for flood flows. The bridge consists of two rectangular culverts separated by a concrete support. There is a staff gauge on the downstream end of this bridge (visible in picture). Riprap is evident around the sides of the banks near the bridge on both sides.

d) Mill River at Forest Lane, Cheshire – The river here contains lots of sediment. As the upstream channel appears to be more swale than channel, it is probable that the erosion is caused by high water eroding soils that don't typically have flowing water. The existing culvert, although old, appears sufficient.

e) Mill River at Fawn Drive, Cheshire – The river is still heavily sedimented. There is a significant concrete channel between Forest Lane and Fawn Drive to protect the residential neighborhood. The river widens on the downstream side.

f) Mill River at Cook Hill Road, Cheshire – The river has lost its brown, sediment color at this point downstream. This is another twin rectangular culvert with concrete support bridge that is sufficient for flood purposes. The upstream photo depicts the debris that can get caught on the support.

g) Honeypot Brook at East Gate Drive, Cheshire – Twin culverts divert flow under this bridge. The bridge may act as a constriction; any future review of this bridge should include an analysis of its design conveyance.

Honeypot Brook at East Gate Drive (note culverts)

h) Honeypot Brook at Country Club Road, Cheshire – The brook here is flowing slightly overbank. There is a concrete weir on the upstream side of the bridge that is in disrepair but could still possibly be used for stream flow calculations. The bridge appears sufficient to handle moderate flood flows. The property owners downstream have taken great pains to reinforce the channel banks with riprap. Nearby, the wetland at the end of Stony Hill Drive is completely flooded.

Honeypot Brook at Country Club Road (upstream)

Honeypot Brook at Country Club Road (downstream)

i) Unnamed Stream at Riverside Drive, Cheshire – This sizeable stream is swollen with floodwater pouring out of the impoundment located just south of Riverside Drive. The culvert here has riprap upstream to prevent erosion. A wooden bridge spans the stream on the downstream end. The waters here flow directly into the Quinnipiac River, located just a few hundred feet downstream.

j) Quinnipiac River at Blacks Road, Cheshire – The river is very high. Upstream, there are several instances of trees and brush being underwater. The floodplain to the northwest of the bridge is also inundated in places and has a small stream flowing out of it, entering the river just above the bridge. This stream may be due to overbank flow upstream or just from rainwater flowing out of the floodplain. There is further evidence of trees being underwater downstream. Flow was eroding the bank in front of the northeast upstream wingwall.

k) Quinnipiac River at Quinnipiac Park, Cheshire – A sewer manhole was placed here on the bank at some point, but it now acts as an island a few feet into the river. The river is high, but not overbank here. This spot was accessed by walking behind the red wall on the soccer field and walking down the trail to the river.

l) Quinnipiac River at Route 322, Southington/Cheshire – The river here is very high and overbank. Inundation was occurring on both sides of the bridge. The upstream wingwalls on both sides of the stream are underwater. The sides of the banks may need to be reinforced with riprap, but the upstream side is outside of the study area.

m) Ten Mile River at W. Johnson Ave, Cheshire – The river here is very high, practically overbank. There is evidence of inundation upstream.

n) Unnamed Stream at Schoolhouse Rd, Cheshire – This stream is probably very low most of the time, evidenced by the thick brush growing in the channel. At the moment the stream is flowing slowly due to the wetland plants, compared to the faster velocities upstream (see Grandview Court, below). The plants downstream are also inundated, but the bridge appears adequate for the demand.

o) Unnamed Stream at Grandview Court, Cheshire – The stream is impounded slightly by a railroad bridge above this point, and flows rapidly out of that constriction and down the slope at the end of the road. The water is high, but not overbank.

p) Judd Brook at Knotter Drive, Cheshire – Judd Brook flows out of Southington to this point before going through the Cheshire Industrial Park where it joins the Ten Mile River. The river is overbank here, but the culvert appears adequate.

q) Hitchcock Lake Brook at College Place, Wolcott – The high water in Hitchcock Lake is causing this overflow to flow rapidly from the Lake. The bridge appears to be more than adequate and streambed is rocky such that erosion is not an issue.

r) Todd Lake at Central Ave., Wolcott – The floodwaters in Todd Lake have risen to the point of flowing over the road. The water is only 1"-2" inches deep in most of the picture. Reportedly, flooding happens here quite frequently.

Todd Lake at Central Avenue

s) Lily Brook at Todd Rd, Wolcott – The brook is not extremely high. The bridge has a badly scoured wingwall on the downstream side.

t) Scoville Reservoir Lower Dam, Wolcott – The water is flowing over the dam.

u) Lily Brook at Woodtick Road, Wolcott – With the addition of the waters of Finch Brook, Lily Brook has swelled compared to its size at Todd Road. The culvert here is too low to support a flood flow event. The water in the picture is less than one foot from the bottom of the bridge.

v) Old Tannery Brook at Nutmeg Valley St, Wolcott – There was a "road closed" sign up at the site, although the flood waters had receded by the point photos were taken. There is evidence of overbank flow in many areas, and the wetland near the street was still inundated with standing water.

