Preliminary Watershed Plan and Environmental Impact Statement

Pocasset River Flood Mitigation Project

Rhode Island

Job Number: 32853.03

Submitted to:

U.S. Department of Agriculture
Natural Resources Conservation Service

NRCS
Natural Resources Conservation Service

PREPARED BY
GZA GEOENVIRONMENTAL, INC.

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Watershed Agreement
Between
The City of Cranston
and
The Town of Johnston
(Referred to herein as sponsors)
State of Rhode Island
and the
Natural Resources Conservation Service
United States Department of Agriculture
(Referred to herein as NRCS)

Whereas, application has heretofore been made to the Secretary of Agriculture by the sponsors for assistance in preparing a plan for works of improvement for the Pocasset River Watershed, State of Rhode Island, under the authority of the Watershed Protection and Flood Prevention Act (16 U.S.C. 1001-1008); and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to NRCS; and

Whereas, there has been developed through the cooperative efforts of the sponsors and NRCS a plan for works of improvement for the Pocasset River Watershed, State of Rhode Island, hereinafter referred to as the watershed plan-Environmental Impact Statement, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through NRCS, and the sponsors hereby agree on this plan and that the works of improvement for this project will be installed, operated, and maintained in accordance with the terms, conditions, and stipulations provided for in this watershed plan and including the following:

Introductory paragraphs explanatory note:

Where it would facilitate carrying out the plan, the specific responsibilities of individual sponsors may be described in appropriate numbered paragraphs of the agreement. Where specific responsibilities are divided among several sponsors, the names of each need not be inserted in the agreement if they are defined elsewhere in the plan.

1. The sponsors will acquire with other than Public Law 83-566 funds, such real property as will be needed in connection with the works of improvement. (Estimated Cost $1,838,644.)

Real property explanatory notes:

(1) Modification of this paragraph is necessary when Public Law 83-566 funds are to be used to acquire real property (nonstructural measures or real property associated with recreation and or fish and wildlife). The following paragraph may be used:

"The sponsors will acquire such real property as will be needed in connection with the works of improvement. The percentages of the real property acquisition costs to be borne by the Sponsors and NRCS are as follows:

Works of improvement	Sponsors (or name of sponsor)	NRCS	Estimated real property acquisition costs
Real estate appraisal fees, Legal fees, survey costs, flowage easements, and landrights:	100%	0%	$1,838,644

(2) When land is acquired or improved with Public Law 83-566 financial or credit assistance, the following paragraph must be included:

The sponsors (or name of sponsor) agree that all land acquired or improved with Public Law 83-566 financial or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.

2. The sponsors (or name of sponsor) hereby agree that they (it) will comply with all of the policies and procedures of the Uniform Relocation Assistance and Real Property Acquisition Policies Act (42 U.S.C. 4601 et. seq. as implemented by 7 C.F.R. Part 21) when acquiring real property interests for this federally assisted project. If the sponsor is legally unable to comply with the real property acquisition requirements of the Act, it agrees that, before any Federal financial assistance is furnished, it will provide a statement to that effect, supported by an opinion of the chief legal officer of the state containing a full discussion of the facts and law involved. This statement may be accepted as constituting compliance. In any event, the sponsor agrees that it will reimburse owners for necessary expenses as specified in 7 C.F.R. 21.1006(c) and 21.1007.

The cost of relocation payments in connection with the displacements under the Uniform Act will be shared by the sponsors and NRCS as follows:

Sponsors (or name of sponsor)	NRCS	Estimated relocation payment costs
10.2%	89.8%	$148,000

Relocation payments

Relocation payments and assurances explanatory notes

(1) Enter the total estimated relocation assistance payment from Table 1. Percentages for cost sharing will be based upon the ratio of Public Law 83-566 and other funds to the “Total Project” line item of Table 1, excluding relocation payment costs. The relocation assistance advisory services cost is to be included when computing the cost-sharing percentages. These percentages are to be used for the life of the project regardless of future changes or supplements.

(2) If the planned project measures will not cause the displacement of any person, business, or farm operation under present conditions, include paragraph No. 2 in the agreement, show cost-sharing percentages, place $0 1/ in “Estimated Relocation Payment Costs,” and footnote the column as follows:

1/ Investigation of the watershed project area indicates that no displacements will be involved under present conditions. However, in the event that displacement becomes necessary at a later date, the cost of relocation assistance and payments will be cost shared in accordance with the percentages shown.

(3) The sponsors (or name of sponsor) will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

(4)The sponsors will obtain all necessary Federal, State, and local permits required by law, ordinance, or regulation for installation of the works of improvement.

(5) The percentages of construction costs to be paid by the sponsors and by NRCS are as follows:

Works of Improvement (Floodwalls)	**Sponsors (or name of sponsor)**	**NRCS**	**Estimated construction costs**
Rotary Drive	5%	95%	$1,788, 125
South Bennett Drive	23%	77%	$2,662,162
Simmons Brook By-Pass Culvert	0%	100%	$391,395
Fletcher Avenue and Rich Box	5%	95%	$3,499,515
Reservoir Avenue	2%	98%	$3,107,655
Riverview Terrace	3%	97%	$4,235,234
Willow Brook Apartments	5%	95%	$2,136,573
Dry Flood Proofing	0%	100%	$419,882
South Bennett Drive Demolitions (River Avenue and River Drive)-Non Structural	0%	100%	$1,120,000
Johnston Non Structural	0%	100%	$484,534
Cranston Non Structural	0%	100%	$88,750

Construction costs explanatory notes

(1) List each multiple-purpose measure separately. Specific cost items and joint costs of multiple-purpose measures will be shown as separate line item entries. Single-purpose measures may be grouped by kind if the rate of assistance is the same for each measure or group.

(2) Where the costs for land treatment will be shared, explain the cost sharing by adding separate paragraphs similar to those shown in Subpart C for financial and technical assistance costs (504.31 and 504.32) and adjust the numbered items accordingly.
(3) Percentages above are based on actual estimated construction costs for NRCS and Sponsors. Sponsors are responsible for works of roadway infrastructure and drainage infrastructure improvements only. NRCS covers all other construction costs.

6. The percentages of the engineering services costs to be borne by the sponsors and NRCS are as follows:

Works of improvement	Sponsors (or name of sponsor)	NRCS	Estimated engineering service costs
Entire Project (same cost share)	0%	100%	$1,982,758

Engineering services costs explanatory notes

(1) List each multiple-purpose measure separately. Specific cost items and joint costs of multiple-purpose measures will be shown as separate line item entries. Single-purpose measures may be grouped by kind when the rate of assistance is the same for each measure or group. Engineering costs to be shown here do not include engineering costs for bridge and utility modifications or other real property acquisition items.

(2) Construction inspection costs should be listed as a separate line item without giving any percentages. A footnote should be added to the estimated cost figure to indicate "The sponsors and the NRCS will bear the cost of construction inspection that each incurs, estimated to be $0 and $750,000 (note, this amount is included in project administration costs) respectively."

(3) Correct cost sharing of engineering costs for public recreation facilities eligible for Public Law 83-566 assistance may be demonstrated in one of the following ways:

(i) Where the plan provides for an A&E firm to perform all engineering services, show as a single-line item the percentage rate of sharing for engineering services to be obtained by contract.

(ii) Where the sponsors are to provide engineering services in addition to those obtained from an A&E firm, use two line items, one showing the percentage rate of sharing the costs of the engineering services contract and the other line item showing that the sponsors will pay 100 percent of all other costs for engineering services.

(iii) Where NRCS is to provide engineering services in addition to those obtained by contract, use a single line item showing the percentage rate of sharing these combined costs.

(iv) Where all engineering services are to be furnished by the sponsors, they will be listed as a separate line item at 100 percent sponsors' cost.

(v) Where NRCS and the sponsors are to provide all engineering services through their staff employees, show a separate line item for the services each party will provide. Services of the sponsors will be at 100 percent sponsors' cost. The cost of those services provided by NRCS will be shared 50-50, except that NRCS may bear 100 percent, upon prior approval of the Chief, in those instances where the actual cost cannot conceivably exceed that provided by the sponsors.

7. The percentages of implementation costs (including as appropriate, construction, engineering, administration, building purchase costs, and overhead) of nonstructural costs to be paid by the sponsors and NRCS are as follows:

Nonstructural works of improvement	Sponsors	NRCS	Estimated costs
South Bennett Demolitions (River Avenue and River Drive)	0%	100%	$1,608,768
Fletcher Avenue Buyout and Demolition	25%	75%	$161,728
Reservoir Avenue Buyout and Demolition	25%	75%	$970,256
Johnston Non	25%	75%	$0

Structural			
Cranston Non Structural	25%	75%	$0

Nonstructural costs explanatory notes

(1) List each nonstructural work separately by item, i.e., flood proofing, relocation, etc.
(2) A footnote should be added to the sponsors and NRCS column if appropriate. The following wording should be used:

An amount up to the percentage rate specified may be satisfied by the sponsors or by NRCS accepting total responsibility for the cost of an element such as engineering, real property acquisition, or construction. The decision to, and arrangements for, such action will be negotiated between the sponsors and NRCS and will be included in a project agreement executed immediately before implementation.

8. **The sponsors and NRCS will each bear the costs of project administration that each incurs, estimated to be $0 and $1,982,758, respectively.**

9. The sponsors will obtain agreements from owners of not less than 50 percent of the land above each multiple-purpose and floodwater-retarding structure. These agreements state that the owners will carry out conservation farm or ranch plans on their land. The sponsors will ensure that 50 percent of the land upstream of any retention reservoir site is adequately protected before construction of the dam.

10. The sponsors will provide assistance to landowners and operators to ensure the installation of the land treatment measures shown in the watershed plan.

11. The sponsors will encourage land owners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

12. The sponsors agree to participate in and comply with applicable Federal flood plain management and flood insurance programs before construction starts. (for flood prevention projects only)

13. The sponsors will be responsible for the operation, maintenance, and any needed replacement of the works of improvement by actually performing the work or arranging for such work, in accordance with agreements to be entered into before issuing invitations to bid for construction work.

14. The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto, will be the actual costs incurred in the installation of works of improvement.

15. This agreement is not a fund-obligating document. Financial and other assistance to be furnished by NRCS in carrying out the plan is contingent upon the fulfillment of applicable laws and regulations and the availability of appropriations for this purpose.

16. A separate agreement will be entered into between NRCS and sponsors before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

17. This plan may be amended or revised only by mutual agreement of the parties hereto, except that NRCS may de-authorize or terminate funding at any time it determines that the sponsor has failed to comply with the conditions of this agreement. In this case, NRCS shall promptly notify the sponsor in writing of the determination and the reasons for the de-authorization of project funding, together with

the effective date. Payments made to the sponsor or recoveries by NRCS shall be in accord with the legal rights and liabilities of the parties when project funding has been de-authorized. An amendment to incorporate changes affecting a specific measure may be made by mutual agreement between NRCS and the sponsor(s) having specific responsibilities for the measure involved.

18. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this plan, or to any benefit that may arise there from; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

19. The program conducted will be in compliance with the nondiscrimination provisions as contained in Titles VI and VII of the Civil Rights Act of 1964, as amended, the Civil Rights Restoration Act of 1987 (Public Law 100-259) and other nondiscrimination statutes, namely, Section 504 of the Rehabilitation Act of 1973, Title IX of the Education Amendments of 1972, the Age Discrimination Act of 1975, and in accordance with regulations of the Secretary of Agriculture (7 C.F.R. 15, Subparts A & B), which provide that no person in the United States shall, on the grounds of race, color, national origin, age, sex, religion, marital status, or handicap be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity receiving Federal financial assistance from the Department of Agriculture or any agency thereof.

20. Certification Regarding Drug-Free Workplace Requirements (7 CFR 3017, Subpart F).

By signing this watershed agreement, the sponsors are providing the certification set out below. If it is later determined that the sponsors knowingly rendered a false certification, or otherwise violated the requirements of the Drug-Free Workplace Act, the NRCS, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

Controlled substance means a controlled substance in Schedules I through V of the Controlled Sub-stances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statues;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacturing, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all direct charge employees; (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantees' payroll; or employees of subrecipients or subcontractors in covered workplaces).

Certification:

A. The sponsors certify that they will or will continue to provide a drug-free workplace by:

(1) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's

workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(2) Establishing an ongoing drug-free awareness program to inform employees about

(a) The danger of drug abuse in the workplace;

(b) The grantee's policy of maintaining a drug-free workplace;

(c) Any available drug counseling, rehabilitation, and employee assistance programs; and

(d) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(3) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (1);

(4) Notifying the employee in the statement required by paragraph (1) that, as a condition of employment under the grant, the employee will —

(a) Abide by the terms of the statement; and

(b) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(5) Notifying the NRCS in writing, within ten calendar days after receiving notice under paragraph (4) (b) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(6) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (4) (b), with respect to any employee who is so convicted—

(a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency.

(7) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (1), (2), (3), (4), (5), and (6)

B. The sponsors may provide a list of the site(s) for the performance of work done in connection with a specific project or other agreement.

C. Agencies shall keep the original of all disclosure reports in the official files of the agency.

21. Certification Regarding Lobbying (7 CFR 3018) (applicable if this agreement exceeds $100,000).

(1) The sponsors certify to the best of their knowledge and belief, that:

(a) No Federal appropriated funds have been paid or will be paid, by or on behalf of the sponsors, to any person for influencing or attempting to influence an officer or employee of an agency, Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Con-gress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Stan-dard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The sponsors shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, sub grants, and contracts under grants, loans, and cooperative agreements) and that all sub recipients shall certify and disclose accordingly.

(2) This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or enter-ing into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the re-quired certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

22. Certification Regarding Debarment, Suspension, and Other Responsibility Matters Primary Covered Transactions (7 CFR 3017).

(1) The sponsors certify to the best of their knowledge and belief, that they and their principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency.

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

(4) Where the primary sponsors are unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this agreement.

Town of Johnston

By _____
(Type name below signature)

Title _____

1385 Hartford Ave, Johnston RI 02919
Address Zip Code

Date _____

The signing of this plan was authorized by a resolution of the (Name of sponsor) governing body of the adopted at a meeting held on: _____

_____ _____
(Type name below signature Address Zip Code
Secretary (or other title)

Date _____

City of Cranston

By _____
(Type name below signature)

Title _____

869 Park Ave, Cranston RI 02910
Address Zip Code

Date _____

The signing of this plan was authorized by a resolution of the (Name of sponsor) governing body of the adopted at a meeting held on: _____

_____ _____
(Type name below signature Address Zip Code
Secretary (or other title)

Date _____

Natural Resources Conservation Service United States Department of Agriculture

Approved by:

_____

(Type name below signature.) State Conservationist

Date: _____

Watershed Plan – Environmental Assessment
Pocasset River Watershed
Providence County, Rhode Island

Prepared under the authority of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended (16U.S.C. 1001-1008) and in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969, Public Law 91-190, as amended (42 USC 4321 et seq.)

Prepared by:

- The Natural Resource Conservation Service (NRCS) Rhode Island Office located in Warwick, RI
- GZA GeoEnvironmental Providence, RI Office
- City of Cranston
- Town of Johnston

Abstract

This plan is for a flood protection project in the Town of Johnston and the City of Cranston, Rhode Island. The Sponsors' (Town of Johnston and City of Cranston) overwhelming concern is floodwater damages to 481 properties by rain storms up to the 100-year, 24-hour event. Average annual damages are estimated at $2,074,580. One alternative plan was developed, the Recommended Plan, which consist entirely of the PL 566 plan that maximizes net benefits. The Recommended Plan includes the installation of seven floodwalls, demolition of eleven properties, dry flood proofing of specific properties, and other structural and nonstructural measures.

The total project cost is estimated at $28,626,737, of which $25,337,523 will be through PL 566 funds and $3,289,214 by other funds. For the Recommended Plan, the average annual cost is estimated at $1,427,790 and the average annual benefit is estimated at $4,535,295, providing a cost/benefit ratio of 3.18. The Sponsor is responsible for costs of operation, maintenance, and replacement of federally assisted works of improvement, estimated at $64,325 annually.

For further information contact:

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Watershed Plan and Environmental Impact Statement

For the

Pocasset River Flood Mitigation Project

Rhode Island

August 2009

Prepared By:

U.S. Department of Agriculture
Natural Resources Conservation Service

Sponsoring Local Organizations:

Town of Johnston
City of Cranston

Technical Assistance By:

GZA GeoEnvironmental, Inc.

LIST OF TABLES/FIGURES

APPENDICES

SECTION 1

PROJECT SUMMARY

Project Name: Pocasset River Flood Mitigation Project

County: Providence **State:** Rhode Island

Sponsors: City of Cranston, RI
Town of Johnston, RI

Purpose and Need:

The Pocasset River has caused extensive flooding in portions of the Town of Johnston and the City of Cranston in the past, with flooding becoming more frequent and wide spread in recent years. Economic damages are recurrent and costly for many properties located where the flooding is most severe. Recognizing this, the affected municipalities and NRCS embarked on the Pocasset River Watershed Project in 2001. This project, funded through the Watershed Protection and Flood Prevention Act (PL 83-566), requires the development of a Watershed Plan (WP). The Watershed Plan documents the sponsoring local organization decisions and serves as the Environmental Impact Statement (EIS) for the project. This Watershed Plan/Environmental Impact Statement (WP/EIS) documents the extent of the flooding problems, identifies potential/recommended engineering measures, evaluates alternatives to alleviate property flooding, and assesses the environmental impact of the proposed flood control measures. The goal of WP/EIS implementation is to mitigate damages from the long term flooding that has occurred within the flood plain and adjacent areas of the Pocasset River.

The major flooding-related problems include loss of property value, damage to residential, commercial and industrial properties, increase in local government cost, and damage to roads and bridges. Other losses include decreased property value in flood prone areas and loss of potential sites for commercial and industrial development. Average annual damages from flooding exceed $2.0 million, affecting 432 residential properties (individual homes and apartment dwelling units) and 49 commercial/industrial sites. Flooding impacts the health and safety of residents in inundated areas, by limiting the access of emergency vehicles. The area's surface and groundwater resources are also impacted from flooded on-site septic systems and sewer systems.

Project Location:

Specific areas along the Pocasset have been the sites of considerable flooding during wet weather events (see Figure 2-2 for locations of critical flooding areas within the watershed). High Hazard Areas have been identified by the Local Sponsoring Organization, which were targeted to evaluate opportunities to provide flood protection.

For the scope of this project, the following areas have been identified as High Hazard Areas and are considered for flood mitigation:

- Rotary Drive,
- South Bennett Drive,
- Simmons Brook Culvert,
- Fletcher Drive,
- Reservoir Avenue,
- Riverview Terrace,
- Willow Brook Apartments,
- Second Mill Street Bridge,
- Morgan Avenue Bridge,
- Morgan Mill Road Bridge,
- Plainfield Street Bridge,
- Reservoir Avenue Bridge, and
- Garden City Bridge.

Other problem areas of flooding do exist upstream of the areas mentioned above. Chronic street flooding occurs on Atwood Avenue in Johnston, where the Pocasset crosses under the roadway. The Town of Johnston is currently examining mitigation strategies in this area. Flooding also occurs at the FM Global office park at the corner of Central Avenue and Atwood Avenue, where the Dry Brook discharges into the Pocasset River. Flooding also occurs at the Second Mill Street Bridge, where Simmons Brook jumps its banks.

Description of Recommended Plan:

The Recommended Plan addresses the chronic flooding that prevails along portions of the Pocasset River during rainfall events, and the associated property damages that result. The Plan includes the following activities:

- The installation of sheet pile floodwalls along seven sections of the Pocasset River (a total approximate length of 9,665 feet).
- Employment of non structural flood control measures on 43 properties (such as dry floodproofing and structure relocation).
- Removal of a debris dam in the Pocasset River.
- The removal of 12 properties located in the Pocasset River flood plain.
- The protection of 12 houses by raising a portion of South Bennett Drive.
- Creation of a series of drainage swales and detention ponds to collect storm runoff behind the flood walls.

The flood mitigation measures to be installed at each High Hazard Area are summarized as follows.

Rotary Drive: The Recommended Plan will include construction of an approximately 1,500-foot long steel sheet pile wall, between 4 feet and 5 feet in height. This floodwall will protect 19 residences along Rotary Drive. A pump station collection system will be constructed to discharge stormwater drainage system from the landside of the floodwall to the river.

South Bennett Drive: The Recommended Plan will include construction of an approximately 1165foot long steel sheet pile wall, ranging between 3 feet and 9 feet in height. This floodwall will protect the Park Place Apartment Complex. Interior drainage modifications will include roadway pavement modifications to prevent runoff from draining into the apartment parking area and a new drainage swale and pump station collection system.

The recommended alternative for the South Bennett Drive and River Drive neighborhoods on the east side of the Pocasset River will include the following measures:

Structural measures:

- The raising of approximately 2,200 feet of roadway between 2 and 5 feet. The raised roadway protects 12 homes and provides for access of homes during flood events.
- The replacement of the 36-inch pipe that the tributary discharges to at South Bennett Drive with a 3-foot by 10-foot concrete box culvert, sized to accommodate 700 cfs.

Non structural measures:

- Removal of 6 homes along portions of River Drive.
- Removal of 2 homes along portions of River Avenue.
- Elevation of 6 homes along portions of Melody Lane and LaFazia Drive.
- Removal of Bingley Truss Factory on River Avenue.
- Dry floodproofing of 7 buildings along portions of Morgan Mill Road, Melody Lane, and River Drive.
- Earthen dike around 2 homes on River Drive.
- Earthen dike around 1 home on River Avenue.

Simmons Brook Bypass Culvert: The recommended plan will include construction of a bypass culvert around the Mill building under which the Simmons Brook currently flows.

Fletcher Avenue: The recommended plan will include one steel sheet pile floodwall on the western side of the river that will be approximately 2,300 feet long, with an average height of 7 feet, and another sheet pile flood wall across the Pocasset River to protect the low lying area near Rich Box Company. The wall will be approximately 500 feet long, with a height of 7 feet. Due to the historic nature of the Rich Box Company building, the wall will be faced with architectural brick in order to match the exterior of the building. Improvements to accommodate interior drainage will also be included.

Reservoir Avenue: The recommended plan will include a steel sheet pile floodwall of approximately 1,350-feet long and between 3 feet and 8 feet in height, along with acquisition of properties owned by Forest Hill Nursery (City of Cranston Plat 9, Lots 3497, 3208, and 3455.) The acquired property could be converted into recreation fields. Another property, City of Cranston Plat 9 Lot 3453 must be acquired to construct the floodwall. A pump station collection system will be included.

Riverview Terrace: The recommended plan will include two separate sections of steel sheet pile floodwall. The first section will be approximately 350 feet long, with a height of 7 feet. The second section will be approximately 1,400 feet long, with a height of 9 feet. Three pump stations will also be located within the area to ensure that storm drainage does not contribute to flooding. The recommended plan will also include the relocation of a small unnamed tributary.

Willow Brook Apartments: The recommended plan will include a steel sheet pile floodwall that will be approximately 1,100 feet long, with an average height of 7 feet, and a pump station collection system for interior drainage.

Morgan Avenue Bridge, Morgan Mill Road Bridge, Plainfield Street Bridge, Reservoir Avenue Bridge, and Garden City Bridge: Modeling simulations were conducted in which these five structures were removed to simulate the effects of the removal of potential constraints to flood flows. Results suggested that the structures affect water elevations independently of each other and effects of constraint removal were minimal downstream. Benefits from bridge/culvert modification are low compared to the high cost of bridge/culvert construction and because of this, alternatives involving modifications to the bridges described above were not pursued further.

Other measures: The recommended plan will include debris dam removal near the confluence of the Pocasset River and Simmons Brook, and the protection of 43 properties with non structural measures, such as dry floodproofing and relocation (some of these included in areas discussed above).

Alternative Plans Considered:

At each project area, the No Action Alternative was evaluated along with the Proposed Action/Recommended Plan. Additional alternative plans were evaluated at the South

Bennett Drive and Fletcher Avenue project areas. Alternatives which were evaluated in formulation of the Recommended Plan include:

- Buyout and/or relocation of affected properties,
- Creation of floodway,
- Wetland restoration/creation,
- Dam rehabilitation,
- Sediment removal/channel dredging,
- Constraint removal,
- Dry floodproofing,
- Elevation,
- Earthen berm dike, and
- Floodwalls.

Impacts Analysis and Mitigation:

- *Properties* – The Recommended Plan includes the demolition of existing industrial, commercial and residential structures and relocation of businesses and people. This is necessary for the protection of life and property and overall public safety. Relocation assistance will be provided to affected property owners as required**.** Relocations will be accomplished by the Sponsor under the guidelines established in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646). Relocation payments cover incidental costs associated relocations (i.e. moving costs, etc).

- *Wetlands* - The Recommended Plan will have minimal impact to wetlands; these will be primarily jurisdictional riverbank wetlands. Approximately 5 acres of floodplain wetlands will be created in areas where building removal is proposed.

- *Floodplains* – Loss of approximately 47 acres of currently existing floodplain due to floodwall construction. The majority of floodplain lost (42 acres) consists of the area behind the proposed floodwalls that currently flood and are currently urbanized (i.e., occupied by roadways, buildings, industrial activities, etc.). These areas currently have low, if any, habitat value. The remaining lost floodplain (5 acres) is due to roadway elevation at one of the project areas.

- *Highly Erodible Land (HEL) and Swampbuster* – The Food Security Act provides disincentives to farmers who produce annually tilled agricultural commodities on wetlands or highly erodible cropland without adequate erosion protection. This provision is not applicable since none of the specific project sites contain agricultural farmed areas. Furthermore, since no modification of wetlands by farmers is anticipated as a result of this project, the Swampbuster provision is also not applicable.

- *Wildlife / Threatened and Endangered Species* – Fish and wildlife resources will not be significantly affected by the proposed floodplain alterations, though temporary effects may occur during construction activities. The Pocasset River riparian corridor runs through densely urbanized neighborhoods of Cranston and Johnston, and thus provides the only essential cover, water, and feeding areas for much of the wildlife found in the areas of proposed actions. Removing anthropogenic structures from the floodplain, flood proofing structures that will remain, and restoring floodplain storage will result in net benefits to aquatic and riparian dependent wildlife. When the Pocasset River rises to levels where it floods roads, industrial and commercial properties, and residential properties; hazardous solid wastes, sewage, sedimentation, and other pollutants are indiscriminately discharged directly into the river and deposited downstream. This ongoing problem is likely affecting the quality of fish and wildlife habitat along the river. Temporary effects of proposed construction activities, may temporarily disturb wildlife, but will be significantly offset by the benefits of increasing floodplain functions and values through the proposed actions.

  The Rhode Island Department of Environmental Management Natural Heritage Program indicated only one State Endangered species (Wild Clematis) is located in the northern portion of the watershed (Snake Den). This area is located upstream of the project area and RI DEM has determined that flood control measures will have no effect on their population or habitat.

- *Cultural Resources* – Preliminary consultation with the State Historic Preservation Office (SHPO) has identified several project areas that may be of archeological significance. All of these project sites will be further reviewed by NRCS for archeological resources. NRCS will perform file research, reconnaissance surveys, and archeological investigations of the identified project sites, as needed. Additional consultation with SHPO will be completed for each suspected project site as implementation proceeds.

- *Water Quality* - Approximately 2,500 acre-feet of River water will no longer be contaminated during the 100-year storm event due to inundated septic systems and sewers.

- *Other Project Impacts* – Construction of each flood mitigation strategy may cause short-term, minor, adverse impacts to air, noise, water quality, and soils at the construction site. These would be short-term beneficial impacts to the local economy from construction job creation. This project complies with the General Conformity Rule for Federal projects in nonattainment air quality regions (ozone in all of Rhode Island). Long-term beneficial impacts of the project include improved surface and groundwater quality. There are no long-term negative impacts identified at this time.

- *Proposed Mitigation* – Since construction of various flood control structures have the potential to impact the surrounding environment, measures will be incorporated to minimize these impacts. Such measures will include working with the communities and property owners, developing sediment and erosion control plans and stormwater pollution prevention plans, adhering to local codes addressing noise pollution, conducting preconstruction surveys, providing aesthetically compatible floodwall construction, and other necessary measures.

Project Costs:

The estimated cost of the Recommended Plan is $28,626,737 of which $25,337,523 would come from Public Law 83-566 (PL 566) funds. The project construction is estimated to be completed in 5 years. A yearly schedule of maintenance and repair will need to be followed in order to maintain the system's effectiveness. Estimated project costs are provided in Table 1-1, below.

PL 566 Component	%	PL 566 Funds	%	Other Funds	Total
Structural Measures for Flood Prevention (Construction and Engineering)	*94*	*$18,901,493*	*6*	*$1,152,478*	*$20,053,971*
Nonstructural Measures for Flood Prevention (Construction and Engineering)	*100*	*$1,862,612*	*0*	*$ 0*	*$1,862,612*
Project Administration	*100*	*$1,982,758*	*0*	*$0*	*$1,982,758*
Relocation Costs	*89.8*	*$132,904*	*10.2*	*$15,096*	*$148,000*
Other (Including Land Rights)	*54*	*$2,457,756*	*46*	*$2,121,640*	*$4,579,396*
Total		$25,337,523		$3,289,214	$28,626,737

- *Project Benefits* – Project benefits in terms of annual cost savings are estimated in Table 1-2, below:

PL 566 Component	Average Annual Cost	% Damage Reduction
Residential	*$1,647,800*	*87*
Industrial/Commercial	*$833,170*	*90*
Total	*$2,480,970*	*88*

Project benefits in terms of land area consist of 68 acres benefited by structural measures and 25 acres by non-structural measures.

Summary:

The recommended plan is the least environmentally damaging alternative for providing flood damage protection. There are no known areas of controversy. The state of Rhode Island, Providence County, the Town of Johnston, and the City of Cranston collectively support the project.

SECTION 2

INTRODUCTION

2.1 History and Project Need

The Pocasset River has historically caused extensive flooding in portions of the Town of Johnston and the City of Cranston with flooding becoming more frequent and wide spread in recent years. Economic damages are recurrent and costly for many properties located where the flooding is most severe. Recognizing this, the affected municipalities and NRCS embarked on the Pocasset River Watershed Project in 2001.

Newspaper reports and personal accounts from local residents show that flooding in the Pocasset River Watershed has been a problem since the 1950's. "The Great Flood of '79" occurred on January 31, 1979, and is recorded to have caused flood damages in excess of $900,000, with Fletcher Avenue being one of the hardest hit sections of the City of Cranston. The Fire Department had to respond to over 250 water emergencies. In 1982, a storm of slightly less than six inches of rainfall caused some of the most serious flooding in the history of the City of Cranston. Having incurred 1.5 million dollars of flood damages within the City, the then Governor J. Joseph Garrahy declared Cranston to be a disaster area. In March 2001, two significant flood events occurred within a ten-day period. Storm events in 2005 and most recently in December of 2008; have also caused substantial flood damages.

The major flooding-related problems include loss of property value, damage to residential, commercial and industrial properties, increase in local government cost, and damage to roads and bridges. Other losses include decreased property value in flood prone areas and loss of potential sites for commercial and industrial development. Average annual damages from flooding exceed $2.0 million, affecting 432 residential dwelling units (individual homes and apartment dwelling units) and 49 commercial and industrial properties.

This project, funded through the Watershed Protection and Flood Prevention Act (PL 83-566), requires the development of a Watershed Plan (WP). The Watershed Plan documents the sponsoring local organization decisions and serves as the Environmental Impact Statement (EIS) for the project. This Watershed Plan/Environmental Impact Statement (WP/EIS) documents the extent of the flooding problems, identifies potential/recommended engineering measures, evaluates alternatives to alleviate property flooding, and assesses the environmental impact of the proposed flood control measures. The goal of WP/EIS implementation is to mitigate damages from the long term flooding that has occurred within the flood plain and adjacent areas of the Pocasset River.

2.2 Floodplain Management Study

The Pocasset River Floodplain Management Study was completed in 2007 and released in 2008. The study provided the baseline for the technical work relied upon in this WP/EIS. It sets forth the current and future conditions related to flooding in the Pocasset River Watershed. All hydrology, hydraulics and watershed modeling were conducted in this phase of the project. As part of the study, damage reach maps were developed that provide a simple tool for property owners to determine if their property will flood and the frequency of each occurrence.

2.3 Summary of Hydrology/Hydraulics Model

The NRCS completed a comprehensive investigation of both the existing and potential flooding conditions within the Pocasset River watershed through the development of two computer simulation models. TR-20 was used to calculate direct runoff produced from various wet weather events and to route this runoff through the various streams and reservoirs through the watershed. HEC-RAS was used to estimate surface water profiles, and in turn, estimate flooding and areas inundated with water during rainfall events. Floodplain drawings and final mitigation strategies were developed using the 100-year, 24-hour duration design storm for the region (7.0 inches over 24 hours with a SCS Type III rainfall distribution). A third computer simulation model, HEC-FDA, was used to estimate the average annual damages from flooding, which were used to evaluate cost/benefit ratios for the various scenarios. Further discussion about model development can be found in Appendix B, Investigations and Analyses Report.

2.4 Description of Study Areas

The Pocasset River is located in the southeast corner of Providence County, Rhode Island as shown in Figure 2-1. For the purposes of this plan, the affected area includes the entire 20.6 sq. mi. of the Pocasset River Watershed. There are three municipalities located in the watershed, all having independent governing bodies: the Town of Johnston, the City of Cranston, and the City of Providence. The majority of the watershed is located within the Town of Johnston (70%); the City of Cranston comprises 29% of the watershed, while the City of Providence contains less than 1% of the total watershed area. Flooding is confined to the Town of Johnston and the City of Cranston. The Pocasset River meanders through a mix of urban, suburban, and rural lands from its headwaters in Johnston to its terminus in the City of Cranston, where it flows into the Pawtuxet River. The Pocasset River originates in the largely undeveloped northwest portion of the Town of Johnston and follows a meandering course, flowing southeast through Johnston and Cranston, until converging with the Pawtuxet just southeast of Pontiac Avenue, approximately 8 miles from its headwaters. The river flows through four large lakes, the Cranston Print Works Pond, an unnamed pond at Factory Mutual Global office park, and the Upper and Lower Pocasset Ponds at Johnston Memorial Park. There are two major tributaries of the Pocasset; Dry Brook, and Simmons Brook. Figure 2-2 provides a view

of the watershed and several landmarks.

A total of 481 residential/commercial properties (homes, apartment dwelling units, businesses) are impacted by flooding. Four hundred seventy three (473) of these are located in the major project sites described below. The remaining eight (8) properties are in areas outside of the major project sites. The following is a brief description of each major project site, beginning at the most upstream area and proceeding downstream. Note that all sites, except as otherwise noted, directly abut the Pocasset River.

- Rotary Drive: A residential neighborhood in Johnston located off Atwood Avenue, approximately 800 feet south of the intersection of Atwood Avenue and Central Avenue. Nineteen (19) residential homes are impacted by flooding in this neighborhood. Approximately four years ago, the Town of Johnston installed a new sanitary sewer line and pump station at Rotary Drive at considerable expense.

- South Bennett Drive: This site includes residential homes, apartment units (Park Place), and a light industrial business. Park Place Apartments is a low income housing apartment complex, located off Atwood Avenue, approximately 0.5 mile north of the intersection of Atwood Avenue and Plainfield Street. The complex contains 78 individual dwelling units impacted by flooding. Directly across the Pocasset River (to the east) is the South Bennett Drive neighborhood, including River Drive and River Avenue. Collectively, the South Bennett Drive Neighborhood contains 34 residential homes and 9 commercial structures, including a wood truss manufacturing business, impacted by flooding.

- Simmons Brook Culvert: A large mill building is located on the Simmons Brook, a tributary of the Pocasset River, along Mill Street in Johnston, approximately 500 feet west of the intersection of Mill Street and Plainfield Street. Currently Simmons Brook runs through a raceway culvert in the Mill building's basement that is overwhelmed when the Pocasset River runs high, flooding the lower floor. An additional 3 residential homes are also impacted during flood conditions.

- Fletcher Avenue: An industrial area located in Cranston near the intersection of Plainfield Street and Atwood Avenue. Twenty four (24) commercial and light industrial buildings and 20 residential homes directly abut Fletcher Avenue, on the south side of the Pocasset River are affected.

- Rich Box Company: A large mill (referred to as the Rich Box Company), which manufactures cardboard boxes, is located off Plainfield Street in Johnston, across the Pocasset River (to the north) of Fletcher Avenue. This property is eligible for listing on the National Register of Historic Places.

- Reservoir Avenue: A commercial/residential area in Cranston, located near the intersection of Reservoir Avenue and Delway Road. Approximately 11 commercial buildings and 3 residential homes directly abut the Pocasset River in this location.

- Riverview Terrace: Includes Davis Court and Autumn Street. Riverview Terrace is a residential neighborhood in Cranston, located to the northwest of the intersection of Pontiac Avenue and Fordson Avenue. Approximately 24 apartment dwelling units and 54 residential homes are located in this general area.

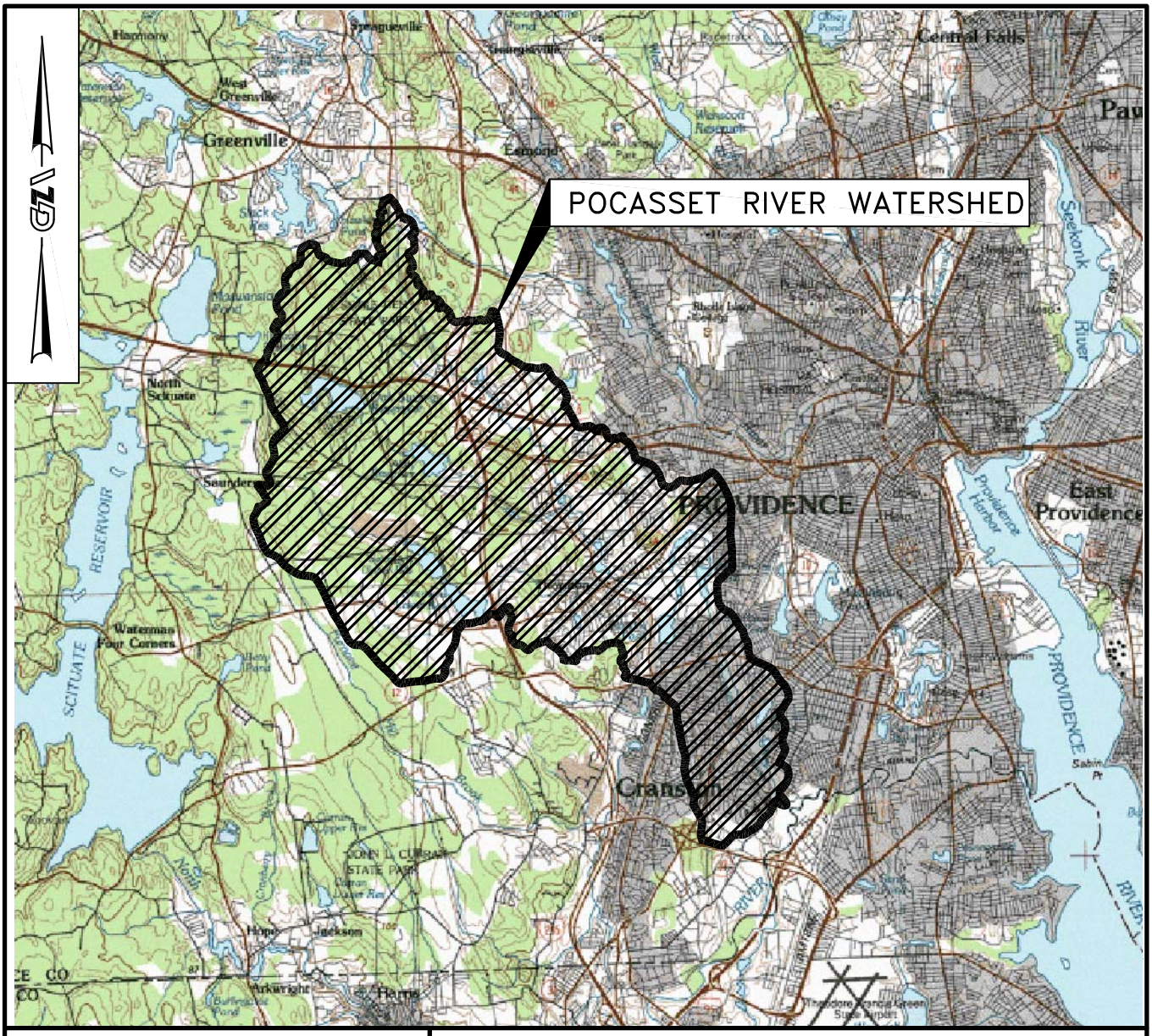
- Willowbrook Apartments: A one hundred and ninety two (192) residential dwelling unit complex located 350 feet southwest of the intersection of Pontiac Avenue and Fordson Avenue is impacted by flooding; it is directly down river of the Riverview Terrace project site. The complex has both a swimming pool and a tennis court.