Old Tannery Brook at Nutmeg Valley Street

Old Tannery Brook at Nutmeg Valley Street (note blocked culvert)

w) Chestnut Hill Reservoir Spillway and Outflow, Wolcott - The water in the reservoir was not above the emergency spillway in the photo, but there was evidence of recent water in the spillway. The outflow from the reservoir was flowing slowly.

x) Old Tannery Brook at Tosun Road, Wolcott – The brook is near bankfull in the pictures, but was higher in the near past. The high water mark on the bridge is over a foot higher than where the water is in the picture. A guard rail on the hill near the stream was damaged by what looks like an auto accident. The bending of the guard rail supports produced an opportunity for runoff to erode the side of the hill rather than continuing down the road. This area is prone to inundation.

y) Mad River at Sharon Road, Waterbury – The river here is slightly overbank and very wide. The bridge appears to be a recent construction and appears suitable for handling a sizeable flood event.

COGCNV field notes
Field inspection on June 7, 2006.
Notes typed June 19, 2006.
David Murphy

Connecticut experienced heavy rain on June 7, 2006 due to a spring "nor'easter." This rainfall event occurred only five days after a powerful storm caused flooding and landslides in the City of Waterbury. Thus, sites in Cheshire, Wolcott, and Waterbury were observed on June 7 to check for potential flooding and/or continued landslide activity. Notes from the May 16, 2006 inspections were used to guide the observations in Cheshire and Wolcott. The June 4, 2006 article in the *Waterbury Republican* was used to guide observations in Waterbury.

Photographs:

1. "Water Over Road" signs on Sandbank Road in Cheshire.
2. Marion Road in Southington (on the way to Wolcott); watercourse flowing over road.
3. Todd Lake at Central Avenue in Wolcott.
4. Mad River at Garthwait Road, Wolcott; note riprap at bend in river.
5. Condominiums at northwest corner of Mad River and Sharon Road in Waterbury.
6. River's Edge Apartments at southeast corner of Mad River and Sharon Road in Waterbury.
7. Same as #6
8. Facing south on Charles Street near 4th Street in Waterbury.
9. Damage at 5th Street and Greenmount in Waterbury.
10. Facing east on 5ht Street from the location of damage.
11. Facing down Highview toward Highland in Waterbury.
12. Jersey Road near Pearl Lake Road.
13. Jersey Road near Pearl Lake Road.
14. Jersey Road near Pearl Lake Road.
15. Jersey Road near Pearl Lake Road.
16. Jersey Road near Pearl Lake Road.
17. East Mountain Road.
18. East Mountain Road.
19. East Mountain Road.
20. East Mountain Road.

These notes follow the sequence of photography above.

a) Sandbank Road, Cheshire – Motorists are warned about shallow pools of water on the road by signs that read "Water Over Road" (Photo #1).

1. Warning sign on Sandbank Road in Cheshire

b) Todd Lake at Central Avenue, Wolcott – This location was inspected on May 16, but the water level in the lake is slightly lower and flooding of the road is not occurring (Photo #3).

c) Mad River parallel to Garthwait Road, Wolcott – An older neighborhood lies between the road and the river. Some of the homes are in the floodplain, and some backyards appeared to be partly flooded. The most upstream building along the road lies at a bend in the river (Photo #4) where riprap has been used to control erosion.

4. Mad River near an older residential area in Wolcott

d) Mad River at Sharon Road, Waterbury – Condominiums and apartments are clustered in the floodplain of the Mad River upstream and downstream of Sharon Road. The condos at the northwest corner of the river and the road lie several feet above the river elevation (Photo #5). The condos at the northeast corner of the river are similar in elevation and layout. The large apartment complex (River's Edge) at the southeast corner of the river and the road has expansive common areas that were partly underwater, and some of the paved areas were close to the water elevation, although some of the building appear to be at least ten feet higher than the water elevation (Photos #6, 7). These residential areas reportedly have a history of flooding.

7. Minor flooding at apartment complex along Mad River

e) Areas west of downtown Waterbury that flooded on June 2, 2006 were inspected. Damage to a street near the hospital was viewed. Riverside Street was then followed to Charles Street (at the foot of 4th and 5th Streets) where flooding occurred. This area (Photo #8) is at the base of a very steep hillside and is shaped like a trough due to the location of Route 8. It is easy to see how a rain event that exceeded the storm drainage capacity could cause rapid flooding.

8. Charles Street at base of 4th Street

5th Street was followed uphill to view the sinkhole/pothole damage from June 2 (Photos #9, 10) where Bank Street, 5th Street, and Greenmount Terrace intersect. This neighborhood was exceedingly difficult to navigate due to the damage, slopes, narrow streets, one-way streets and location of Route 8, which together cause conditions that are contradictory to hazard mitigation.

9. Damage to 5th Street & Bank Street

Eventually Highland Avenue was reached, and the stretch between Highview and Nichols was viewed. Evidence of storm damage was observed. However, it appears that recent construction has been underway in this area, so it was difficult to separate construction impacts from storm impacts (Photo #11, for example).

f) While following Pearl Lake Road back to Interstate 84, two areas of damage were "discovered" that had not been reported in the June 4 newspaper. The first of these involves Jersey Street near Hopeville Pond Brook. An excessive amount of water was viewed flowing down along Jersey Street toward, and into, the brook (Photos #12 through 16). The flow was sufficiently strong that asphalt damage was occurring. The water was originating from a catch basin. A resident remarked that it was a brook that begins in the Town of Naugatuck and is piped underground. It is possible that the brook culvert was clogged and the water was escaping to the next-nearest outlet (the catch basin). The resulting condition was quite hazardous.