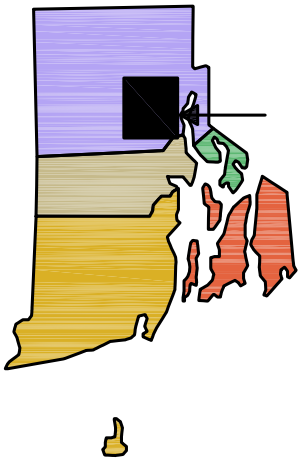
2.5 NEPA Requirement

The Pocasset River Flood Mitigation Project is in the planning stages. Through the process described in this Plan-EIS, and with support from local and state agencies, NRCS has developed a series of projects that will meet the sponsors' objectives. All of these projects have received a planning level analysis to ensure that they appear feasible and are capable of providing the flood mitigation benefits sought through this project. When the Project is authorized and funded, the sponsors will propose specific projects to NRCS. NRCS will review each project in more detail to evaluate the best practice for that site and to verify that the flood mitigation objectives will be achieved.

This Watershed Plan was prepared in accordance with Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA) and its implementing regulations (40 CFR 1500-1508). NEPA requires that federal agencies evaluate the impacts of projects or programs that have the potential for significant impact to the environment. The environment includes the natural environment (e.g. wetlands, water quality, and wildlife) and the man-made environment (e.g. population, housing, land use).

Each federal agency has responsibility for preparing Environmental Classification Documents (ECDs) that outline the types of projects that have the potential for causing significant environmental impacts and the types of projects that generally would not cause environmental impacts. The latter are referred to as Categorical Exclusions, which require minimal documentation because the agency has determined that such actions would typically not cause significant environmental damage. Projects that are not categorically excluded must either be evaluated in an Environmental Assessment/Finding of No Significant Impact (EA/FONSI) or an Environmental Impact Statement (EIS).





FROM USGS PROVIDENCE, RHODE ISLAND–MASSACHUSETTS–CONNECTICUT QUADANGLE MAP (1984)

(DIGITAL TOPOGRAPHIC MAPS PROVIDED MY MAPTECH. INC.)

(COUNTOUR ELEVATIONS ARE SHOWN IN METERS ABOVE NGVD 29, AT 10 METER INTERVALS)

APPROXIMATE SCALE IN FEET

0' 5000' 10000' 20000'

POCASSET RIVER WATERSHED

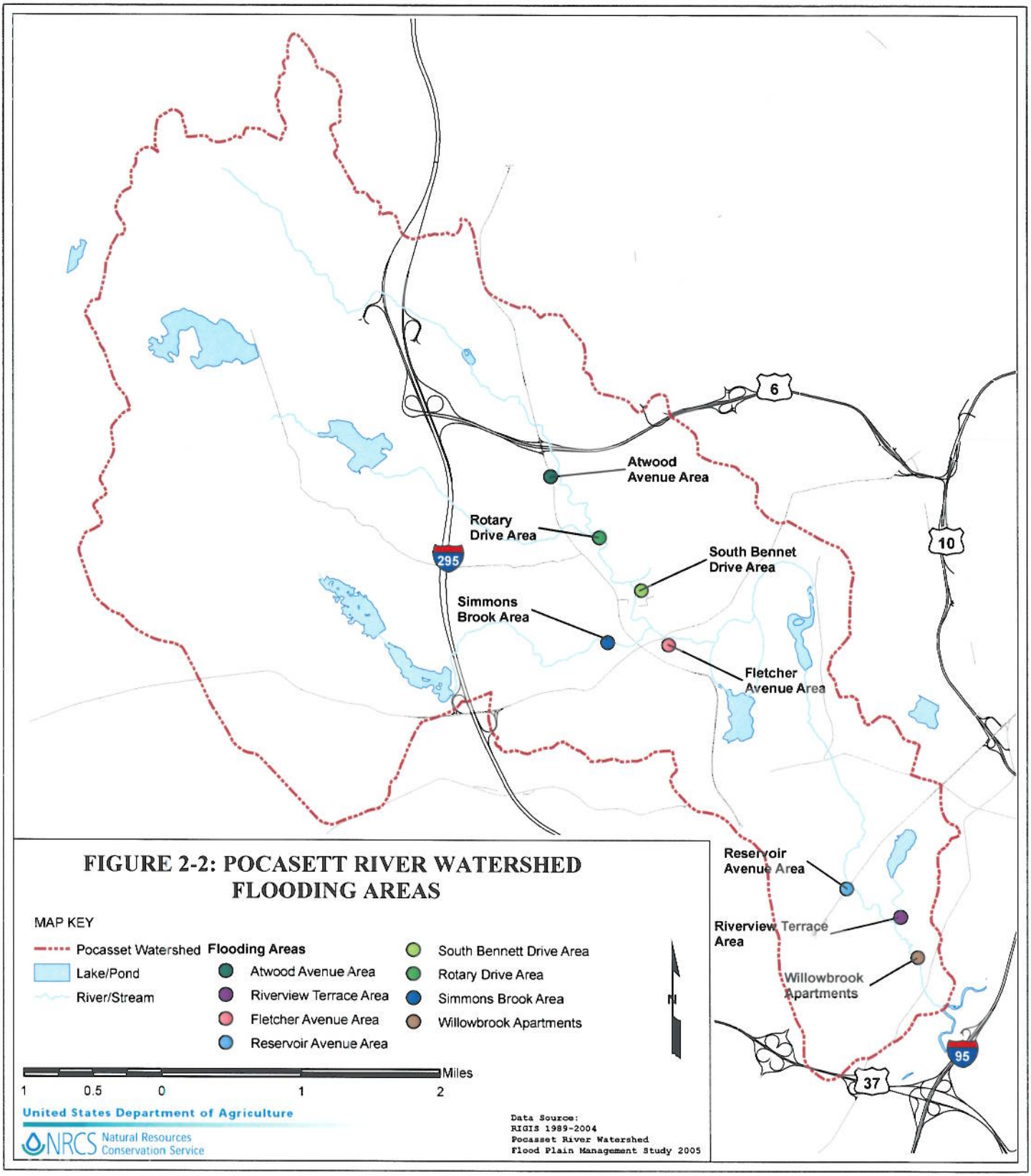
PROVIDENCE, RHODE ISLAND

LOCUS PLAN

AUGUST 13, 2009

FIGURE NO. 2–1

© 2009 – GZA GeoEnvironmental, Inc. GZA–J:\ENV\32853–03.ir\FIGURES\DWG\GZA\32853.03_LOCUS PLAN.dwg [8.5x11–PORT] September 08, 2009 – 4:03pm Christopher.dias


6
Atwood Avenue Area
Rotary Drive Area
295
South Bennet Drive Area
10
Simmons Brook Area
Fletcher Avenue Area
Reservoir Avenue Area
Riverview Terrace Area
Willowbrook Apartments
95
37
FIGURE 2-2: POCASETT RIVER WATERSHED FLOODING AREAS
MAP KEY
Pocasset Watershed
Lake/Pond
River/Stream
Flooding Areas
Atwood Avenue Area
Riverview Terrace Area
Fletcher Avenue Area
Reservoir Avenue Area
South Bennett Drive Area
Rotary Drive Area
Simmons Brook Area
Willowbrook Apartments
N
Miles
1 0.5 0 1 2
United States Department of Agriculture
NRCS Natural Resources Conservation Service
Data Source:
RIGIS 1989-2004
Pocasset River Watershed
Flood Plain Management Study 2005

Public Law 83-566 requires Congressional committee approval for all projects with Federal construction assistance exceeding $5 million. An EIS is required for all projects that receive such approval and because the Federal financial assistance for this project exceeds $5 million, an EIS is required.

The general procedures for NRCS programs for compliance with NEPA are in 7 CFR 650, Secretary's Memorandum 1695 (as supplemented), Protecting and Improving the Quality of the Environment, and 7 CFR 3100 further implement the provisions of NEPA.

Furthermore, the NRCS National Watershed Manual (1992) provides a framework for integrating Watershed Plans and NEPA requirements into a single joint document. It is this framework that is used for this report.

2.6 Organization of the Plan-EIS

This Plan-EIS follows the format recommended for such documents in the NRCS National Watershed Manual. NRCS developed this format to meet the water resources planning requirements of Public Law 83-566 and the environmental analysis required by NEPA. The elements of the plan are:

Section	Description
1. Summary	A brief version (i.e., Executive Summary) of the plan, suitable for use at meetings and presentations to describe the project
2. Introduction	An overview of the Pocasset River Flood Mitigation Project with a brief history of the Pocasset River Watershed, study areas, and NRCS and NEPA policies pertinent to the Plan-EIS
3. Project Setting	A description of the physical, social, cultural, and economic conditions in the Pocasset River Watershed that are pertinent to the project
4. Watershed Problems and Opportunities	A summary of the problems that need to be solved and the opportunities for enhancing the quality of life in the project area, based on public concerns and desires
5. Scope of the EIS	A summary of public concerns raised in the scoping process required by NEPA

6. Formulation and Comparison of Alternatives	A description of the rationale of plan formulation, from the development and comparison of alternatives to the selection of the recommended plan
7. Consultation and Public Participation	Documentation of the opportunities provided to the public for participating in the planning process from the initial request for NRCS assistance to the preparation of the final plan
8. Recommended Plan	A summary of the recommended plan, including descriptions of the projects selected for implementation and the purposes achieved by those projects in compliance with Public Law 83-566
9. Watershed Plan Figures	A compilation of the diagnostic and design drawings depicting the specific project areas and recommended plan elements
10. References	A list of references used to prepare the portions of the Plan-EIS
11. List of Preparers	A list of the primary preparers of the Plan-EIS and their credentials
12. Index	A list of key terms and the Section in which they are discussed

SECTION 3

PROJECT SETTING

3.1 Socioeconomics

3.1.1 Land Use

The land use within the Pocasset River watershed is summarized in Table 3-1. The entire watershed consists of 13,188 acres. Ninety-seven percent (97%) of the land in the watershed is privately-owned and three percent (3%) is owned by State or local governments. There is no federally-owned land in the watershed.

The land use within the watershed is diverse. The upper watershed, which is outside the project area, consists primarily of forest land, whereas the middle and lower watersheds are dominated by medium-high density residential, commercial and industrial land uses. There are 15 farms in the watershed and most of those are located in the upper watershed. According to NRCS there are 990 acres of prime farmland soils in the watershed, most of which are in the upper watershed and most of which are forested.

Specific land uses within each flooding area are presented in Section 6.6.1.1.

The Pocasset River, its tributaries, and large water bodies within the watershed are used for recreation, but mostly in the upper watershed. Fishing takes place in both the streams and reservoirs. Boating takes place on Oak Swamp Reservoir.

Table 3-1 Land Use Within the Pocasset River Watershed.

Land Use	Acres	Percent
High Density Residential	960	7.28
Medium-High Density Residential	1,780	13.50
Medium Density Residential	1,222	9.27
Commercial	710	5.38
Industrial	507	3.84
Institutions and Cemeteries	406	3.07
Developed Recreation	167	1.27
Waste Disposal	587	4.45
Mine or Quarry	68	0.52
Roads	400	3.03
Power Lines	83	0.63
Transitional and Brush Land	182	1.38

Land Use	Acres	Percent
Agricultural	723	5.48
Forest	3,630	27.53
Wetland	1,363	10.34
Water	400	3.03
TOTAL	13,188	100%

3.1.2 Demographics & Environmental Justice

Approximately seventy percent (70%) of the watershed is located in the Town of Johnston, twenty-nine percent (29%) in the City of Cranston, and less than one percent (1%) in the City of Providence. All three municipalities are within Providence County. According to the 2000 Census, the population within the watershed is approximately 39,000. The total population of Cranston and Johnston is estimated at 108,000 according to the U.S. Census Bureau.

In compliance with Executive Order 12989, impacts to low-income or minority populations as a result of this project need to be assessed. Table 3-2 presents summary minority population and income data for the three municipalities within the project. Please note that data for Providence is less relevant as only one percent (1%) of the watershed is located within its municipal boundaries and none of this area is prone to flooding.

Both Cranston and Johnston have a relatively low percentage of minorities (non-white) and persons living below the poverty level compared to all of Providence County, the State of Rhode Island, and the entire United States. The median household income of people within these two municipalities is similar to the average for the entire State and the Nation.

Table 3-2
Comparison of Affected Communities to
Providence County, State of Rhode Island, and the United States

Indicator	Providence	Cranston	Johnston	Providence County	Rhode Island	United States
Non-White Persons	75.5%	15.4%	4.5%	31.1%	21.3%	33.8%
Persons with Income below Poverty Level	29.1%	7.3%	8.3%	14.4%	11.3%	12.5%
Median Household Income	$26,867	$44,108	$43,514	$38,681	$45,006	$43,318

Source: U.S. Bureau of the Census, based on 1999 - 2004 data.

3.1.3 Economics

As depicted in Table 3-2, the per capita income of Johnston was $43,514, slightly below the Rhode Island average of $45,006, and the per capita income of Cranston is $44,108, also slightly below the Rhode Island average. Rhode Island's average per capita income is above the national average of $43,318.

Agriculture is not a significant industry in the watershed. In Johnston and Cranston the service, sales, and management sectors account for the majority of jobs. The leading industries are manufacturing, retail and educational, health, and social services.

3.2 Public Health and Safety

Flooding has a large effect on the health and safety of residents living in close proximity to certain areas of the Pocasset River. Flood events restrict or prevent emergency services from reaching some residences and have the potential to trap people in their homes. Flooding of roadways is a significant hazard to motorists and flooding of homes may cause structural damage to homes or create an environment favorable for mold growth, potentially endangering the homes' inhabitants. Flooding can also cause sewage backups and power outages.

Emergency services in the two Sponsor communities consist of police and fire departments. The City of Cranston Police Department headquarters is located at 5 Garfield Street in Cranston, RI and there are 6 additional sub stations located throughout the City. The department also owns one mobile resource center. The department consists of 153 officers, along with 52 civilian staff. The City of Cranston Fire Department has 7 stations, with their headquarters located at 301 Pontiac Avenue in Cranston, RI. The department has 6 engines, 3 ladder trucks, 4 rescue vehicles, and 1 special hazards truck. The Town of Johnston Police Department headquarters is located at 1652 Atwood Avenue, and employs 85 officers. The Town of Johnston Fire Department consists of 4 stations, with the headquarters located at 1521 Atwood Avenue in Johnston, RI. The department owns 4 engines, 1 ladder truck, and 3 rescue vehicles.

3.3 Aesthetic Considerations

The project area consists of a mix of commercial, industrial, and residential land uses. In many areas, commercial and industrial uses adjacent to the Pocasset River have negatively impacted the aesthetic quality of the River and the associated riparian corridor. The Pocasset River near the residential areas is generally more pristine and offers an aesthetic amenity for residents in these areas. The aesthetic impacts of the proposed flood improvements are presented in Section 6.6.3.

3.4 Cultural Resources (Historical and Archaeological Resources)

The Rhode Island Historical Preservation and Heritage Commission (HPHC) was contacted to provide information on historic structures in the project areas. The Town of Johnston and the City of Cranston were also contacted. The Rich Box Company facility was identified as a property eligible for listing on the National Register of Historic Places. In a letter dated August 17, 2009, HPCH (Appendix C) states that the proposed flood wall proximal to the Rich Box Company will not have an adverse effect on this facility.

In a prior letter dated May 12, 2009 l (Appendix C), HPHC stated that there is one site with potential Native American resources and clarifies in their August 17, 2009 letter that completion of an archaeological survey prior to construction is warranted at the location.

3.5 Climate and Air Quality

Rhode Island has cold winters and hot summers, periodicity of the seasons are influenced by the moderating effect of the Atlantic Ocean. Temperatures average 30 degrees Fahrenheit (F) in winter and 70 degrees F in the summer. The average relative humidity is between 55 and 75 percent.

Total annual precipitation is approximately 43 inches per year, with almost half falling between April and September. Annual precipitation is usually adequate for the common crops of the region. During the winter months snow cover is common, with an average annual snowfall of about 36 inches.

Prevailing annual winds are from the southwest; the highest average wind speed of 13 miles per hour is observed in April.

All of Rhode Island is in an area currently designated by the EPA as a nonattainment area for 8-hour ozone. EPA defines nonattainment as an area that “does not meet the national primary or secondary ambient air quality standard for that pollutant.”

3.6 Topography, Geology, and Soils

The watershed consists of glaciated uplands with relatively low hills separated by narrow valleys. The northern portion has bedrock controlled topography with short steep slopes and wetlands in low areas. Most of the Cranston portion consists of glacial outwash plains and terraces. The stream channels and ponds in the headwaters of the Pocasset River have an elevation of approximately 300 feet above sea level. At its terminus, the confluence with the Pawtuxet River, the elevation is about 5 feet. Most of the hills in the headwaters section of the watershed have an elevation of 400 to 500 feet.

The majority of the watershed consists of well drained to poorly drained sandy soils developed in stony ablation till. Almost all the soils in the watershed formed during glacial drift and have moderate to high permeability. Many of the soils along the river have been manipulated by man; therefore, cuts and fills are common along the channel, particularly in the lower part of the watershed. Soils in the northern portion of the watershed are generally unsorted glacial till. The southern portion of the watershed is made up of primarily sorted sand, gravel, and silt (glacial outwash). The predominant bedrock is Mussy Brook Schist, a green to greenish gray, fine grained rock. Soil and geologic characteristics for each profiled area (i.e., the areas of significant flooding where mitigation measures are proposed) are given below.

Below is a detailed description of soil types at the major project areas taken from the Rhode Island Soil Survey, dated July 1981.

- Rotary Drive MU (Merrimac-Urban land complex) soils are present at Rotary Drive. MU soil is made up of predominantly sandy loam. The permeability of the soil is high and therefore suited mainly for development. State-wide important soils are mapped adjacent to the river channel and extending to the rear of some of the houses on Rotary Drive. State-wide important soils or "Additional Farmlands of Statewide Importance" are soils which are valuable for farm enterprises but are less well suited for intensive farming. They fall into one of the categories of NRCS-mapped soil map units that have state-wide, local, or unique importance as farmland capable of producing food, feed, fiber, forage, and oilseed crops.

- Fletcher Avenue and South Bennett Drive UD (Udorthents-Urban land complex) soils are present at these areas. Udorthents-Urban land complex is a soil made up of well drained cut and fill material. Soil properties and the types of soils are variable, requiring a detailed site investigation to characterize. A narrow bank of State-wide important soils follows the river channel behind these areas.

- Reservoir Avenue The Reservoir Avenue area is made up of the following soil types: MU (Merrimac-Urban land complex, 75%), Pp (Podunk fine sandy loam, 15%), Ru (Rumney fine sandy loam, 5%), and UD (Udorthents-Urban land complex, 5%). Podunk fine sandy loam is a well drained soil, with a moderately high permeability. This is a flood plain soil that is susceptible to flooding when the water table is high. Rumney fine sandy loam is a poorly drained soil present on flood plains. This soil has a low permeability and is susceptible to flooding. It is characterized as a State-wide important soil.

- Riverview Terrace The River View Terrace neighborhood, inclusive of Davis Court and Autumn Street areas, is made up of the following soil types: MU (Merrimac-Urban land complex, 75%), Pp (Podunk fine sandy loam, 10%), HkC (Hinckly gravelly sandy loam, rolling, 5%), Ru (Rumney fine sandy loam, 5%),

and UD (Udorthents-Urban land complex, 5%). Hinckly gravelly sandy loam is an excessively drained, high permeability soil that is well suited for community development and is a State-wide important soil.

- Willowbrook Apartments The following soil types are present in the Willowbrook Apartments area: MU (Merrimac-Urban land complex, 90%) and Ru (Rumney fine sandy loam, 10%).

3.6.1 Highly Erodible Land and Swampbuster

The Food Security Act of 1985, as amended, provides disincentives to farmers and ranchers who produce annually tilled agricultural commodity crops on highly erodible cropland without adequate erosion protection. In addition, these disincentives apply to farmers and ranchers who produce annually tilled agricultural commodities or make possible the production of agricultural commodities on land classified as wetlands. This provision is not applicable to this project.

In addition, the Swampbuster provisions of the Food Security Act withhold certain Federal farm program benefits from farmers who convert or modify wetlands. This provision is not applicable to this project.

3.7 Water Resources

3.7.1 Surface Water

Water Quantity

The Pocasset River drainage area defines the project area, and as such is the primary water resource within the watershed. The river is 21.5 river miles long, with approximately 1.62 square miles (1,043 acres) of active floodplain. Impoundments along the Pocasset River include the Upper Pocasset Pond, Lower Pocasset Pond, Insurance Company Pond, and Cranston Print Works Dams. The Pocasset has two major tributaries; Simmons Brook and Dry Brook. There are several reservoirs associated with the Simmons and Dry Brook tributaries which were constructed around 1840 to provide water for the Cranston Print Works.

As described by the Flood Plain Management Study (NRCS, 2007), the Pocasset River begins in the northwestern portion of the Town of Johnston and flows southeast through the Town of Johnston until it passes under Interstate 295. From there it flows east along Route 6 and enters the Johnston Memorial Park. It leaves the park flowing to the south under Route 6, then turns to the southeast towards Route 5. The river crosses under Route 5 approximately one-half mile south of Route 6. The river then flows to the south towards the City of Cranston where it flows under Plainfield Street. The river then meanders through the City of Cranston until it reaches the Cranston Print Works. From the Print

Works, the river flows to the south until it discharges into the Pawtuxet River just southeast of Pontiac Avenue. The Pawtuxet River flows to the east 1.7 miles and discharges into Narragansett Bay at Pawtuxet Cove.

The Simmons Brook watershed encompasses 6.9 square miles within the Town of Johnston. There are two major man-made impoundments on Simmons Brook; Upper Simmons Reservoir (50 acres) and Lower Simmons Reservoir (45 acres). Pierce Pond is also located on Simmons Brook. Simmons Brook flows into the Pocasset River just north of Plainfield Street.

Dry Brook has a watershed of 3.2 square miles within the Town of Johnston. It enters the Pocasset River just south of Central Avenue and east of Atwood Avenue (Route 5). There are several man-made reservoirs along Dry Brook; most notably, Oak Swamp Reservoir (111 acres), and Almy Reservoir (54 acres). The Hughesdale Pond-Fontaine's and the Gross' dams on Dry Brook are also within the study area.

Flooding in the Pocasset River watershed occurs fairly frequently. The river is not gaged, but anecdotal accounts have suggested that the severity and frequency of flooding has increased over the past twenty years. During precipitation events, some as small as 2 to 3 inches of total rainfall, the river rises rapidly and dramatically, causing frequent property damage and stream bank erosion. Channel modification has occurred throughout the watershed as the area has been urbanized. Bridges, culverts, and concrete/masonry and riprap retaining walls have been constructed throughout the watershed and have altered the natural flow characteristics of the Pocasset River and its tributaries.

The NRCS modeled the hydrology and hydraulics of the Pocasset River to determine the extent and severity of flooding in the Pocasset River watershed. A detailed explanation of the model can be found in the Flood Plain Management Study and its associated Technical Report (NRCS, 2007). The model predicted the flows and water surface elevations for current conditions, as well as the expected increase as a result of full build out of the watershed. Table 3-3 shows the model results for both conditions during the 100-year/24-hour duration storm event.

Table 3-3
Predicted Water Surface Elevations and Discharges in the Pocasset River under Existing Conditions and Watershed Build-Out Without Flood Mitigation (100-year, 24-hour, Type III Precipitation Event)

Location	Existing Conditions		Future Build-Out	
	Elevation (ft)*	Discharge (cfs)	Elevation (ft)*	Discharge (cfs)
Atwood	125.8	831	126.1	1027
Rotary	98.4	1038	99.4	1264
Morgan St.	97.3	1038	98.4	1264
Morgan Mill	87.1	1249	87.4	1470
Bennet/Melody	84.4	1305	85.3	1549
Park Place	84.4	1305	85.3	1549
Plainfield Pike	80.6	1927	84.3	2419

Location	Existing Conditions		Future Build-Out	
	Elevation (ft)*	Discharge (cfs)	Elevation (ft)*	Discharge (cfs)
Reservoir Ave.	30.4	1739	31.4	2415
Willowbrook	25.9	2116	26.8	2370
Garden City	25.7	1863	26.7	2271

*Elevations are in NAVD 88.
Source: Table 2.5 of the Flood Plain Management Study Technical Report (NRCS, 2007)

Water Quality

Although water quality throughout the river has not been thoroughly characterized, it is influenced by stormwater runoff from paved residential areas, industrial sites, and highways. In addition, the state's Central Landfill is located on a tributary to the Pocasset River.

In 1989, Rhode Island Department of Environmental Management (RIDEM) contracted the US Geological Survey (USGS) to conduct sampling at 13 river stations throughout the state. The Pocasset River was sampled at one station on two dates, September 22, 1989 and November 30, 1989. Physical water quality parameters (DO, temperature, pH, hardness), bacteria (fecal coliform), nutrients, and metals were analyzed. This study indicated that the river had bacteria levels that exceeded the primary contact recreation and swimming criteria.

In 1990, the three communities along the Pawtuxet River (West Warwick, Warwick, and Cranston) contracted Applied Science Associates to characterize selected water quality parameters within the Pawtuxet River as part of the facilities' planning studies for the upgrades at the wastewater treatment facilities. The mouth of the Pocasset River at Pontiac Avenue was sampled during this study. During this project, analyses were conducted for total and dissolved metals, nutrients, and physical water quality parameters. Results indicated exceedences of total copper and total lead criteria and elevated nitrate levels.

From November 1993 to December 1994, the River Rescue project conducted a water quality monitoring study of the Pawtuxet River. The mouth of the Pocasset River at Pontiac Avenue was sampled monthly during this study. Physical parameters and total metals were analyzed under the Pawtuxet River Monitoring Project. Results of this study indicated exceedences of total copper and total lead criteria in the Pocasset River.

The water quality data collected from the studies summarized above were used to list the Pocasset River as impaired for bacteria, total copper and total lead on Rhode Island's 1994, 1996, 1998, and 2002 List of Impaired Waters. Under Section 303(d) of the Clean Water Act, states are required to identify waters for which existing required pollution controls are not stringent enough to achieve State water quality standards. These waters are referred to as water quality limited or impaired. Once a water body is identified as impaired, Section 303(d) requires that water quality restoration plans, also known as

Total Maximum Daily Loads (TMDL), be developed for each pollutant causing the impairment. These restoration plans describe the non-point source and point source pollution controls necessary for the water body to meet water quality standards. In 1998, the TMDL Program in RIDEM's Office of Water Resources conducted a monitoring project of water bodies that were listed as impaired for total metals. Since the State had recently adopted water quality criteria for dissolved metals, the more bioavailable form of metals, it was necessary to determine if each of these water bodies was actually impaired and exceeding the new dissolved metals criteria.

The TMDL staff monitored the Pocasset River at Pontiac Avenue in September, November and December 1998 and April and July 1999. The samples were analyzed for dissolved copper and lead. The data showed no violations of dissolved copper criteria, but three out of the five samples exceeded the chronic dissolved lead criteria. The results of this study were used to remove dissolved copper from the list of impairments on the Pocasset River. The Pocasset River remains on Rhode Island's 2008 List of Impaired Waters for bacteria (fecal coliform) and dissolved lead. The river is currently targeted for development of a water quality restoration plan for these pollutants in 2010-2012. Regular monitoring on the Pocasset River and all waters of the state will be addressed in the Statewide Monitoring Strategy that is currently under development.

Flooding in the Pocasset River watershed results in bacterial contamination of downstream areas from the flooding of individual sewage disposal systems and sewage backups. Flooding also washes sediments, debris, and associated pollutants into the river from adjacent residential, commercial, and industrial areas. Pollutants likely include oils and greases, metals, nutrients, and other chemicals.

3.7.2 Groundwater

There are no sole source aquifers as defined by U.S. EPA, community well head protection areas, or groundwater reservoirs as defined by RIDEM within the project area. A non-community well head protection area is located within one mile south of the Fletcher Avenue project area. In the areas where floodwalls are proposed, groundwater flows and elevations are likely related to the condition of the Pocasset River and vary accordingly.

Groundwater in all of the project area is classified as either GA (suitable for public or private drinking water use without treatment) or GB (not suitable for public or private drinking water use without treatment due to known or presumed degradation). GB water is typically located in the southern portion of the project area, under the highly urbanized areas with dense concentrations of historic industrial and commercial activity.

Nearly the entire project area receives its water supply from the Scituate Reservoir located in central Rhode Island. Relatively few of the properties utilize groundwater from private or public wells as potable water.

3.7.3 Wetlands and Floodplains

According to the US Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI), there are 1,822 acres of wetlands in the Pocasset River watershed (see Figure 3-1). The majority of wetland resources within the watershed are associated with the Pocasset River and its tributaries, and are located in the upper reaches of the watershed, outside of the areas proposed for flood mitigation. Historic development of the lower watershed, particularly for commercial, industrial and residential uses, has reduced the abundance of wetland resources when compared with pre-settlement conditions.

The distribution of wetland cover types are summarized in Table 3-4 below. As mentioned above, these acreages are primarily within the upper reaches of the watershed, outside of the project area as shown in Figure 3-1.

Table 3-4
Wetland Cover Types Within
The Pocasset River Watershed

Wetland Type (Cowardin et al. 1979)	Area (acres)
Palustrine Emergent	119
Palustrine Forested	1,149
Palustrine Open Water	83
Palustrine Scrub-Shrub	140
Riverine Open Water	28
Lacustrine Open Water	303
TOTAL	**1,822**

Palustrine emergent wetlands within the watershed are dominated by smartweeds (*Polygonum* sp.); pickerelweed (*Pontederia cordata*); and spatterdock (*Nuphar variegata*). The woody species northern arrowwood (*Viburnum dentatum*) is also common in the drier portions of emergent wetland communities. In shallower water areas, reed canary grass (*Phalaris arundinacea*); soft-stemmed bulrush (*Scirpus validus*); and several sedges (*Carex* sp.) are common. Portions of the emergent wetlands associated with the impoundments of the Simmons and Dry Brook watersheds are essentially monocultural stands of the non-native invasive, reed canary grass.

Forested wetlands are dominated by red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), spice bush (*Lindera benzoin*) and ostrich fern (*Matteucia struthiopteris*). Shrub-scrub wetlands are dominated by silky dogwood (*Cornus amomum*); northern arrowwood; speckled alder (*Alnus incana*); and red maple.
Vegetation commonly occurring within open water habitats of the watershed includes coontail (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), mermaid weed (*Proserpinaca palustris*), common bladderwort (*Utricularia vulgaris*), and tape grass (*Vallisneria americana*).

Wetlands within the project area are generally limited to the Pocasset River proper and its immediate stream banks. Because the River is deeply incised, bordering wetland areas, which are typical in less developed areas, are limited. Typically, vegetation along the margins of the River consists of red maple, silver maple (*Acer saccharinum*), willow (*Salix spp*.), dogwood (*Cornus spp*.), spicebush, and poison ivy (*toxicondendron radicans*). A fair number of invasive plants typical in urban stream areas were noted along the corridor including reed canary grass, phragmites (*Phragmites communis*), and greenbrier (*Smilax sp.).*

Floodplain

There are approximately 1.62 square miles (1,043 acres) of active floodplain within the watershed (as depicted by the HEC/RAS generated floodplain maps shown in Section 9). Vegetation within the undeveloped floodplain areas of the watershed is typical for the region and consists of a canopy of sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), and silver maple (*Acer saccharinum*). Understory and herbaceous cover is typically sparse due to frequent disturbance from flooding, and is dominated by stinging nettle (*Boehmeria cylindrica*), cinnamon fern (*Osmunda cinnamomea*), and poison ivy (*Toxicodendron radicans*).

Much of the floodplain in the watershed, particularly in the lower portions of the watershed, occurs on developed land. It has been postulated that development within the watershed has contributed to the increased frequency, duration, and intensity of flooding. There has been documentation of flooding within the watershed beginning in the 1950s and in recent years flooding has become more common. The resulting damages to commercial, residential, and industrial property have caused considerable concern within the affected communities, as well as within municipal and state government agencies.

As noted in Section 2.2, in response to trends in the recent flooding events of the Pocasset River, the NRCS prepared the *Pocasset River Watershed: Floodplain Management Study, Providence County, Rhode Island*. Released in 2008, the study documented existing conditions within the watershed, provided updated floodplain maps for present and future conditions, and states potential solutions to mitigate or prevent damages from future flooding caused by the Pocasset River and its tributaries.

3.8 Utilities

3.8.1 Sewer

The City of Cranston has a 30-year contract with Veolia Water, a private company, for the operation and maintenance of the Cranston Wastewater Treatment Facility (WWTF), a 23 million gallon per day facility. The WWTF services the City east of Interstate 295 (I-295) and an area west of I-295 located south of Plainfield Pike and north of Scituate Avenue. Most of western Cranston is serviced by private septic disposal systems and the

City does not plan to extend service to these areas. A pressurized sewer line runs through western Cranston, part of the way down Pippin Orchard Road, to connect the Florida Power & Light (FP&L) Plant in Johnston to the WWTF in Cranston. The WWTF discharges to the Pawtuxet River (Cranston Comprehensive Plan Update, veoliawaterna.com).

Rhode Island Geographic Information Systems (RIGIS) has a data layer which indicates the locations of main sewer lines, force mains, or interceptors for public and private sewer systems, provided by RI DOT and updated as of 1996. According to these data, the majority of the Town of Johnston is not serviced by sanitary sewer. Some areas along the Johnston border with Providence and North Providence are serviced, along with limited areas along the pressurized sewer line from the FP&L Plant to the WWTF in Cranston (RIGIS).

In Cranston, the area surrounding the Pocasset River is generally part of the sewered service area. In Johnston, the FP&L pressurized line is near the Pocasset River and crosses the river north of I-195. Sewer lines are present in the vicinity of the Riverview Terrace project area, including one which crosses the Pocasset River. A main sewer line passes very close to the Pocasset River behind the Willow Brook Apartments (RIGIS).

3.8.2 Water

The Providence Water Supply Board delivers treated drinking water from the Scituate Reservoir system to Cranston, Johnston, and other communities in the greater Providence area. Some homes in western Cranston are serviced by private wells. The proposed project areas are within the Providence Water District. In general, water supply lines follow roadway right of ways. Two supply lines cross the Pocasset River in the vicinity of the Reservoir Avenue project area (Cranston Comprehensive Plan Update, RIGIS).

3.8.3 Electrical, Gas, & Telecommunications

Both Cranston and Johnston receive electrical service from Rhode Island-Electric, a subsidiary of National Grid. National Grid also supplies natural gas service to both communities through Rhode Island-Gas. Based on the RIGIS data layers for electrical transmission lines and gas lines, there are no major distribution lines in the vicinity of the proposed project areas.

Cable, telephone, and internet service is provided by Cox or Verizon in Cranston and Johnston.

3.8.4 Stormwater

Portions of Cranston and Johnston are serviced by traditional stormwater collection systems with catch basins, drainage pipes, and outfalls. The following is a summary of

stormwater collection systems within the project areas.

Rotary Drive

Topography in the area between Atwood Avenue and the proposed floodwall slopes to the east, toward the floodwall. The area to the north of Rotary Drive drains to the Dry Brook. The Rotary Drive drainage area is divided into an upland area (3.2 acres) and a local area (7.4 acres). The large upland area across Atwood Avenue drains toward Rotary Drive. This area is served by an extensive storm drain network that leads under Atwood Avenue and discharges at the rear of Rotary Drive (toward Alcar Drive), above the river flood stage. A cursory inspection of this pipe revealed it to be approximately 36-inch RCP in poor condition. It also appears the line runs beneath the adjacent home. The remaining local area drains towards a local subdrain system which exists to the rear of the homes along Rotary Drive and exits to the Pocasset River behind Rotary Drive.

South Bennett Drive

There are no traditional drainage collection systems at the Park Place Apartments or in the vicinity. Stormwater runoff flows overland towards the river. A large woodland area across Atwood Avenue presently drains to Atwood Avenue. This section of Atwood Avenue lacks drainage control structures and it is probable that runoff from this area drains towards the river due to the steep roadway that leads from Atwood Avenue to Park Place Apartments. The drainage area for Park Place Apartments is divided into an upland area (6.2 acres) and a local area (4.3 acres).

East of the river, River Drive is also drained by overland flow towards the river without any stormwater collection systems. South Bennett Drive may have some limited formal drainage systems with outlets to the 36-inch pipe culverted tributary that drains the South Bennett Drive neighborhood.

Fletcher Avenue

The Fletcher Avenue drainage area is 48.7 acres and extends from Atwood Avenue to the Pocasset River. Atwood Avenue serves as a drainage divide, with piped stormwater collection in the roadway conveying upgradient stormwater flows away from the location of the proposed floodwall. Downgradient of Atwood Avenue, stormwater flows in a northerly direction toward the river, following surficial topography. A drainage system is currently in place at Fletcher Avenue, with one outfall that discharges to a small tributary, which eventually flows into the Pocasset.

On the other side of the river at the Rich Box site, stormwater flows overland toward the Pocasset River. There are no stormwater control structures within the Rich Box site and stormwater flows overland to the river from the 4.4 acre drainage area.