12. Water discharging from stormwater catch basin on Jersey Street

14. Water flowing down Jersey Street

g) The second area of damage involves East Mountain Road. While approaching the end of the road from the west along Pearl Lake Road, an excessive amount of water was observed flowing downhill along the side of Pearl Lake Road. This water was flowing from the north end of East Mountain Road, and the road was closed with a barricade. A brief reconnaissance of the road was undertaken, and a severe condition was observed where a landslide/gully had caused the road to fail (Photos #17 through 20). Potholes and sinkholes were scattered in various nearby locations. While this area is not within a mapped floodplain or floodway, it appears that a small watercourse flowing from the northeast has caused this damage.

17. Northwest end of East Mountain Road (note flowing water)

20. Damaged section of East Mountain Road

Meeting Minutes

NATURAL HAZARD MITIGATION PLANS FOR CHESHIRE, PROSPECT, WATERBURY, AND WOLCOTT
Council of Governments Central Naugatuck Valley
Project Kick-Off Meeting
June 26, 2006

I. Welcome & Introductions

The following individuals attended the project kick-off meeting, and will comprise the steering committee:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Ken Livingston, AICP, Fitzgerald & Halliday, Inc. (FHI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- Jeffrey Cormier, Council of Governments Central Naugatuck Valley
- Chet Sergey, Wolcott Local Emergency Planning Commission
- Bob Chatfield, Mayor, Town of Prospect
- George Noewatne, Cheshire Public Works Department
- Jack Casner, Cheshire Fire Department
- Adam Rinko, Waterbury Fire Department

II. Description and Need for Hazard Mitigation Plans / Disaster Mitigation Act of 2000

David described the Disaster Mitigation Act of 2000 and the desire of FEMA to have hazard mitigation planning occur at the local level. A discussion about the pre-disaster hazard mitigation grant program and eligible types of projects took place at this time, and continued intermittently throughout the meeting. The issue is especially relevant in Waterbury, where FEMA will likely be assisting with response and clean-up after the June 2 events. Although funding for disaster response is allocated differently than funding for hazard mitigation, some of the long-term solutions in Waterbury (and other communities) will require pre-disaster hazard mitigation funding.

III. Project Scope

David described the project scope, organized as follows:

- Task 1 – Project Initiation and Data Collection
- Task 2 – Vulnerability Assessment
- Task 3 – Public Meetings
- Task 4 – Response Planning and Recommendations
- Task 5 – FEMA Review and Plan Adoptions

Unlike most planning projects, this project began before the kick-off meeting because the unusual rainfall events in May and June provided opportunities to observe flooding or near-flooding conditions.

The team had questions about the public meetings and public hearings. One public meeting will be held in each municipality to hear from the public and exchange information. David and Ken will likely lead these meetings. These may be coincident with regularly-scheduled meetings of different commissions, although it is not required. The team discussed the likelihood that members of the public would talk about some issues that are not covered in the plans, such as water in basements, potholes and sinkholes caused by water and sewer main breaks, etc. MMI and FHI will listen to all comments and subsequently determine which will be included in the planning process with the steering committee.

The public hearings to adopt the natural hazard plans will occur at the end of the project. The Board of Selectmen, Board of Alderman, or other executive commission will need to adopt each plan after FEMA's comments are addressed.

IV. Hazards

The COG's grant application included a number of hazards that have been organized as follows:

- Flooding
- Hurricanes
- Winter storms
- Summer storms and tornadoes
- Earthquakes
- Dam failure
- Wildfires

Over the last month, the following additional hazards have been considered for inclusion in the plans:

- Mass movement/Landslides (Waterbury)
- Collapse/Subsidence above Mines (Cheshire)

Virginia raised two points for discussion. First, the mine subsidence issue may not be appropriate for the Cheshire natural hazard plan, depending on other factors. Nevertheless, we are likely to hear about it at the public meeting. Second, significant water main breaks were originally noted in the grant application based on incidents in Waterbury. However, water main breaks and their resulting damage are not really natural hazards, and this will not be included. Although damage resulting from a compromised storm sewer pipe (earth movement, sinkholes, potholes, washed out roads) may be similar, the cause of the damage is natural (heavy rainfall).

V. Data Collection Needs, Availability, and Key Contacts

David explained that the following departments and/or their commissions typically provide an individual to attend the data collection meetings in each municipality:

- ❑ Public Works
- ❑ Engineering
- ❑ Planning & Zoning
- ❑ Emergency Management or Fire Department
- ❑ Optional: Mayor or Selectman's Office

Each local official in the steering committee should begin to identify the other individuals who should attend the data collection meeting. These meetings will need to occur during the summer, despite the difficulty of working around vacations.

Each municipality will need to provide lists of hazard events such as winter storms, flooding, summer storms, and brush fires, along with descriptions of their results and effects on populations. MMI and FHI can rely on other sources of information (such as the Connecticut Natural Hazard Mitigation Plan) to describe notable hurricanes and earthquakes, although each municipality is free to offer information about these as well.

In the case of Waterbury, Adam indicated that the damage caused by the June 2 storm has been well-documented and organized, and this information will be provided to MMI and FHI. Lists of potential projects have been compiled by the City's engineering consultant.

Bob provided a preliminary list of problem areas in Prospect and marked some of these on a map. It is anticipated that these areas will be field-checked, along with any others that are listed during the meeting in Prospect. Meetings in Wolcott and Cheshire will also yield lists of problem areas that will be field-checked.

A related conversation ensued regarding the erosion damage caused by ATV use in Prospect. Although ATVs are not a natural hazard, the erosion is caused by excessive rainfall. There may be a way to address some of the problem areas in the plan.