Reservoir Avenue

The drainage area behind the proposed floodwall at Reservoir Avenue is delineated by Reservoir Avenue to the south and the floodwall to the north and west and is approximately 8.8 acres. Reservoir Avenue contains formal stormwater drainage collection which conveys stormwater away from the location of the proposed floodwall. The drainage area is relatively flat, with the ground gently sloping northwest toward the river. A topographic ridge separates the northern end of the drainage area from the river.

Riverview Terrace

Stormwater flows in the southwest direction toward the Pocasset River. Stormwater control structures within the adjacent Pontiac Avenue serve to convey water away from the site and serves as the eastern drainage divide. Stormwater from the Riverview Terrace 32.3 acre drainage area, west of the divide, presently sheet flows along the roadways and enters the river as overland sheetflow and through various existing drainage culverts.

A small unnamed tributary is located to the west of Riverview Terrace, flowing in an easterly direction from Blackmore Pond. Currently the stream flows under the neighborhood through a culvert and discharges to the Pocasset River downstream of the neighborhood.

Willow Brook Apartments

Stormwater flows overland southwest toward the Pocasset River. Storm water control structures exist within the adjacent Pontiac Avenue to convey water away from the site and serve as the eastern drainage divide. Stormwater from the Willow Brook Apartments 15.2 acre drainage area, west of the divide, presently sheet flows along the roadways and enters the river via several drainage swales.

3.9 Wildlife / Threatened and Endangered Species

Wildlife

Wildlife in the region has been subject to drastic disturbances from European settlement, including the extermination and/or reduction in populations of large predators and vertebrates (e.g., wolf and moose) by hunting and habitat loss (McNab and Avers 1994). Some formerly displaced species have become re-established on abandoned agricultural lands, with the exception of large predators, whose niche has been partially filled by mid-size predators (e.g., coyote) (McNab and Avers 1994). Common wildlife species include the white-tailed deer (*Odocoileus virginianus*), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and an assortment of resident and migratory birds. River

corridors, such as the Pocasset River corridor, provide important conduits for travel and migration for various forms of wildlife.

The value of the impoundment and its associated and immediately fringing wetlands for avian breeding habitats would normally be very high. No breeding bird survey has been conducted, but occasional observation suggests that black duck (*Ana rubripes*) and mallard (*A. platyrhynchos*) make occasional use of the impoundments for summer feeding. Bufflehead (*Bucephala albeola*) have been observed during the winter.

Great blue heron (*Ardea herodias*) and green-backed heron (*Butorides striatus*) have been observed feeding in the impoundment shallows, and belted kingfisher (*Ceryle alcyon*) have occasionally been observed feeding from overhanging trees along impoundment borders. Although no specific survey has been made, a variety of passerines are also likely to feed and nest in the scrub-shrub and forested wetlands along the river corridor.

Mammals directly observed include eastern chipmunk (*Tamias striatus*) and gray squirrel. Red fox (*Vulpes fulva*), raccoon, and coyote (*Canis latrans*) are also likely to utilize remaining habitat within the watershed. Tracks and scat of domestic dog (*Canis familiaris*) and cat (*Felis cattus*) are also widely observable.

Additional small mammals likely to be present in the watershed include white-footed mouse, meadow jumping mouse (*Zapus hudsonicaus*), meadow vole (*Microtus pennsylvanicus*), short-tailed shrew (*Blarina brevicauda*), and eastern mole (*Scalopus aquaticus*). Medium-sized mammals also likely to be observed include striped skunk (*Mephitis mephitis*), Virginia opossum, and mink (*Mustela vison*). White-tailed deer is likely the only large mammal present within the watershed.

There is limited fishery information for the reaches of the Pocasset River within the study area. However, the following information on the impoundments in the upper reaches of the watershed can be used to characterize the general fishery resources in the River as a whole. The Pocasset River is reported to support a moderate quality warm water fishery, including largemouth bass (*Micropterus salmoides),* and perch (*Morone americana),* which are extensively used by recreational anglers. Fish surveys conducted in 1996 and 1997 by the Rhode Island Department of Environmental Protection (RIDEM) have documented longnose dace (*Rhinichthys cataractae*), white sucker (*Catostomus commersoni*), American eel (*Anguilla rostrata),* redfin pickeral (*Esox americanus),* bluegill (*Lepomis macrochirus),* and golden shiner (*Notemigonus crysoleucas*).

Those species of fish that migrate upstream from saltwater to freshwater for breeding purposes (i.e., anadromous fish such as alewive [*Alosa pseudoharengus*], blueback herring [*A. aestivalis*] , and shad [*A. sapidissima*]) have limited access to upper reaches of the watershed due to the obstacle formed by the Pawtuxet Falls dam at the mouth of the Pawtuxet River. Restoration of anadromous fish passage is currently being considered at

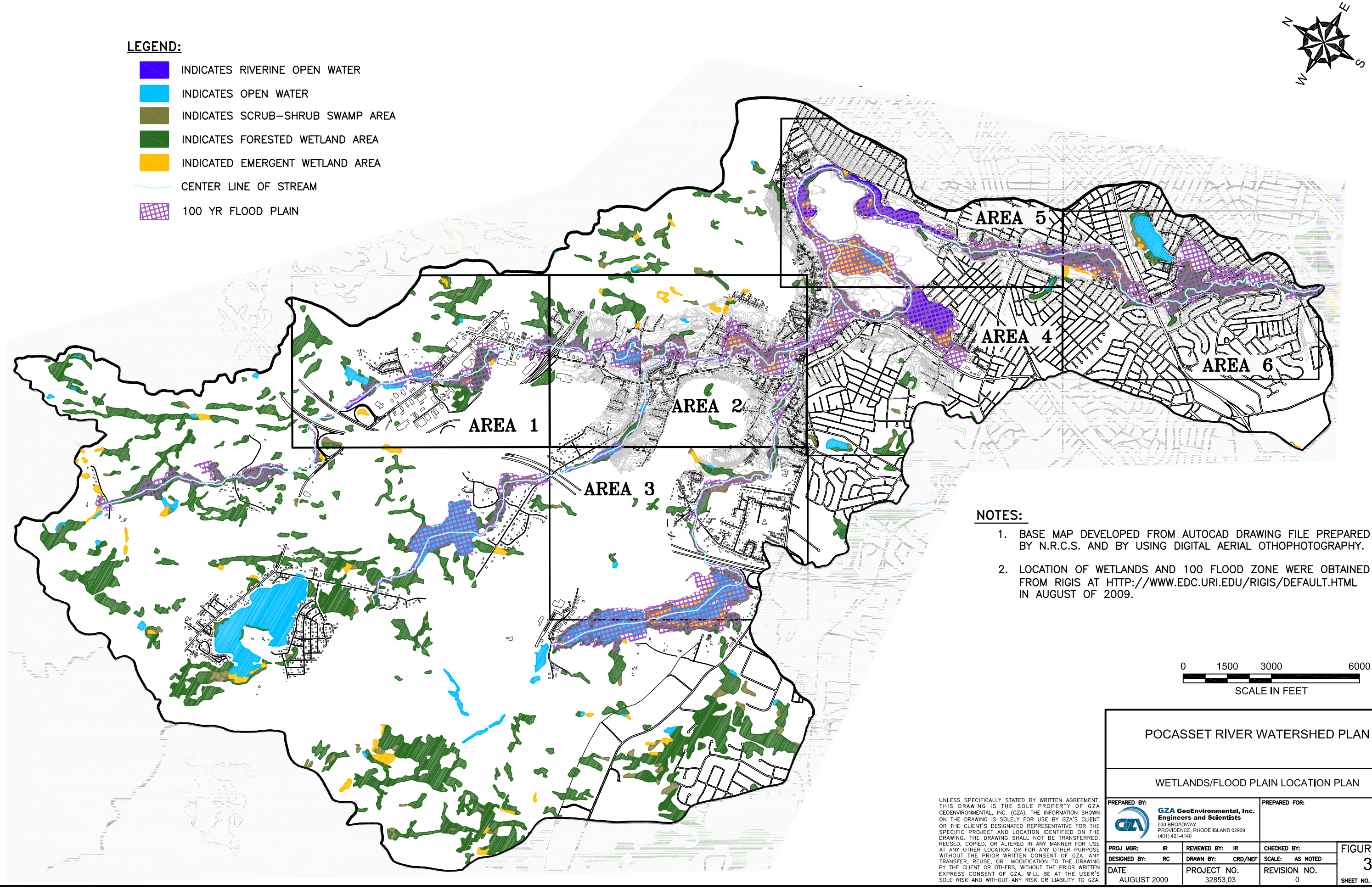
that site. Once passage is restored anadromous fish will have access to the Pocasset River as far upstream as the Cranston Print Works' dam. This will open approximately three river miles of currently inaccessible spawning and nursery habitat to anadromous fish.

Threatened and Endangered Species

According to the Rhode Island Natural Heritage Program (RINHP), there are several species of plants on the State Rare Species list that have been reported within the watershed. All of these are found within the upland Snake Den State Recreation Area in Johnston, which is in the upper watershed, far removed from the project area. One of these species is purple clematis (*Clematis occidentalis*), which is listed as State Endangered because it is the only known population of this plant in Rhode Island.

3.10 Energy

Flooding incidents in the project area require energy resources in order to protect human health and property and to repair water damage. On a yearly basis and sometimes even more frequently flooding of properties in the project area requires emergency services (fire, police, and ambulance). Energy is expended in the form of fuel to service the vehicles used in emergency operations including fire trucks, rescue vehicles, police cars, generators and pumps. After the flooding subsides, energy is also expended to repair water damaged property.



NOTES:

1. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY N.R.C.S. AND BY USING DIGITAL AERIAL OTHOPHOTOGRAPHY.
2. LOCATION OF WETLANDS AND 100 FLOOD ZONE WERE OBTAINED FROM RIGIS AT HTTP://WWW.EDC.URI.EDU/RIGIS/DEFAULT.HTML IN AUGUST OF 2009.

0 1500 3000 6000

SCALE IN FEET

POCASSET RIVER WATERSHED PLAN

WETLANDS/FLOOD PLAIN LOCATION PLAN

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PREPARED FOR:

PROJ MGR: IR	REVIEWED BY: IR	CHECKED BY:	FIGURE 3-1
DESIGNED BY: RC	DRAWN BY: CRD/NEF	SCALE: AS NOTED	
DATE AUGUST 2009	PROJECT NO. 32853.03	REVISION NO. 0	SHEET NO. 1 OF 1

J:\ENV\32853-03.IR\FIGURES\DWG\GZA\32853.03_F0_R0_WETLAND AREA AND WATER SHEDS

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SECTION 4

WATERSHED PROBLEMS AND OPPORTUNITIES

This section discusses the problems that need to be solved and the opportunities that these problems present. Some problems have a quantifiable dollar amount associated with them, such as flood damages. Other problems and opportunities do not have quantifiable dollar damages, but an identified need or opportunity exists to increase the quality and/or quantity of a resource.

Previous floodplain studies have been conducted in parts of the Pocasset Watershed but a comprehensive watershed analysis had not previously been performed. Upon receiving federal funding in 2001, the start of the Pocasset Floodplain Management Study marked the start of NRCS involvement to provide solutions to the flooding and its associated damages.

4.1 Flooding Problems

The severity, duration, and frequency of flooding within the Pocasset River watershed has increased over the past 20 years to a point where, in March of 2001, two significant flood events occurred within a ten day period. The two storms occurred on March 21 and March 30 and had rainfall amounts of 3.11 and 2.88 inches, respectively, as measured at the T.F. Green Airport in Warwick, RI. Appendix F contains photographs of these and other precipitation events that illustrate the severity of the flooding.

Figure 2-2 provides a visual depiction of specific areas within the watershed along the Pocasset that have experienced considerable flooding during wet weather events. The number of documented flooding episodes has become increasingly more common over the years (Flood Plain Management Study, 2006), probably due to the increased imperviousness of the watershed. High Hazard Areas were determined by the Local Sponsoring Organization (Cranston and Johnston), based on the flood proofing measures adopted by the Local Sponsoring Organization.

High Hazard Areas have been identified, which the sponsor feels need to be addressed. High Hazard Classification is based on a consideration of depth and velocity of flood flows. Areas of floodplain where depth is greater than 3 feet, velocity of floodwater is greater than 5 feet per second, or where the product of the depth and velocity exceeds 7, are included in High Hazard Areas. To be considered a High Hazard Area, the area must be used for overnight occupation. High Hazard Areas were targeted to evaluate opportunities to provide flood protection.

Under normal flow conditions the Pocasset slowly meanders through a number of culverts and roadway bridge openings. During periods of high flows, these features serve

to effectively limit flow causing water to back up, creating upstream flood conditions and considerable property damage. There are several sites where existing building foundations are immediately adjacent to the bank of the river, defining the channel banks; thereby impending overbank flows.

For the scope of this project, the following areas have been identified as High Hazard Areas and are considered for flood mitigation:

- Rotary Drive
- South Bennett Drive
- Simmons Brook Culvert
- Fletcher Drive
- Reservoir Avenue
- Riverview Terrace
- Willowbrook Apartments
- Morgan Avenue Bridge
- Morgan Mill Road Bridge
- Plainfield Street Bridge
- Reservoir Avenue Bridge
- Garden City Bridge

.
In terms of numbers of impacted buildings, in the South Bennett Drive project area, there are in excess of 32 residential properties that can be impacted during a flood event. The Park Place Apartments consists of 78 low-income residential units where the lower units experience severe flooding and emergency access is severely curtailed during large storm events. Note that additional isolated areas (individual homes, small groups of homes, etc) have also been identified as High Hazard Areas and are considered for flood mitigation.

In the South Bennett Drive and River Drive neighborhoods, the 2001 floods caused significant damages to homes. Immediately upstream, at the Morgan Mill Road Industrial Park, flooding occurred during the 2001 floods, but no damage occurred due to previously completed stream bank stabilization projects that repaired damages following flooding in 1999. Flooding at Riverview Terrace, Davis Court, and Autumn Street causes damage to buildings resulting in high clean up costs and loss of personal belongings from residential properties. The chronic nature of flooding issues in these areas has resulted in decreasing property values.

The most severe flooding (both in magnitude and recovery efforts) occurs on Fletcher Avenue in Cranston. The area is a mixture of industrial, commercial, and residential properties. This area sustains some of the highest losses due to flooding in the Pocasset watershed. Losses include property damage, temporary loss of housing, loss of business, loss of wages, and loss of development potential. There are thirty two commercial and industrial properties affected during a typical flooding event in this area.

Other problem areas of flooding do exist upstream of the areas mentioned above. Chronic street flooding occurs on Atwood Avenue in Johnston, where the Pocasset crosses under the roadway. The Town of Johnston is currently examining mitigation strategies in this area. Flooding also occurs at the FM Global office park at the corner of Central Avenue and Atwood Avenue, where the Dry Brook discharges into the Pocasset River. There are eleven properties that were flooded during recent large storm events, including a commercial development, which contains a supermarket, a commercial storefront, and several restaurants. Economic losses in this area have included a reduction in business, increased police and fire protection costs, and direct property damage. Figure 2-2 shows the Watershed and identifies areas of major flooding. Table 4-1 provides a summary of 24-hour 100-year flood event damages with and with-out protective measures of the project.

Table 4-1
Summary of 24-Hour, 100-Year Damages With and Without Project.

Type	Number Damaged	Without Project (Dollars)[2]	With Project (Dollars)[2]	Reduction	Percent Reduction
Residential[3]	427	1,525,470	179,740	1,345,730	88
Commercial/Industrial/Public	54	549,110	37,690	511,420	93
Totals	481	2,074,580	217,430	1,857,150	90

1. Above figures are for a storm which has a 1-percent chance of being equaled or exceeded in a given year. This table does not include buildings flooded above the 1-percent chance event
2. Price base 2007, figures shown are average annual damages
3. Includes single family/multi family homes and apartment units

4.2 Flood Mitigation Opportunities

High Hazard Areas were targeted to evaluate opportunities to provide flood protection. Each area where flood mitigation was considered presents a site specific set of feasible alternatives that reflect opportunities and constraints particular to that site. Sections 6.1, 6.2, and 6.3 provide a brief description of the general alternatives considered for flood mitigation, as well as those that were removed for consideration and the rationale for removal. Site specific alternatives analysis was also conducted, the details of which are provided in Section 6.4.

SECTION 5

SCOPE OF THE EIS

NRCS conducted a scoping process to identify concerns of the public, state and local governments, and federal, state, and local agencies, and to meet NEPA requirements for public participation. The first meetings between the NRCS and the Sponsors (Town of Johnston and the City of Cranston) to discuss funding through Public Law 83-556 (the Watershed Protection and Flood Prevention Act) for flood mitigation in the Pocasset River Watershed were held in 2000. In March of 2005 the Pocasset River Steering Committee met to discuss flooding issues along the Pocasset River. The Committee consisted of residents, federal, state, and local elected officials and their representatives, and representatives from federal, state, and local agencies, including Army Corp of Engineer, the Environmental Protection Agency, Rhode Island Department of Environmental Management, the Federal Emergency Management Agency, and the Rhode Island Emergency Management Agency. The Committee's role has been to represent the interests of the public during development of the WP/EIS. In addition to meeting with the steering committee, NRCS has met individually with local officials, congressional staff, other regulatory agencies, and citizens whose homes and businesses are affected by flooding in the Pocasset River Watershed.

NRCS then held a public meeting on __ to seek public input on the WP/EIS in ___; after NRCS gave an introduction to the project, local citizens and local government officials provided comments. Rhode Island NRCS published the notice of availability for interagency review in the Federal Register on___.

The concerns identified by the public are listed in Table 5-1 along with concerns that NRCS is required to address through the NEPA process. The 'Degree of Concern' is a relative ranking of the importance attached to the concern by the public, measured by the depth of discussion. The degree of significance is a relative ranking by NRCS of the issues that are important for defining the problems or formulating and evaluating alternative solutions. In rating the 'Degree of Significance', NRCS considered that the purpose of the current plan is flood protection. Concerns that are rated high or moderate in significance are discussed in further detail in this WP/EIS.

Table 5-1: Evaluation of Identified Concerns

Economic, Social Environmental, and Cultural Concerns	Degree of Concern[1]	Degree of Significance to the Decision Making[2]	Comments	Section of Watershed Plan-EIS where concern is discussed
Water Resource				
Flooding	High	High	Average Annual Damages of $2,074,580 Damage Area of 1,000 Acres (Flood Plain) Potential for Loss of Life; Primary Concern of Sponsors	2, 4
Pocasset River Water Quality	Low	Low	Contamination from inundated septic and sewer systems (2,500 acre feet of uncontaminated river water during 100-year event)	6.3, 7
Land Resources				
Prime and Important Farmland	High	Low	Evaluated for all NRCS Projects; Not Affected by this Project	3.1, 6.3.1
Highly Erodible Cropland	High	Low	Evaluated for all NRCS Projects; Not Affected by this Project	3.6, 6.3.6
Air Resources				
Air Quality	High	Low	Rhode Island in moderate non-attainment area for 8-hour ozone national ambient air quality standard; analysis required under Clean Air Act	3.5, 6.3.5
Visual Resources				
Aesthetics	High	Low	Aesthetics related to construction of floodwalls	3.3, 6.3.3
Biological Resources				
Fish Habitat	Low	None	Only Incidental Work to Occur in Water Bodies	3.9, 6.3.9
Wildlife Habitat	Low	Low	Project Area Generally Urban	3.9, 6.3.9
Wetlands	High	Low	Little to no Impacts; Analysis of Effects Required by Clean Water Act and Executive Order 11990	3.7.3, 6.3.7
Rare, Threatened, and Endangered Species	High	Low	None Known to be Present in project area; Analysis Required by Endangered Species Act	3.9, 6.3.9.2
Loss of Flood Plain	Moderate	Moderate	Concern over possible downstream impacts of lost flood plain, i.e. loss of flood storage	3.7.3, 6.3.7.3
Socio-Economic and Cultural Resources				
Cultural and Historic	High	Low	Analysis of Effects Required by National Historic Preservation Act	3.4, 6.3.4
Human Health and Safety	High	High	Flooding with Threat to Cause Loss of Life; Primary Concern of Sponsors	3.2, 6.3.2
Economic	High	High	Flood Damages; Primary Concern of Sponsors	3.1.3, 6.3.1.3

1. Concerns raised in scoping process or required by Agency or Federal Policy
2. Relative significance of given concern for defining the problems and formulating and evaluating alternative solutions

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SECTION 6

FORMULATION AND COMPARISON OF ALTERNATIVES

This section describes the process used to formulate the project alternatives (Section 6.1) and the components of the alternative plans in detail (Section 6.2). Section 6.3 describes the effects of the alternative plans on the socioeconomic and environmental resources within the project area. A comparison of alternative plans, risk and uncertainty, and rationale for plan selection are discussed in Sections 6.4, 6.5, and 6.6, respectively.

Section 6.1 describes the formulation of the High Hazard areas selected for flood protection and the combination of measures selected to provide flood mitigation at each area. Table 6-1 compares the feasibility of the various flood mitigation measures at each site, while Table 6-3 compares the alternatives developed from the feasible measures with respect to resources of medium and high concern and project costs.

Section 6.2, Description of Alternative Plans, summarizes the flood mitigation measures to be incorporated into the Recommended Plan. The subsections within Section 6.2 are organized by High Hazard Area to provide a detailed description of the alternative plans proposed at each area. For most of the areas, the alternative plans are limited to the Recommended Plan and the No Action alternative. However, additional alternative plans were evaluated and are described for the South Bennett Drive area and the Fletcher Avenue area.

The effects of alternative plans on socioeconomic and environmental resource areas are described in Section 6.3. This section is organized into subsections by resource area, where the effects of the Recommended Plan and the No Action alternative are described. Where applicable, the discussion is broken out by High Hazard area. Indirect and Cumulative Impacts are also discussed in this section.

Comparison of Alternative Plans, Risk and Uncertainty, and Rationale for Plan Selection are included as Sections 6.4, 6.5, and 6.6, respectively. Table 6-8, Summary and Comparison of Alternative Plans, in Section 6.4, summarizes the major environmental and socioeconomic impacts of the No Action and Recommended Plan alternatives.

6.1 Formulation Process

NRCS worked with the Rhode Island Emergency Management Agency Floodplain Management Program, Johnston town officials, and City of Cranston officials to identify sites affected by flood water damages and subsequent flooding impacts on human health and safety, economics, and surface water drainage.

The goal of the plan formulation process was to maximize the reduction in Average Annual Damages at the least cost. A cost-benefit analysis was done for each damage reach and project site to achieve greatest benefits for the least cost. For planning purposes, alternatives were developed for each priority site.

All project planning, including evaluation of alternatives, utilized the appropriate guidance manual "National Watershed Manual, part 504" (NWM) (United States Department of Agriculture, 1992) and "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" (P&G) (U.S. Water Resources Council, 1983). This document is intended to ensure proper and consistent planning and design of flood mitigation structures and practices. The alternatives presented in this document were evaluated using the objectives and planning guidelines presented in P&G.

Alternative plans were formulated in a systematic manner to ensure that all reasonable alternatives were evaluated. In keeping with P&G requirements, plan formulation concentrated on alternatives which contribute to the federal water resource objective of National Economic Development (NED). In terms of federal assistance, the most important alternative is that plan which maximizes NED benefits, in this case flood damage reduction. All alternatives were formulated using the following criteria:

Completeness **-** Provides the opportunity to reduce flood damages for the entire Pocasset River Watershed 100-year flood plain.

Effectiveness **-** Alternatives should provide for the maximum protection from damages.

Efficiency **-** The alternative is cost-efficient in reducing flood damages relative to other alternatives and if possible provides for net economic benefits.

Acceptability **-** Does not have insurmountable adverse effects on the human environment that cannot be mitigated and has the potential to:

- Win public support;
- Receive federal, state, or local financial assistance *or* be affordable without financial assistance, and;
- Can receive all necessary permits required by local, state, and federal agencies.

In addition to the economic aspects of P&G, alternative plans must also be evaluated in terms of environmental quality, especially the effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that sustain and enrich human life. Underlying this process is the requirement that each increment provide benefits at least equal to its cost.

High Hazard Areas were identified by the Local Sponsoring Organization and were targeted to evaluate opportunities to provide flood protection. Using the modeled 100-year, 24-hour flood elevation and the surveyed elevations of each building within the 500-year floodplain, all buildings subject to hazardous conditions were identified. High Hazard Areas were determined by the Local Sponsoring Organization (City of Cranston and Town of Johnston). Seven large High Hazard Areas have been identified which the sponsor feels need to be addressed (additional isolated High Hazard Areas were also identified). High Hazard Classification is based on a consideration of depth and velocity of flood flows Areas of the floodplain where depth is greater than 3 feet, velocity of floodwater is greater than 5 feet per second, or where the product of the depth and velocity exceeds 7, are defined as High Hazard Areas. In addition, to be considered a High Hazard Area, the area must be used for overnight occupation. Other structures subject to High Hazard conditions do exist within the floodplain. These are primarily commercial use buildings and the proposed recommended measures reflect the high hazard conditions (i.e. were chosen to withstand high hazard conditions). For the scope of this project, the following areas were identified as High Hazard Areas and are considered for flood mitigation:

- Rotary Drive,
- South Bennett Drive,
- Park Place Apartments (collocated with South Bennett Drive and discussed as a part of it)
- Simmons Brook Culvert,
- Fletcher Drive,
- Reservoir Avenue,
- Riverview Terrace,
- Willow Brook Apartments,
- Second Mill Street Bridge,
- Morgan Avenue Bridge,
- Morgan Mill Road Bridge,
- Plainfield Street Bridge,
- Reservoir Avenue Bridge, and
- Garden City Bridge.

The present study is built upon a previous report, “The Pocasset River Watershed Flood Plain Management Study,” released by NRCS in 2007, which identified locations of severe flooding and possible solutions to reduce flooding. The formulation process began with the development of a comprehensive list of flood mitigation options with input from personnel from the Natural Resources Conservation Service (NRCS) National Water Management Center, the NRCS New England Interdisciplinary Resource Technical Team, the NRCS Rhode Island State Engineer, and planning staff from NRCS offices in Rhode Island, New Jersey, and New York. Once the initial list was developed, the potential alternatives were sent for review to the Rhode Island Department of Environmental Management, Rhode Island Emergency Management Agency, United

States Environmental Protection Agency, United States Army Corps of Engineers and the United States Fish and Wildlife Service. Public scoping meetings were held to allow the public to provide input regarding potential alternatives.

Potential flood mitigation options were analyzed at each site for feasibility and effectiveness in meeting the project goals. The following narrative briefly discusses each specific practice considered at the High Hazard Areas and their applicability at each site.

No Action – The No Action Alternative was considered at each site in order to gage the effectiveness of the other alternatives in providing efficient flood protection. The No Action alternative does not meet the project goals of reducing flooding and the associated economic and social impacts.

Buyout and/or Relocation of Affected Properties – The buyout of properties affected by flooding in the project area would allow residents and businesses to avoid the social and economic impacts associated with frequent flooding, thereby addressing by the human health and safety concern as well as some of the economic concerns. The floodplain could potentially be restored to accommodate the flood flows. Buyout of all affected properties was initially considered. However, due to the considerable cost involved (estimated at $110,000,000 using 2006 and 2008 appraisal data for Johnston and Cranston, respectively), this alternative was eliminated from consideration.

Buyout of selected properties was also considered at each site. Flooded property plat and lot information was provided as GIS data by NRCS. Property values for affected properties were obtained from Vision Appraisal Technology Online Databases for Johnston (assessment date 12/31/2006) and Cranston (assessment date 12/31/2008). This alternative included the purchase price of the real estate (structure and land) as well as relocation of affected people. As indicated in Table 6-1 below, buyout of selected properties was found to be feasible at several flood prone sites mainly because of economic considerations. At other locations buyouts were not considered feasible because of the expense of relocation. At the Fletcher Avenue site, populated with many commercial and small industrial businesses, socioeconomic impacts to workers living nearby caused by displaced businesses was considerable.

Table 6-1
Buyout Potential of Properties Affected by Flooding

Site	Property Buyout Feasible?	Number of Buyout Properties / Total Cost	Comments
Rotary Drive	No	NA	Buyout of 19 residential homes not economically feasible – neighborhood sewer service recently installed at considerable cost.
South Bennett Drive	Yes	9 / $2,670,192	Economically favorable to construct floodwall to protect78 apartment units and buyout 9 properties on opposite side of the Pocasset River.
Simmons Brook Culvert	No	NA	Buyout of existing business not economically feasible.
Fletcher Avenue	Yes	1 /$226,184	Many established commercial and small industrial businesses; buyout of one building necessary to accommodate floodwall.
Reservoir Avenue	Yes	2 / $1,629,020	Nursery and one commercial business – buyout would create floodplain and potential recreational fields.
River View Terrace	No	NA	24 apartment units, 54 residences; expensive to relocate families in all affected buildings.
Willowbrook Apartments	No	NA	192 apartment units; expensive to relocate families in all affected buildings.
Dry Flood Proofing (areas of isolated flooding less than 3 feet deep spread throughout the watershed	No	NA	In areas where dry flood proofing (DFP) was considered, flooding not severe enough to warrant buyout; DFP provides flood protection at a much lower cost than buyout.

The physical relocation of buildings was considered at all sites. Unlike property buyout, relocation typically consists of the physical movement of people and personal property (structures) to sites not affected by flooding. Relocation was evaluated and deemed not to be economically feasible at many of the flood prone sites. The cost of moving structures and subsequent acquisition of property is significant.

Floodway – A floodway consists of the stream channel and adjacent overbank areas necessary to effectively convey floodwaters in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. This alternative can reduce unwanted flooding and improve human health and safety concerns related to flooding. Creation of additional channel areas to contain and convey flood flows would require significant tracts of land in strategic locations. The limited amount

of land available for channel work around affected bridges and culverts made them infeasible at all sites. At several locations, property buyouts were required and these were expensive and afforded little benefit according to the computer modeling results.

Wetland Restoration / Creation – Several of the hydrologic and hydraulic model simulations included the creation and restoration of wetland resources to provide flood storage and attenuation functions, which would reduce unwanted flooding and address associated human health and safety concerns. A standard rule of thumb for estimating the storage volume required to have a minimal reduction in flooding is to consider 1 inch over the watershed area; this amounts to 1,100 acre feet of storage. Due to the urban nature of the watershed, the large amount of open land required for even this minimal flood mitigation is not available; therefore this alternative was removed from consideration.

Dam Rehabilitation – Several of the hydrologic and hydraulic model simulations included the rehabilitation of industrial reservoirs constructed during the industrial revolution as a means to reduce unwanted flooding and related human health and safety concerns. During the initial alternative development process, NRCS proposed reconstructing several of these dams into flood storage reservoirs in the affected areas. None of the modeled scenarios provided reduction in damages in the areas of concern; therefore this alternative was removed from consideration.

Sediment Removal / Channel Dredging - Several of the hydrologic and hydraulic model runs included the excavation of the channel bed to assess the possibility of providing additional volumetric capacity within the channel and thereby reducing flood elevations floodplain widths, and addressing the human health and safety concerns tied to the flooding concern. As was anticipated, this alternative did not provide a measurable decrease in flood damages in the affected areas; therefore this alternative was removed from consideration.

Constraint Removal – Certain features of the channel or adjacent structures (i.e., bridge apertures) create limitations to the conveyance of water under certain flow conditions. These constraints can result in higher flood elevations than what would occur if the constraints were removed. However, in some cases, the constraints have little to no impact on the flood elevations due to the overall magnitude of the flood.

A field reconnaissance effort found five potential constraints (4 bridges and 1 culvert) along the Pocasset River. In several instances the modification or removal of these constraining features was evaluated to estimate the impact of each constraint on flood elevations. These evaluations were based on the results of hydraulic modeling with the HEC-RAS model, which included constraint removal. The model simulations were conducted such that these five structures were removed independently of each other, followed by a simulation with all five constraints removed simultaneously. The resulting flood heights were compared to the 100-year flood heights for future build-out conditions

with proposed floodwalls and constraints in place, to assess if constraint removal within the system resulted in a drop of flood height.

The results of the independent analysis are as follows:

- Morgan Avenue Bridge removed: 0.5 ft water level drop upstream to Central Avenue Bridge.
- Morgan Mill Road Culvert removed: 1.9 ft water level drop 400 ft upstream.
- Plainfield Street Bridge removed: 2 ft water level drop upstream to Morgan Mill Road Culvert.
- Reservoir Avenue Bridge removed: 0.6 ft water level drop 4,000 ft upstream.
- Garden City Drive Bridge removed: 2.5 ft water level drop upstream to Reservoir Avenue Bridge.

In the simulation with all five constraints removed, results were unchanged, suggesting that the structures affect water elevations independently of each other. Effects of constraint removal were minimal downstream. Benefits from bridge/culvert modification are low compared to the high cost of bridge/culvert construction and because of this, alternatives involving modifications to the bridges described above were not pursued further.

The field reconnaissance effort also revealed one other potential constraint to river flows. A debris dam was observed near the Pocasset River's confluence with Simmons Brook. The debris dam causes the Pocasset River to be routed out of its channel and into a residential backyard, causing the backyard to be flooded, in wet weather as well as dry weather conditions; removal of the debris dam will restore the river to its channel. Removal of the debris dam was evaluated to be relatively inexpensive and is included in the Recommended Plan.

Dry Floodproofing – Dry floodproofing measures primarily address human health and safety concerns and are generally a combination of adjustments and additions to features of buildings that eliminate or reduce the potential for flood damage by keeping floodwaters out of the structure. A typical example of a dry floodproofing measure is the installation of watertight shields for doors and windows. Dry floodproofing is not permitted by the Federal Emergency Management Agency (FEMA) for new, substantially improved, or damaged residential structures located in the floodplain. Dry floodproofing is generally considered not feasible if floodwaters are expected to rise in excess of 3 feet above the base elevation of a structure because of the large hydrostatic pressure forces.

Dry floodproofing was evaluated at all the sites as a means of providing protection. The most feasible (cost effective) locations were those where only individual homes or small clusters of homes had to be protected outside of areas where collective protection from a floodwall was not available. Dry floodproofing was considered feasible for 23 properties within the project area; 16 in Johnston and 7 in Cranston.

Elevation – Elevation is the lifting of a structure above the flood elevation through the use of piles, piers, posts, or columns as a means of addressing human health and safety concerns. Elevation is a FEMA accepted strategy for substantially improved or damaged residential structures located in the flood plain. Since most of the structures in the project area are constructed with a basement, elevating a structure can be costly. Elevation was considered infeasible for all of the apartment building structures and the commercial/light industrial sites. Topographical features in other areas (steep slopes) made elevation difficult. Elevation of six residential properties in the South Bennett Drive area was considered a cost effective strategy and is included in the Recommended Plan.

Earthen Berm Dike – An earthen berm dike is a physical flood barrier constructed of earthen materials to address flooding and human health and safety concerns. For a typical earthen dike, standard engineering practice recommends a three foot horizontal space to gain one foot in vertical elevation (3:1 slope) as well as a three foot top width. A six-foot height of protection, which is typical in many of the flood prone areas along the Pocasset River, requires an earthen berm that is approximately 39 feet wide (18 ft per side, plus a 3 ft top width). This size requirement coupled with limited available space at potential sites makes earthen berms infeasible at the majority of locations. Earthern berms were considered through the project area to provide collective protection for groups of properties, but were eliminated for further consideration because of the extensive space requirements. Earthen berms were examined for protection of individual homes and deemed feasible at the South Bennet Drive area and included in the recommended alternative.

Floodwalls – A floodwall is a wall built parallel to the river to act as a physical flood barrier to address flooding and human health and safety concerns. Floodwalls are commonly constructed of concrete or steel. Poured concrete floodwalls require significant sub-surface foundations to provide an acceptable base (foundation) to support the floodwall. The extensive excavations and the large size of the foundation coupled with the limited available space at opportunity areas made poured concrete floodwalls infeasible. Steel sheet pile flood walls were considered at each site in order to provide a physical barrier to protect life and property from flood flows. Steel sheet pile walls were considered the most feasible design due to the limited space available to implement flood protection measures. Floodwalls were considered at all project locations where topographic conditions necessitated protection for a large group of properties. Floodwalls were especially feasible at apartment building complexes and other multifamily sites because of cost benefits. Flood walls were deemed the best alternative at seven project sites and range in height from three to nine feet.

- The Recommended Alternative for each project Site was developed from the above flood mitigation alternatives in the following manner:

- At each Site, each of the above flood mitigation measure (including no action) were first analyzed for physical feasibility (the measure could be constructed and if constructed would control flooding)
- If a flood protection measures was deemed feasible for a given Site, it was given a ranking from 0 to 5 (with 5 being the highest) in three categories costs (economic account), human health and safety (social account) and net loss of flood plain (environmental account). The three categories were then summed and the highest ranking alternative chosen as the Recommended Alternative at each Site. The Site rankings for each flood mitigation alternative, along with the rationale for the ranking system used, are displayed in Table 6-2.

The combination of recommended alterative for each project Site is the Recommended Plan. For each project site the Recommended Alternative and the No Action Alternative are evaluated in this Section 6.2. In addition, for South Bennett Drive and Fletcher Avenue, it was deemed important to discuss other alternatives from Table 6-2 because other feasible alternatives similar to the Recommended Plan were developed for these two Sites.

This formulation process resulted in the following alternatives:

- Alternative 1 (Recommended Plan)– Construction of Seven Floodwalls and Other Structural and Non Structural Measures
- Alternative 2 - No Action
- Additional Alternatives at the South Bennett Drive and Fletcher Avenue project areas

The identified alternatives address the Sponsor's objective and satisfy the requirements of P&G. The No Action Alternative is included in accordance with National Environmental Policy Act (NEPA) requirements. The computer simulation models were used to evaluate the effectiveness of Alternative 1 (the recommended alternative) as well as the No Action Alternative (Alternative 2) and the additional alternatives at South Bennett Drive and Fletcher Avenue project areas in the context of a full watershed build-out[1].

A matrix (Table 6-3) was developed to provide a concise comparison in narrative form of Alternative 1, the Recommended (NED) Plan, to the No Action alternative and the additional alternatives at South Bennett Drive and Fletcher Avenue project areas, with respect to certain economic, social, and environmental factors identified in scope.

[1] Full Watershed Build-out assumes that all potentially developable land is developed. This scenario accounts for the ultimate "worst case" flooding condition in the watershed as a result of maximum surfacing and minimum flood storage and flow attenuation capacity.

6.2 Description of Alternative Plans

This section provides a description of the flood mitigation measures to be implemented under Alternative 1, the Recommended (NED) Plan, Alternative 2, the No Build Plan, and the additional alternatives evaluated at the South Bennett Drive and Fletcher Avenue sites. Refer to Section 6.3 and Table 6-X, Summary and Comparison of Alternative Plans, at the end of Section 6 for a comparison of the alternatives.