VI. Proposed Schedule

The following proposed schedule was modified from the schedule presented in the scope of services. It has been updated to the current status of the project.

Month and Year	***Tasks***
April – May 2006	Preliminary data collection and field reconnaissance.
June 2006	***Project kick-off meeting*** with COGCNV and a representative from each municipality; data collection; field reconnaissance.
July 2006	Meet with municipalities; data collection; field reconnaissance.
August 2006	Meet with municipalities; data collection; field reconnaissance; data review; vulnerability assessments.
September 2006	Data review; vulnerability assessments.
October 2006	Data review; vulnerability assessments; additional data collection and field reconnaissance (if necessary).
November 2006	Additional data collection and field reconnaissance (if necessary); Present findings to the public and collection of comments.
December 2006	Incorporate public comments; develop recommendations.
January 2007	Draft plans to COGCNV.
February 2007	Meet with COGCNV.
March 2007	Edits to plans; final draft plans to municipalities.
April 2007	Meet with municipalities; final edits.
May 2007	Submit final draft plans to FEMA.
June 2007	FEMA review.
July 2007	FEMA review.
August 2007	Incorporate FEMA edits.
September 2007	Adopt plans in municipalities.
October 2007	Submit final plans to FEMA.
November 2007 – March 2008	*Reserve time for delays associated with DEP and FEMA review, etc.*

The next step is for David to contact the steering committee members and schedule the data collection meetings in each municipality.

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley
Initial Data Collection Meeting
October 10, 2006

I. Welcome & Introductions

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Samuel Eisenbeiser, Fitzgerald & Halliday, Inc. (FHI)
- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- Jeffrey Cormier, Council of Governments Central Naugatuck Valley
- Peter Dorpalen, Council of Governments Central Naugatuck Valley
- Adam Rinko, Waterbury Fire Department

II. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas

Adam mentioned that he initiated the grant for this project after the serious water main break in 2003 or 2004. Adam stated that he will write the resolution to approve the final plan and the mayor will sign it, after which it will need to go before a board for adoption. The public meeting for Waterbury was scheduled to be on November 9th at 4:00 p.m.

A. Emergency Response Capabilities & Evacuation Routes

Evacuation Shelters are the three high schools in the City (all have generators).

The city looked at emergency routes after Hurricane Katrina. Adam mentioned that Lt. Corbett at Waterbury PD has the evacuation information; Sam is going to call him.

B. Zoning and Subdivision Regulations

Building codes are the Connecticut codes (Combined CT building and Fire codes).

The fire marshal has been dealing with roadways dimensions and utilities. Virginia said that the Planning Department has proposed some changes. The Engineering Department sets the standard widths, which is generally 21 feet in Waterbury. This came up when FEMA came in after the June storm as FEMA had questions about the roadways.

C. Roadways

Adam provided an engineering assessment performed by ANI Engineering to characterize the damages of the June storm.

D. Noted Problem Areas

Complaints eventually go to the Engineering / Planning Department. They had 1,000 complaints related to the June storm. There are few spots which historically flood near streams and rivers due to the steep grades in Waterbury. Most complaints concern flooded basements which are not the City's responsibility. In general, Waterbury has more problems dealing with flashy runoff than with flooding. Floodplain issues are nil.

Overbank flooding is only a minor issue along the Naugatuck River and occurs temporarily and infrequently near the Waste Treatment Plant on South Main Street. The Naugatuck River is heavily flood controlled. Adam said there are no problems along the Mad River, even during the 2 weeks of rain in October 2005.

Since the city has combined storm and wastewater sewers, many flooding problems are addressed by the Water Pollution Control authority. This also means that when culverts fill, sewage can overflow into the streets during heavy rain events.

Adam mentioned that Waterbury installed several 36" mains in 1968 or 1969 which was the same year that the State Engineers temporarily relaxed their standards for steel to be used in rebar. Those are the mains that have been breaking in the city.

Mark Pronovost (mark.compass@snet.net) and Jim Sequin (jasequin.aicp@comcast.net) may have more information regarding flooding and runoff problems. Dave Simpson (dsimpson.wtby@snet.net), the Deputy Director for the Dept. of Public Works, has snow plowing routes and other information. Plowing is mainly subcontracted, so he can provide cost information. Adam will give these three a heads up to compile that information.

Industrial facilities with wood have been inventoried for fire planning purposes.

IV. Acquisitions

- Emergency Operations Plan: (on CD).
- Plan of Conservation and Development: November 2005
- Damage Assessment for June Storms completed by ANI Engineering.
- City regulations are on the city website.

To: File
From: David Murphy
Date: December 8, 2006

Re: Meeting with Ken Skov, Waterbury Water Department
December 8, 2006 at 10:00 AM

A 24" prestressed concrete cylinder pipe (PCCP) is the primary water transmission main from the water treatment plant transmission line to the east side of Waterbury. At the east end of the main, (1) a 24" line splits and runs south to the Benefit Street Water Tank and (2) a 16" line splits and continues to the east, ultimately providing water to the interconnection with the Town of Wolcott water system. The Benefit Street Water Tank has a capacity of four million gallons and provides service to the eastern portion of Waterbury. The PCCP transmission main therefore provides public water supply and fire protection to thousands of people in Waterbury and Wolcott. A sketch of the PCCP route was provided by Ken.

In the past several years, the PCCP main has catastrophically failed in two locations (twice at the 24" west end of once at the 16" east end). A condition assessment of the pipe revealed that other sections of the pipeline were likely to fail due to corrosion of the prestressing steel from the surrounding soil and ground water. The City plans to embark on a main replacement program, beginning with the 24" portion of the pipe and possibly continuing through the replacement of the 16" portion of the pipe. The estimated cost of the project is $6 million.

David explained to Ken that two primary means of applying FEMA pre-disaster funds could potentially be pursued. First, if a natural disaster could cause the PCCP main to fail, then pre-disaster funds could be used to replace the pipe with a stronger material that would withstand the hazard. Second, if the means of conveying water is necessary for controlling or responding to a natural disaster, then pre-disaster funds could be used to replace the pipe with a stronger material that would ensure its reliability when needed. Therefore, the plan should (1) investigate and discuss the possibility that a flood, earthquake, or landslide could break the pipe, leaving thousands without water; and (2) investigate and discuss the importance of the pipe for supplying water for firefighting (wildfires and urban fires caused by earthquakes, storms, lightning, etc.).

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley

PUBLIC INFORMATION MEETING – DECEMBER 12, 2006

I. Welcome & Introductions

The following individuals attended the information meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley (COGCNV)
- Peter Dorpalen, COGCNV
- Adam Rinko, Waterbury Fire Department / Director of Emergency Management
- Bryan Segarra, Waterbury resident

Virginia introduced the project team and the project, explaining the COG's role in the project, the goals of the Disaster Mitigation Act, and the relationship to the FEMA pre-disaster and post-disaster funding processes.

II. Power Point: "Natural Hazard Pre-Disaster Mitigation Plan, Waterbury, Connecticut"

David presented the power point slideshow *(copy to be appended to notes during Plan compilation).*

III. Discussion

After the presentation, the resident remarked that flooding occurs near his apartment off South Main Street. Adam indicated that the problem was mainly due to poor drainage, but it is worsened by high waters in the Naugatuck River because the drainage system isn't able to convey water to the river when it rises. The Fire Department has rescued people from this area in the past.

A discussion about the June 2, 2006 storm revealed that most of the damage has been repaired as of this week. The landslide off South Main Street has been regraded and shored up to repair the area.

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley
Second Data Collection Meeting
January 8, 2007

I. Welcome & Introductions

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Scott Bighinatti, Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- John Lawlor, Jr., Director of Public Works
- Jim Sequin, AICP, City Planner
- Sheila O'Malley, Mayor's Office
- Adam Rinko, Waterbury Fire Department

II. Power Point: "Natural Hazard Pre-Disaster Mitigation Plan, Waterbury, Connecticut"

David presented the power point slideshow presented at the public meeting *(copy to be appended to notes during Plan compilation).*

III. Discussion of Hazard Mitigation Procedures in Effect & Problem Areas

A. General Information

In terms of flood management, the DEP priority for the current funding cycle is to promote acquisition / demolition of buildings on state and municipal lands.

The City of Waterbury is looking for funding to aid their poor drainage network, as they feel that the primary cause of damage related to natural hazards relates to their stormwater management. The network is largely insufficient. They have access to funding for homeland security projects. Mitigation funds are needed to prevent future damage similar to the June 2nd storm, where the drainage network was overwhelmed. The A-N Engineering Damage Assessment is a good place to start looking at trouble spots, and the capital budget list also has areas queued for repairs. Items on the list are drawn from complaints from residents. If items don't get repaired, they are carried on the budget year to year. Mark Pronovost will have an updated list by the end of January.

B. Flooding and Drainage

Waterbury has a difficult time handling stormwater runoff for several reasons:

- Much of the topography of the City includes steep slopes and a shallow water table that decreases infiltration and increases velocity. Individual property owners can pave private driveways without a permit, increasing impervious surfaces without the City's knowledge such that they can't account for the increases downstream. MMI should look at their regulations and recommend changes which will improve this situation.

- A significant portion of the City lacks a drainage network, so all runoff in that area sheet flows down roadways until it infiltrates in yards or reaches a down-gradient storm drain. This sheet flow causes erosion on roadways and yards. Some storm sewers tie into the City sanitary sewers, reducing available carrying capacity. During heavy storms (one inch), the storm/sanitary sewers back up into the street, bringing sewage with it. The City also has many one-way roads, which restricts egress and can cause serious transportation jams when those one-way roads are closed.

The City wants to have a comprehensive stormwater management plan developed, but this project would be very expensive (approximately $500,000). As City residents know about the drainage problems and want to have storm drains installed in front of their property, this plan should be a top priority with money for construction projects to follow. They currently spend money to fix specific problems as needed, but overall these solutions may not be appropriate for the big picture. New developments in uphill areas are generally correctly sized where they tie into existing system, but the downstream portion of the system may be undersized. The majority of damage on June 2nd occurred in older neighborhoods.

C. Drainage Projects

The City is looking for money to clear brush in the floodplain and floodway of the Mad River in order to reduce brush and growth inhibiting flood flows. This project should be put into the plan as a recurring item. This is especially important in the Townline Road area where the topography is very flat.

There are questions about the structural integrity of the box culvert Great Brook flows through. This brook flows underneath the Palace Theatre. The city wants a study performed as soon as possible with any necessary construction to follow.

The Mark Lane Landfill and Highland Metro North Railroad were heavily damaged by flooding during the June 2nd storm, and mitigation funding is required to properly

protect these areas from future disasters. These areas should be mentioned in the recommendations.