Alternative 1 (NED Plan) includes the construction of engineered flood walls at the following locations (Figures 9-4, 9-5, 9-9, 9-9A, 9-12, 9-13, and 9-14):

- Rotary Drive
- South Bennett Drive (Park Place Apartments)
- Fletcher Avenue (and Rich Box Company building)
- Reservoir Avenue
- Riverview Terrace
- Willowbrook Apartments

The floodwalls at each of the proposed locations would be engineered to provide flood protection during a 100-year, 24-hour storm event at full build-out. FEMA guidelines require that one foot of "free board," or exposed portion of the wall be included in the design as a safety measure. All of the proposed floodwall designs incorporate FEMA guidance and requirements where practicable.

The NED plan also includes the following measures, shown on Figures 9-5, 9-6, 9-8, 9-9, 9-11, 9-12, and 9-14:

- South Bennett Drive project area structural and non structural measures
- A bypass culvert
- Various non structural measures (debris dam removal, dry floodproofing)

Three additional alternatives were evaluated at the South Bennett Drive project area and one additional alternative was evaluated at the Fletcher Avenue project area.

The following sections provide additional detail of the actions associated with the various alternative plans. In general, the description of each alternative plan is organized by site location.

6.2.1 Rotary Drive

Alternative 1- Recommended Plan

Rotary Drive is a residential neighborhood located upstream of the Morgan Avenue Bridge in Johnston, Rhode Island. Nineteen properties (all single family residences) are located within the 100-year flood plain. Costs associated with flooding in this area are primarily damages to residential property and cleanup. The proposed action will install a steel sheet pile floodwall between 4 and 5 feet above grade. The total length of the floodwall would be approximately 1,500 feet.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

6.2.2 South Bennett Drive (Park Place Apartments)

Alternative 1- Recommended Plan

Park Place Apartments is a large low-income apartment complex located upstream of the Plainfield Street Bridge in Johnston, Rhode Island. The apartment complex is located within the 100-year flood plain and is very close to the Pocasset River. Costs associated with flooding in this area are primarily damages to the apartment complex and cleanup costs. The proposed action seeks to install a steel sheet pile floodwall approximately 3 to 9 feet above grade for a total approximate length of 1,165 feet.

Across the river from Park Place Apartments are River Avenue and River Drive, which is part of a larger, mainly residential development. Nine buildings along River Avenue and River Drive are within the 100-year floodplain and severely affected by flooding on a regular basis. Costs associated with flooding in this area are primarily damages to the buildings and cleanup costs. The proposed action seeks to buyout/demolish 8 homes and 1 business along River Avenue and River Drive, restore floodplain along River Avenue and River Drive, and move families/business to new locations.

See Tables 6-2 and 6-3 for the formulation processed used in developing the alternatives at South Bennett Drive and a narrative description of the major impacts of each alternative.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

Alternative 3 – Removal of Park Place Apartments and Floodwall along River Avenue and River Road

In this alternative a 2,500 foot steel sheet pile floodwall, with an average height of 10 feet above ground surface would be constructed along River Avenue and River Road. In addition, Park Place Apartments would be bought out and demolished, the flood plain restored at Park Place Apartments, and the families living in the apartment complex moved to new locations. See Tables 6-2 and 6-3 for the formulation processed used in developing the alternatives at South Bennett Drive and a narrative description of the major impacts of each alternative.

Alternative 4 – Floodwall at Park Place Apartments and Move all Properties on River Road and River Avenue

In this alternative the floodwall would be constructed at Park Place Apartments as described in Alternative 1 and the buildings along River Avenue and River Drive physically relocated to new locations. In addition, the floodplain at River Drive and River Avenue will be restored as described in Alternative 1. See Tables 6-2 and 6-3 for the formulation processed used in developing the alternatives at South Bennett Drive and a narrative description of the major impacts of each alternative.

Alternative 5 – Floodwall at Park Place Apartments and Floodwall along River Avenue and River Road

In this alternative floodwalls would be constructed along both Park Place Apartments (as described in Alternative 1) and River Drive/River Avenue (as described in Alternative 3). See Tables 6-2 and 6-3 for the formulation processed used in developing the alternatives at South Bennett Drive and a narrative description of the major impacts of each alternative.

6.2.3 Fletcher Avenue

Alternative 1- Recommended Plan

Fletcher Avenue is an industrial/commercial area located downstream of the Plainfield Street Bridge in Cranston, Rhode Island. The Pocasset River causes severe flooding during storm events in this area. Fifty-four properties are within the future 100-year flood plain. Costs associated with flooding in this area are primarily damages to industrial/commercial property, lost wages and sales, and cleanup costs.

The proposed action will install a steel sheet pile floodwall to protect the Fletcher Avenue area. The proposed floodwall will be approximately 5 to 7 feet above grade for a total approximate length of 2,300 feet. One property will be removed to site the floodwall.

In addition, The Rich Box Company is a low lying area located across the Pocasset River from Fletcher Avenue. It is a large industrial mill, which manufactures card board boxes. Costs associated with flooding in this area are commercial property damage, lost sales and wages, and cleanup costs.

To alleviate flooding, an individual steel sheet pile floodwall, approximately 500 feet long, with a height of 7 feet, is recommended.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

Alternative 3 – Floodwall at Fletcher Avenue and no Floodwall at Rich Box Company

This alternative is identical to Alternative 1, except the floodwall at Rich Box Company would not be constructed, which would expose the building to potentially higher surface water elevations. For this reason, Alternative 3 was not chosen. See Table 6-2 for the ranking of this alternative versus the Recommended Plan.

Refer to the Environmental, Economic, and Social Justification Matrix at the end of Section 6 for a comparison of the alternatives.

6.2.4 Reservoir Avenue

Alternative 1- Recommended Plan

Reservoir Avenue is a commercial area located adjacent to the Reservoir Avenue Bridge in Cranston, Rhode Island. Twenty-nine properties are within the future 100-year flood plain in this area. Costs associated with flooding in this area are commercial property damage, lost sales and wages, and cleanup costs.

The installation of steel sheet pile floodwalls is proposed in order to adequately protect properties along Reservoir Avenue. The floodwall will be between 3 and 8 feet above grade for a total approximate length of 1,350 feet. In addition, 18 properties will be purchased to site the floodwall. Most are vacant land or are currently owned by a plant nursery. Following construction of flood protection measures the acquired land is planned to be used as a recreational sports field.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

Refer to the Environmental, Economic, and Social Justification Matrix at the end of Section 6 for a comparison of the alternatives.

6.2.5 Riverview Terrace

Alternative 1- Recommended Plan

Riverview Terrace, including the Davis Court and Autumn Street areas form a large residential neighborhood located approximately 2,100 feet upstream of the Garden City Bridge in Cranston, Rhode Island. Costs associated with flooding in this area are primarily damages to residential property and cleanup. The area is primarily single family housing. Fifty one properties (residential homes and an apartment complex) in this area are located within the 100-year flood plain. In order to adequately provide flood damage protection in this area a steel sheet pile floodwall is proposed. The proposed floodwall will be approximately 9 feet above grade and consist of two sections with a total length of approximately 1,750 feet. This measure includes the relocation of a small tributary that currently flows under the neighborhood through a culvert. This tributary relocation is required to route the stream around the new floodwall. NRCS Channel Modification Guidelines (GM 410.27) will be followed in the planning and design of the realigned channel.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

Refer to the Environmental, Economic, and Social Justification Matrix at the end of Section 6 for a comparison of the alternatives.

6.2.6 Willowbrook Apartments

Alternative 1-Recommended Plan

The Willowbrook Apartments are located approximately 390 feet upstream of the Garden City Bridge in Cranston, Rhode Island. The area is relatively flat, causing a large area to be flooded when the Pocasset flows overtop its banks. Current land use includes high density residential developments and associated landscaping and manicured lawns. There are 13 buildings, containing 156 apartment units within the future 100-year flood plain in this area. Costs associated with flooding in this area are primarily associated with damages to the apartment complex and cleanup costs. In order to adequately provide flood damage protection in this area a steel sheet pile floodwall is proposed. The proposed floodwall will be approximately 7 feet above grade and continue for a total approximate length of 1,100 feet.

Alternative 2 - No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

Refer to the Environmental, Economic, and Social Justification Matrix at the end of Section 6 for a comparison of the alternatives.

6.2.7 Simmons Brook Bypass Culvert

Alternative 1- Recommended Plan

Currently the Simmons Brook runs through a culvert under a mill building near its confluence with the Pocasset River. The culvert is undersized and causes flooding of 4 properties, including the mill building. The proposed remedy for the problem is to construct a bypass culvert that will route high flows around the mill building culvert.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

Refer to the Environmental, Economic, and Social Justification Matrix at the end of Section 6 for a comparison of the alternatives.

6.2.8 South Bennett Drive – Additional Structural and Nonstructural Measures

Alternative 1- Recommended Plan

Aside from the alternatives discussed in Section 6.2.2, additional floodproofing measures were considered for another portion of the South Bennett Drive area. This residential area is "upstream" of the portion discussed in Section 6.2.2, where flooding affects 32 homes. The structural measures for this area will be the raising of 2,200 feet of roadway and the replacement of a culvert that a small tributary of the Pocasset River runs through. Non structural measures will consist of the following:

- Elevation of 6 homes,
- Dry floodproofing of 7 buildings, and
- Earthen dike around 3 homes (including a home on Bingley Terrace, across the Pocasset River from River Avenue).

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

6.2.9 Modification of Atwood Avenue Bridge and Second Mill Street Bridge

Alternative 1- Replace Bridges

The Atwood Avenue Bridge spans the Pocasset River approximately 1.3 miles upstream of the Rotary Drive neighborhood (River Station # 42820.5). The existing culvert configuration is insufficiently sized and promotes frequent flooding during even relatively small precipitation events (2-3 inches of rain). The resulting flooding impacts six structures and Atwood Avenue itself. The bridge is proposed to be reconstructed and the bridge opening enlarged to pass the 100-year, 24-hour design flow, in order to prevent water from backing up behind the bridge. The bridge is owned and maintained by the Rhode Island Department of Transportation. However, economic analysis showed the cost-benefit ratio to be below one; thus the bridge reconstruction was excluded from the Recommended Plan. All reconstruction costs for the bridge will have to be borne by the State of Rhode Island.

In addition, the configuration of the culverts on the Second Mill Street Bridge, located approximately 0.4 miles upstream of the proposed bypass culvert on Simmons Brook (Simmons Brook River Station # 3046) limits the volume of flood flows safely conveyed causing the brook to overtop its banks. The bridge is proposed to be reconstructed and the bridge opening enlarged to pass the design flow, in order to prevent water from backing up behind the bridge. The bridge is owned and maintained by the Town of Johnston. However, economic analysis showed the cost-benefit ratio to be below one; thus the bridge reconstruction was excluded from the Recommended Plan. All reconstruction costs for the bridge will have to be borne by the Sponsor.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes.

6.2.10 Dry Flood Proofing in Low Hazard Areas

Alternative 1- Recommended Plan

Fifteen (15) buildings, 8 in Johnston and 7 in Cranston, that are predicted to have flood elevations between 0 and 3 feet above ground surface will be dry flood proofed using standard NRCS procedures.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes

6.2.11 Confluence of Pocasset River and Simmons Brook

Alternative 1- Recommended Plan

A small debris dam is located near the confluence of the Pocasset River and the Simmons Brook upstream of River Avenue. This debris dam causes the river to migrate outside of its channel into adjacent areas, including residential yards. We recommend this debris dam be removed to restore the River's flow path.

Alternative 2 – No Build

The no build alternative would leave the project area as is and provide for no flood mitigation. Property damages would continue during flooding episodes

6.3 Effects of Alternative Plans

In this section, the effects of the Proposed Action and the No Action Alternatives on the natural and human environment are evaluated. The Proposed Actions will result in the loss of approximately 47 acres of active floodplain as a result of the construction of floodwalls which will increase the bank height and limit the lateral extent of flood flows. The floodplain areas will still exist but be non-functional since they will be obstructed by the floodwalls. Floodwalls will protect adjacent residential, industrial, and commercial property from damages caused by flooding. The areas where these measures are proposed are currently heavily developed and are not considered highly functional floodplains for flood flow attenuation, peak discharge or critical habitat areas. The Proposed Actions will protect life and property along the Pocasset River by remedying flooding in High Hazard Areas of the Pocasset River.

In addition to the impacts described in this section, construction of projects funded under the proposed action alternative in the Pocasset River Watershed Plan would have short-term, minor effects on vegetation, soils, wildlife, noise, traffic, the local economy (jobs), and people in the immediate vicinity of the construction. During the construction phase of each plan measure, best management practices would be used to minimize environmental impacts. These impacts, therefore, are not discussed in detail.

The National Environmental Policy Act (NEPA) requires the federal agency preparing an EIS to evaluate the indirect and cumulative impacts of its proposed action. Indirect impacts are those that are "caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable". Cumulative impacts are those impacts that

result from the proposed project and other known past, present, and future actions in the affected area.

NEPA requires that the indirect (a.k.a. secondary) impacts of the proposed action are disclosed and that these are considered in the agency's decision-making process. Indirect and Cumulative Impacts are discussed below for each resource area as applicable.

6.3.1 Socioeconomics

6.3.1.1 Land Use

The proposed project will provide for continued use of land within the Pocasset River watershed that is chronically flooded. In some portions of the project area, there will be alterations to existing land use. The following is a summary of land use impacts by area.

Rotary Drive

Rotary Drive is a residential neighborhood located upstream of the Morgan Avenue Bridge in Johnston, Rhode Island (Figure 9-4). Nineteen properties (single family residences) are located within the 100-year flood plain. These would be protected by the proposed floodwall in this area. In addition, there is an existing sanitary sewer pump station that would be protected. A proposed detention pond would be located between this pump station and a single family residence in an area that is currently a forest/cleared area used for yard debris.

South Bennett Drive

The proposed project in the vicinity of the Park Place Apartments (Figure 9-5) consists of installing a floodwall on the west side of the river, surrounding the apartment complex on three sides. Park Place Apartments consist of 78 units of low income housing, the lower units of which currently experience flooding.

The construction of the floodwall will occur between the existing paved parking area and the river and will not affect parking at the complex. During construction, however, there will be a temporary displacement of parking that will be accommodated elsewhere on site.

South Bennett Drive and River Drive is a residential neighborhood across the river from Park Place Apartments. Flooding in this area affects 32 single family homes. No floodwalls are proposed in this area, therefore other measures are proposed. The proposed project would result in the removal of eight single family residences, elevation of 6 residences, dry flood proofing of 6 residences and the construction of an earthern dike around one home. The 8 residences to be removed would be converted to open space and would serve as flood storage. The residential character of the neighborhood

would remain.

Fletcher Avenue

The Fletcher Avenue site lies within a depressional area with gentle slopes (Figure 9-9). It is primarily industrial, with large tracts of impervious area. The proposed floodwalls in this area would protect forty three individual structures from flood damage. Also, nine structures would be fitted for dry flood proofing. The two largest structures that would benefit from the floodwalls are the Rich Box Company facility on the north side of the river and a large food processing plant directly across the river. Both experience chronic flooding that severely hampers their business operations. The Rich Box Company facility, which is still used for industrial and office purposes, has been considered for renovation as an apartment/condominium complex.

One commercial structure (daycare center) located immediately adjacent to the river near the Plainfield Pike Bridge would need to be relocated because of the proposed flood wall tie-in. That property would be rendered non-developable due to its lack of size. Therefore it would be considered as open space.

One single family residential structure on the south side of the Pocasset River would be relocated.

A detention basin is provided on the south side of the River to accommodate stormwater runoff from the commercial/industrial area along Fletcher Avenue. This area is currently maintained as lawn (70%), tree row (10%) and parking lot (20%).

Reservoir Avenue

At the Reservoir Avenue site (Figure 9-12), the proposed action would result in the acquisition of properties owned by Forest Hill Nursery and City of Cranston Plat 9 Lots 3497, 3208, and 3455. At this time, NRCS and the two parties mentioned above are discussing the possible purchase of these properties and relocation of the Nursery. After the Nursery is relocated, the current site would be converted to recreation fields. Access to the fields would need to be provided through the floodwall. Three buildings west of the proposed floodwall along Reservoir and Knollwood Avenues would be removed.

This floodwall will protect businesses and seven commercial structures along Reservoir and Knollwood Avenues. One property, City of Cranston Plat 9 Lot 3453 must be acquired to site the flood wall. This property is approximately 10 feet from the river and it is not feasible to protect it from flood water.

A utility easement is present at Reservoir Avenue that will not interfere with construction. The floodwall will be placed completely on one side of the easement.

Riverview Terrace

For the Riverview Terrace neighborhood (including Davis Court and Autumn Street neighborhoods (see Figure 9-13), the construction of a steel sheet pile floodwall, detention basin and pump station collection system would protect a total of fifty residential structures from flooding. Forty seven of the fifty are single family residences and three units are multi-family apartments and condominiums.

Willowbrook Apartments

Within this area (Figure 9-14), the proposed floodwalls along the Willow Brook Apartment complex would protect 13 residential structures and one outbuilding from flooding during the 100-year storm event. There would be 156 dwelling units protected from flooding. Recreational facilities (tennis courts, playgrounds) within the complex would also be protected. The proposed project also calls for dry flood proofing of one commercial structure immediately downstream of the apartment complex.

The erection of a floodwall would occur along the western edge of the perimeter drive/parking area of the apartment complex, therefore there will no effect on parking or traffic movement as a result of the project. However, during construction, a portion of the perimeter drive may need to be closed. This should only affect traffic internal to the apartment complex and not the local roadway system.

Simmons Brook Bypass Culvert

This area consists primarily of industrial land use, including a mill building (Figure 9-6). Currently the Simmons Brook runs through a culvert under a mill building near its confluence with the Pocasset River. The culvert is undersized and causes flooding of four properties, including the mill building. Construction of a bypass culvert that will route high flows around the mill building culvert will protect four industrial properties in this area. The new culvert will be located underneath an existing parking lot for an industrial business. During construction, there will be a temporary loss of parking. However, ample parking exists on site to accommodate parking needs in the short term.

Prime Farmland Soils

There are no viable prime farmland soils or active farms that would be impacted by the proposed project. All floodplain areas that are to be alleviated from flooding are developed for residential, commercial or industrial uses except for the Forest Hill Nursery in the Reservoir Avenue area. This business consists of greenhouse and a small outdoor tree/shrub storage area. No in-soil crops are produced there. The conversion of this property to recreational fields would not impact prime farmland soils.

No Action Alternative

The No Action alternative would not result in any land use changes in the corridor. However, flooding of residential, industrial and commercial properties would continue which, in the long term, could result in some of the buildings being vacated (particularly those commercial and industrial-leased buildings). The No Action alternative will have no impact on prime farmland soils or farmlands.

Indirect and Cumulative Impacts

In general, the flood-protected land may become more attractive to development because the chronic incidents of flooding have been reduced. Land use changes may result in areas that are newly protected from flooding.

Reconstruction of the Atwood Avenue Bridge and the Second Mill Street Bridge are not part of the proposed project, however they need to be considered because the Rhode Island Department of Transportation and the Town of Johnston propose to upgrade these bridges, respectively. The reconstruction of these bridges will help to alleviate flooding at ten commercial/industrial structures in the immediate areas. No changes to existing land use are proposed.

6.3.1.2 Demographics/Environmental Justice

In compliance with Executive Order 12989, impacts to low-income or minority populations as a result of this project have been assessed. Socioeconomic data from Table 3-2 is used herein to support the conclusions of this Environmental Justice analysis.

The proposed project is located in the City of Cranston, and the Town of Johnston. The percentage of minority individuals living within these two communities is lower than the percentage of minority individuals living within the nation, state, and county. The percentage of both families and individuals living below the poverty line are below the percentages of individuals and families living below the poverty line within the nation, state, and county.

Portions of the project implemented within the City of Providence and Providence County, Rhode Island will affect a higher percentage of non-white persons, persons of Hispanic origin, and persons below the poverty line than the percentages as a whole within Rhode Island and the Country. However, the proposed projects would actually have a net positive impact on the populations within the project area because of reduced flooding and property damage.

Indirect and Cumulative Impacts

The reconstruction of the Atwood Avenue Bridge and the Second Mill Street Bridge will help to alleviate flooding at ten commercial/industrial structures in the immediate areas. These cumulative actions would all have a positive impact on the community by reducing flooding and associated property damage.

6.3.1.3 Economics

Proposed Action Alternative

The proposed project will have considerable long term direct economic benefits for the Sponsor; average annual flood damages in the project area will be reduced by approximately 68%. This will greatly reduce the economic burden of flooding on property owners and the Sponsor. In addition, the proposed project will have long term indirect economic benefits, including a reduction in hours lost by business and wages lost by workers due to flooding, increased property values within flood zones, and economic benefits from utilization of land formerly inundated periodically by flooding.

Also, time and monetary resources spent by local emergency organizations (fire, police, ambulance) would be lessened as the frequency and severity of flooding would decrease.

Controlling floods of the Pocasset River may contribute to improving the standard of living in the area. Property values, which may have been diminished due to frequent flooding, may increase as flooding becomes less frequent and severe. Costs will not have to be paid for property damage, loss of personal items, and clean up. In addition, local government costs can be expected to decrease due to a reduction in flood damages to roadways and bridges.

No Action Alternative

Under the No Action Alternative severe flooding will continue to occur in the watershed. Damages will continue to occur and burden property owners and the Sponsor. If development in the watershed increases, as it has in recent years, flooding will become more frequent and more severe, potentially increasing long term flood damage costs as outlined in Table 6-4.

Table 6-4: Damage Cost Estimates With and Without Project

Item	Average Annual Damage				Damage Reduction Benefits			
	Without Project		With Project		Without Project		With Project	
	Agricultural Related[3]	Non Agricultural Related	Agricultural Related[3]	Non Agricultural Related	Agricultural Related[3]	Non Agricultural Related	Agricultural Related[3]	Non Agricultural Related
Residential	1,105,550	419,920	70,340	109,400	0	0	1,035,210	310,520
Commercial	123,950	425,160	15,020	22,670	0	0	108,930	402,490
Totals	1,229,500	845,080	85,360	132,070	0	0	1,144,140	713,010

1. Price base 2007
2. Road and bridge damages were not evaluated
3. Agricultural related damage include damages to rural communities.

6.3.2 Public Health and Safety

Proposed Action Alternative

Approximately 681 people will be relocated from high hazard areas. Additionally approximately 275 people will be relocated from less severe flooding. This will reduce the threat to human health and safety (both direct and indirect) posed by flooding. Direct threats include physical harm due to flood waters, building damages, etc., while indirect threats include mold growth due to periodic flooding of buildings and contact with floodwaters contaminated by flooded septic systems, cemeteries, etc. The proposed project will allow egress from homes during flood events and will allow access of emergency vehicles to formerly flood prone areas during flood events. Indirectly, property owners will worry less about impending flood events. Approximately 25 residents will be removed from their homes; however they will be provided fair market value for the property, will be offered relocation payments, and will be allowed to find a home outside of the Pocasset River floodplain. This is considered an overall benefit, i.e. the inconvenience of moving is out weighted by the benefits of relocation to a home outside of a flood plain.

No Action Alternative

Under the No Action Alternative severe flooding will continue to occur in the watershed and continue to pose a threat to human life (directly and indirectly) and continue to limit egress and emergency vehicle access to flood prone areas during flood events. The potential for increase in flooding frequency and severity in the future may increase the future threat to human health and safety.

6.3.3 Aesthetic Considerations

Along the banks of the Pocasset River lie residential areas which are closely located along the river corridor. In certain cases, views and access to the corridor is a significant visual component of the landscape which surrounds the dwellings. In some instances, the river corridor isn't visible due to overgrown, dense vegetation. The implementation of necessary flood control measures along these areas will likely have a visual impact to the areas surrounding the river corridor. This visual impact is outweighed by the benefits provided by protecting the homes and property from future flood damages.

Residential Areas

The visual impact of flood walls near residential areas varies from minor to great. In some cases the corrugated sheet pile-driven steel walls will only be 4 feet tall. In other instances the walls may be up to 9 feet in height. Location-specific design measures will need to be taken in order to lessen the visual impact. These design measures include: earthen berms constructed along the landside edge of the wall which partially cover the face of the wall, shrub plantings and hedges, and painting of the walls in neutral colors which will compliment the surroundings.

There are three apartment complexes and one area with single family detached homes that will see visual impacts by the proposed floodwalls.

At Willowbrook Apartments the watercourse is located approximately 20 feet away from the roadway in the rear of the apartment complex. The river channel is shaded by trees and views of the water are limited due to the existing shrub and tree growth. The proposed floodwall in this area will be up to 7 feet in height. The floodwall would be painted a neutral color of cream to match the apartments and may be flanked by an earthen berm along the landside edge. Plantings with evergreen shrubs may also be incorporated to deflect views of the wall.

At the Riverview Terrace Apartments the River is located approximately within thirty feet of parking spaces and buildings. A grass covered lawn with shrub and tree plantings extends from the parking area to banks of the river. The apartment buildings have a contemporary architectural style and are painted in a cream color. It is necessary for the floodwalls to be up to 9 feet tall in this area. The proposed floodwall will be painted in a color which complements the Riverview Terrace Apartments. Landscaping along the flood wall will also be provided.

The Park Place Apartments have a heavily vegetated visual buffer along the river bank. During the summer when vegetation is thick, the river is not visible from within the apartment complex. The proposed floodwall shall run along the perimeter of the parking area and along the back sides of the tenements. The floodwall shall extend up to 9 feet in certain areas. The apartment buildings currently are painted in a brown color. The

proposed floodwalls shall be painted in a neutral color to compliment the color of the apartments. An earthen berm and landscaping shall also be installed at the time of floodwall construction. Figures 6-1a and 6-1b show the proposed floodwall at Park Place Apartments (without and with floodwall). A low earthen berm covered with grass is placed along the landside edge of the wall for additional structural support.

The Rotary Drive area consists of single family homes and the floodwall may be visible from these homes. Therefore the floodwalls will be painted with a neutral color that is appropriate for the area.

Industrial Areas

At the former Pocasset Mill, now Rich Box Company, a different floodwall treatment is proposed, as shown on Figures 6-2a and 6-2b (without and with floodwall). The 19th century four-story brick building retains a glimpse of the area's industrial history with its large arched windows and granite window sills. The river is approximately 50 feet away from the side of the building. A dense vegetative buffer separates the paved drive from the river and views of the water are very limited. A 7 to 9 foot tall floodwall is proposed to be put in place along the back of the Rich Box property. The floodwall shall be a sheet pile-driven steel wall with a brick veneer façade. The color of the brick and its shape shall match that of the former mill building. A wall cap of either granite or concrete shall run along the top edge of the floodwall to match the building's windowsills.

At the Fletcher Avenue industrial area the proposed flood wall shall be constructed of the same corrugated, sheet pile-driven steel, but shall remain the natural color of steel. The steel will eventually rust until its turns a rusty orange color.

Commercial Areas

At the commercial area along Reservoir Avenue it is proposed to have a 3 to 8 foot tall floodwall. The floodwall shall follow the outer edge of the property. It is proposed to leave the sheet pile-driven, corrugated steel wall to remain the color of natural steel. Landscaping may be added to soften the appearance of the steel wall.

No Action Alternative

The No Action alternative would encompass no floodwall construction and, therefore, no potential for visual impacts to residential and historic areas of the River corridor. However, negative visual impacts do occur on a temporary basis as a result of flood damage to buildings and other structures.

6.3.4 Cultural Resources

The Rhode Island Historical Preservation and Heritage Commission (HPHC) was contacted to provide information on historic structures in the project areas. The Town of Johnston and the City of Cranston were also contacted. The Rich Box Company facility was identified as a property eligible for listing on the National Register of Historic Places. Due to the historic nature of the Rich Box Company building, the wall will be faced with architectural brick in order to match the exterior of the building.

In addition, HPCH, in its May 12, 2009 letter (Appendix C), also stated that there is one site with potential Native American resources; an archaeologist will be onsite during excavation at this site to ensure potential Native American resources are not disturbed.

No Action Alternative

The No Action alternative would leave conditions at the Rich Box Company and the potential Native American resource site as is. Therefore no cultural impacts would occur.

6.3.5 Climate and Air Quality

Proposed Action Alternative

The proposed Project was evaluated under the Clean Air Act General Conformity Rule. Compliance with the General Conformity Rule requires that direct and indirect emissions, including construction activities, be addressed. Under the General Conformity Rule, a project is not required to perform a conformity determination if the increase in emissions due to the proposed project is less than the *de minimus* thresholds contained in the Federal Code 40 CFR Part 93 Subpart B. The State of Rhode Island is currently designated as a moderate non-attainment area for the 8-hour ozone national ambient air quality standard. For areas of moderate ozone non-attainment, the *de minimus* threshold for nitrogen oxides (NO_X) is 100 tons per year while the threshold for volatile organic compounds (VOCs) is 50 tons per year. These criteria pollutants are contributors to the formation of ground-level ozone.

The Conformity Assessment included NO_X and VOC emissions from on-site construction activity, construction vehicles traveling to and from the site on local roadways, construction vehicle material loading and unloading on-site and employees commuting to and from the site. Project Year 2 was determined to be the worst-case construction year and included three construction projects: Fletcher Avenue Flood Wall Construction Project, Park Place Apartments Flood Wall Construction Project and South Bennett Drive Structural Measures Construction Project. In addition to construction activities, emissions from the operation of proposed Pump Stations (scheduled for start-up in Project Year 3) utilizing emergency generators for back-up power were also included in the Conformity Assessment. As a conservative emissions estimate, it was assumed that

operational emissions would occur in Project Year 2 to coincide with the worst-case construction year. Although actual generator operation was assumed to be no more than 96 hours total for eight 30 kW Caterpillar emergency generators, as a conservative estimate, operational emissions were based on potential emissions from running the emergency generators for an entire year. Finally, emissions of CO, SO_2, PM_{10} and $PM_{2.5}$ were assessed to address the NEPA requirement to disclose all project-related impacts. Particulate emissions included construction activity that results in the generation of fugitive dust emissions on-site.

For each of the three construction projects in Project Year 2, annual air emissions were estimated using construction equipment activity data provided for each project. Data included construction equipment types, engine sizes, usage factors and project duration and hours of daily operation for each equipment type. For on-site construction equipment, emission factors were obtained from U.S. EPA's NONROAD2008 emission factor program and EPA's AP-42 emission factor document. Construction vehicle emissions on local roadways and on-site loading/unloading activities were estimated using emission factors obtained from EPA's MOBILE6.2 emission factor program. Fugitive dust emissions were estimated using construction activity data and emission factors obtained from AP-42. As a conservative estimate, all on-site construction equipment emissions were calculated using uncontrolled emission factors. Finally, operational emissions were estimated using equipment data and emission factors obtained from the manufacturer with the exception of SO_2 emission factors which were obtained from AP-42. Detailed emissions calculations, including equipment data and emission factors, can be found in Appendix F.

The results of the Conformity Assessment are presented in Table 6-5. The table also presents all other criteria pollutant emissions generated by the project as required by NEPA. As shown in Table 6-4, project-wide NO_X emissions were conservatively estimated to be approximately 33 tons per year while VOC emissions were determined to be about 2 tons per year. These overly conservative estimates are below the *de minimus* thresholds for NO_X (100 tons per year) and VOC (50 tons per year) and, therefore, the General Conformity Rule does not apply to this project. As a result, no further evaluation of General Conformity is required.

Table 6-5
Project-Wide Air Emissions Summary.

Item	Emissions (tons per year)					
	NO_X	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$
Fletcher Avenue Flood Wall Construction Project						
- Construction Emissions	5.462	0.550	2.716	0.569	0.356	0.356
- Fugitive Emissions	-	-	-	-	1.500	0.225
Fletcher Avenue Total	**5.462**	**0.550**	**2.716**	**0.569**	**1.856**	**0.581**
Park Place Apartments Flood Wall Construction Project						
- Construction Emissions	2.428	0.250	1.278	0.258	0.160	0.159
- Fugitive Emissions	-	-	-	-	0.750	0.113
Park Place Total	**2.428**	**0.250**	**1.278**	**0.258**	**0.910**	**0.272**
South Bennet Drive Structural Measures Construction Project						
- Construction Emissions	4.055	0.478	2.489	0.456	0.280	0.278
- Fugitive Emissions	-	-	-	-	0.900	0.135
South Bennet Drive Total	**4.055**	**0.478**	**2.489**	**0.456**	**1.180**	**0.413**
Operational Emissions (Project-wide)	**21.094**	**0.350**	**3.030**	**3.898**	**1.255**	**1.255**
Project-wide Total	**33.039**	**1.627**	**9.513**	**5.181**	**5.200**	**2.520**
Conformity Determination						
De Minimus Limit	**100**	**50**	**-**	**-**	**-**	**-**
Exceed De Minimus Limit?	**NO**	**NO**	**-**	**-**	**-**	**-**

Note:
As a conservative estimate, operational emissions were assumed to occur in the same year as the worst-case construction year.

No Action Alternative

None of the proposed construction projects would occur under the No Action Alternative; thus there would be no construction-related air emissions and no change in air quality.

6.3.6 Topography, Geology, and Soils

Proposed Action Alternative

The proposed action will have little impact on the overall topography of the watershed. Minimal changes to grades will result from installation of the sheet pile floodwalls. The most significant changes to topography will occur at River Drive, in the South Bennett Drive project area. Several homes will be removed and the channel's floodplain will be expanded into the area of the removed buildings. A retaining wall will likely be required along the western edge of River Drive. A portion of River Drive and South Bennett Drive will be elevated by 2 to 5 feet and several homes will be raised.

The soils at the locations of the proposed flood walls may be reworked slightly during installation of the flood walls and surrounding grading. At River Drive, soils removed to

expand the floodplain may be utilized for elevating the nearby sections of River Drive and South Bennett Drive if they are determined to be suitable for use as structural fill. Otherwise, they will have to be relocated or disposed of in accordance with local, state, and federal regulations, and fill materials will have to be imported from off site. Potential construction impacts include the disturbance of soils by equipment and erosion of disturbed soils by stormwater runoff or river flows. Construction site sediment and erosion controls will be employed to minimize soil erosion.

Prime Farmland and State-wide Important soils located adjacent to the river channels may be impacted minimally by some reworking of the soils during installation of the floodwalls. The presence of the floodwalls will result in protection of some of the existing Prime Farmland and State-wide Important soils by reducing future development of those areas behind the floodwalls.

No Action Alternative

Under the No Action alternative, impacts to soils as a result of construction for sheet pile installation and changes to grading will not occur. Current soil erosion impacts as a result of flood flows will continue.

6.3.6.1 Highly Erodible Land and Swampbuster

These programs are not relevant in the watershed, thus neither the Proposed Action or the No Action Alternatives will result in impacts.

6.3.7 Water Resources

6.3.7.1 Surface Water

Water Quantity

Proposed Action Alternative

The measures proposed in the Recommended Plan will not result in any major changes to the surface water elevations or discharge flows. As shown in Table-6-6, surface water elevations remain approximately the same for the proposed alternative, when compared to without project conditions. In two instances, significant water surface elevation changes occur due to the proposed alternative:

- Along the proposed Fletcher Avenue floodwall, water surface elevations increase up to 3-feet due to the Pocasset River being constricted, because of the proposed Rich Box floodwall on the opposite side of the river and the existing north bank of the river, which is largely manmade. However, the floodwall heights at Fletcher Avenue and Rich Box have been adjusted for this increase; upstream and

downstream impacts on water surface elevations are negligible.

- Along the proposed Reservoir Avenue floodwall, water surface elevations increase up to approximately 1-foot; this increase continues upstream of the floodwall, with the increase in water surface elevations becoming negligible approximately 3,300 feet upstream of the northern end of the floodwall. Note that a building is located in the HEC-RAS model at river stations 10135.42 and 10279.39 which may be impacted by this increase; these structures have been identified as two residential structures, 27 and 37 Tudor Street in Cranston and the impacts to these two properties should be examined in detail during the design phase.

Water surface elevation increases due to the Recommended Plan outside of the two areas discussed above are considered to be minor and insignificant, i.e. on the order of a few tenths of a foot.

No dams will be altered as part of the Recommended Plan.

Table 6-6
Predicted Water Surface Elevations and Discharges in the Pocasset River Under Watershed Build-Out Without and With Flood Mitigation (100-year, 24-hour, Type III).

Location	River Station Number (approximate)	Without Flood Mitigation[1]		With Flood Mitigation	
		Elevation (ft)*	Discharge (cfs)	Elevation (ft)*	Discharge (cfs)
Atwood	42821	126.1	1027	126.1	1027
Rotary	36014	99.4	1264	99.4	1234
Morgan St.	34741	98.4	1264	98.4	1234
Morgan Mill	33451	87.4	1470	87.4	1522
Bennett/Melody	32739	85.3	1549	85.3	1582
Park Place	32739	85.3	1549	85.3	1582
Plainfield Pike	29781	84.3	2419	84.1	2443
Reservoir Ave.	7732	31.4	2415	31.4	2334
Willowbrook	2896	26.8	2370	26.8	2360
Garden City	1609	26.7	2271	26.7	2360

*Elevations are in NAVD 88.
[1]Source: Table 2.5 of the Flood Plain Management Study Technical Report (NRCS, 2007)

No Action Alternative

The No Action Alternative assumes that nothing is performed to address current or future flooding issues within the Pocasset River watershed. Under the No Action Alternative, severe flooding will continue to occur in the watershed. If development in the watershed increases, as it has in recent years, flooding will become more frequent and more severe. As indicated by Table 3-3 in Section 3.7.1, full build out of the watershed will result in increases in the water surface elevation by approximately one foot, with a potential increase of about 3.5 feet at Plainfield Pike, during the 100-year, 24-hour duration storm

event. These increases may result in an expansion of the area impacted by flooding, with new properties being affected.

Indirect and Cumulative Impacts

Water surface elevations outside the areas to be protected would remain the same or increase slightly. Computer modeling of the proposed action indicates that such increases would be relatively small and limited to areas that are not developed (forest, lawn, etc). Slight increases (a few tenths of a foot) in flood elevations should not hinder use of the affected land. Two areas would see substantial increases in surface water elevations due to the proposed project. At Fletcher Avenue the increase is limited to areas adjacent to flood mitigation structures and the structure designs take the surface water elevation increase into account. At Reservoir Avenue, a surface water elevation increase of up to 1 foot continues approximately 3,300 feet upstream. Two residential structures, 27 and 37 Tudor Street, may be impacted by this increase. Impacts to these two properties will be examined in detail during the design phase. Impacts may include damage to structures and usability of the backyards. Other impacts upstream of Reservoir Avenue where surface water increases are predicted should be limited to areas that are not developed (forest, lawn, etc) and should not hinder use of the affected land.

The reconstruction of the Atwood Avenue Bridge and Second Mill Street Bridge will help to alleviate flooding at ten commercial/industrial structures in the immediate areas. The two bridge reconstruction projects would result in improved hydraulics of the River and improved road conditions. The improved hydraulics are integral to the success of the other flood mitigation efforts proposed as part of this project.