Important Capital Projects for 2006-2010 include safety improvements for reducing road icing, the Great Brook Rehabilitation (Design and Construction) as above, Progress Lane Culvert repair, Division Street drainage design and construction, S.W. drainage III design and construction, and funding for the small sand/salt storage facility.

Important Capital Projects for 2007-2011 include the Division Street drainage design and construction, Great Brook Rehabilitation (capacity study and design) as above, Mad River maintenance as above, safety improvements and road de-icing program, sand/salt storage, Trak-It Complaint Tracking System (good for hazard mitigation), Trumpet Brook reconstruction (a bond was previously authorized), and Waterville Street reconstruction (see below).

C. Other Hazards

The City was hit by a tornado that caused a fair amount of damage in 1989. There should be information about this tornado in the NCDC Storm Events Database.

Landslides and slumps don't always occur near watercourses. In areas where the drainage network is sheet flow, roads can become watercourses and slide apart. When construction activities undermine the natural grade of a hill, the hillside can collapse. This occurred on Waterville Street, which is perched on a steep grade 50' to 75' above the bottom of the slope. During construction at the bottom of the slope, the slope was compromised and one side of the road collapsed. The road is now one-way. Waterville Street is considered a potential landslide area and needs to be refilled to establish the predevelopment grade and repair the road.

During the winter, the shallow water table causes icing of roads in several areas due to the lack of infiltration and drainage.

During the water main break, there was a potential loss of firefighting capacity in the southeastern section of the City. These mains are important for wildfire hazard mitigation.

IV. Acquisitions

- Capital Budget Summary, 2006-2010
- Capital Budget Summary, 2007-2011 (Draft)

Meeting Minutes

NATURAL HAZARD MITIGATION PLAN FOR WATERBURY
Council of Governments Central Naugatuck Valley
Third Data Collection Meeting
January 22, 2007

I. Welcome & Introductions

The following individuals attended the data collection meeting:

- David Murphy, P.E., Milone & MacBroom, Inc. (MMI)
- Virginia Mason, Council of Governments Central Naugatuck Valley
- Mark Pronovost, P.E., City Engineer

Mason gave Mark an overview of the program and future funding possibilities. All programs under this grant are 75% FEMA funded. The list of projects in the plan should be as comprehensive as possible.

II. Discussion of Problem Areas

The meeting with Mark focused mainly on drainage problems and the resulting nuisance flooding and roadway icing that occurs in Waterbury. Mark believes that many of the problems in Waterbury are due to undersized, old, and ineffective drainage systems; or simply due to a lack of drainage systems. The City would like to undertake a comprehensive stormwater drainage analysis with survey and modeling, but such a study is very expensive. As during the last meeting, we discussed whether this was a good candidate for a pre-disaster grant (it appears to be).

Flashy conditions along smaller streams can also be a problem. On the other hand, flooding is rarely caused by out-of-bank conditions along the Mad River or Naugatuck River. Some of the troublesome small streams include:

- Little Brook
- Trumpet Brook
- Great Brook
- Beaver Pond Brook (along I-84)
- Sled Haul Brook (out of culvert, damaged road in June 2006)
- Hopeville Pond Brook and its tributaries (including Pritchards Pond)

The Engineering Department maintains a "wish-list" of projects that originated as complaints but haven't made their way onto the annual capital improvement projects list. Some of these are filed in a special three-ring binder. In addition, general complaints are filed in six to seven three-ring binders, and some of these are related to chronic flooding and drainage problems. Approximately six to eight complaints are received each day.

Scott Bighinatti (MMI) will contact Joanne at the Department of Public Works and make an appointment to come review the six or seven three-ring binders containing complaints.

Of all the projects on the 2008-2012 capital improvement projects list, it is likely that three will be prioritized (not including paving projects): East Liberty bridge repair, East Main Street bridge repair at Mad River, and Sharon Road bridge design and construction. These will be prioritized because bridge safety is important.

Mark noted that a complaint database and tracking system would be nice to have, as it would make it easier to prioritize and respond to complaints. It should be noted that a complaint tracking system is on the 2008-2012 capital improvement projects list for $10,000.

David asked Mark to identify his "top 10" (or any number) projects related to drainage and flooding. These were identified and marked on a Mail-A-Map.

- Division Street drainage improvements
- Sunnyside above Bunker Hill Avenue experiences heavy runoff that blows through this neighborhood
- Icing on Waterville Street
- Icing on West Side Blvd East due to poor drainage is chronic
- [something] Brook at Bishop Street & Grove Street
- Campfield Road drainage improvements
- Trumpet Brook backyard flooding and poor drainage
- Edgewood Street is very flat and houses are at the level of the pond, so the area does not drain
- Corby Avenue is very flat and does not drain
- Edgewater Street off Edgewood Avenue is very flat and does not drain
- Beaver Brook is believed to have drainage and flooding problems although few complaints have been received
- Robbins Street drainage improvements
- The intersection of Bank & Congress Streets floods a couple times each year due to poor drainage
- Jean Street drainage improvements below Greenmount Terrace
- Westwood drainage improvements near Devonwood Drive
- Calumet Street drainage improvements near Columbia Blvd
- Great Brook at Brown & Water Streets
- Chipman Street Extension has a low spot where a stream crosses underneath
- Bank Street is the most expensive problem to solve, as it requires getting water under Route 8 to the Naugatuck River

In addition to the above areas, the following were discussed:

- A number of detention ponds in the City need to be rehabilitated. Specifically, new outlet structures are needed to correct detain and/or convey water. Some of these basins are always full. This is mainly a problem along Trumpet Brook. The problem is that many basins are private and are not maintained. Mark would like the City to obtain easements to the basins so they could be accessed and maintained/repaired. In other words, it would be helpful to get funding for easements, regular maintenance, and repairs.

- The potential subdivision between Pearl Lake Road and Purdy Road was discussed. This property has steep slopes and drainage problems are known to exist in nearby neighborhoods. This raised an interesting topic: all new developments proposals in the City need to have a drainage analysis that includes upstream and downstream areas, as well as a consideration of other potential development in the watershed. Although Mark instructs applicants to go through this type of analysis, it is not required by regulations. This would possibly be easier if the City were to have a comprehensive stormwater drainage analysis. Then Mark could instruct applicants to demonstrate how their projects would fit into the overall stormwater management scenario.

- When Sled Haul Brook damaged Highland Avenue in June 2006, the problem occurred because the brook jumped its culvert and followed its previous course, instead of flowing within the culvert under the road. The culvert was not designed for the storm intensity that was experienced.

Jeff Cormier of the COGCNV provided hard copies of the Waterbury drainage system maps. These will be used to produce a schematic of the portions of Waterbury that are served by drainage systems.

To: File
From: Scott Bighinatti
Date: January 31, 2007
Edited February 12, 2007

Re: Review of Waterbury Citizen Complaint Files
January 31, 2007 at 10:00 AM

The Department of Public Works keeps several three-ring binders full of complaints -logged by telephone and email - related to City maintenance issues. These complaints are categorized by letter of the street of occurrence and stem from the 2005 and 2006 calendar years. Many of the complaints are on a standardized, handwritten form; others are logged using the "Track-It!" complaint tracking system. Complaints are removed from the binders and filed after investigation and remediation surrounding each individual situation is concluded.

There were several complaints regarding settling from "adequate" or "poor" installations of utilities in City right of ways. Many complaints regarded surface runoff from neighboring private properties which flooded private yards. Still others were requests for the repair of sidewalks and streets which had not been paved or resurfaced in decades. The majority of these complaints do not directly relate to hazard mitigation.

Other complaints dealt specifically with poor drainage on roadways causing flooding and icing of city streets and neighboring properties. Damage to curbing and erosion to the road surface from sheet flow were also mentioned in several complaints. Curbing is especially important on roads where there are no storm sewers; the lack of curbing puts adjacent properties at risk for erosion. There were also a few complaints related to dead or fallen trees which needed to be removed by the City Department of Public Works. These instances occur on City property and are directly related to hazard mitigation.

Many of the drainage-related complaints suggest that blockages in culverts and storm sewers be cleared. A City-wide maintenance plan for cleaning culverts on a regular basis would help mitigate the impacts of clogged storm sewers on Waterbury's drainage system.

The following are a list of highlights from the complaint files that are closely related to natural hazard mitigation:

Arline Drive: This road requires storm drains in the vicinity of #68. This is a proposed capital improvement project.

Alder Street: Has icing problems due to poor drainage.

Alexander Ave (#23): Trees on City property fell on a house.

Amity Street: A new bituminous street was installed on top of the old Amity Street. The new street is narrower than the old street, and as a result there are two paved trenches on top of the

old road on each side of the new road. The trenches aren't deep (3 to 4" at most) but represent a tripping hazard and act as poorly designed drainage systems.

Baldwin Ave (#1167): Water flows along the avenue and floods this property during storms.

Bishop Street: Sinkholes have occurred on this street and near Hopkins Street. The cause is unknown.

Blanchard Street: This road has been slated for capital improvement construction for nearly a decade but has always been bumped to a subsequent schedule. This road is near I-84 and Scott Road in Waterbury. The road has no storm drains, and the water ponds on the road and freezes in the winter causing icing concerns. The water also ponds in the yards at #125 and #129. Repeated freezing and thawing creates uneven ice and treacherous walking and driving conditions. #133 also has flooding issues.

Boyden Street (#248): The sidewalks in this neighborhood have been damaged for years, presumably from freeze/thaw cycles. The sidewalks raise and dip up to seven inches of vertical difference in places.

Brook Street: Two catch basins near the intersection of Scovill Street need replacement. These basins were installed in the early 20th century and are known to be deteriorating. Flooding has occurred in the basement of 11 Scovill street and is believed related to these leaking basins.

Brookview Avenue (#36): Curbing is needed on this road as a result of washout damage from the 6/2/06 storm.

Calumet Street (#16): The 9/17/05 rainstorm caused erosion leaving sand, stone, and junk debris in front of this house. The debris-laden flow also damaged the sidewalk.

Campfield Road: Runoff from private properties is entering the roadway and pools due to poor drainage. This causes road icing in the winter. Adding storm drainage to this area is a proposed capital improvement project.

Chambers Street: There is a lot of erosion to the street which could be fixed by the installation of curbing and a storm drainage system.

Charles Street: A "spring" floods the street. The City fixed a trench to mitigate the problem. This is related to the problems along Saint Jean Street which were not listed in the binders. It is presumed that the Saint Jean Street problem was solved through the trench repair.

Colby Avenue: This is a local access way used by children to access Crosby High School. A washout occurred after the 6/2/06 storm. The washout is continuing to erode due to the lack of a nearby storm drainage system. This is a proposed capital improvement project.