Water Quality

Proposed Action Alternative

Flood prevention in the Pocasset River watershed should have a positive effect on water quality in the Pocasset River. Proposed stormwater controls will include water quality best management practices. Fewer episodes of high water and flooding will prevent bacterial contamination from the flooding of individual sewage disposal systems and sewage backups; approximately 50 individual sewage disposal systems are estimated to be located within the 100 year flood plain Reduced flooding will also decrease the amounts of sediments and debris washed into the river from adjacent residential, commercial, and industrial areas. This will contribute to the improvement of the water quality of the Pocasset River, which has been placed on Rhode Island's 2008 List of Impaired Waters for bacteria (fecal coliform) and dissolved lead.

No Action Alternative

The No Action Alternative will do nothing to improve the water quality of the Pocasset

River. The river has exhibited bacteria levels that exceeded the primary contact recreation and swimming criteria, and exceedences of total copper and total lead criteria and elevated nitrate levels. Continued flooding will result in harmful water quality impacts to the Pocasset River and downstream areas from bacterial contamination due to sewage backups and the washing of pollutants from developed areas into the river by floodwaters.

6.3.7.2 Groundwater

Proposed Action Alternative

Groundwater conditions in the areas of the proposed floodwalls will be evaluated during the design phase once detailed subsurface information is available at each project area. The potential exists for limited groundwater mounding on the upstream sides of the steel sheet pile floodwalls; however the proposed underdrains on the upstream side of the floodwalls should mitigate this impact. Impacts to river inflow from groundwater due to the sheet pile walls is deemed to be negligible. Vibration during sheet pile installation is unlikely to impact local wells. The proposed action will likely have little impact on groundwater quality.

No Action Alternative

The No Action Alternative will not result in any significant impacts to groundwater conditions or quality.

6.3.7.3 Wetlands and Floodplains

Proposed Action Alternative

As stated earlier the proposed project sites are urbanized. Permanent impacts to wetlands from project measures will be limited, except for the Riverview Terrace area, as discussed below. Flood walls and other plan measures are proposed outside of wetlands; however some are proposed within the jurisdictional buffer zone of water bodies, including the Pocasset River. However these buffer zones are primarily within urbanized areas and the loss of vegetated buffer zones would be minimal. In-stream work will have minor short term impacts to wetlands; any wetlands disturbed during these activities will be restored upon the completion of work.

In areas where buildings will be removed, the former foot prints will be restored to natural floodplain; approximately 5 acres of wetland/vegetated flood plain area is expected to be created in this manner.

The installation of floodwalls throughout the various problems areas would result in areas that are currently designated as floodplain to no longer being floodplain. This is a

necessary consequence of correcting flooding problems and protecting property. Floodplains that are also wetlands and floodplains that are used for agriculture rely on periodic flooding events for nourishment. However, the floodplains within the project area are all urbanized areas and the floodplains only functions as reservoirs for flood waters.

Table 6-7 depicts the approximate acreage and land use of the lost floodplain by area.

Table 6-7
Urban Floodplain Lost as a Result of the Proposed Project.

Site	Urban Floodplain Acreage Lost (acres)*	Current Land Use
Rotary Drive	2	Medium density single family residential
Park Place Apartments	1	Multifamily residential
South Bennett Drive	5	Medium density single family residential
Fletcher Avenue	20	Industrial, commercial
Reservoir Avenue	4	Commercial
Riverview Terrace	10	Medium density single family residential
Willowbrook Apartments	5	Multifamily residential
TOTAL	47	

* Areas within 100-year floodplain as defined by FEMA

The land that is currently occupied by homes in the South Bennett Drive area (River Drive) and within the 100-year floodplain would be demolished thereby offering the opportunity for approximately five acres of floodplain wetland reclamation. This area, currently maintained as lawn would be regraded (lowered) and planted with wetland vegetation appropriate for the hydrologic regime and soil conditions of the area. Detailed plans will be prepared during the design stage of the project.

No Action Alternative

None of the proposed projects would occur, hence, there would be no effect to wetlands.

Indirect and Cumulative Impacts

A portion of the existing unnamed tributary to the Pocasset River near Fordson Avenue is proposed to be relocated as part of a separate federally-funded project. Nevertheless, the stream relocation is integral to the correction of flooding problems in this area, therefore its impacts are considered in this report.

Approximately 400 feet of stream would be relocated to the southwest to join with the Pocasset River (Figure 9-11). Currently, the unnamed stream enters the Fordson Avenue residential area through piping that eventually outlets to the Pocasset River. The stream

would still outlet to the River, but further to the north. The relocated stream would be an open channel approximately 900 feet in length. Details of the stream geometry, hydraulics and associated wetland mitigation will be provided at a later date during the design/permitting phase of that project. Initial meetings have been held with RIDEM to discuss this proposal. In summary, approximately 400 feet of stream would be replaced by 900 feet of new stream within an open channel.

6.3.8 Utilities

Proposed Action Alternative

The installation of the proposed floodwalls has the potential to interfere with underground utilities. At the Riverview Terrace project area, it may be necessary for the floodwall to cross existing sewer lines in at least two locations. The proposed floodwall at Reservoir Avenue may cross two water mains. A utility easement is present at Reservoir Avenue that will not interfere with construction. The floodwall will be placed completely along one side of the utility easement. The impacts to any underground utility lines will depend on their depths relative to the depth of penetration of the sheet piles and associated features.

The layouts and depths of underground utilities will be surveyed at each project site and indicated on the design plans for construction of the sheet pile floodwalls. The placement of the floodwalls will be planned to avoid interference with underground utilities to the maximum extent practical. In locations where interference cannot be avoided, the design plans will incorporate mitigation strategies. Rhode Island Dig Safe will be contacted prior to construction to confirm the presence of utilities within the construction areas.

Proposed floodwalls will disconnect certain areas of the watershed from the main stream channels and improper drainage controls could flood areas protected by floodwalls. A pump station collection system or a floodwall runoff collection system is proposed behind each floodwall. In many cases these systems include storage and diversion chambers (either above or below ground) to limit the size of the pump stations or diversion of upstream runoff away from floodwalls. In critical areas, emergency back-up generators are recommended along with motorized outlet gates. The intent is to allow for natural drainage to the river during normal conditions and pumping during flood stage. These systems are an integral part of the floodwalls and part of floodwall installation. The nature of these floodwall and stormwater systems will require regular inspection and maintenance programs. Such maintenance will be required to insure that floodways remain clear and pumps and mechanical systems are operational.

The following is a description of the proposed stormwater collection system behind the floodwall at each site.

Rotary Drive

It will be necessary to divert the drainage from an existing local subdrain system to a new collection basin. The pump station collection system will consist of:

- One berm along the inland side of the floodwall.
- Three outfalls with suitable flaps or motorized gates (flap or motorized gates prevent flood waters from backing up through the floodwall).
- One detention basin with an integrated collection swale to Rotary Drive.
- A drain line along the inside of the floodwall.
- One 3,800 gpm pump station with emergency generator (to pump runoff over/through the wall when the Pocasset is at flood stage, generators are provided for back up power in the event of a power failure).

South Bennett Drive

Roadway pavement modifications at the entrance to Park Street will be necessary to prevent drainage from the upland area west of Atwood Avenue from flowing down Park Street towards the floodwall. Additional roadway pavement modifications will be required at the driveway intersection at the entrance to the Park Place apartments to prevent runoff from draining into the apartment parking area. These pavement modifications consist of raising the pavement elevation to create a gentle diversion berm across the width of the roadway. A new drainage swale is to be placed leading from the entrance area along the western side of the extended floodwall to divert upland runoff. The pump station collection system will consist of:

- One drainage swale along the inland side of the floodwall and collection basin.
- One outfall with flap or motorized gates.
- Roof drains to the collection system.
- A drain line along the inside of the floodwall.
- One 8,000 gpm pump station with emergency generator.

The 36-inch tributary culvert in the South Bennett Drive neighborhood will be expanded to a 3-foot by 10-foot concrete box culvert, sized to accommodate 700 cfs. Any stormdrains discharging to this culvert will be located prior to construction and maintained.

Fletcher Avenue

The floodwall runoff collection system at Fletcher Avenue, for the south side of the river, will consist of:

- Five pipes with flap gates to convey the small tributary and storm water through the floodwall.
- One detention pond.
- One storage swale along the inside of the floodwall.
- A drain line along portions of the inside of the floodwall.
- A back up 8,000 gpm pump station and emergency generator.

On the north side of the river, at the Rich Box site, a drainage swale will be required along the inland side of the wall and roadway modifications will be required at the entrance to the parking area along Pocasset Street to direct stormwater away. An access point will be required to allow for maintenance and cleaning of the constricted riverbed between the Fletcher Avenue and Rich Box floodwalls. The floodwall runoff collection system will consist of:

- One pipe outfall with suitable flap gate or motorized gate to convey the storm water through the floodwall.
- One berm along the inside of the floodwall.
- One collection basin integrated into the drainage swale.
- One drain line along portions of the inside of the floodwall.
- One diversion chamber and 11,000 gpm pump station.

Reservoir Avenue

A detention basin will be constructed on the inland side of the floodwall to collect run off from the Reservoir Avenue area. In order for the basin to function properly, a 60 foot section of Knollwood Avenue will need to be regraded to drain into this basin. The proposed pump station collection system behind the floodwall will be composed of:

- One berm along the inland side of the floodwall.
- One drain line along the inside of the floodwall.
- One detention basin integrated into the roadway (to ensure the roadway drains to the detention basin).
- One outfall with suitable flap or duck motorized gate.
- One diversion chamber and 4,000 gallon pump station with emergency generator.

Riverview Terrace

The large drainage area that drains into the site at Riverview Terrace necessitates construction of a large detention basin to store the peak storm runoff. Two pump stations will also be located within the area to ensure that storm drainage does not contribute to flooding. The proposed collection system behind the wall will be composed of:

- One large detention basin to be located in the area of Fordson Avenue.
- One discharge outfall from the basin to the river in vicinity of the existing drainage culvert.
- One diversion chamber and a 8,000 gpm pump station located within the large detention basin.
- One small collection basin located central to the parking area of the Riverview Terrace parking lots along with two 250 gpm pump stations.
- Three emergency generators, one to power each pump station.
- Three outfalls with suitable flaps or motorized gates.
- Removal or abandonment of the drainage culvert currently flowing under the neighborhood.

It is anticipated that prior to implementation of the Recommended Plan, the stream culvert under the neighborhood will be relocated and the culvert abandoned, so that the tributary flows in a southerly direction toward the Pocasset River and will not have to intersect the floodwall.

Willow Brook Apartments

At Willow Brook Apartments, the proposed pump station collection system behind the wall will be composed of:

- One drainage swale located along the inland side of the floodwall to catch overland surface runoff.
- One collection basin located at the central point of the swale exiting to a diversion chamber.
- Five pump diversion chambers to collect gravity stormwater flow.
- Five 8,000 gpm pump stations with emergency generators.
- Five outfalls with a suitable flap or motorized gate.

No Action Alternative

None of the proposed floodwall projects would occur under the No Action Alternative and existing utilities and drainage patterns would remain unchanged. Without flood protection, flooding of developed areas will continue with a possible increase in frequency and magnitude. Frequent repair of damaged utilities as a result of flooding will continue to be required. Sewage backups, loss of potable water, power outages, and loss of other services will continue on a regular basis.

6.3.9 Wildlife / Threatened and Endangered Species

6.3.9.1 Fish Habitat and Wildlife Habitat

Proposed Action Alternative

Currently the proposed project sites are highly urbanized and therefore impacts to fish and wildlife habitat would be minimal if the proposed action alternative is implemented. Wildlife of many taxa (small mammals, large mammals, amphibians, reptiles) have unique and varying habitat and spatial requirements. Some, such as amphibians, usually require an aquatic environment and an adjacent upland environment to fulfill their full seasonal and life cycle requirements. Placement of a barrier, such as a floodwall near the aquatic system (Pocasset River) may inhibit horizontal wildlife movement in the various project areas where floodwalls are proposed. However, the habitat adjacent to the River in these areas is highly developed and does not offer significant habitat for wildlife, except for typical urban species that are well adapted to these conditions (e.g. skunk, raccoon, squirrel).

Approximately five acres of the existing residential area on River Drive in the South Bennett Drive area will reclaimed as floodplain wetland which will increase the wildlife habitat potential of the River corridor in this area.

In-stream work will be limited to clearing a debris dam and demolition of one old railroad bridge, which limits potential impacts to fish. Fish will not be significantly impacted by the proposed project. There will be slight increases in floodwater velocities, but fish should be capable of thriving under these conditions. The floodwalls will be located outside of the streams. During construction, erosion control devices will be installed immediately downgradient of the floodwalls to prevent soil from being eroded and transported into the River.

No Action Alternative

None of the proposed projects would occur; thus fish and wildlife habitat would remain unchanged.

6.3.9.2 Threatened and Endangered Species

Proposed Action Alternative

According to the Rhode Island Natural Heritage Program (RINHP), there are several species of plants on the State Rare Species list which have been reported within the watershed; all occur within the Snake Den State Recreation Area, which is in the upper watershed, far removed from the project area. One of these species is purple clematis (*Clematis occidentalis*), which is listed as State Endangered because it is the only known

population of this plant in Rhode Island. According to the RINHP, in a letter dated 27 October 2005, none of these species are aquatic, and their occurrence in the outskirts of the watershed away from any current flooding issues, suggests that any flood control measures would have no impact on these populations or their habitat.

No Action Alternative

None of the proposed projects would occur, thus there would be no effect to threatened and endangered species.

6.3.10 Energy

Proposed Action Alternative

There will be a temporary increase in energy consumption as a result of constructing the floodwalls, detention basins and ancillary structures as wells as the demolition and relocation of buildings. However, this temporary increase in energy usage will be offset, in the long term, by decreases in the amount of energy needed to respond to emergencies and to effect water-damage repairs that currently occur. Energy use will be required to operate the pumping systems associated with the stormwater collection systems on the landside of the floodwall, during flood conditions.

No Action Alternative

None of the proposed projects would occur, thus there would be no energy consumed implementing the proposed project. However the long term decrease in the amount of energy needed to respond to emergencies and to effect water-damage repairs that currently occur will not occur because the flooding problems will continue.

6.3.11 Long Term Productivity of Commitment of Resources

The resources to be committed to this project are the labor, money and energy expended for the construction of the flood mitigation structures, including flood walls, detention basins, piping and pump stations. These resources are necessary to correct recurring and chronic flooding problems in the middle and lower portions of the Pocasset River watershed. These resource expenditures will be offset by the substantial reduction in the amount of labor needed to respond to flooding emergencies and the amount of time and labor necessary for clean-up and repair.

6.3.12 Consistency with Local and Regional Plans

The Sponsor's major resource concern is flood damage reduction. This purpose is in line with priorities of NRCS's National Conservation Program. There is no existing River Basin Plan in which this project has been given a priority; however, NRCS has identified

this watershed as its highest planning priority in the state.

The City of Cranston and the Town of Johnston are participants in the National Flood Insurance Program (NFIP). This program was established under the Housing and Urban Development Act of 1968 and expanded by the Flood Disaster Protection Act of 1973 to make limited amounts of flood insurance, which was previously unavailable from private insurers, available to property owners and occupiers. In return, the Act requires that state and local governments adopt and enforce land use control measures that will restrict future development in flood prone areas in order to avoid or reduce future flood damages. The Act was most recently revised on May 6, 1988 with an effective date of October 1, 1988.

Several of the structural measures contained in the Recommended Plan fall within adopted regulatory floodways established by the Flood Insurance Studies. While regulatory programs such as the NFIP and flood prevention projects aimed at reducing existing flood damages are generally considered to be complimentary, prior to October 1, 1988 no provisions existed within the NFIP regulations to specifically distinguish between flood prevention construction (floodwalls, etc) and other development. One of the final rule revisions was made to accommodate situations where proposed floodplain actions can result in reduced flood hazards or have a net public benefit.

Proposals for flood prevention construction in the floodway must have the prior approval of the Flood Insurance Administration (FIA). As noted earlier, the affected community must apply for a conditional Flood Insurance Rate Map and flooding revision. The application by the City of Cranston and Town of Johnston for the revision must show the effects on the flood stage due to the flood control measure. Once approval is received, construction may take place. When the project has been installed, the communities must provide FIA with as built certifications, and FIA will initiate final map revisions.

As noted earlier, some of the structural and non structural areas are located in areas regulated by the RIDEM. Wetland permits and water quality certification will have to be received from RIDEM before construction can commence.

The City of Cranston Comprehensive Plan Update makes no specific mention of the Pocasset River flooding issues but does reference the City's Hazard Mitigation Plan. The Comprehensive Plan does recommend increasing access to the rivers in the City, including the Pocasset River. This goal, however, is not achievable and is, in fact, in direct conflict with the goals of this WP/EIS for the areas to be protected from flooding. The areas being considered for floodwalls are all developed. Improved access to the River from other, less developed areas, in the watershed better serve the overall goal of improved access to the River for recreation.

The conversion of the Forest Hill Nursery in the Reservoir Road area to recreational fields is consistent with the City's goal of providing additional active recreational

facilities for its citizens.

The Town of Johnston's Comprehensive Community Plan specifically addresses the flooding issues of the Pocasset River. It states, as one of its land use objectives, "to protect against the loss of life and property damage caused by flooding". Also, it states as Policy NCR-60 to "Continue to promote a cooperative effort between Johnston and the adjacent Towns for the shared responsibility for maintaining and improving the water quality and reducing the flood potential of the Pocasset River". Therefore, this project is consistent with the Town's Comprehensive Community Plan.

6.4 Comparison of Alternative Plans

Alternative plans that the Sponsor could select are called candidate plans.

Note that justification matrices were developed for all NED plan measures except dry flood proofing and the removal of a small debris dam. A justification matrix was not developed for the debris dam removal because the planned measure is in response to a localized condition and the recommended plan is the only feasible alternative. A justification matrix was not developed for dry flood proofing because areas to be dry flood proofed are located in low hazard areas spread throughout the watershed and outside of critical damage areas.

Table 5-1, Evaluation of Identified Concerns, has previously displayed the economic, social, environmental, and cultural factors that are important to decision making. Table 6-x summarizes and compares the significant differences between candidate plans with respect to those factors of medium and high significance.

Table 6-8: Summary and Comparison of Alternative Plans

Measure of Effects	Without Project	With Project (NED Plan)
Alternative Components	None	Seven floodwalls, other various structural and non-structural measures
Project Investment (all project investment to be used for flood mitigation)	$0	$28,626,737
Flooding [1,2]	No Flood protection measures; severe flooding to continue	Flood protection benefits as shown below
Annualized Costs	5,141,784	1,427,399
Annualized Benefits	None	4,535,295
Net Beneficial Effect	None	3,107,896
Benefit Cost Ratio	0	3.2
Environmental		
Net Urban Flood Plain Lost	None	47 acres of urbanized flood plain lost. 5 acres of natural flood plain restored. 42 net acres of urban flood plain lost
Economic[3]		
Annualized Costs, Rhode Island	None	Project will not Affect the Local Tax Basis
Rest of Nation	None	Project will not Affect the Local Tax Basis
Annualized Benefits, Rhode Island	None	Project will not Affect the Local Tax Basis
Rest of Nation	None	Project will not Affect the Local Tax Basis
Net Beneficial Effect, Rhode Island	None	Project will not Affect the Local Tax Basis
Rest of Nation	None	Project will not Affect the Local Tax Basis
Human Health and Safety[4]		
Properties Benefited[6]	0	473
Properties Damaged by 1 Percent Chance Event	481	8
Residential Properties Protected in or Removed[7]	0	57
From the Residential High Hazard Zones		
Damage Reduction (%)	0	88

1. 2007 dollars, 4.625% discount rate, 50-year analysis period, 5 year installation period. Project investment includes the present value cost of installation, operation, maintenance, and replacement of project measures.

2. Flooding evaluated using cost benefit ratio and level of flood protection. All proposed flood mitigation features provide protection to project areas for the design storm (full build-out 100 year flood)

3. Benefits to local and national economy were ignored in the calculation of project benefits because of the difficulty in qualitatively evaluated these benefits. Qualitatively, the proposed project would provide a local and national economic benefit because of increase usage and increase value of property protected by flood mitigation measures

4. Benefits to human health and safety defined as number of properties protected from design flood or removed from the design flood plain

5. Numbers not identical to Table 8-8 due to rounding errors.

6. Includes single family/multi family homes, apartment units, and commercial/industrial buildings.

7. Counts apartment buildings as one unit.

6.5 Risk and Uncertainty

Issues associated with risk and uncertainty in alternatives analysis is discussed in detail in Appendix B of this report.

6.6 Rationale for Plan Selection

P&G states that the alternative with the greatest net economic benefit consistent with protecting the Nation's environment is to be selected as the Recommended Plan. Included in the Recommended Plan is the sponsor's statutory requirement that flood protection be offered to all occupants in the 1-percent chance floodplain, with acceptance of this offer being on a purely voluntary basis. This is accomplished in the NED (Recommended) Plan.

FIGURE 6.1a PARK PLACE APARTMENTS– WITHOUT FLOOD WALL

FIGURE 6.1b PARK PLACE APARTMENTS–WITH FLOOD WALL

FIGURE 6-2a RICH BOX- WITHOUT FLOOD WALL

FIGURE 6-2b RICH BOX- WITH FLOOD WALL

TABLE 6-2
FORMULATION PROCESS

Flood Mitigation Alternative Ranking Matrix

Project Site	Proposed Measure	Ranking Criteria				
			Economic Account	Social Account	Environmental Account	
		Feasible (yes/no); If Yes Continue Ranking, If No Stop Ranking[1]	Economic Costs[2]	Human Health and Safety[3]	Net Loss of Flood Plain[4]	Total
Rotary Drive						
	Property Buyout	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging	No				
	Constraint (Bridge or Culvert) Removal	No				
	Floodwall	**Yes**	**3**	**3**	**2**	**8**
	Individual Measures (elevation, individual dikes)[5]	Yes	2	0	3	5
	Dry Flood Proofing[6]	No				
	No Action	NA	0	0	3	3
South Bennett Drive/River Avenue[7]	**Floodwall at Park Place Apartments, buyout and demolish buildings at River Avenue and River Drive, individual measures along South Bennett Drive, including raising of roadways**	**Yes**	**3**	**3**	**3 (+)**	**9**
	Buyout and demolish Park Place Apartments, floodwall along River Avenue and River Drive, individual measures along South Bennett Drive, including raising of roadways	Yes	0	3	3 (+)	6
	Floodwall at Park Place Apartments, relocate buildings at River Avenue and River Drive, individual measures along South Bennett Drive, including raising of roadways	Yes	2	3	3 (+)	8
	Floodwall at Park Place Apartments and floodwall along River Avenue and River Drive	Yes	3	3	2	8
	No Action	NA	0	0	3	3
Simmons Brook Mill						
	Property Buyout	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging	No				
	Constraint (Bridge or Culvert) Removal[8]	**Yes**	**3**	**3**	**3**	**9**
	Floodwall	No				
	Individual Measures (elevation, individual dikes)[5]	No				
	Dry Flood Proofing[6]	No				
	No Action	NA	0	0	3	3
Fletcher Avenue (Including Rich Box Company)						
	Property Buyout[9]	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging	No				
	Constraint (Bridge or Culvert) Removal	No				
	Floodwall on Fletcher Avenue Side of River Only[10]	No				
	Floodwall on Fletcher Avenue Side of River and Rich Box Side of River	**Yes**	**3**	**3**	**2**	**8**
	Individual Measures (elevation, individual dikes)[5]	Yes	2	0	3	5
	Dry Flood Proofing[6]	No				
	No Action	NA	0	0	3	3

TABLE 6-2
FORMULATION PROCESS

Flood Mitigation Alternative Ranking Matrix

		Ranking Criteria				
			Economic Account	Social Account	Environmental Account	
Project Site	**Proposed Measure**	**Feasible (yes/no); If Yes Continue Ranking, If No Stop Ranking[1]**	**Economic Costs[2]**	**Human Health and Safety[3]**	**Net Loss of Flood Plain[4]**	**Total**
Reservoir Avenue						
	Property Buyout[9]	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging	No				
	Constraint (Bridge or Culvert) Removal	No				
	Floodwall	**Yes**	**3**	**3**	**2**	**8**
	Individual Measures (elevation, individual dikes)[5]	Yes	2	0	3	5
	Dry Flood Proofing[6]	No				
	No Action	NA	0	0	3	3
Riverview Terrace						
	Property Buyout	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging	No				
	Constraint (Bridge or Culvert) Removal	No				
	Floodwall	**Yes**	**3**	**3**	**2**	**8**
	Individual Measures (elevation, individual dikes)[5]	Yes	2	0	3	5
	Dry Flood Proofing[6]	No				
	No Action	NA	0	0	3	3
Willow Brook Apartments						
	Property Buyout	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging	No				
	Constraint (Bridge or Culvert) Removal	No				
	Floodwall	**Yes**	**3**	**3**	**2**	**8**
	Individual Measures (elevation, individual dikes)[5]	Yes	2	0	3	5
	Dry Flood Proofing[6]	No				
	No Action	NA	0	0	3	3

TABLE 6-2
FORMULATION PROCESS

Flood Mitigation Alternative Ranking Matrix

Project Site	Proposed Measure	Ranking Criteria				
			Economic Account	Social Account	Environmental Account	
		Feasible (yes/no); If Yes Continue Ranking, If No Stop Ranking[1]	Economic Costs[2]	Human Health and Safety[3]	Net Loss of Flood Plain[4]	Total
Various Other Sites[11]						
	Property Buyout	Yes	0	3	3	6
	Floodway	No				
	Wetland Creation	No				
	Dam Rehabilitation	No				
	Sediment Removal/Channel Dredging[12]	**Yes**	**3**	**3**	**3**	**9**
	Constraint (Bridge or Culvert) Removal	No				
	Floodwall	Yes	0	3	2	5
	Individual Measures (elevation, individual dikes)[5]	Yes (includes measure for egress)	1	3	3	7
	Dry Flood Proofing[6]	**Yes (includes measure for egress)**	**3**	**3**	**3**	**9**
	No Action	NA	0	0	3	3

1. "Feasibility" means that measure could be constructed and if constructed would control flooding.

2. "Economic Costs" ranking system is as follows: 0 = provide no damage reduction or provides damage reduction at highest relative cost, 1 = provides damage reduction with a high relative cost, 2 = provides damage reduction with a moderate relative cost, 3 = provides damage reduction with a low relative cost.

3. "Human Health and Safety" ranking system is as follows: 0 = Egress to/from protected structures not provided, 3 = egress to/from protected structures provided.

4. "Net Loss of Flood plain" ranking system is as follows: 0 = loss of over 5 acres of natural flood plain, 1 = loss of under 5 acres of natural floodplain, 2 = loss of over 1 acre of urban flood plain, 3 = loss of less than 1 acre of urban flood plain or loss of protected building foot prints only. Plus 1 for creation of over 1 acre of natural flood plain (indicated by a plus sign (+) in cell)

5. Individual measures protect buildings only and do not provide egress during a flood event. To provide egress raising of all flooded roadways would be required and would need to be fully paid by the Sponsors. Due to the high costs, the Sponsors removed this from consideration, except where it was the only feasible alternative.

6. Dry flood proofing only feasible when flood elevation is less than 3-feet above groud surface.

7. Due to complexity of area, the only feasible flood mitigation alternatives are the combinations of flood mitigation measures presented here.

8. Construction of a bypass culvert.

9. Selected property buyout required to site floodwall.

10. Not feasible because this alternative increases flooding at Rich Box Company, across the Pocasset River from Fletcher Avenue.

11. Areas of relative low flood elevations (less than 3 feet above grade) where egress during flood events can be provided for minimum cost.

12. Only applicable to a small debris dam near confluence of Pocasset River and Simmons Brook.

13. Highest ranking alternative for each project Site is in bold.

TABLE 6-3:
ENVIRONMENTAL, ECONOMIC, AND SOCIAL JUSTIFICATION MATRIX

River Avenue, River Drive, and Park Place Apartments

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; floodwall at Park Place Apartments, buyout/demolish 8 homes and 1 business along River Avenue and River Drive, and restore floodplain along River Avenue and River Drive. Move families/business to new locations. Note, cost to buyout Park Place Apartments and all buildings along River Avenue and River Drive estimated at $8,400,000; full buyout was considered to be not economically feasible and was not analyzed further.	$292,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$5,300,000 upfront cost, $6,825 operation and maintenance costs yearly.	Mitigate flooding at Park Place apartments; demolish River Avenue/River Drive buildings from flood plain and move eight families and 1 business to new locations. Probable that suitable and comparable locations for new homes/business will be found in general area (i.e. within the Town or in neighboring communities. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Approximately 4.3 acres of natural floodplain will be restored, which will serve as high value wildlife habitat. Loss of approximately 1.4 acres of urban flood plain (parking lot and surrounding area of Park Place Apartments). The floodplain lost is highly urbanized and has no ecological value. Negligible (less than 0.5 feet) increase in water surface elevations at project area, upstream of project area, and downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage).
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$318,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris. No floodplain would be restored to its natural condition and no wildlife habitat created.
Alternative 3: Buyout/demolish Park Place Apartments and Install floodwall along River Avenue and River Drive.	Floodwall along River Avenue and River Road, buyout/demolish Park Place Apartments and restore floodplain at Park Place Apartments. Move families to new locations.	$292,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$8,100,000 upfront cost, $6,825 operation and maintenance costs yearly.	Remove Park Place Apartments from floodplain and mitigate flooding at River Avenue/River Drive. Park Place Apartments contains approximately 100 units of low income housing, it is unlikely that suitable and comparable low income housing can be found in general area, i.e. in the Town or in neighboring communities. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Approximately 2.3 acres of natural floodplain will be restored, which will serve as high value wildlife habitat. Loss of approximately 7.8 acres of urban flood plain (area surrounding buildings on River Drive and River Avenue). The floodplain lost is highly urbanized and has no ecological value. Negligible difference in water surface elevations at project area, upstream of project area, and downstream of project area compared to NED Plan (i.e. negligible impact on flood storage).
Alternative 4: Floodwall at Park Place Apartments and physically relocate all Properties on River Road and River Avenue	Floodwall at Park Place Apartments and physically relocate homes along River Drive and River Road; restore floodplain at River Drive and River Avenue.	$292,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$5,900,000 upfront cost, $8,500 operation and maintenance costs yearly.	Mitigate flooding at Park Place apartments; relocate River Avenue and River Drive buildings from flood plain; unlikely that suitable vacant lots required for relocations will be found in general area, i.e. in Town or in neighboring communities. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and shrub plantings at front of wall.	Water quality impacts due to sewage contaminated flood water would be mitigated. Approximately 4.3 acres of natural floodplain will be restored, which will serve as high value wildlife habitat. Loss of approximately 1.4 acres of urban flood plain (parking lot and surrounding area of Park Place Apartments). The floodplain lost is highly urbanized and has no ecological value. Negligible difference in water surface elevations at project area, upstream of project area, and downstream of project area compared to NED Plan (i.e. negligible impact on flood storage).
Alternative 5: Floodwall on Both Sides of River	Floodwalls at both Park Place Apartments and along River Drive and River Avenue.	$292,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$5,100,000 upfront cost, $17,000 operation costs yearly. Difference in operation and maintenance costs from NED plan is $6,825. Using the 50-year life span of the project, the total estimate cost, without taking into account interest, is $5,950,000, where as the total cost for the NED Plan, when evaluated in the same manner is $5,641,000.	Mitigate flooding at Park Place Apartments and mitigate flooding along River Avenue/River Drive. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage contaminated flood water would be mitigated. No floodplain or wildlife habitat would be created. Loss of approximately 9.2 acres of urban flood plain (parking lot and surrounding area of Park Place Apartments, and area surrounding buildings on River Drive and River Avenue). The floodplain lost is highly urbanized and has no ecological value. Negligible difference in water surface elevations at project area, upstream of project area, and downstream of project area compared to NED Plan (i.e. negligible impact on flood storage).

TABLE 6-3:
ENVIRONMENTAL, ECONOMIC, AND SOCIAL JUSTIFICATION MATRIX

Rotary Drive

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; 1,500 foot long steel sheet pile floodwall with a height of between 4 and 5 feet. Protects 19 properties. Note, cost to buyout all homes on Rotary Drive estimated at $5,100,000; full buyout was considered to be not economically feasible and was not analyzed further.	$92,000 in average annual flood damage reductions. Clean up costs greatly reduced.	$2,200,000 upfront cost, $8,500 operation and maintenance costs yearly.	Mitigate flooding at Rotary Drive. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of approximately 2 acres of urban flood plain (residential areas along Rotary Drive). The floodplain lost is highly urbanized and has no ecological value. Negligible (less than 0.5 feet) increase in water surface elevations at project area, upstream of project area, and downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage).
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$102,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.

Fletcher Avenue

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; 2,300 foot long steel sheet pile floodwall with a height of between 5 and 7 feet along Fletcher Avenue. Protects 54 properties. One business (day care center) will be removed in order to site the floodwall. Steel sheet pile floodwall installed at Rich Box Company across the river from Fletcher Avenue to protect building. Note, cost to buyout all buildings at Fletcher Avenue estimated at $9,700,000; full buyout was considered to be not economically feasible and was not analyzed further.	$225,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$4,300,000 upfront cost, $16,000 operation and maintenance costs yearly.	Mitigate flooding at Fletcher Avenue and Rich Box Company. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall. Probable that suitable and comparable location for bought out business will be found in general area (i.e. within the Town or in neighboring communities).	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of approximately 20 acres of urban flood plain (industrial, commercial, and residential areas along Fletcher Avenue). The floodplain lost is highly urbanized and has no ecological value. Approximately 3 foot increase in water surface elevations at project area; flood mitigation designs account for this increase. Negligible (less than 0.5 feet) increase in water surface elevations upstream of project area and downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage upstream and downstream).
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$225,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.
Alternative 3: Floodwall at Fletcher Avenue Only	Recommended Plan; 2,300 feet long steel sheet pile floodwall with a height of between 5 and 7 feet along Fletcher Avenue. Protects 54 properties. One business (day care center) will be bought out, demolished, and relocated in order to site the floodwall. No flood mitigation at Rich Box Company	$225,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$3,000,000 upfront cost, $12,500 operation and maintenance costs yearly. Damages continue (and potentially increase due to water surface elevation increase) at Rich Box Company	Mitigate flooding at Fletcher Avenue. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall. Probable that suitable and comparable location for bought out business will be found in general area (i.e. within the Town or in neighboring communities).	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of approximately 20 acres of urban flood plain (industrial, commercial, and residential areas along Fletcher Avenue). The floodplain lost is highly urbanized and has no ecological value. Approximately 3 foot increase in water surface elevations at project area; increase flooding across river at Rich Box Company. Negligible (less than 0.5 feet) increase in water surface elevations upstream of project area and downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage upstream and downstream).

TABLE 6-3:
ENVIRONMENTAL, ECONOMIC, AND SOCIAL JUSTIFICATION MATRIX

Reservoir Avenue

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; 1,400 foot long steel sheet pile floodwall with a height of between 3 and 8 feet along Reservoir Avenue. Protects 29 properties. One business, Forest Hill Nursery, will be bought out and demolished. The property formerly owned by the Nursery will be converted to recreational fields. Note, cost to buyout all buildings at Reservoir Avenue estimated at $6,800,000; full buyout was considered to be not economically feasible and was not analyzed further.	$131,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$5,400,000 upfront cost, $7,750 operation and maintenance costs yearly.	Mitigate flooding at Reservoir Avenue. Provide new recreation fields to the public. Forest Hills Nursery Owner has expressed interest in selling business. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of approximately 4 acres of urban flood plain (commercial areas along Reservoir Avenue). The floodplain lost is highly urbanized and has no ecological value.. Up to a 1 foott increase in water surface elevations upstream of project area (impact becomes negligible approximately 3,300 feet upstream of floodwall); increase may impact two homes. These potential impacts will be analysis during the design phase. Negligible (less than 0.5 feet) increase in water surface elevations downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage downstream).
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$148,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.

Riverview Terrace

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; 1,800 foot long steel sheet pile floodwall with a height of approximately 9 feet. Protects approximately 50 homes and 78 apartment units. A small tributary, which currently is piped underground, will be restored to a surface stream. Note, cost to buyout all buildings in Riverview Terrace area estimated at $15,00,000; full buyout was considered to be not economically feasible and was not analyzed further.	$163,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$5,100,000 upfront cost, $11,750 operation and maintenance costs yearly.	Mitigate flooding at Riverview Terrace and surrounding neighborhood. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of approximately 10 acres of urban flood plain (residential areas at Riverview Terrace and the surrounding area). The floodplain lost is highly urbanized and has no ecological value. Negligible (less than 0.5 feet) increase in water surface elevations at project area, upstream of project area, and downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage). Restoration of approximately 900 feet of natural open channel and the habitat associated with it.
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$215,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.

Willow Brook Apartments Alternative Matrix

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; 1,100 feet long steel sheet pile floodwall with a height of approximately 7 feet. Protects approximately 156 apartment units. Note, cost to buyout Willowbrook Apartments estimated at $20,000,000; full buyout was considered to be not economically feasible and was not analyzed further.	$120,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$2,600,000 upfront cost, $10,500 operation and maintenance costs yearly.	Mitigate flooding at Willow Brook Apartments. Visual impact from floodwalls mitigated by painting wall, facing wall with stone or brick, or through tree and scrub plantings at front of wall.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of approximately 5 acres of urban flood plain (grounds of Willow Brook Apartments). The floodplain lost is highly urbanized and has no ecological value. Negligible (less than 0.5 feet) increase in water surface elevations at project area, upstream of project area, and downstream of project area, compared to existing conditions (i.e. negligible impact on flood storage).
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$178,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.

TABLE 6-3:
ENVIRONMENTAL, ECONOMIC, AND SOCIAL JUSTIFICATION MATRIX

Simmons Brook

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; Construct bypass culvert around mill building, through which the Simmons Brook currently flows. Protects 4 industrial and commercial buildings, including the mill. Note, cost to buyout all buildings at Simmons Brook mill area estimated at $1,500,000; full buyout was considered to be not economically feasible and was not analyzed further.	$38,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$476,000 upfront cost, $3,000 operation and maintenance costs yearly.	Mitigate flooding around mill over Simmons Brook.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated.
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$53,000 average annual flood damages. Impacts include lost wages, lost business revenue, and cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.

South Bennet Drive Structural and Non Structural Measures

Alternative	Description	Economic Impacts-Benefits	Economic Impacts-Costs	Social Impacts	Environmental Impacts
Alternative 1: NED Plan	Recommended Plan; Raise approximately 2,200 feet of roadway between 2 and 5 feet, install a culvert to convey a small tributary to the Pocasset River, elevate 6 homes, dry flood proof 7 homes, and install individual earthen dikes around 3 homes. The elevated roadway would protect 12 homes. Note, cost to buyout all homes at South beent Drive area, except those on River Drive and River Avenue, estimated at $6,900,000; full buyout was considered to be not economically feasible and was not analyzed further.	$493,000 in average annual flood damage reductions. Increase in wages and business revenue due to flood reductions. Clean up costs greatly reduced.	$ 1,700,000 upfront cost.	Mitigate flooding along South Bennet Drive. Raised roadway will allow increase egress during flood events.	Water quality impacts due to sewage and debris contaminated flood water would be mitigated. Loss of negligible floodplain. Loss of approximately 5 acres of urban flood plain (homes around South Bennet Drive). The floodplain lost is highly urbanized and has no ecological value.
Alternative 2: No Action Alternative	No proposed project, existing conditions continue.	No benefits	$515,000 average annual flood damages. Impacts include cleanup costs.	Continued flooding; impacts include potential loss of life and potential injury, negative impacts to quality of life (i.e. utilization of building space, etc), negative impacts to property values, and worry incurred by residents.	Continued water quality impacts due to floodwater contaminated with sewage and debris.