Columbia Blvd: Near "Lawncrest", curbing washed away during spring '06 storms.

Cooke Street: Flooding occurred during the 9/17/05 storm at the 1st Lutheran Church due to the lack of maintenance on a neighboring property. Sand, rocks, trash, junk and other debris flooded

the property. Part of the problem was due to a clogged storm drain nearby which the City later cleaned. Apparently a nearby underground brook flooded the adjacent property near Adam and Grove Street (see Grove Street below).

East Main Street: The 9/17/05 storm flooded East Main Street and caused water to enter the basement of the Palace Theatre.

East Main Street: A deteriorated sidewalk has caused problems with icing in the winter at the corner of Silver Street.

East Main Street: Heavy rain at Eastgate Apts. (#2171 and #2221) turns the parking lot into a "river", and the nearby catch basin on Fairlawn Ave. appears insufficient.

East Mountain Road: Icing is a problem between Pineridge Road and East Mountain Park.

Fiske Street: Poor drainage on the street causes icing.

Frost Road Pond: A partial breach was installed on the dam at the pond upstream of Frost Road and Circular Avenue after flooding problems in 1980. It is believed that this breach was installed by municipal personnel in conjunction with the property owner. I am unsure if the DEP was involved in this project. The lack of proper maintenance in the breach caused trash and natural debris to accumulate in the gap, and the "debris-dam" failed during the 6/2/06 storm causing flooding damage downstream.

Gaylord Drive (#21): Curbing poorly installed nearby and is causing flooding in the yard.

Gaylord Drive (#403): Street runoff during the 9/17/05 storm washed a large hole in the noted property located at the end of this dead end street.

Gem Drive: This road has no storm drains, and the road ices and floods driveways.

George Street: This road has no storm drains, and runoff pools on the street and nearby yards.

Grandview Ave: Flooding during 6/2/06 and 8/3/06 storms caused damage to curb and sidewalk near Opticare. This road needs a better drainage system and reconstruction of curb and sidewalk. This is a proposed capital improvement project.

Grove Street: This street flooded from Cooke Street to Adams Street and washed out, leaving large amounts of sand, debris, and rocks in the road. Flooding was caused from the clogging of the Little Brook culvert with trash, shopping carts, and natural debris.

Hans Ave: Icing problems related to poor drainage occur near Bradley Avenue and Arnold Street.

Highland Drive: According to Public Works personnel, this road needs curbing due to runoff problems.

Highview Street: According to Public Works personnel, this road needs a stormwater management system.

Hillhouse Road: A drainage problem has existed on this street since Dewberry Street was paved. Apparently the crown was removed from that road, and street runoff floods a Hillhouse Road yard, driveway, and cellar. This road needs a drainage system. This is a proposed capital improvement project.

John Street: Floods three times per year, likely related to poor drainage.

Lakeside Blvd East: Needs a storm drainage system. Icing is a problem in winter.

Meriline Ave: Needs a storm drainage system. This has been recommended for the capital project list.

Mountain View Drive: Groundwater is seeping onto the roadway, causing icing in the winter. This road needs a drainage system. This is a proposed capital improvement project.

North Walnut Street (#154): Groundwater seepage causes icing in the roadway. A sinkhole has developed in the road which is four feet wide, two feet deep, and nine feet long. The cause of the sinkhole is undetermined. A curtain drain has been proposed for installation in front of #154 as a capital improvement project.

Pritchards Pond Dam: According to notes by Public Works personnel, this dam needed repair as of 8/11/05. It is in the vicinity of Pearl Lake Road.

Progress Lane: A storm drainage failure in 2005 closed this road to through traffic. This is a significant construction project which may already have been completed, but is still in the complaint binders.

Reid Street: The curbing on the street has been compromised, and runoff on the street is flowing through the breach and causing flooding in a nearby basement.

Rockledge Drive: Groundwater seepage is causing icing on the roadway during the winter. A storm drainage network for this area is needed.

Rose Street: This area and the area near Webb Street have insufficient drainage. The problem is exacerbated by a low point in the road. This project is in the proposed capital improvement file.

Traverse Street: Water seeping up through Hope Street causes icing on both roads in winter.

West Main Street: The storm drains on Douglas Avenue and Park Road are insufficient for carrying away storm water in the area, resulting in repetitive basement flooding of Saint Mary's Physical Medicine and Rehabilitation Center. These storm drains failed on 6/2/06 and during several other storms. The lack of drainage causes a high water table that floods the lower levels and the hospital has had to repeatedly replace sheetrock and other equipment.

Westridge Drive(#77): Water flowing down the street causes icing problems.

Woodhaven Street: The lack of street drainage causes nearby flooding.

Woodstock Street: The lack of street drainage causes nearby flooding.

Wooster Avenue: Water flowing down the street floods the yard at #101. This flooding is washing out their driveway, deck, and retaining wall.

APPENDIX C
RECORD OF MUNICIPAL ADOPTION

OFFICE OF THE CITY CLERK
Memorandum

Date: December 11, 2007

From: Board of Aldermen

To: Theresa Caldarone,
Counsel to Mayor Jarjura

Subject: **City of Waterbury Natural Hazard Pre-Disaster Mitigation Plan**

At a regular meeting of the Board of Aldermen held on Monday, December 10, 2007, the Board voted by unanimous consent calendar roll call vote to approve the City of Waterbury's Natural Hazard Pre-Disaster Mitigation Plan.

Attest:
Michael J. Dalton
City Clerk

MJD/amb