SECTION 7

CONSULTATION AND PUBLIC PARTICIPATION

This section documents meetings, public participation and milestones which have taken place during the planning process.

August 1999: NRCS contacted by Town of Johnston to determine if funding was available to restore several eroded stream banks along the Pocasset River and Simmons Brook. Rhode Island NRCS applied to the national office to fund two projects through the Emergency Watershed Program (EWP). The two projects were the restoration of the stream bank at Morgan Mill Road and stabilization of the stream bank on Simmons Brook, located at St. Rocco's Church.

March 2000: Town of Johnston requested federal assistance for watershed protection and flood prevention under provisions of the Watershed Protection and Flood Prevention Act (Public Law 83-566) for the Pocasset River Watershed. Although the Town of Johnston made the application, the policy of NRCS is to address flooding problems on a watershed basis. A large portion of the City of Cranston lies within the Pocasset River Watershed. The City of Cranston was contacted, and they requested to become part of the study.

October 2000: NRCS begins work on Pocasset River Watershed Plan.

March 2002: NRCS contacts Historical Preservation and Heritage Commission and the Narragansett Tribe for information on historic structures/cultural concerns in project area. No historic structures were identified at that time.

April 2002: US Fish and Wildlife and Rhode Island Department of Environmental Management contacted by NRCS to determine if any National or State endangered or threatened species, or their habitats are located within project area. None are identified.

February 2004: Mayors of Cranston and Johnston give comments on Watershed Plan.

March 2004: Cranston planning department gives NRCS comments on Watershed Plan

March 2005: Pocasset River Watershed Project Steering Committee, made up of local officials meets with NRCS, GZA, and EA personnel to discuss project.

October 2005: Large storm event leads to reevaluation and revision of hydrology and hydraulics model.

October 2005: Rhode Island Department of Environmental Management is again contacted to determine if any National or State endangered or threatened species or their habitats are located within project area. None are identified.

May 2006: Final hydrology and hydraulics model is approved by NRCS State Engineer.

June 2007: Rhode Island Office of Statewide Planning signs off on Town of Johnston's completed form SF-424.

September 2007: Final "Flood Plain Management Study: Pocasset River Watershed, Providence County, Rhode Island" Technical and Popular Reports published by NRCS.

November 2007: Rhode Island Office of Statewide Planning signs off on City of Cranston's completed form SF-424.

February 2008: Meeting with officials from NRCS, GZA, Town of Johnston and City of Cranston.

April 2009: Meeting with officials from Johnston, Cranston, RIDEM, RI Emergency Management Association, USEPA-New England, NRICP, NRCS, GZA, and RI Congressional Offices.

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SECTION 8

RECOMMENDED PLAN

One alternative, the Recommended Plan (NED Plan), has been developed that would meet all planning criteria. The sole purpose of the Recommended Plan is flood prevention. Detailed topography data will be necessary to complete final design. Consequently, these designs may need to be altered based upon topographic or other constraints observed during a detailed field reconnaissance. Prior to construction of any project for local flood protection, the Sponsors shall agree to participate in and comply with applicable Federal flood plain management and flood insurance programs (Public Law 99-662).

8.1 Purpose and Summary

In summary, the recommended plan will consist of:

- Seven floodwalls
- One bypass culvert
- Various non-structural measures (relocation, floodproofing, etc)
- Raising of a roadway
- Removal of a debris dam

The Recommended Plan calls for the elimination of all flood damages in the Pocasset River 100-year flood plain, with the exception of Atwood Avenue Bridge and Second Mill Street Bridge.

A pump station collection system or a floodwall runoff collection system is proposed behind each floodwall. In many cases these systems include storage and diversion chambers (either above or below ground) to limit the size of the pump stations or diversion of upstream runoff away from floodwalls. In critical areas, emergency back-up generators are recommended along with motorized outlet gates. The intent is to allow for natural drainage to the river during normal rainfall conditions and to pump the water during the flood stage. These systems are an integral part of the floodwalls and part of floodwall installation. The nature of these floodwall and stormwater systems will require regular inspection and maintenance programs, as described in Section 8.7. Such maintenance will be required to insure that floodways remain clear and pumps and mechanical systems are operational.

As described in Section 8.3, no mitigation for impacts to wetlands or wildlife habitat will be included, as the impacts are minimal. There will also be no mitigation for the loss of floodplain; the hydraulic model of the flood mitigation designs takes into account the minimal increased flood stage caused by the loss of floodplain proposed in the NED plan

of approximately 47 acres.

Table 8-1: PL-566 Component of Recommended Plan, National Economic Development Account

Components	Measure of Effects (Annualized Average Annual Dollars)[1]	Components	Measure of Effects (Annualized Average Annual Dollars)[1]
Beneficial Effects		Adverse Effects	
1. Floodwater Damage Reduction	4,535,295	The Value of the Opportunity Costs	
		Associated with the Resources used	
		in Implementing the Plan:	
		1. Construction Costs	935,254
		2. Technical Assistance Cost	95,772
		3. Project Administration Cost	92,100
		4. Operation, Maintenance and Replacement Cost	43,518
		5. Land Rights	93,847
		6. Building Purchase Cost	158,392
		7. Relocation Payments	8,515
Total Beneficial Effects	4,535,295	Total Adverse Effects	1,427,399
Net Beneficial Effects	3,107,896		

1. 2007 dollars, 4.625% discount rate, 50-year analysis period, 5 year installation period.
2. Numbers not identical to Tables 8-6 and 8-8 due to rounding errors.

Table 8-2: PL-566 Component of Recommended Plan, Regional Economic Development Account

Components	Measure of Effects (Annualized Average Annual Dollars)[1]		Components	Measure of Effects (Annualized Average Annual Dollars)[1]	
	Rhode Island	Rest of Nation		Rhode Island	Rest of Nation
Beneficial Effects			Adverse Effects		
1. Floodwater Damage Reduction	4,535,295	0	The Value of the Opportunity Costs		
			Associated with the Resources used		
			in Implementing the Plan:		
			1. Construction Costs	62,745	872,509
			2. Technical Assistance Cost	0	95,772
			3. Project Administration Cost	0	92,100
			4. Operation, Maintenance and Replacement Cost	43,518	0
			5. Land Rights	93,847	0
			6. Building Purchase Cost	27,847	130,545
			7. Relocation Payments	869	7,647
Total Beneficial Effects	4,535,295		Total Adverse Effects	228,827	1,198,572
Net Beneficial Effects	3,107,896				

1. 2007 dollars, 4.625% discount rate, 50-year analysis period, 5 year installation period.
2. Numbers not identical to Tables 8-6 and 8-8 due to rounding errors.

8.2 Measures To Be Installed

8.2.1 Rotary Drive

A steel sheet pile floodwall is recommended for the Rotary Drive area (see Figure 9-4 & 9-4A). The Recommended Plan will include construction of an approximately 1,500-foot long steel sheet pile wall, between 4 feet and 5 feet in height. This floodwall will protect 19 residences along Rotary Drive. To improve aesthetics, the inside of the floodwall along the rear yards of the residences will be painted a neutral color and planted with trees and shrubs.

Topography in the area between Atwood Avenue and the floodwall slopes to the east, toward the floodwall. The area to the north of Rotary Drive drains to the Dry Brook. The Rotary Drive drainage area is divided into an upland area (3.2 acres) and a local area (7.4 acres). The large upland area across Atwood Avenue drains toward Rotary Drive. Fortunately, this area is served by an extensive storm drain network that leads under Atwood Avenue and discharges at the rear of Rotary Drive (toward Alcar Drive), above the river flood stage. A cursory inspection of this pipe revealed it to be approximately 36-inch RCP in poor condition. It also appears the line runs beneath the adjacent home. The remaining local area will be collected at the floodwall. A local subdrain system exists to the rear of the homes along Rotary Drive and exits to the Pocasset River behind Rotary Drive. It will be necessary to divert this drainage to a new collection basin. The pump station collection system will consist of:

- One berm along the inland side of the floodwall.
- Three outfalls with suitable flaps or motorized gates (flap and motorized gates prevent flood waters from backing up through the floodwall).
- A drain line along the inside of the floodwall.
- One detention basin with an integrated collection swale to Rotary Drive.
- One 3,800 gpm pump station with emergency generator. (to pump runoff over/through the wall when the Pocasset is at flood stage, generators are provided for backup power in the event of a power failure).

8.2.2 South Bennett Drive

A steel sheet pile floodwall is recommended for the Park Place Apartments property (on the west side of the Pocasset River) in the South Bennett Drive neighborhood (see Figure 9-5 & 9-5A. The Recommended Plan will include construction of an approximately 1150-foot long steel sheet pile wall, ranging between 3 feet and 9 feet in height. This floodwall will protect the Park Place Apartment Complex. To improve aesthetics, the inside of the floodwall will be painted a neutral color and planted with trees and shrubs.

The topography of the Park Place Apartments site is steep between the apartments and nearby Atwood Avenue. The northern portion of the site slopes to the northeast, conveying runoff away from the floodwall. The southern portion of the site slopes steeply toward the southeast, conveying water to the floodwall. A large woodland area across Atwood Avenue presently drains to Atwood Avenue. This section of Atwood Avenue lacks drainage control structures and it is probable that runoff from this area drains to the floodwall due to the steep roadway that leads from Atwood Avenue to Park Place Apartments. The drainage area for Park Place Apartments is divided into an upland area (6.2 acres) and a local area (4.3 acres). Roadway pavement modifications at the entrance to Park Street will be necessary to prevent drainage from the upland area west of Atwood Avenue from flowing down Park Street. Additional roadway pavement modifications will be required at the driveway intersection at the entrance to the apartments to prevent runoff from draining into the apartment parking area. These pavement modifications consist of raising the pavement elevation to create a gentle diversion berm across the width of the roadway. A new drainage swale is to be placed leading from the entrance area along the western side of the extended flood wall to divert upland runoff. The pump station collection system will consist of:

- One drainage swale along the inland side of the floodwall and collection basin.
- One outfall with flap or motorized gates.
- Roof drains to the collection system.
- A drain line along the inside of the floodwall.
- One 8,000 gpm pump station with emergency generator.

The recommended alternative for the South Bennett Drive and River Drive neighborhoods on the east side of the Pocasset River (see Figure 9-5 & 9-5A) consists of a variety of structural and non structural measures. One home, 18 Melody Lane, appears to be located within the project defined 100-year flood plain, but based on survey data from a field reconnaissance, is located at an elevation above the flood plain. Due to this, no mitigation measures are planned at this residence, however, this will be re-evaluated at the time of WP/EIS implementation.

A small tributary traverses the South Bennett Drive neighborhood and may be responsible for a portion of the flooding in the neighborhood. GZA performed a field investigation and observed that the stream enters a 36” pipe. GZA could not locate the discharge location, but suspects it is somewhere in the wetland area between the Pocasset River and South Bennett Drive. GZA, using surface topography and best engineering judgment, delineated the watershed of the small tributary and estimates the drainage area to be 340 acres. Sixty percent of the drainage is medium density residential and forty percent is woodland. Runoff was modeled using WIN TR-55 and peak runoff for a 100-year 24-hour event was approximately 700 cfs.

Structural measures will consist of the following:

- The raising of approximately 2,200 feet of roadway between 2 and 5 feet. The raised roadway protects 12 homes and provides for access of homes during flood events.
- The replacement of the 36-inch pipe that the tributary discharges to at South Bennett Drive with a 3-foot by 10-foot concrete box culvert, sized to accommodate 700 cfs.

Non structural measures will consist of:

- Removal of 6 homes along portions of River Drive.
- Removal of 2 homes along portions of River Avenue.
- Elevation of 6 homes along portions of Melody Lane and LaFazia Drive.
- Removal of Bingley Truss Factory on River Avenue.
- Dry floodproofing of 7 buildings along portions of Morgan Mill Road, Melody Lane, and River Drive.
- Earthen dike around 1 home on River Drive.
- Earthen dike around 1 home on River Avenue.

Approximately 4.3 acres of natural flood plain will be restored in the areas described above where buildings along River Drive and River Avenue will be removed.

Further refined field analysis will be necessary to evaluate water levels at home openings and to determine if homes can withstand flood forces, including hydraulic pressure on foundations. This is particularly true for dry floodproofing and structure elevation. Evacuation during flood events may not be possible from four homes located outside the future 100-year 24-hour floodplain on River Drive during a flood event, due to flooding on the roadway. These homes will require further evaluation when more detailed designs are developed.

All buildings slated to be removed (including the structures discussed in other sections of Section 8) will be purchased at the appraised fair market value (estimated to be 12% higher than the appraised value, based on property sales in late 2006/early 2007). The buildings will be salvaged or demolished, the foundations backfilled and seeded, and utilities capped. Re-vegetation of floodplain soils will follow RIFOTG recommended guidelines as specified by technical standards for the Critical Area Planting conservation practice (Code 342) and any other conservation practices utilized to restore floodplain soils and stabilize stream banks. Compliance with EO 13112 (Invasive Species) will be achieved by adhering to procedures outlined in NECH 610.91. The land acquired will be maintained in a manner that is consistent with federal and state flood plain zoning regulations.

8.2.3 Simmons Brook Bypass Culvert

We recommend the construction of a bypass culvert (see Figure 9-6) around the mill building under which the Simmons Brook currently flows. The bypass culvert will eliminate the constriction at the mill culvert.

A hydraulic analysis using Culvert Master, a Haestad Methods hydraulic program, was used to calculate a preliminary size for the bypass culvert and determine the capacity of the existing mill culvert. The existing mill culvert will remain in place. The capacity of the existing culvert is approximately 217 cubic feet per second (cfs). The total 100-year, 24-hour flow at this location is approximately 1,011 cfs. The difference results in design capacity of approximately 800 cfs for the bypass culvert. It is estimated that a 300-foot long, five barrel, 6-foot by 3-foot box culvert, or equal, would be required. As part of final design of the bypass culvert, rerouting of the stream channel could be examined and substituted for the bypass culvert if it is a more feasible option.

8.2.4 Fletcher Avenue

Two floodwalls, one on both sides of the Pocasset, are recommended for this area. One steel sheet pile floodwall is recommended on the western side of the river for the Fletcher Avenue site (see Figures 9-9 & 9-9A). The wall will be approximately 2,200 feet long, with an average height of 7 feet. The Fletcher Avenue area lies in a low area, with gentle slopes. It is primarily industrial, with large tracts of impervious area. Stormwater flows in a northerly direction toward the river, following surface topography. Atwood Avenue serves as a major conduit and drainage divide, carrying water away from the flood wall. The Fletcher Avenue drainage area is 48.7 acres. A drainage system is currently in place at Fletcher Avenue and will be modified. One outfall is present, discharging to a small tributary, which eventually flows into the Pocasset River. The floodwall runoff collection system will consist of:

- Five pipes with flap gates or motorized gates to convey the small tributary and stormwater through the floodwall.
- One detention pond.
- One storage swale along the inside of the floodwall.
- A drain line along portions of the inside of the floodwall.
- A back up 8,000 gpm pump station and emergency generator.

A second sheet pile flood wall is recommended across the Pocasset River from the proposed Fletcher Avenue Floodwall to protect the low lying area near Rich Box Company (see Figures 9-9 & 9-9B. The wall will be approximately 500 feet long, with a height of 7 feet. Due to the historic nature of the Rich Box Company building, the wall will be faced with architectural brick in order to match the exterior of the building. Stormwater flows in an easterly direction toward the Pocasset River. There are no

stormwater control structures within the Rich Box site and stormwater flows overland to the river from the 4.4 acre drainage area. A drainage swale will be required along the inland side of the wall and roadway modifications will be required at the entrance to the parking area along Pocasset Street to direct stormwater away. An access point will be required to allow for maintenance and cleaning of the constricted riverbed between the Fletcher Avenue and Rich Box floodwalls. The floodwall runoff collection system will consist of:

- One pipe outfall with suitable flap gate or motorized gate to convey the stormwater through the floodwall.
- One berm along the inside of the floodwall.
- One collection basin integrated into the drainage swale.
- One drain line along portions of the inside of the floodwall.
- One diversion chamber and 11,000 gpm pump station.

8.2.5 Reservoir Avenue

A steel sheet pile floodwall is recommended for the Reservoir Avenue site (see Figures 9-12 & 9-12A). We recommend that an approximately 1,250-foot long floodwall be constructed, between 3 feet and 8 feet in height, along with acquisition of properties owned by Forest Hill Nursery (City of Cranston Plat 9, Lots 3497, 3208, and 3455.) The acquired property could be converted into recreation fields. Access will need to be provided through or around the floodwall. To improve aesthetics, the inside of the floodwall will be planted with trees and shrubs. This floodwall will protect businesses along Reservoir Avenue. Another property, City of Cranston Plat 9 Lot 3453 must be acquired to construct the floodwall. This property is approximately 10 feet from the river and is not beneficial to preserve and protect from flood water.

Reservoir Avenue is a commercial area with large tracts of impervious areas. Reservoir Avenue acts as a major conduit of flow, carrying stormwater away from the floodwall. The drainage area behind the wall is delineated by Reservoir Avenue to the south and the floodwall to the north and west. The drainage area extends east approximately 1,500 feet from the western edge of the floodwall. The area is relatively flat, with the ground gently sloping northwest toward the river. At the approximate end of the drainage area to the east, the ground slopes sharply to the northwest, toward the river. The Reservoir Avenue drainage area is 8.8 acres. A detention basin will be constructed on the inland side of the flood wall to collect run off from the Reservoir Avenue area. In order for the basin to function properly, a 60 foot section of Knollwood Avenue will need to be re-graded to drain into this basin. The proposed pump station collection system behind the flood wall is composed of:

- One berm along the inland side of the flood wall.
- One drain line along the inside of the floodwall.

- One detention basin integrated into the roadway (to ensure the roadway drains to the detention basin).
- One outfall with suitable flap or motorized gate.
- One diversion chamber and 4,000 gallon pump station with emergency generator.

A utility easement is present at Reservoir Avenue that will not interfere with construction. The floodwall will be placed completely along one side of the easement.

8.2.6 Riverview Terrace

A steel sheet pile floodwall is recommended for the Riverview Terrace neighborhood (see Figures 9-13 & 9-13A). The flood wall will be composed of two separate sections. The first section will be approximately 300 feet long, with a height of 7 feet. The second section will be approximately 1,400 feet long, with a height of 9 feet. To improve aesthetics, the inside of the floodwall will be painted and planted with trees and shrubs. Stormwater flows in the southeast direction toward the Pocasset River. Stormwater control structures within the adjacent Pontiac Avenue serve to convey water away from the site and serves as the eastern drainage divide. Stormwater from the Riverview Terrace 32.3 acre drainage area, west of the divide, presently sheet flows along the roadways and enters the river as overland sheet flow and various existing drainage culverts.

The large drainage area that drains into the site at Riverview Terrace necessitates construction of a large detention basin to store the peak storm runoff. Three pump stations will also be located within the area to ensure that storm drainage does not contribute to flooding. The proposed collection system behind the wall is composed of:

- One large detention basin to be located in the area of Fordson Avenue.
- One discharge outfall from the basin to the river in vicinity of the existing drainage culvert.
- One diversion chamber and an 8,000 gpm pump station located within the large detention basin.
- One small collection basin located central to the parking area of the Riverview Terrace parking lots along with two 250 gpm pump station.
- Three emergency generators, one to power each pump stations.
- Three outfalls with suitable flaps or motorized gates.
- Removal or abandonment of the drainage culvert currently flowing under the neighborhood.

A small unnamed tributary is located to the west of Riverview Terrace, flowing in an easterly direction from Blackmore Pond. Currently the stream flows under the neighborhood through a culvert. It is anticipated that prior to implementation of the

Recommended Plan, the stream channel will be relocated and the culvert abandoned, so that the tributary flows in a southerly direction away from the floodwall and toward the Pocasset River.

8.2.7 Willowbrook Apartments

A steel sheet pile floodwall is recommended for the Willowbrook Apartments site as shown on Figures 9-14 & 9-14A. The floodwall will be approximately 1,100 feet long, with an average height of 7 feet. To improve aesthetics, the inside of the floodwall will be painted a neutral color and planted with trees and shrubs. Underground utilities are not known to be present at the proposed construction site.

Stormwater flows overland southeast toward the Pocasset River. Stormwater control structures exist within the adjacent Pontiac Avenue to convey water away from the site and serve as the eastern drainage divide. Stormwater from the Willowbrook Apartments 15.2 acre drainage area, west of the divide, presently sheet flows along the roadways and enters the river via several drainage swales.

At Willowbrook Apartments, the proposed pump station collection system behind the wall is composed of:

- One drainage swale located along the inland side of the flood wall to catch overland surface runoff.
- One collection basin located at the central point of the swale exiting to a diversion chamber.
- Five pump diversion chambers to collect gravity stormwater flow.
- Five 8,000 gpm pump stations with emergency generators.
- Five outfalls with a suitable flap or motorized gate

8.2.8 Dry Flood Proofing

Fifteen buildings, 8 in Johnston and 7 in Cranston will be dry flood proofed. Further refined field analysis will be necessary to evaluate water levels at building openings and to determine if homes to be dry flood proofed can withstand flood forces, including hydraulic pressure on foundations

8.2.9 Other Non Structural Measures Not Previously Discussed

Non structural measures not previously discussed are:

- Removal of a debris dam near the Pocasset River's confluence with the Simmons Brook, as shown on Figure 9-3 (estimated total cost to remove of $60,000).

8.3 Mitigation Features

The National Environmental Policy Act (NEPA) requires that significant impacts from proposed federal agencies on the socioeconomic and natural environment need to be mitigated. The details of the mitigation will be addressed during the permitting phase of the project, but the mitigation measures and strategies are outlined below.

Construction of the various flood control structures, particularly the floodwalls have the potential to temporarily impact the surrounding environment. The following measures will be undertaken to minimize impacts:

- Notify affected property owners of the construction activity scope and duration prior to construction.

- Limit construction to normal working hours as defined by the City of Cranston and Town of Johnston ordinances.

- Implement erosion and sedimentation control measures during construction to ensure that the river and adjacent wetlands are unaffected. This will be done by preparing a Stormwater Pollution Prevention Plan as required by the National Pollution Elimination Discharge System (NPDES) Stormwater Construction General permit.

- Conduct a pre-construction survey of structures in the project area that could be impacted by the vibrations of sheet pile driving. Monitor vibration during construction if needed.

- Work with the communities and property owners in/near construction areas to minimize and mitigate for temporary impacts to parking.

- Provide relocation assistance to affected property owners as required**.** Relocations will be accomplished by the Sponsor under the guidelines established in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646). Relocation payments cover incidental costs associated relocations (i.e. moving costs, etc).

- Provide aesthetically-compatible floodwall construction in residential and historic areas of the project.

- Conduct Environmental Site Assessment of properties to be purchased by NRCS in accordance with federal and state regulations to ensure that demolition does not release harmful materials to the environment.

NRCS will have an archaeologist onsite during excavation of the detention basin at reservoir Avenue and NRCS will first cause work to cease if cultural resources are discovered during implementation, and then follow policy as outlined in General Manual 420, part 401.

8.4 Permits and Compliance

The Recommended Alternative involves work to be performed within areas that are regulated by a number of Federal, State, and Local Agencies. The list of potentially applicable environmental permits, approvals, and consultations for each plan measure include:

- Rhode Island Department of Environmental Management (RIDEM) Wetlands Permit
- Rhode Island Department of Transportation Physical Alteration Permit
- Rhode Island Pollution Discharge Elimination System Permit
- Stormwater Pollution Prevention Plan for Construction Activities and Notice of Intent to Discharge Stormwater Related to Construction Activities
- RIDEM Water Quality Certification
- US Army Corps of Engineers Programmatic General Permit or other US Army Corps Permits

In addition, the construction of plan measures that alter the location of the Federal Emergency Management Agency (FEMA) 100-yr flood lines will require the submission of a request for a Letter of Map Amendment (LOMA) to FEMA.

8.5 Costs

Costs in this plan are planning estimates. Final costs will be based upon the actual cost of installation. The total installation cost of the Recommended Plan is estimated to be $28,626,737. Tables 8-3 through 8-8 summarize cost information, cost sharing amounts, and project benefits. The Watershed Agreement details cost sharing rates. Tables 8-7 and 8-8 break out the damages and benefits into agriculture related damages and non-agriculture damages. Since the Town of Johnston qualifies as a rural community (population lass than 50,000 people) damages and benefits in the Town of Johnston are considered agriculture related. The City of Cranston has a population which exceeds 50,000 people; thus damages and benefits in the City of Cranston are considered non agriculture related. There are no direct (damages to farms, etc) agricultural damages.

Table 8-3: Estimate Installation Cost

Installation Cost Item	Unit	Number Nonfederal Land (feet)	Estimated Costs PL 566 Funds ($)	Other Funds ($)	Totals ($)
PL 566 Component					
Structural					
Rotary Drive Floodwall	Feet	1,500	2,062,505	89,245	2,151,750
Fletcher Avenue Floodwall	Feet	2,800	4,169,156	264,446	4,433,602
Reservoir Avenue Floodwall	Feet	1,350	4,446,451	967,755	5,414,206
Riverview Terrace Floodwall	Feet	1,750	4,950,973	161,307	5,112,280
Willow Brook Apartments Floodwall	Feet	1,100	2,438,072	110,846	2,548,918
South Bennet Drive	Feet	3,400	2,580,970	619,624	3,200,594
Simmons Brook Mill Culvert	Feet	300	469,395	6,000	475,395
Dry Floodproofing	Properties	22	503,858	0	503,858
Subtotal Structural			21,621,382	2,219,222	23,840,604
South Bennet Non Structural	Properties	9	3,028,200	1,069,992	4,098,192
Johnston	Properties	9	687,941	0	687,941
Subtotal Non Structural			3,716,141	1,069,992	4,786,133
Total PL 566 Component (Recommended Plan)			25,337,523	3,289,214	28,626,737

Notes:
1. Dollar Amounts Price Base 2007
2. Floodwall Lengths Round to Nearest 10 Feet
3. Property values represent Fair Market Values, estimated to be 12% higher than the appraised value, based on late 2006/early 2007 property sales

Table 8-4: Estimated Cost Distribution-Structural and Nonstructural Measures

Cost Item	Installation Cost PL 566 Funds							Installation Cost Other Funds							Total Installation Cost
	Construction	Engineering Services	Building Purchase Costs	Land Rights	Relocation Payments	Project Administration	Totals	Construction	Engineering Services	Building Purchase Costs	Land Rights	Relocation Payments	Project Administration	Totals	
PL 566 Component															
Structural															
Rotary Drive Floodwall	1,704,880	178,813	0	0	0	178,813	2,062,505	83,245	0	0	6,000	0	0	89,245	2,151,750
Fletcher Avenue and Rich Box Floodwall	3,340,773	349,952	121,296	0	7,184	349,952	4,169,156	158,742	0	40,432	64,456	816	0	264,446	4,433,602
Reservoir Avenue Floodwall	3,046,940	310,765	727,692	0	50,288	310,765	4,446,451	60,715	0	242,564	658,764	5,712	0	967,755	5,414,206
Riverview Terrace Floodwall	4,103,927	423,523	0	0	0	423,523	4,950,973	131,307	0		30,000	0	0	161,307	5,112,280
Willow Brook Apartments Floodwall	2,031,727	203,173	0	0	0	203,173	2,438,072	104,846	0		6,000	0	0	110,846	2,548,918
Simmons Brook Mill Culvert	391,395	39,000	0	0	0	39,000	469,395	0	0		6,000	0	0	6,000	475,395
South Bennet Drive	2,048,538	266,216	0	0	0	266,216	2,580,970	613,624	0	0	6,000	0	0	619,624	3,200,594
Dry Flood Proofing	419,882	41,988	0	0	0	41,988	503,858	0	0		0	0	0	0	503,858
Subtotal Structural	17,088,062	1,813,430	848,988	0	57,472	1,813,430	21,621,382	1,152,478	0	282,996	777,220	6,528	0	2,219,222	23,840,604
Non Structural															
South Bennett Non Structural	1,120,000	112,000	1,608,768	0	75,432	112,000	3,028,200	0	0	0	1,061,424	8,568	0	1,069,992	4,098,192
Johnston	484,534	48,453	0	0	0	48,453	581,441	0	0	0	0	0	0	0	581,441
Cranston	88,750	8,875	0	0	0	8,875	106,500	0	0	0	0	0	0	0	106,500
Subtotal Non Structural	1,693,284	169,328	1,608,768	0	75,432	169,328	3,716,141	0	0	0	1,061,424	8,568	0	1,069,992	4,786,133
Total PL 566 Component	18,781,346	1,982,758	2,457,756	0	132,904	1,982,758	25,337,523	1,152,478	0	282,996	1,838,644	15,096	0	3,289,214	28,626,737

Notes:

1. Dollar Amounts Price Base 2007
2. Floodwall Lengths Round to Nearest 10 Feet
3. Property values represent Fair Market Values, estimated to be 12% higher than the appraised value, based on late 2006/early 2007 property sales
4. 25% Contingency Applied to Construction Costs
5. Engineering services assumed to be 10% of construction costs
6. Project administration assumed to be 10% of construction costs
7. Landrights include land purchase price, appraisal, survey, title, and other incidental costs related to property acquisition or acquisition of easement
8. South Bennet Drive Structural Measures includes cost to raise backyards of 6 homes, which will be elevated, which are to be paid for by PL-566. Funds are allocated accordingly, above

Table 8-5: Structural Data

Floodwall	Type	River Stationing (feet)	Average Side Slope (ft/ft)	Average Height (ft)	100 Year Frequency Velocity (ft/s)
Rotary Drive Floodwall	Sheet Pile	36623-35161	Vertical	4.5	2.03
South Bennet Floodwall	Sheet Pile	33180-31656	Vertical	9	3
Fletcher Avenue Floodwall	Sheet Pile	29781-27892	Vertical	7	8.6
Reservoir Avenue Floodwall	Sheet Pile	8935-7605	Vertical	6	8
Riverview Terrace Floodwall	Sheet Pile	4788-3109	Vertical	7	1.9
Willow Brook Apartments Floodwall	Sheet Pile	2896-1889	Vertical	7	1.9

Floodway	Type	Stationing	Average Depth (ft)	100 Year Frequency Depth (ft)	100 Year Frequency Velocity (ft/s)
Simmons Brook Mill Culvert	Bypass Culvert	1574-1368	NA	8	5
South Bennet/River Avenue Culvert	Culvert	not on main branch-300 ft long	NA	2-5	3

Structure	Type	Stationing	Average Height (ft)	100 Year Frequency Depth (ft)	100 Year Frequency Velocity (ft/s)
South Bennet Drive and River Avenue Roadway	Raising of Roadway	33180-30745	5	2-4	3

Table 8-6: Annualized Adverse National Economic Development Effects

Evaluation Item	Project Outlays[1]		Totals
	Amortized Present Value of Installation Costs	Amortized Present Value of Operation, Maintenance, and Replacement Costs	
Rotary Drive Floodwall	93,080	6,398	99,478
South Bennet Floodwall	151,555	6,451	158,006
Fletcher Avenue Floodwall	209,899	8,035	217,934
Reservoir Avenue Floodwall	233,930	3,839	237,769
Riverview Terrace Floodwall	231,372	7,634	239,006
Willow Brook Apartments Floodwall	105,371	6,884	112,255
Simmons Brook Mill Culvert	21,515	2,694	24,209
Dry Flood Proofing	52,322	0	52,322
Non Structural Measures	286,811	0	286,811
Totals	1,385,855	41,935	1,427,790

1. The discounted present value of the installation costs amortized over a 50 year period of analysis-price base 2007 dollars with a 4.625% discount rate value

Table 8-7: Estimated Average Annual Flood Damage Reduction Benefits

Item	Average Annual Damage				Damage Reduction Benefits			
	Without Project		With Project		Without Project		With Project	
	Agricultural Related[3]	Non Agricultural Related	Agricultural Related[3]	Non Agricultural Related	Agricultural Related[3]	Non Agricultural Related	Agricultural Related[3]	Non Agricultural Related
Residential	1,105,550	419,920	70,340	109,400	0	0	1,035,210	310,520
Commercial	123,950	425,160	15,020	22,670	0	0	108,930	402,490
Totals	1,229,500	845,080	85,360	132,070	0	0	1,144,140	713,010

1. Price base 2007
2. Road and bridge damages were not evaluated
3. Agricultural related damage include damages to rural communities.

Table 8-8: Comparison of NED Benefits and Costs

Evaluation Item	Agricultural Related Damage Reduction[3]		Non-Agricultural Related Damage Reduction		Total Annualized Benefits	Annualized Costs[1, 2]	Benefit/Cost Ratio
	Residential	Commercial/Industrial	Residential	Commercial/Industrial			
Rotary Drive Floodwall	218,898	0			218,898	99,478	2.20
South Bennett Floodwall	1,447,525	0			1,447,525	158,006	9.16
Fletcher Avenue Floodwall	0	0	50,437	507,045	557,482	217,934	2.56
Reservoir Avenue Floodwall	0	0	4,940	304,999	309,940	237,769	1.30
Riverview Terrace Floodwall	0	0	396,229	0	396,229	239,006	1.66
Willow Brook Apartments Floodwall	0	0	278,874	0	278,874	112,255	2.48
Simmons Brook Mill Culvert	1,966	91,176			93,142	24,209	3.85
Dry Flood Proofing	94,139	80,293	11,162	161,553	347,147	52,322	6.63
Non Structural	807,229	78,828			886,057	286,811	3.09
Totals					4,535,295	1,427,790	3.18

1. 2007 dollars, 4.625% discount rate, 50-year analysis period, 5-year installation period. The present value of all costs includes installation, operation, maintenance, and replacement.
2. From Table 8-6
3. Agricultural related damage include damages to rural communities.

The Recommended Plan measures serve only the purpose of flood prevention; therefore, installation costs are allocated entirely to that purpose. Total costs include costs for construction, engineering services, project administration, land rights, and relocation payments. Measures in the Recommended Plan will be installed under federal contract. Construction costs include estimated contract costs plus a 25 percent contingency. All costs are based on estimated quantities and 2007 unit costs. The unit costs are based on bid prices for similar work, current published values, and quotes from manufacturers. Construction costs include landscaping, drainage, wall installation, floodproofing, etc, and are estimated to be approximately $19,933,824.

Cost estimates are subject to change. Prices of individual components of cost estimates may be subject to large price fluctuations. Drainage cost estimates include site work and drainage structures. Floodwall cost estimates include the structures themselves and site

work. Cost estimates for non structural measures are based on information in the FEMA document titled "Engineering Principles and Practices of Retrofitting Flood Prone Residential Structures" dated 2001. Detailed geotechnical investigations, including borings to determine water table depth and bedrock depth, are required before final design. Findings from this could drastically change cost estimates. It is assumed in cost estimates that boulders greater than 5 feet in diameter will not be encountered at any site. This cost estimate assumes that existing utilities will not have to be reset or removed. All cost estimates are at their 2007 value. All cost estimates assume existing utilities will not have to be relocated in order to install plan measures. All cost estimates also assume that no environmental contamination, solid waste, or hazardous waste will be encountered during construction of project measures, and cost estimates assume soil disposal will not be required.

The drainage design for Riverview Terrace assumes that the following pieces of vacant property can be used as detention basins: City of Cranston Tax Assessor's Plat 9 Lots 1874, 3479, 3480, and 3486. Only Lot 3486 is owned by a private owner. The other properties are owned by the City of Cranston. The cost estimate assumes that only Lot 3486 will need to be acquired.

The following assumptions were made when estimating the cost of steel sheet pile walls:

- The depth below ground of the sheeting is double the height above the ground
- Overall sheeting wall is 1 foot wide
- The weight of steel is 22 lb/ft^2
- The total cost for materials and labor is $1.00 per lb

Engineering services costs include the direct cost of engineers, geologists, and other technicians for surveys, engineering, geologic investigation, preparation of plans, and specifications for each plan measure. Geotechnical services are estimated at $64,000. This geotechnical cost estimate assumes the following (note that field conditions may require more frequent explorations):

- 4 borings per day
- $2,000 per day for truck rig, operator, helper, and oversight
- Borings every 100 feet along floodwall
- Borings every 100 feet along Simmons Brook bypass culvert
- 1 boring at the center of each detention basin
- Borings every 100 feet along center line of underground stormwater storage systems
- 1 boring at each elevated home
- Borings will not be required for storm sewer pipes, catch basins, manholes, drywells, and pump chambers. If they are needed this is an added cost.

The cost for engineering services is estimated at approximately $1,982,758. Project administration includes those costs related to project coordination and oversight and is estimated at $1,982,758.

Land-rights and building purchase costs include all expenditures to purchase land, buildings, and or easements, permits, utility relocations, and road and railroad modifications. It is assumed that easements to place floodwalls, drainage structures, and culverts will cost no more than $8,000 each, including incidental costs (survey, closing, etc.) associated with acquiring the land. Land-rights and building purchase costs are estimated to be approximately $4,579,396

Relocation assistance payments include moving and related expenses for a displaced person, business, or farm operation, including incidental costs (survey, closing, etc) associated with acquiring the property. In addition, financial assistance is available for replacement housing for a displaced person who qualifies and whose dwelling is acquired because of the project. Relocation assistance payments were estimated to be $8,000 per relocated property. In cases where multiple adjacent properties owned by the same entity (person, business, etc.) are to be acquired, relocation assistance payments were applied once. Relocation assistance payments are estimated to be approximately $148,000.

8.6 Installation and Financing

The NRCS will utilize funds appropriated annually under Public Law 83-566, the Watershed Protection and Flood Prevention Act, as the source of the federal share of the installation cost. The Sponsor will bear the remaining costs for project administration and legal fees utilizing cash reserves, loans, bonds, and/or annual tax revenues appropriated to it by the State.

The period during which all measures in the Recommended Plan are expected to be installed is 5 years. Table 8-9 shows the planned schedule and funding by year. During the 50-year evaluation, operation and maintenance costs will be incurred and benefits will accrue in years 2 through 50. The planned sequence of installation was developed using the following criteria:

- Proportioning the funding equally by installation year
- Prioritizing sites based on flooding frequency, severity, and potential for loss of life
- Potential impacts to other planned project areas

Table 8-9: Planned Funding by Year

Year	Measures	Estimated Costs[1]		
		PL 566 Funds	Other Funds	Total Funds
Year 1	Fletcher Avenue & Rich Box Engineering	349,952	0	349,952
Year 1	South Bennet Drive Non-Structural and River Drive River Ave	3,028,200	1,069,992	4,098,192
Year 1	South Bennet Drive Structural Engineering	266,216	0	266,216
Year 1	Non Structural	687,941	0	687,941
Year 1	Total	4,332,309	1,069,992	5,402,301
				0
Year 2	Fletcher Avenue & Rich Box Construction	3,819,205	264,446	4,083,651
Year 2	South Bennet Drive Construction	2,314,754	619,624	2,934,378
Year 2	Riverview Terrace Engineering	423,523	0	423,523
Year 2	Simmons Brook Engineering	39,000	0	39,000
Year 2	Total	6,596,482	884,070	7,480,552
Year 3	Riverview Terrace Construction	4,527,450	161,307	4,688,757
Year 3	Simmon Brook Construction	430,395	6,000	436,395
Year 3	Rotary Drive Engineering	178,813	0	178,813
Year 3	Reservoir Avenue Engineering	310,765	0	310,765
Year 3	Total	5,447,423	167,307	5,614,730
				0
Year 4	Rotary Drive Construction	1,883,693	89,245	1,972,938
Year 4	Reservoir Avenue Construction	4,135,685	967,755	5,103,440
Year 4	Willowbrook Engineering	203,173	0	203,173
Year 4	Total	6,222,551	1,056,999	7,279,550
				0
Year 5	Willowbrook Construction	2,234,900	110,846	2,345,745
Year 5	Dry Flood Proofing (Various Sites)	503,858	0	503,858
Year 5	Total	2,738,758	110,846	2,849,604
	Total Project	25,337,523	3,289,214	28,626,737

Responsibilities for carrying out the Plan will be shared between the Natural Resources Conservation Service and the Sponsors as follows:

NRCS

a. Provide overall Project administration.
b. Provide engineering design and construction inspection for works contracted by NRCS.
c. Provide engineering designs for works contracted by Sponsors.
d. Provide funds to Sponsors for preparing engineering designs and construction inspection for works contracted by Sponsors.

e. Provide 100% of the total engineering services costs for structural and non-structural measures.
f. Provide funds to Sponsors for project management and engineering typically performed by NRCS to implement projects.
g. Provide 89.8 percent of the cost of relocation assistance payments.
h. Provide 75 percent of the building fair market value purchase costs

Sponsors

a. Responsible for their Project and contract administration costs for installing works of improvement.
b. Acquire any land rights necessary for installing the works of improvement.
c. Bear the costs of relocating or modifying utilities.
d. Secure all required federal, state and local permits.
e. Provide 10.2 percent of the cost of relocation assistance payments.
f. Bear the operation, maintenance, and replacement costs for the life of the project.
h. Provide 25 percent of the building fair market value purchase costs

Property whose acquisition is required for a particular measure (include easements for floodwalls and other plan structures) will be acquired in advance of engineering designs to ensure property acquisition does not impede implementation of project measures. Excluding easements, the following is a summary of property to be acquired:

Johnston

- Plat 3 Lots 239, 442, and 230
- Plat 6 Lots 137, 138, 139, 140, 141, 142

Cranston

- Plat 9 Lots 3453, 3500, 2434, 3435, 3089, 3513, 2436, 2433, 2432, 2431, 2430, 2526, 3497, 3208, and 3455 (site Reservoir Avenue flood wall portions vacant)
- Plat 12 Lot 410 (site Fletcher Avenue Floodwall)
- Plat 9 Lots 1874, 3479, and 3480 (owned by City of Cranston, excluded from cost estimate currently vacant)
- Plat 9 Lot 3486 (detention basin behind Riverview Terrace floodwall, currently vacant land)

The following is a summary of other proposed non-structural measures.

Johnston-South Bennett Drive Non Structural Measures

- Plat 3 Lots 433 and 389; earth levee
- Plat 6 Lot 148; earth levee
- Plat 6 Lots 101, 102, 118, 119, 120, and 121; home elevation
- Plat 6 Lots 93, 136, 152, and 167; dry floodproofing
- Plat 3 Lots 432 and 434; dry floodproofing

Johnston-Dry Floodproofing

- Plat 3 Lots 313, 225, 224, 310, 391, 369, and 422
- Plat 6 Lot 168
- Plat 23 Lot 91 (1 of 2 buildings)

Cranston-Dry Floodproofing

- Plat 9 Lots 2694, 3359, 3466, and 2754
- Plat 10 Lot 112
- Plat 12 Lots 3138 and 3140

Contracting

For the Recommended Plan, it is expected that the Sponsors will formally request NRCS to contract for installation of the planned measures utilizing federal contracting procedures.

Land Rights and Relocation

All necessary land rights for installation of the structural measures of the Recommended Plan will be acquired by the Sponsor at no cost to the federal government. The Sponsor has the needed authority to obtain land rights, including the power of eminent domain. The land requirements are estimated to be 16 acres. Of the relocations described earlier, 12 are single family residences, 1 is a small apartment building, and 2 are commercial structures. In addition, along the Reservoir Avenue Floodwall, 12 commercial properties (some vacant) and two vacant residential properties will be acquired. All of these properties will be acquired, the business or residents relocated, the buildings demolished, and the site restored.

The relocation and modification of water, gas, sewer, and other utilities; modification to roads or railroads; and costs of legal services, property surveys, and other items necessary for the acquisition of land rights are considered land rights costs.

Relocations will be accomplished by the Sponsor under the guidelines established in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646).

Conditions for Providing Assistance

Federal assistance, financial and other to be furnished by NRCS, is contingent on the appropriation of funds for this purpose. Before federal construction funds are made available the Sponsor will:

a) Provide written assurance that they have the legal authority, sufficient funds, and are willing and able to obtain all necessary land rights, easements, and permits.
b) Execute an Operation and Maintenance Agreement.
c) Execute a Project Agreement
d) Provide written assurance that 65 percent of the residents to be protected by nonstructural measures in the High Hazard Zones will participate in the project.
e) Prior to construction of any project for local flood protection, the Sponsors shall agree to participate in and comply with applicable Federal flood plain management and flood insurance programs (Public Law 99-662).

All construction will be in accordance with the Occupational Safety and Health Administration Standards. Note that technical and financial assistance will only be provided when it contributes to indentified project objectives and does not result in significant adverse impacts.

Other Agency Responsibility

At this time, no other State or Federal agency is expected to aid in installation of any Recommended Plan measures; this may change in the future.

8.7 Operation, Maintenance, and Replacement

The operation, maintenance, and replacement of the nonstructural measures are the responsibility of the property owner. The operation, maintenance, and replacement of the structural measures are the responsibility of the Sponsor. The estimated annualized cost of operation, maintenance, and replacement is $64,325, as shown in the below table.

Table 8-10: Operation and Maintenance Costs

Plan Measure	Length of Floodwall (feet)	Number of Pump Stations	Total Yearly O&M Cost[1]
Rotary Drive	1,500	1	$8,500
South Bennett Drive	1,165	1	$6,825
Fletcher Avenue	2,800	2	$16,000
Reservoir Avenue	1,350	1	$7,750
Riverview Terrace	1,750	3	$11,750
Willow Brook Apartments	1,100	5	$10,500
Simmons Brook Bypass Culvert	NA	NA	$3,000
Total			**$64,325**

[1]Note: Yearly floodwall operation and maintenance estimated using the following formula: (number of pump stations)x($1,000) + (length of wall in feet)x($5) = (yearly operation and maintenance cost)

An operation and maintenance agreement, between NRCS and the Sponsor, will be executed prior to the signing of a land rights, relocation, or project agreement. The term of the operation and maintenance agreement will be 50 years, based on the projected project life span. A typical operation and maintenance agreement used by NRCS is provided in Appendix G. The agreement will contain a reference to the NRCS National Operation and Maintenance Manual. An operation and maintenance (O&M) plan will be prepared for each separate plan measure in accordance with the guidelines in the manual. The O&M plan will specify the responsibilities of the Sponsor, including, but not limited to, the following:

a) Periodic inspection of measures
b) Repair of fencing, riprap, vegetated area
c) Mowing of drainage swales and detention basins
d) Inspection and maintenance of flap or motorized gates
e) Testing of pumps and generators
f) Cleaning of catch basins and detention basins
g) Installation of closures
h) Training of people responsible for operation and maintenance

The Sponsor will make inspections annually, after unusually severe floods, and after the occurrence of any other conditions that might adversely affect the plan measures to determine what maintenance is needed. These inspections will continue annually for the life of the project. The NRCS may assist the Sponsor with the inspections at the discretion of the State Conservationist. The Sponsor will prepare an inspection report and send a copy to the NRCS annually.

SECTION 9

WATERSHED PLAN FIGURES

This Section contains all of the drawings developed using output from the HEC/RAS computer model depicting the 100-year floodplain maps. The 500-year floodplain maps are not shown since floodwalls and non-structural measures will preclude any loss of life.

The drawings also provide details of the drainage areas for each of the major mitigation sites as well as locations of proposed mitigation practices.

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED FLOOD WALL
- FLOOD ZONE

AREA 1

AREA 2

AREA 3

AREA 4

AREA 5

AREA 6

SCALE 1:3000

0 1500 3000 6000

SCALE: AS INDICATED

0

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

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DESIGNED BY: RC
REVIEWED BY: IR
OPERATOR: PJS
DATE: 08/07/09

POCASSET RIVER
WATERSHED PLAN

INDEX TO RECOMMENDED PLAN
AND URBAN FLOOD PLAIN MAP

PROJECT NO.
32853.03

FIGURE NO.
9-1

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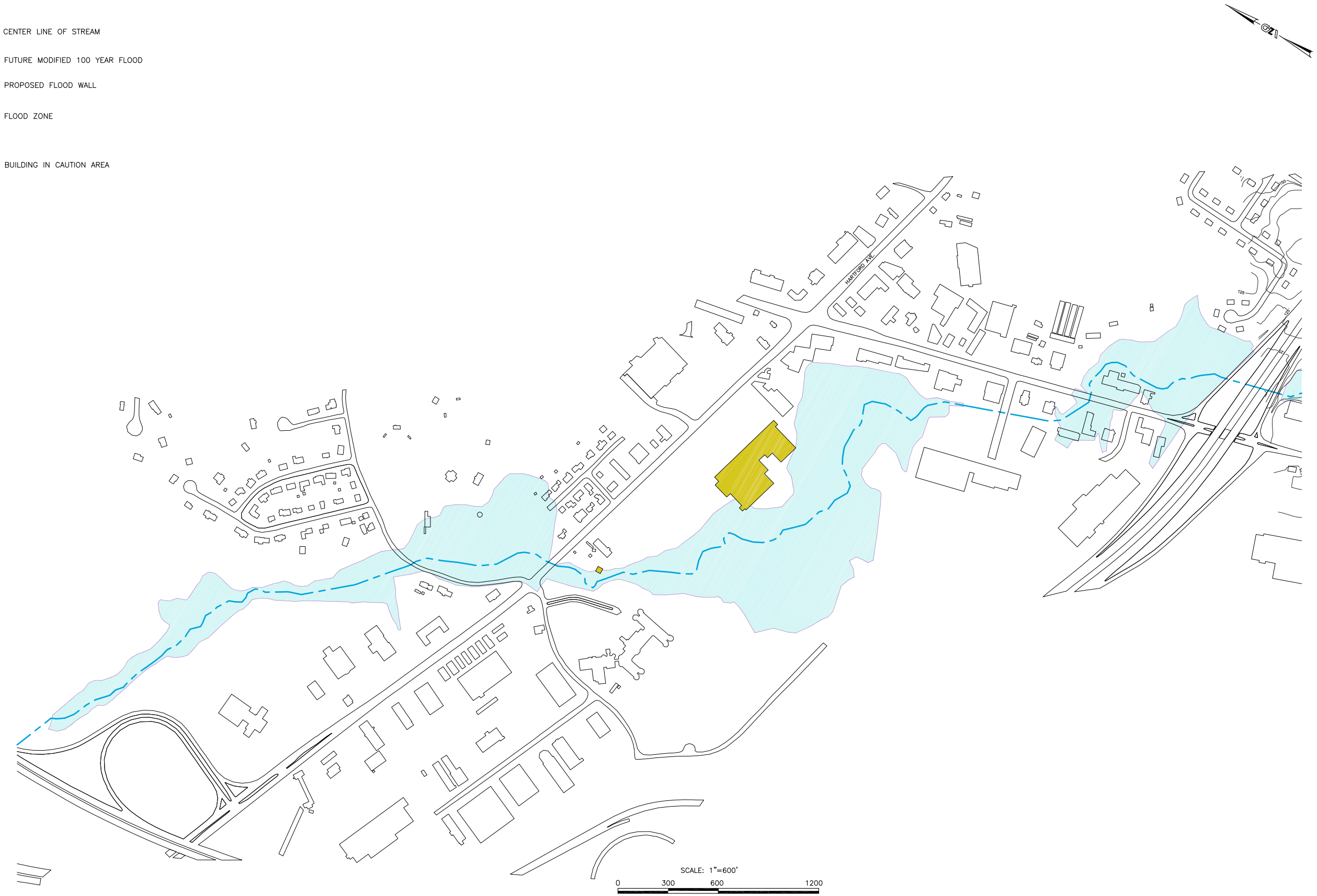
LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED FLOOD WALL
- FLOOD ZONE
- BUILDING IN CAUTION AREA



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1	NEW FIGURE	CRD	8/7/09

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REVIEWED BY: IR
OPERATOR: PJS/TLE
DATE: 08/07/09

POCASSET RIVER
WATERSHED PLAN

AREA 1- RECOMMENDED PLAN
AND URBAN FLOOD PLAIN MAP

PROJECT NO.
32853.03

FIGURE NO.
9-2

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GZA-J:\ENV\32853-03.ir\FIGURES\DWG\GZA\32853.03_F9_R1_OVER VIEW PLAN.DWG [2-AREA 1] September 08, 2009 - 3:33pm Christopher.dias

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED FLOOD WALL
- PROPOSED RING DIKE
- FLOOD ZONE
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING TO BE PROTECTED BY EARTH LEVEE
- BUILDING IN CAUTION AREA
- BUILDING TO BE PROTECTED BY FLOOD WALL OR RAISED ROADWAY
- BUILDING TO BE PROTECTED BY ELEVATING

APPROXIMATE LOCATION OF DEBRIS DAM TO BE REMOVED

ROTARY DRIVE FIGURE 9-4

SOUTH BENNETT DRIVE FIGURE 9-5

SIMMONS BROOK CULVERT FIGURE 9-6

SCALE: 1"=600'

0 300 600 1200

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

SCALE: AS INDICATED

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POCASSET RIVER
WATERSHED PLAN

AREA 2- RECOMMENDED PLAN
AND URBAN FLOOD PLAIN MAP

PROJECT NO.
32853.03

FIGURE NO.
9-3

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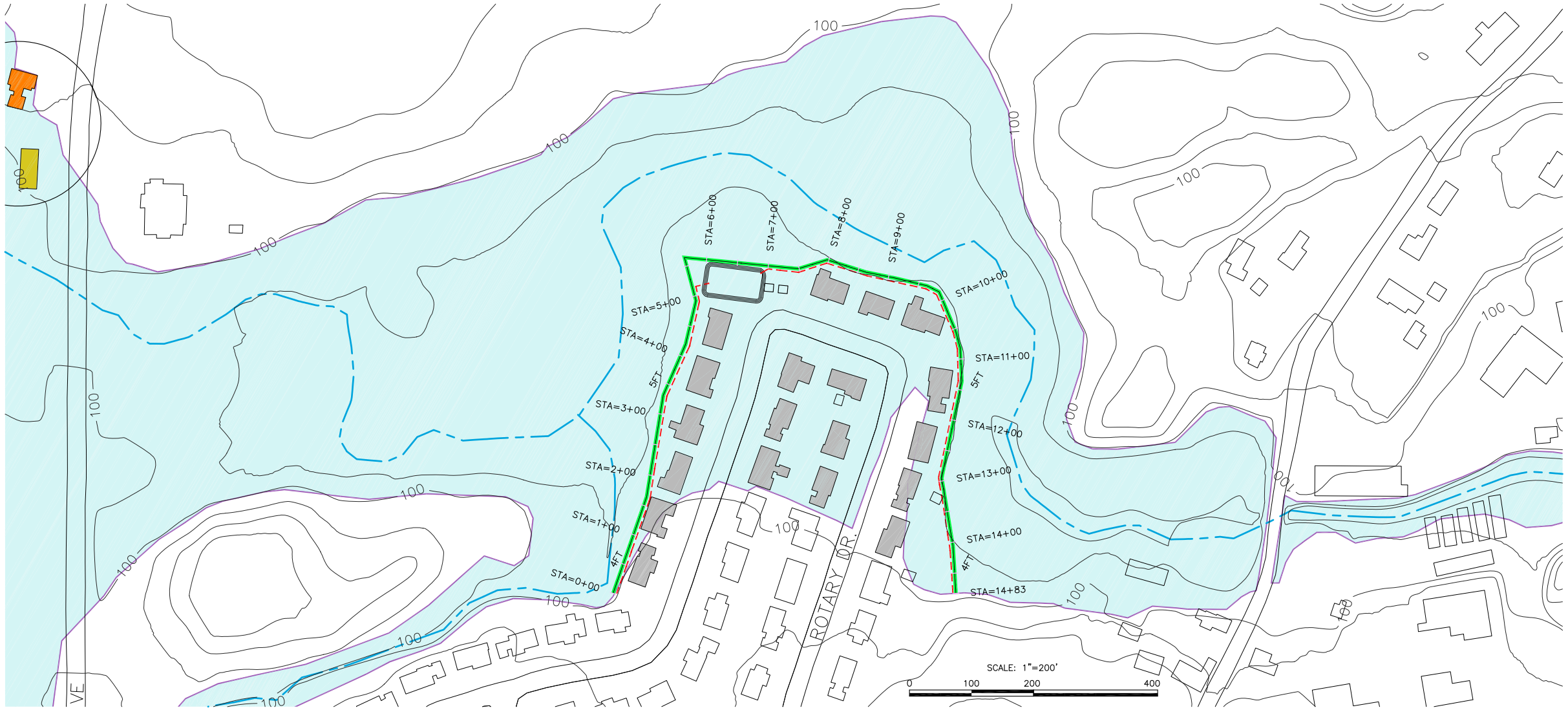
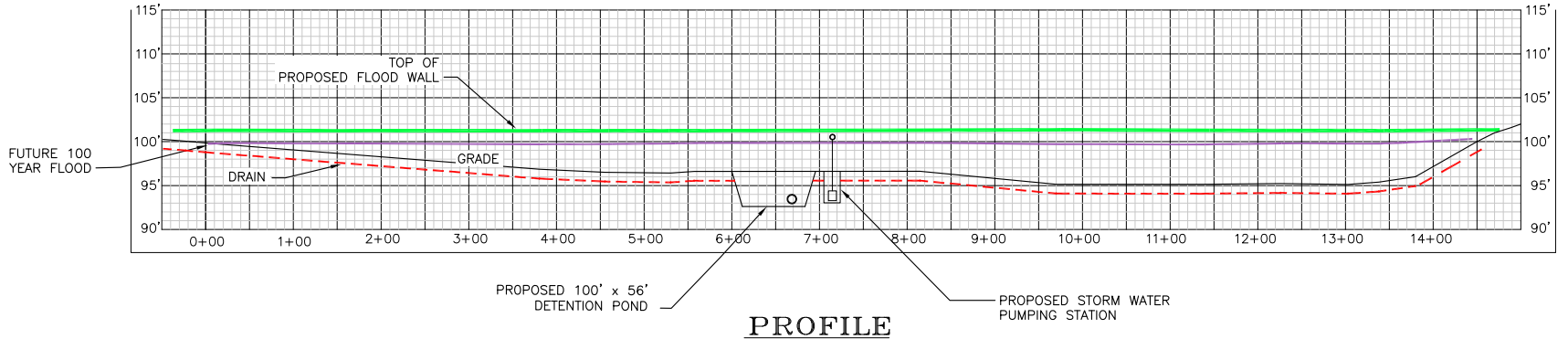
GZA-J:\ENV\32853-03.ir\FIGURES\DWG\GZA\32853.03_F9_R1_OVER VIEW PLAN.DWG [3-AREA 2] September 08, 2009 - 3:35pm Christopher.dias



LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING TO BE PROTECTED BY FLOOD WALL



PROFILE

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

SCALE: AS INDICATED

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POCASSET RIVER WATERSHED PLAN

ROTARY DRIVE FLOOD WALL

PROJECT NO.
32853.03

FIGURE NO.
9-4

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PROPOSED STORM WATER PUMPING STATION (3800 GPM)

PROPOSED OUTFALL & FLAP GATE

EXISTING SANITARY SEWER PUMP STATION

PROPOSED OUTFALL & FLAP GATE (TYPICAL)

100' x 56' DETENTION POND

PROPOSDED DRAIN LINE (TYPICAL)

EXISTING OUTFALL TO BE MODIFIED WITH FLAP GATE

CENTRAL AVE

ROTARY DR.

ATWOOD

ATWOOD AVE.

ALCAR DR.

CB

100 125 150

5FT

NOTES:

1. THE EXISTING STORMWATER DRAINAGE SYSTEMS LOCATION AND CONFIGURATION OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND/OR TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
2. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY NRCS AND BY USING DIGITAL AERIAL ORTHOPHOTOGRAPHY.
3. EXISTING PIPE CONDITIONS REQUIRE REMEDIAL EVALUATION.

LEGEND:

- CENTER LINE OF STREAM
- MODELED 100 YEAR FLOOD LIMIT BASED ON FUTURE WATERSHED DEVELOPMENT PER LOCAL ZONING MAPS.
- APPROXIMATE WALL HEIGHT
- 5FT — PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- EXISTING DRAIN LINES
- EXISTING CATCH BASINS
- PROPOSED 5' DIA. 5' DEEP HOLLOW DRY WELL
- PROPOSED PUMP STATION
- PROPOSED OUTFALL & FLAP GATE
- PROPOSED SWALE

SCALE: 1"=200'

0 100 200 400

REV. NO.	DESCRIPTION	BY	DATE

SCALE: AS INDICATED

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POCASSET RIVER WATERSHED PLAN

ROTARY DRIVE DRAINAGE PLAN

PROJECT NO.
32853

FIGURE NO.
9-4A

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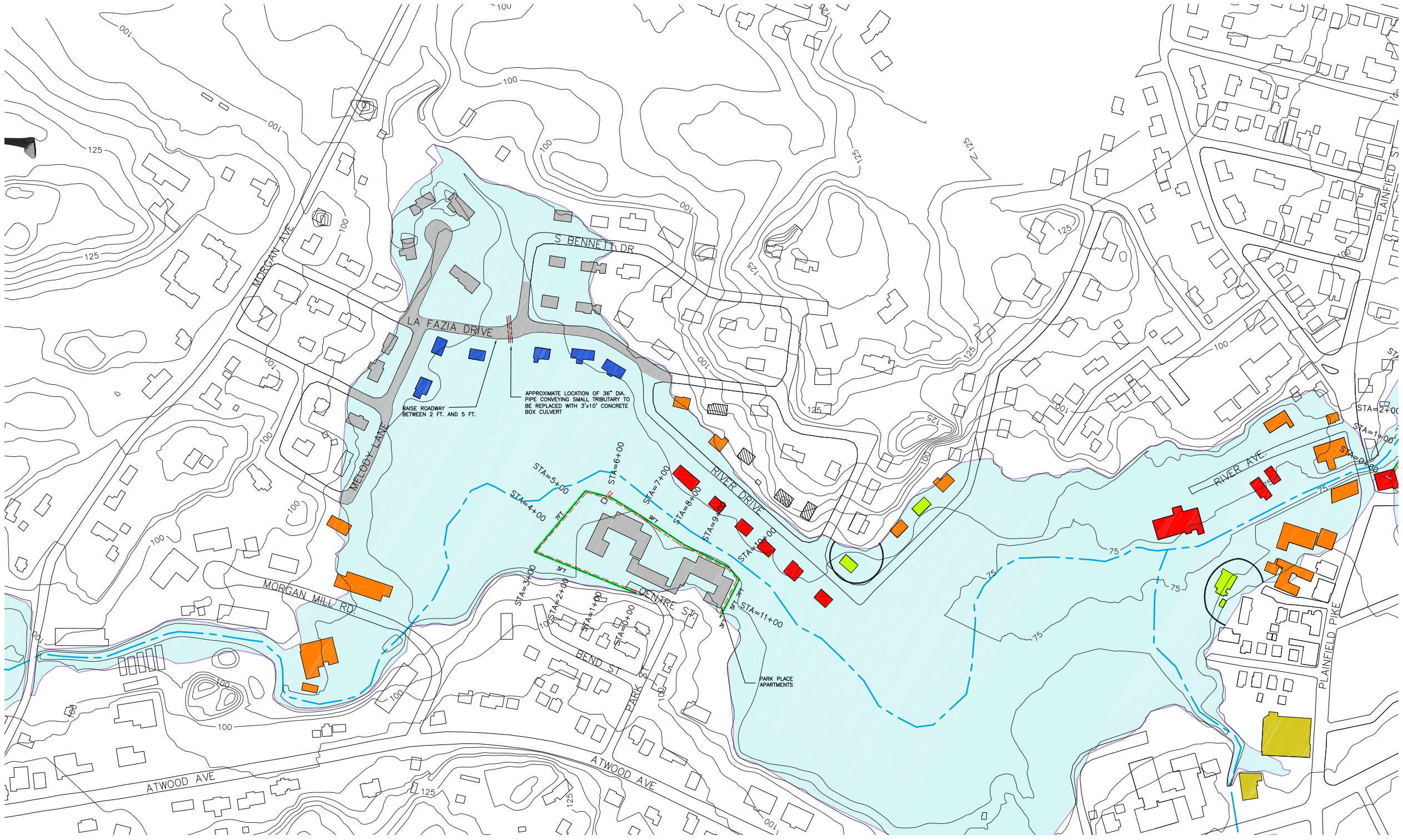

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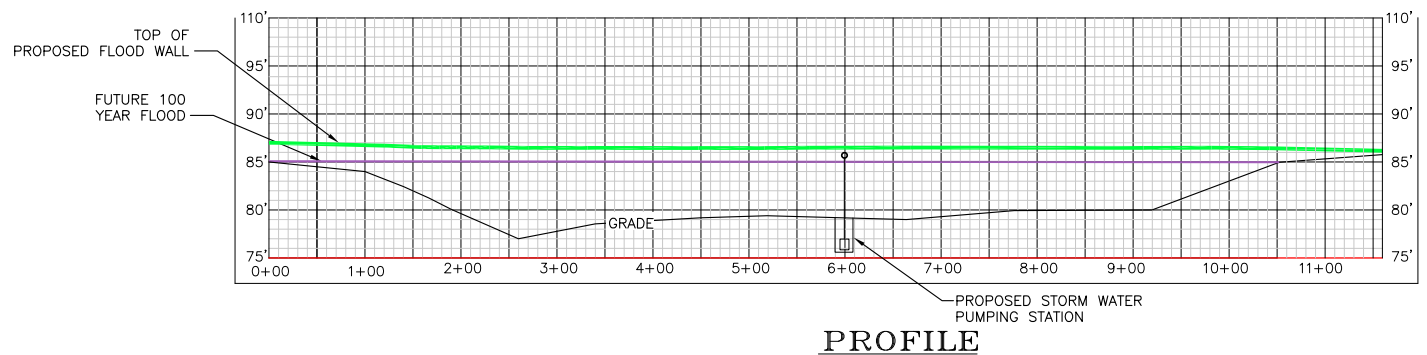

PROFILE

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING TO BE PROTECTED BY EARTH LEVEE
- BUILDING TO BE PROTECTED BY FLOOD WALL OR RAISED ROADWAY
- BUILDING TO BE PROTECTED BY ELEVATING
- EMERGENCY EVACUATION CONCERNS
- PROPOSED RING DIKE
- PROPOSED PUMP STATION
- PROPOSED OUT FALL & FLAP GATE

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

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POCASSET RIVER WATERSHED PLAN

SOUTH BENNETT DRIVE FLOOD WALL

PROJECT NO.
32853.03

FIGURE NO.
9-5

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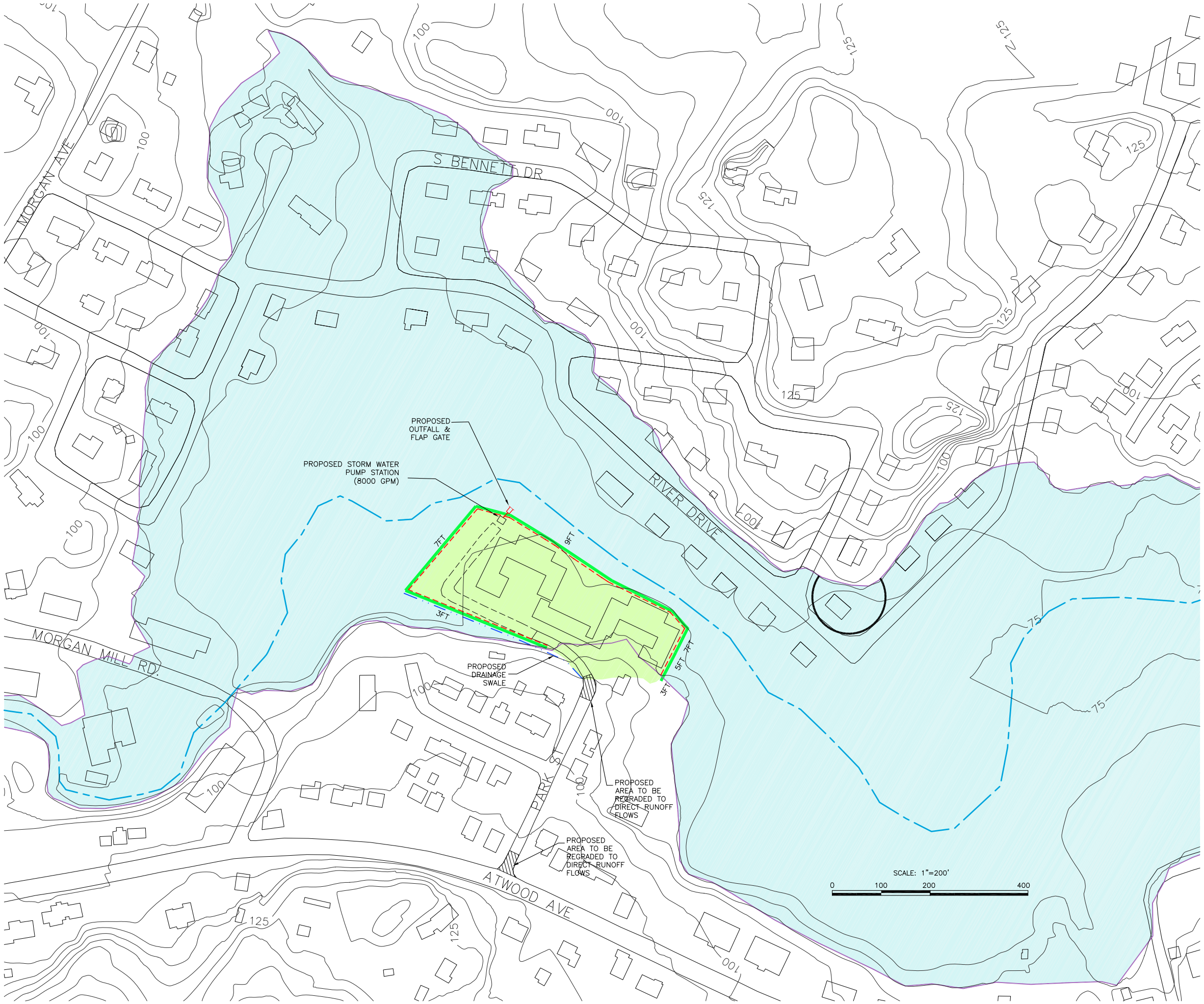
NOTES:

1. THE EXISTING STORMWATER DRAINAGE SYSTEMS LOCATION AND CONFIGURATION OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND/OR TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
2. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY NRCS AND BY USING DIGITAL AERIAL ORTHOPHOTOGRAPHY.

LEGEND:

- CENTER LINE OF STREAM
- MODELED 100 YEAR FLOOD LIMIT BASED ON FUTURE WATERSHED DEVELOPMENT PER LOCAL ZONING MAPS.
- APPROXIMATE WALL HEIGHT
- 5FT — PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- EXISTING DRAIN LINES
- EXISTING CATCH BASINS
- PROPOSED PUMP STATION
- PROPOSED OUTFALL & FLAP GATE
- PROPOSED AREA TO BE REGRADED TO DIRECT RUNOFF FLOWS
- PROPOSED SWALE
- PROPOSED RING DIKE



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GZA-J:\ENV\32853-03.J\FIGURES\DWG\GZA\32853.03_FX_R1_MASTER DRAINAGE.DWG [PARK PLACE D] September 08, 2009 - 3:02pm Christopher.dias

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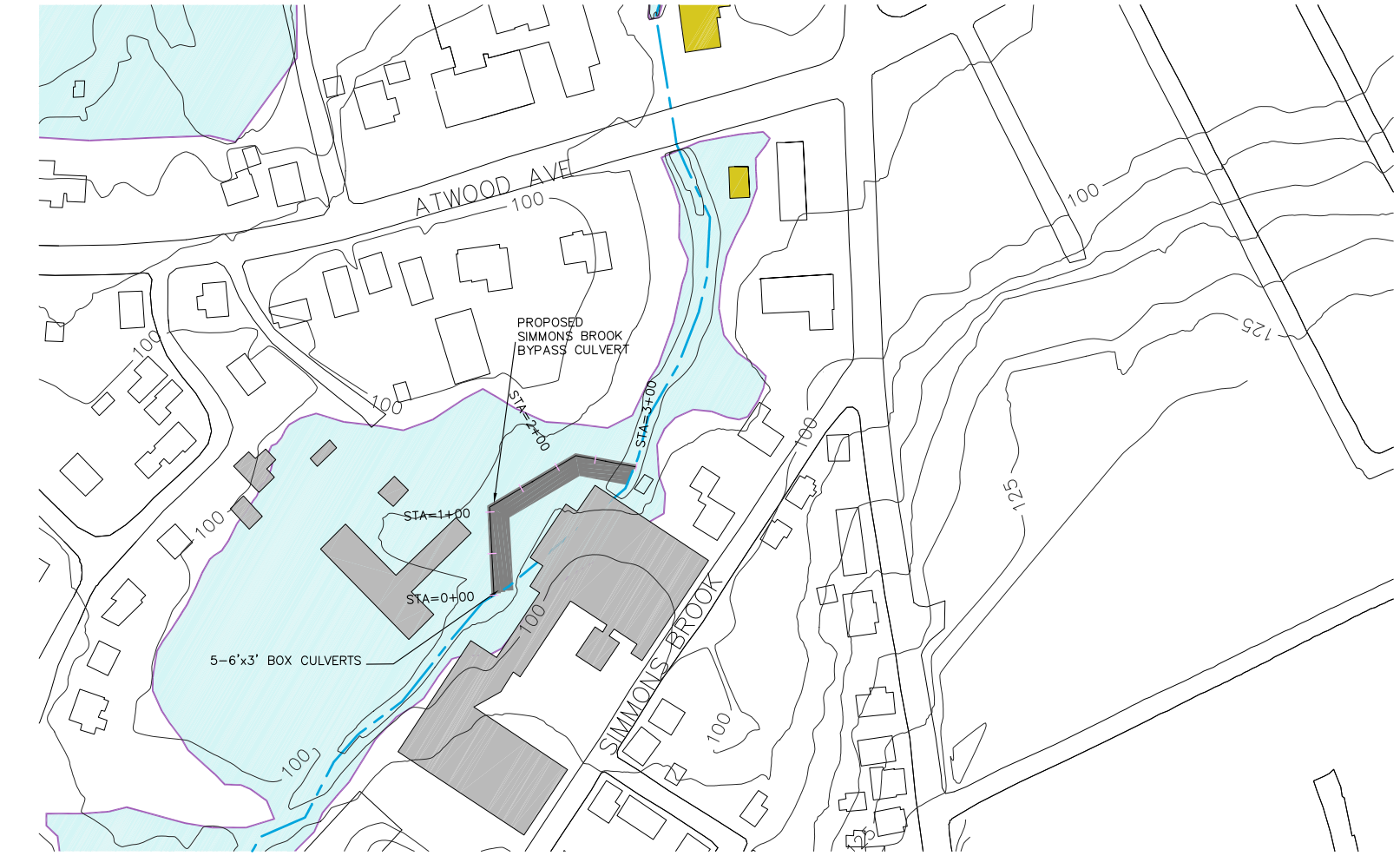
POCASSET RIVER WATERSHED PLAN

SOUTH BENNETT DRIVE DRAINAGE PLAN

PROJECT NO.
32853

FIGURE NO.
9-5A



FOR CONTINUATION SEE SHEET # 9-7

SCALE: 1"=200'

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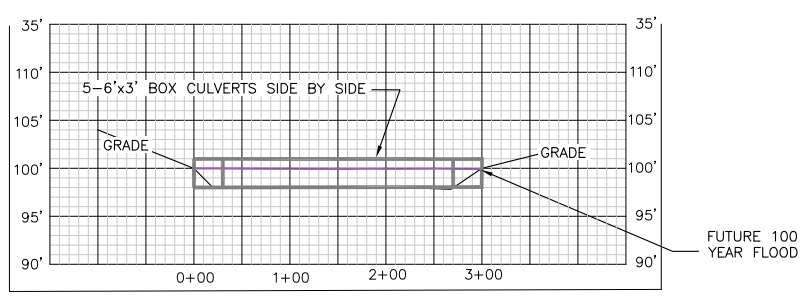

PROFILE

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED BYPASS CULVERT
- BUILDING IN CAUTION AREA
- BUILDING TO BE PROTECTED BY CULVERT

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

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OPERATOR: PJS
DATE: 08/07/09

POCASSET RIVER
WATERSHED PLAN

SIMMONS BROOK
BYPASS CULVERT

PROJECT NO.
32853.03

FIGURE NO.
9-6

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G:\ENV\32853-03.IR\FIGURES\DWG\GZA\32853.03_FIG_R1_OVER VIEW PLAN.DWG [7-AREA 3] September 08, 2009 - 3:46pm Christopher.dilos

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED FLOOD WALL
- FLOOD ZONE
- BUILDING IN CAUTION AREA

FIGURE NO. 9 – 7	PROJECT NO. 32853.03	POCASSET RIVER WATERSHED PLAN AREA 3– RECOMMENDED PLAN AND URBAN FLOOD PLAIN MAP	PROJ MGR: IR DESIGNED BY: RC REVIEWED BY: IR OPERATOR: PJS/TLE DATE: 08/07/09

SCALE: AS INDICATED
0

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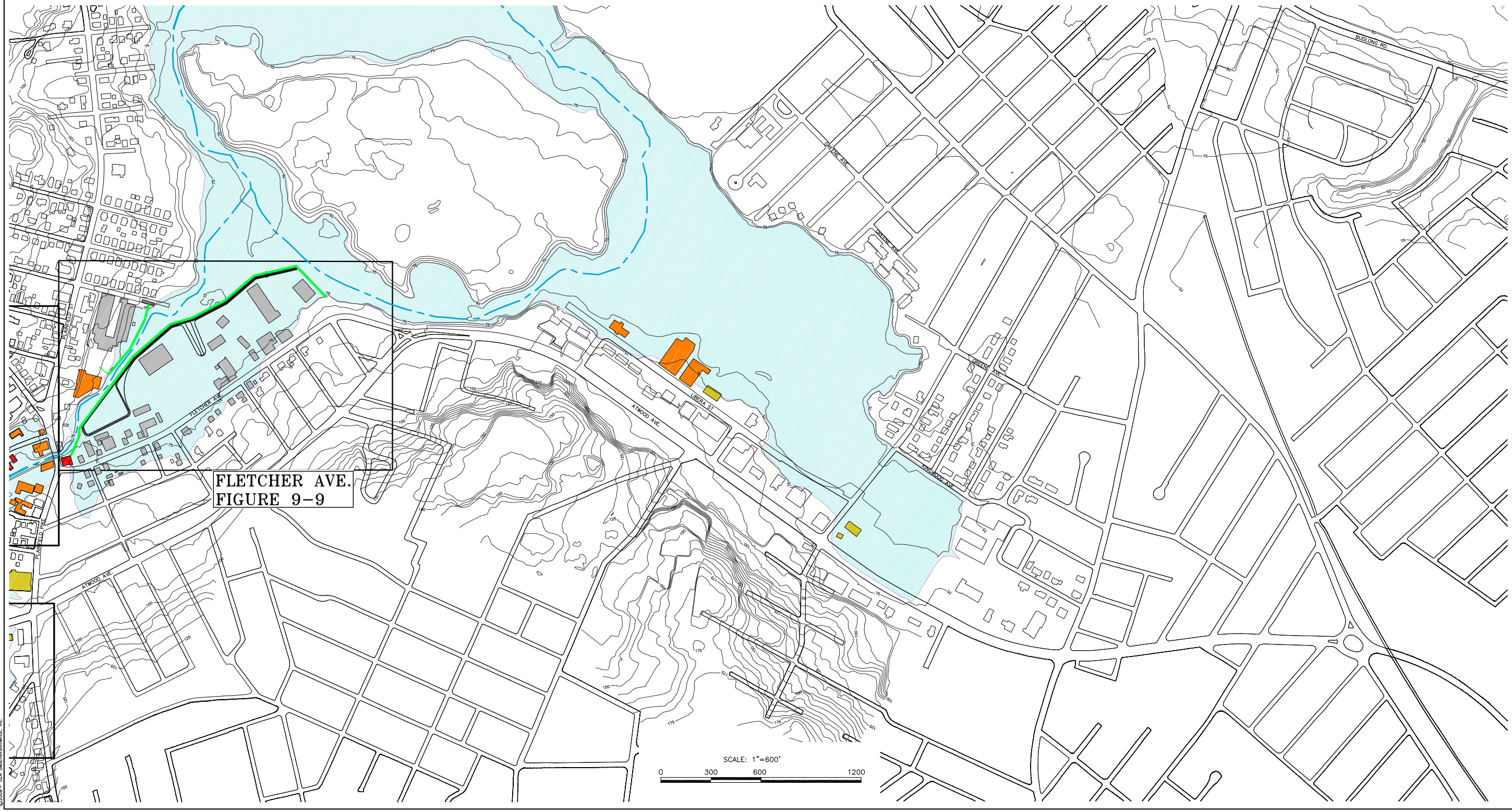
REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED FLOOD WALL
- FLOOD ZONE
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING IN CAUTION AREA



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1	NEW FIGURE	CRD	8/7/09

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REVIEWED BY: IR
OPERATOR: PJS
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POCASSET RIVER
WATERSHED PLAN

AREA 4- RECOMMENDED PLAN
AND URBAN FLOOD PLAIN MAP

PROJECT NO.
32853.03

FIGURE NO.
9-8

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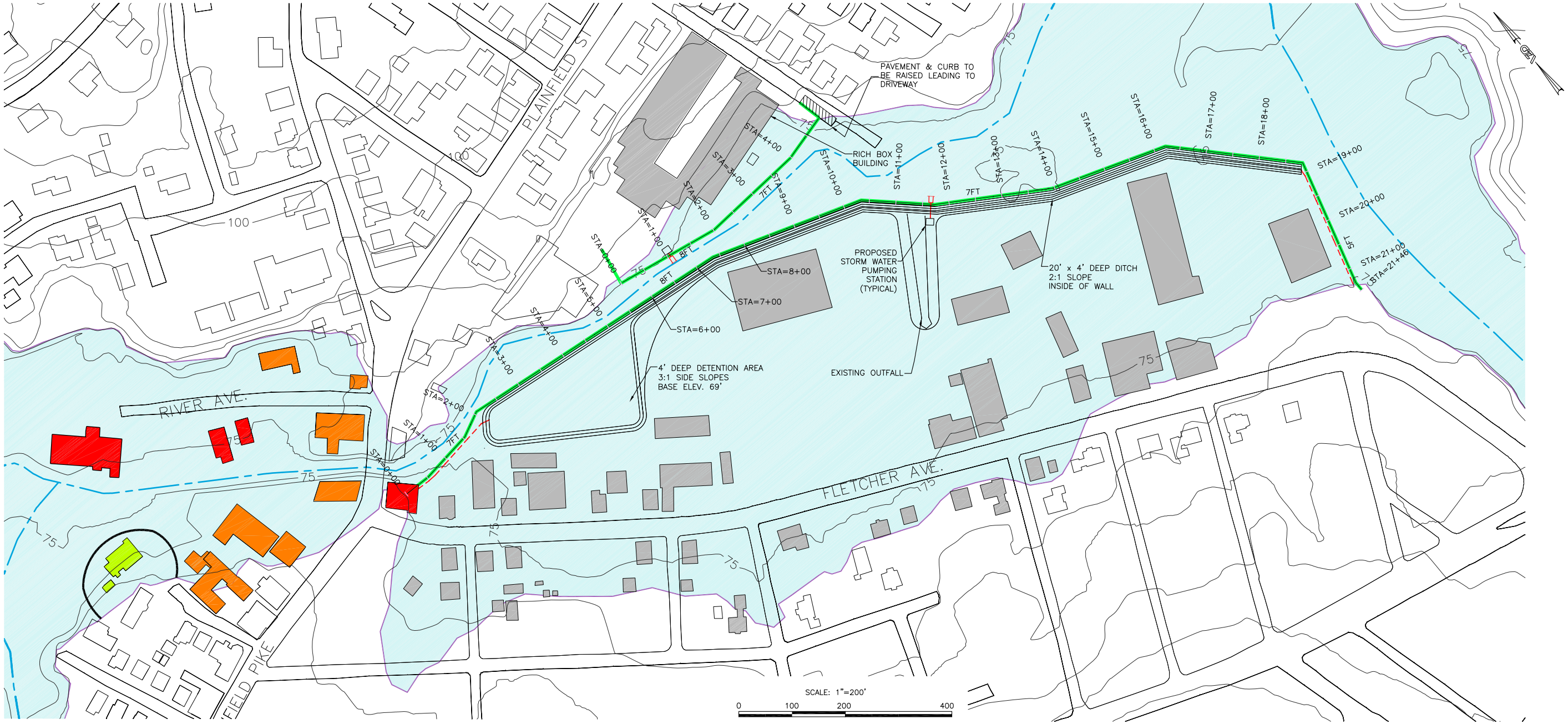
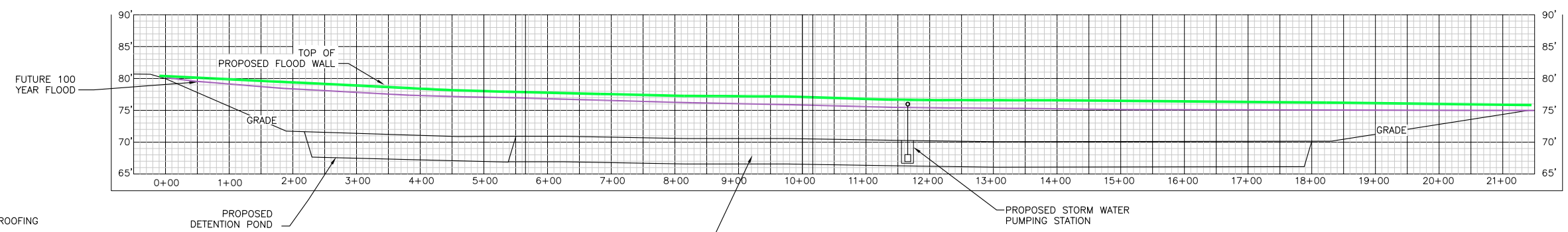


LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT — PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- PROPOSED STORM WATER PUMPING STATION
- PROPOSED OUTFALL & FLAP GATE
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING TO BE PROTECTED BY FLOOD WALL
- BUILDING TO BE RELOCATED OUTSIDE OF FLOOD PLAIN
- BUILDING TO BE PROTECTED BY EARTH LEVEE



PROFILE (FLETCHER FLOOD WALL)

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

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POCASSET RIVER WATERSHED PLAN

FLETCHER AVENUE FLOOD WALL

PROJECT NO. 32853.03

FIGURE NO. 9-9

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PAVEMENT & CURB TO BE RAISED LEADING TO DRIVEWAY

RICH BOX BUILDING

PROPOSED STORM WATER PUMPING STATION (TYPICAL)

EXISTING OUTFALL

20' x 4' DEEP DITCH 2:1 SLOPE INSIDE OF WALL

4' DEEP DETENTION AREA 3:1 SIDE SLOPES BASE ELEV. 69'

PLAINFIELD ST.

RIVER AVE.

FLETCHER AVE.

FIELD PIKE

STA=0+00 STA=1+00 STA=1+80 STA=2+00 STA=3+00 STA=4+00 STA=5+00 STA=6+00 STA=7+00 STA=8+00 STA=9+00 STA=10+00 STA=11+00 STA=12+00 STA=13+00 STA=14+00 STA=15+00 STA=16+00 STA=17+00 STA=18+00 STA=19+00 STA=20+00 STA=21+00 STA=21+46

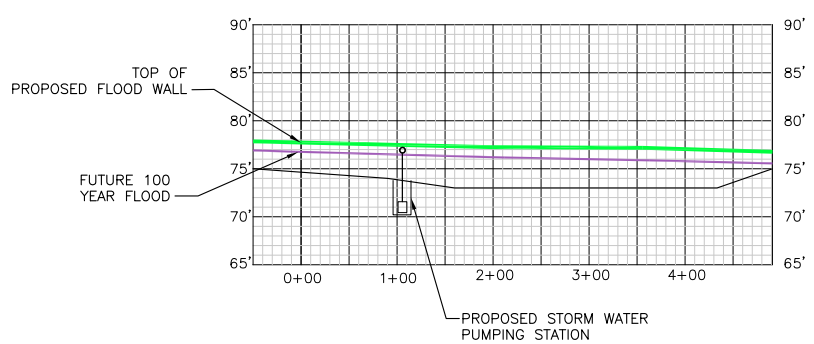
5FT 7FT 8FT

SCALE: 1"=200'

0 100 200 400

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- PROPOSED STORM WATER PUMPING STATION
- PROPOSED OUTFALL & FLAP GATE
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING TO BE PROTECTED BY FLOOD WALL
- BUILDING TO BE PROTECTED BY EARTH LEVEE
- PROPOSED RING DIKE



PROFILE (RICH BOX FLOOD WALL)

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

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POCASSET RIVER WATERSHED PLAN

FLETCHER AVENUE FLOOD WALL

PROJECT NO. 32853.03

FIGURE NO. 9-9A

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NOTES:

1. THE EXISTING STORMWATER DRAINAGE SYSTEMS LOCATION AND CONFIGURATION OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND/OR TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
2. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY NRCS AND BY USING DIGITAL AERIAL ORTHOPHOTOGRAPHY.

LEGEND:

- CENTER LINE OF STREAM
- MODELED 100 YEAR FLOOD LIMIT BASED ON FUTURE WATERSHED DEVELOPMENT PER LOCAL ZONING MAPS.
- APPROXIMATE WALL HEIGHT
- 5FT — PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- EXISTING DRAIN LINES
- EXISTING CATCH BASINS
- PROPOSED STORM WATER PUMPING STATION
- PROPOSED OUTFALL & FLAP GATE

PLANFIELD ST
PLANFIELD PIKE
FLETCHER AVE.
ATWOOD AVE.
AVE.
EXISTING TRANSFORMER TO BE RELOCATED
PROPOSED FLAP GATE TO BE INSTALLED ON ALL EXISTING DRAINAGE OUTLETS SERVICING FACILITY CHECK FOR DIRECT CONNECTIONS TO RIVER
PROPOSED STORM WATER PUMP STATION (TYPICAL)
PROPOSED OUTFALL WITH FLAP GATE
5–30" PIPES SIDE BY SIDE W/ FLAP GATES
PROPOSED STORM WATER PUMP STATION (TYPICAL)
20' x 4' DEEP DITCH 2:1 SLOPE INSIDE OF WALL
4' DEEP DETENTION AREA 3:1 SIDE SLOPES BASE ELEV. 69'
EXISTING OUTFALL
7FT
8FT
5FT
75
100
125
150
SCALE: 1"=200'
0 100 200 400

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GZA–J:\ENV\32853–03.R\FIGURES\DWG\GZA\32853.03_FX_R1_MASTER DRAINAGE.DWG [FLETCHER AVENUE] September 08, 2009 – 3:04pm Christopher.dias

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REVIEWED BY: IR
OPERATOR: PJS
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POCASSET RIVER WATERSHED PLAN

FLETCHER AVENUE DRAINAGE PLAN

PROJECT NO.
32853

FIGURE NO.
9–9B

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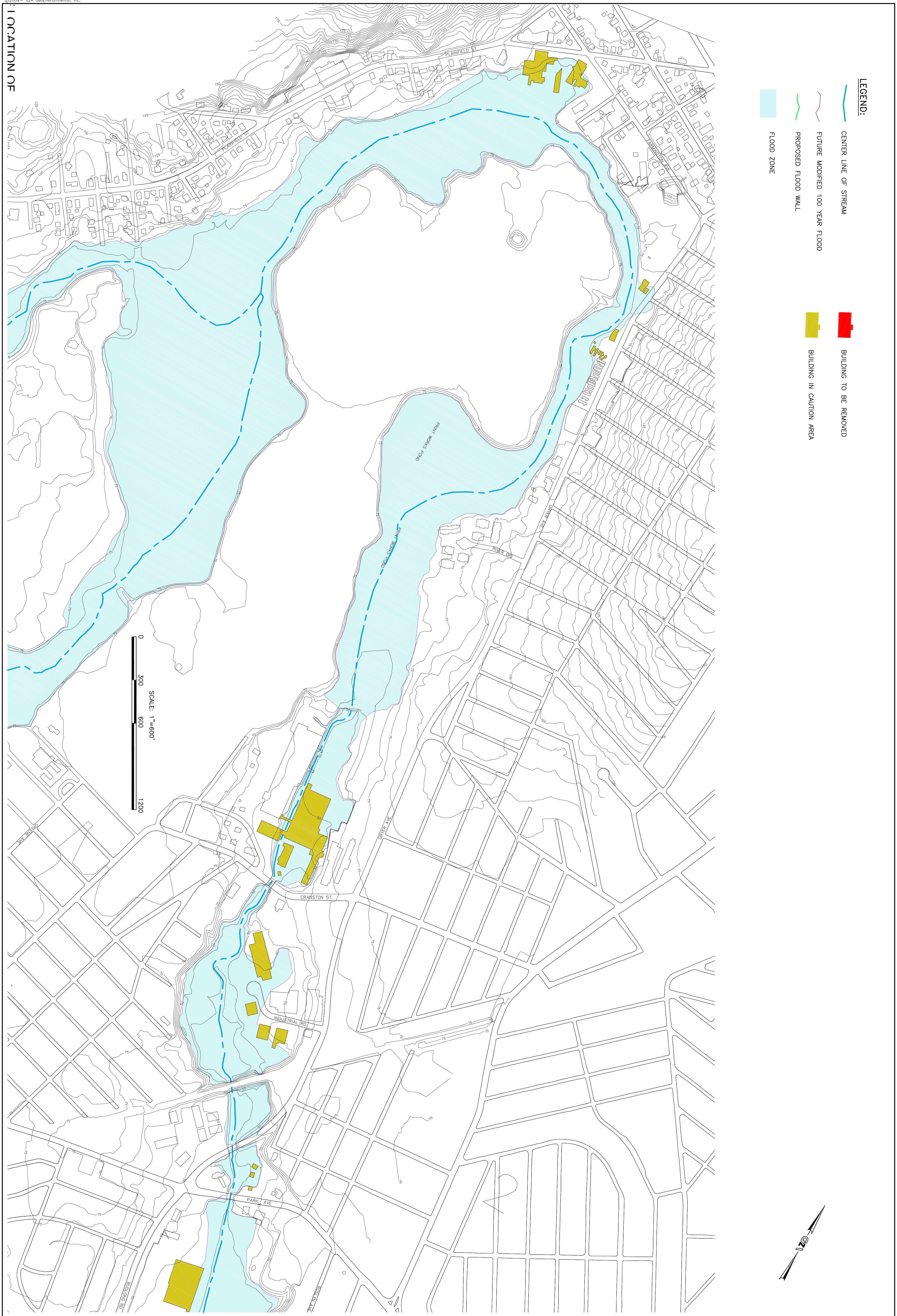

FIGURE NO. 9–10	PROJECT NO. 32853.03	POCASSET RIVER WATERSHED PLAN	PROJ MGR: IR DESIGNED BY: RC REVIEWED BY: IR OPERATOR: PJS DATE: 08/07/09
		AREA–5 RECOMMENDED PLAN AND URBAN FLOOD PLAIN MAP	

SCALE: AS INDICATED

0

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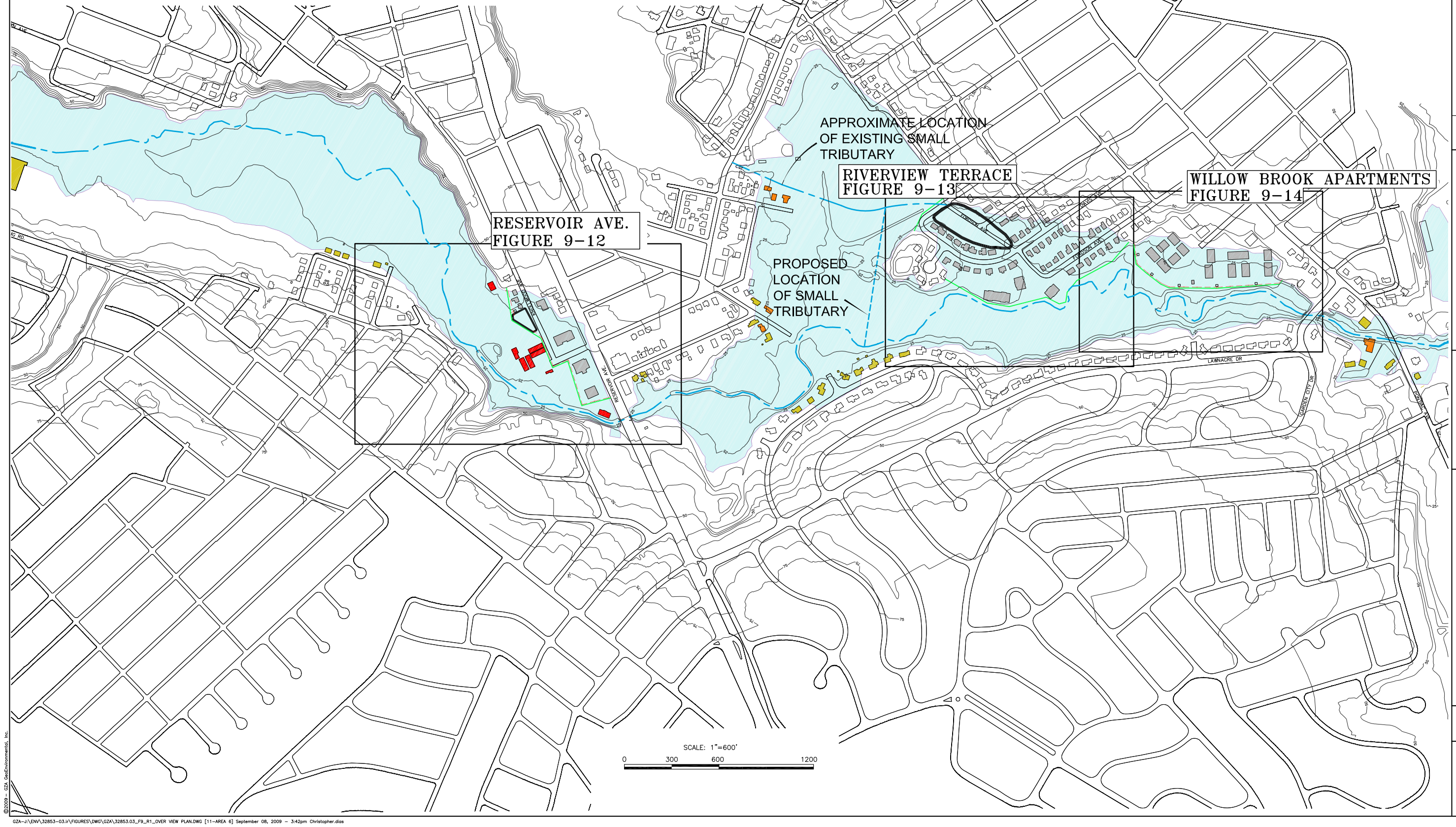
REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- PROPOSED FLOOD WALL
- FLOOD ZONE
- BUILDING TO BE REMOVED
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING IN CAUTION AREA



NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

SCALE: AS INDICATED

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PROJ MGR: IR
DESIGNED BY: RC
REVIEWED BY: IR
OPERATOR: PJS/TLE
DATE: 08/07/09

POCASSET RIVER
WATERSHED PLAN

AREA 6- RECOMMENDED PLAN
AND URBAN FLOOD PLAIN MAP

PROJECT NO.
32853.03

FIGURE NO.
9-11

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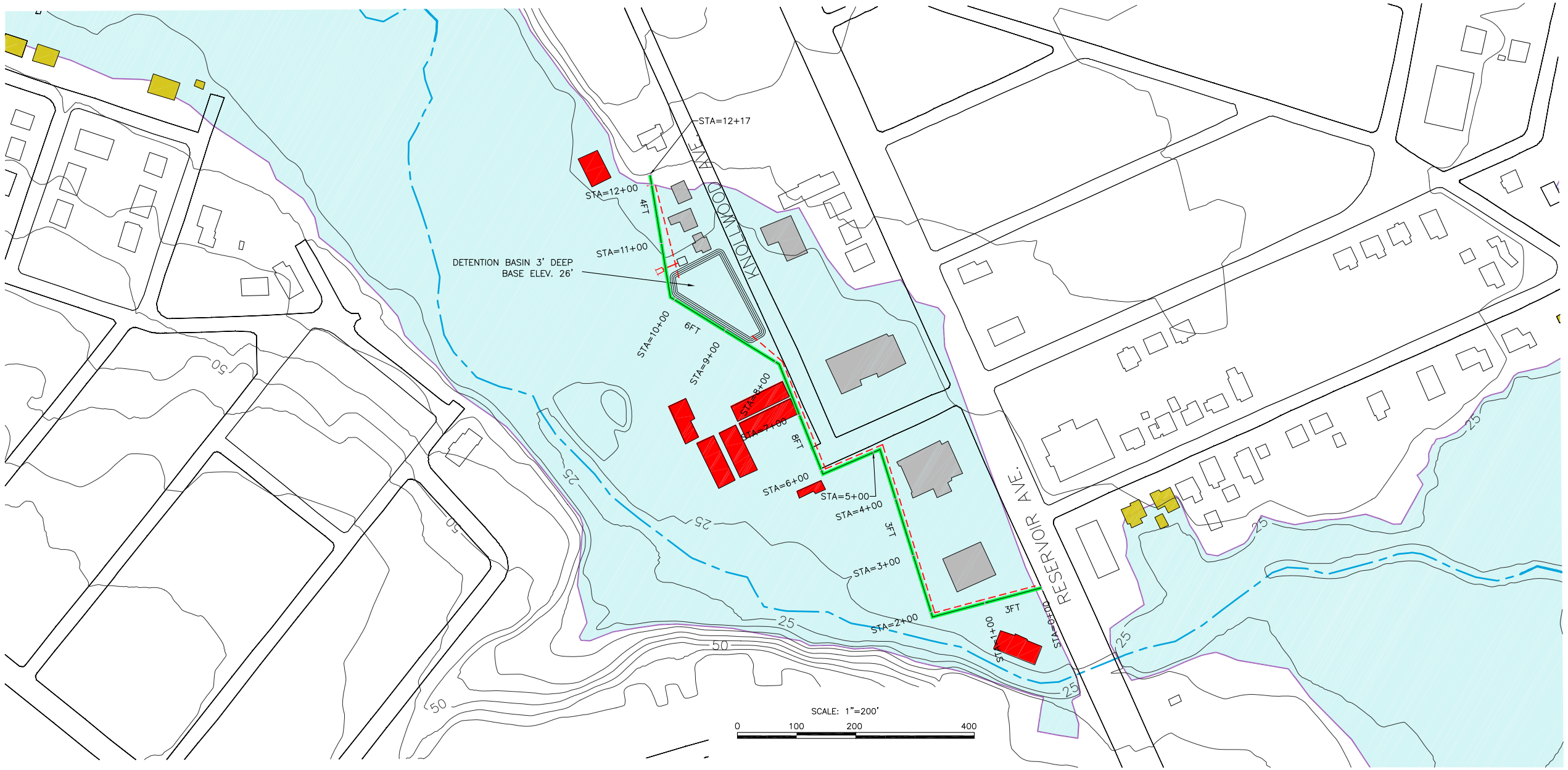
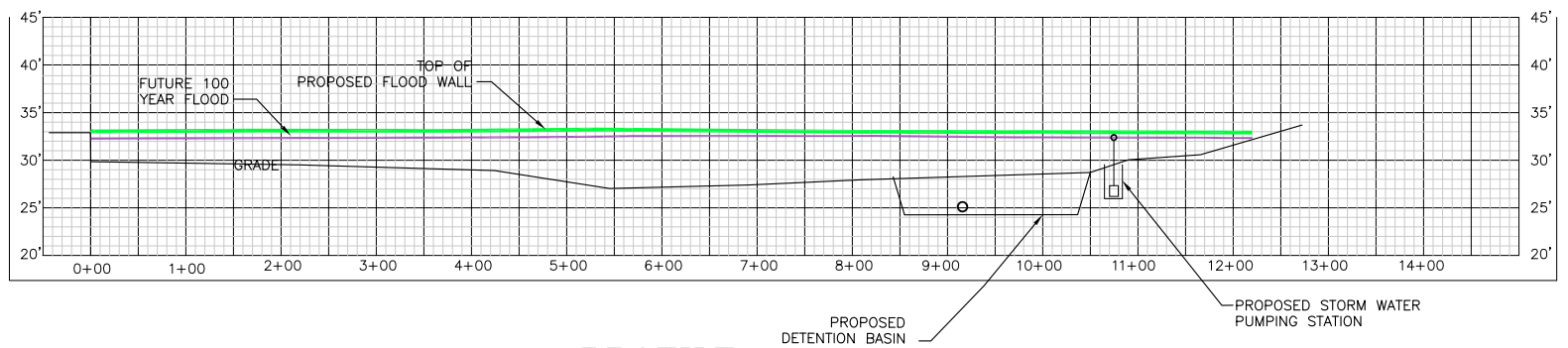


LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT — PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- BUILDING TO BE REMOVED
- BUILDING IN CAUTION AREA
- BUILDING TO BE PROTECTED BY FLOOD WALL



PROFILE

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

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GZA-J:\ENV\32853-03.ir\FIGURES\DWG\GZA\32853.03_F9_R1_OVER VIEW PLAN.DWG [12-RESERVOIR AVENUE] September 08, 2009 - 3:54pm Christopher.dias

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DESIGNED BY: RC
REVIEWED BY: IR
OPERATOR: PJS
DATE: 08/07/09

POCASSET RIVER
WATERSHED PLAN

RESERVOIR AVENUE
FLOOD WALL

PROJECT NO.
32853.03

FIGURE NO.
9-12

NOTES:

1. THE EXISTING STORMWATER DRAINAGE SYSTEMS LOCATION AND CONFIGURATION OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND/OR TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

2. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY NRCS AND BY USING DIGITAL AERIAL ORTHOPHOTOGRAPHY.

LEGEND:

- CENTER LINE OF STREAM
- MODELED 100 YEAR FLOOD LIMIT BASED ON FUTURE WATERSHED DEVELOPMENT PER LOCAL ZONING MAPS.
- APPROXIMATE WALL HEIGHT
- 5FT — PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- EXISTING DRAIN LINES
- EXISTING CATCH BASINS
- PROPOSED STORM WATER PUMPING STATION
- PROPOSED OUTFALL & FLAP GATE

PROPOSED AREA TO BE REGRADED TO DIRECT RUNOFF FLOWS

PROPOSED STORM WATER PUMP STATION (TYPICAL)

DETENTION BASIN 3' DEEP BASE ELEV. 26'

OUTFALL PIPE

PROPOSED OUTFALL & FLAP GATE

EXISTING GREENHOUSE AND NURSERY

4FT

6FT

8FT

3FT

3FT

KNOLLWOOD AVE.

RESERVOIR AVE.

50

25

SCALE: 1"=200'

0 100 200 400

REV. NO.	DESCRIPTION	BY	DATE

SCALE: AS INDICATED

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DESIGNED BY: RC
REVIEWED BY: IR
OPERATOR: PJS
DATE: 02/19/09

POCASSET RIVER
WATERSHED PLAN

RESERVOIR AVENUE
DRAINAGE PLAN

PROJECT NO.
32853

FIGURE NO.
9-12A

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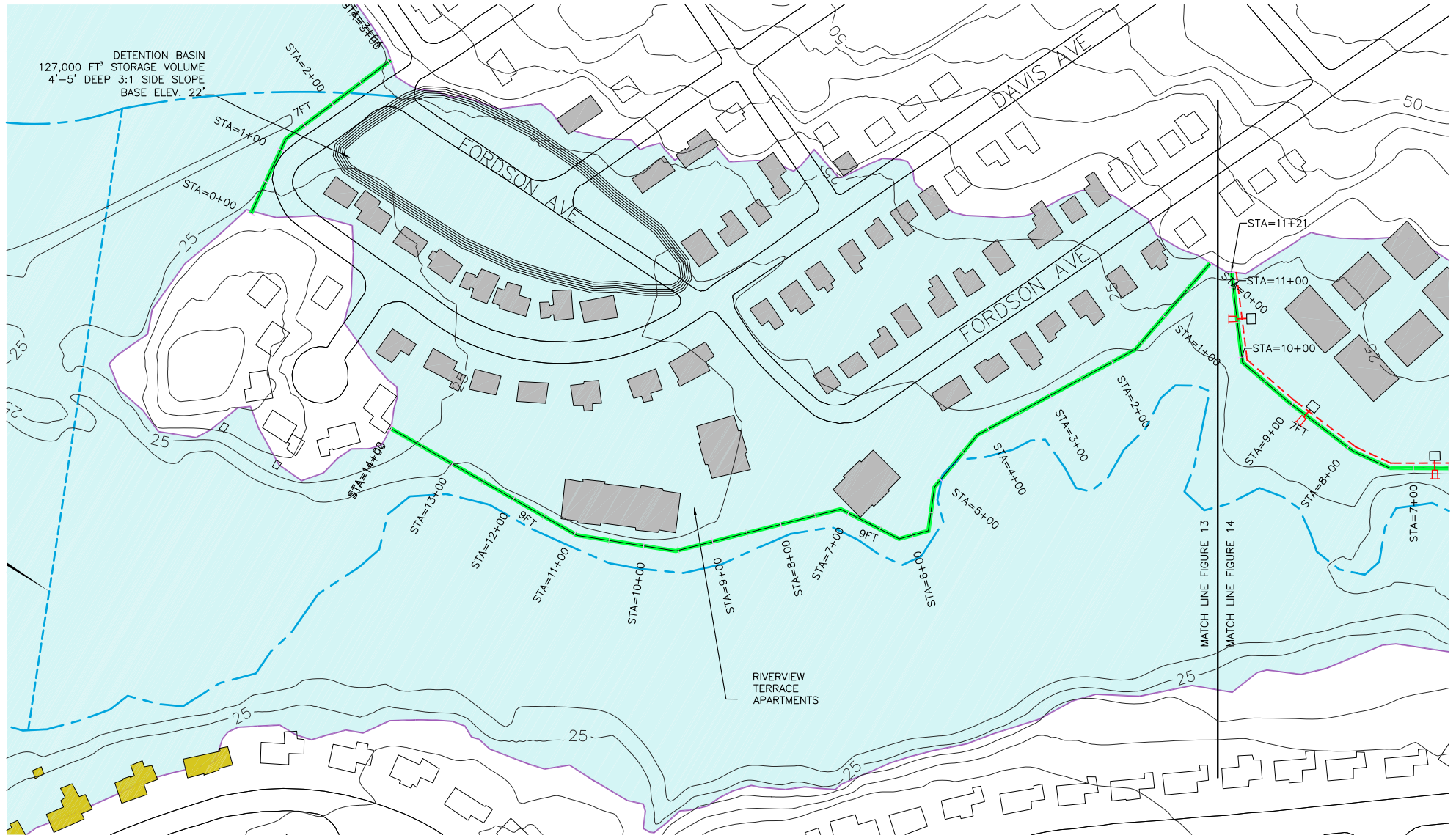
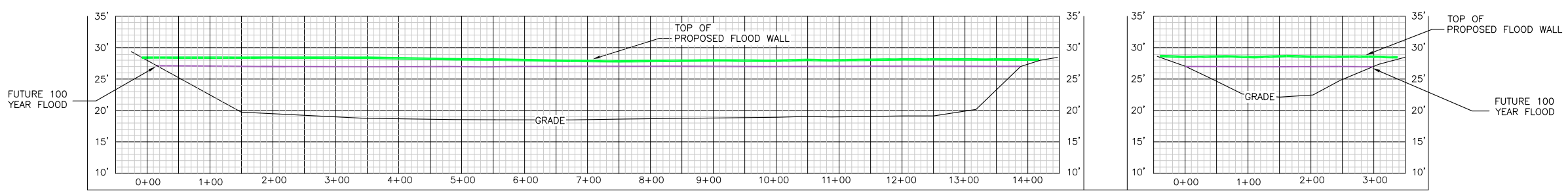


LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT
- PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- BUILDING IN CAUTION AREA
- BUILDING TO BE PROTECTED BY FLOOD WALL
- PROPOSED STREAM RELOCATION



PROFILE

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

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POCASSET RIVER WATERSHED PLAN

RIVERVIEW TERRACE FLOOD WALL

PROJECT NO.
32853.03

FIGURE NO.
9–13

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SCALE: 1"=200'

0 100 200 400

NOTES:

1. THE EXISTING STORMWATER DRAINAGE SYSTEMS LOCATION AND CONFIGURATION OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND/OR TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
2. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY NRCS AND BY USING DIGITAL AERIAL ORTHOPHOTOGRAPHY.

LEGEND:

- CENTER LINE OF STREAM
- MODELED 100 YEAR FLOOD LIMIT BASED ON FUTURE WATERSHED DEVELOPMENT PER LOCAL ZONING MAPS.
- 5FT — APPROXIMATE WALL HEIGHT
- PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- PROPOSED DRAIN LINES
- PROPOSED CATCH BASINS
- PROPOSED PUMP STATION
- PROPOSED OUTFALL & FLAP GATE
- PROPOSED REGRADED TO DIVERT RUNOFF TO PROPOSED POND AND PUMP STATIONS.

REV. NO.	DESCRIPTION	BY	DATE

SCALE: AS INDICATED

0

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REVIEWED BY: IR
OPERATOR: PJS
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POCASSET RIVER WATERSHED PLAN

RIVERVIEW TERRACE DRAINAGE PLAN

PROJECT NO.
32853

FIGURE NO.
9–13A

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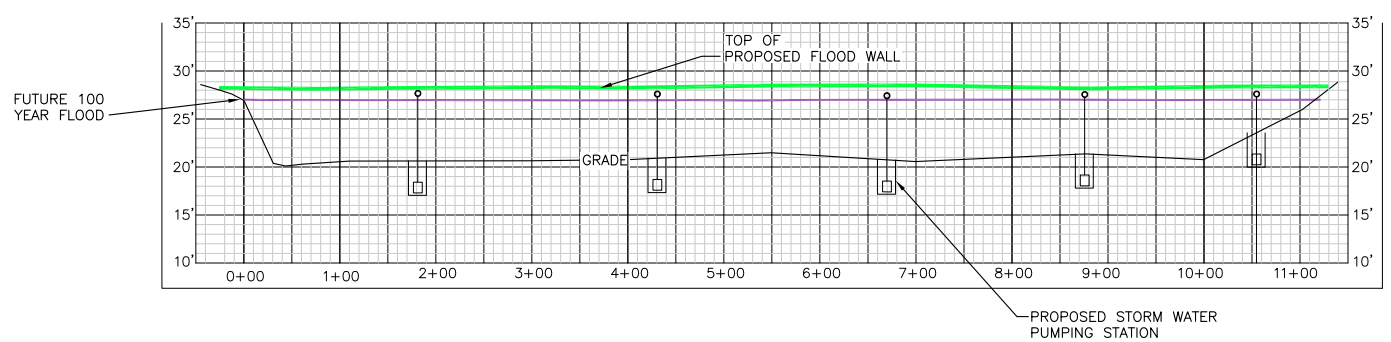
LEGEND:

- CENTER LINE OF STREAM
- FUTURE MODIFIED 100 YEAR FLOOD
- APPROXIMATE WALL HEIGHT
- 5FT
- PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- BUILDING TO BE PROTECTED BY DRY FLOOD PROOFING
- BUILDING IN CAUTION AREA
- BUILDING TO BE PROTECTED BY FLOOD WALL
- PROPOSED STORM WATER PUMPING STATION
- PROPOSED OUTFALL & FLAP GATE



PROFILE

HORIZ. SCALE 1" = 200'
VERT. SCALE 1" = 20'

REV. NO.	DESCRIPTION	BY	DATE
1	NEW FIGURE	CRD	8/7/09

SCALE: AS INDICATED
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DESIGNED BY: RC
REVIEWED BY: IR
OPERATOR: PJS/TLE
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POCASSET RIVER WATERSHED PLAN

WILLOW BROOK APARTMENTS FLOOD WALL

PROJECT NO.
32853.03

FIGURE NO.
9-14

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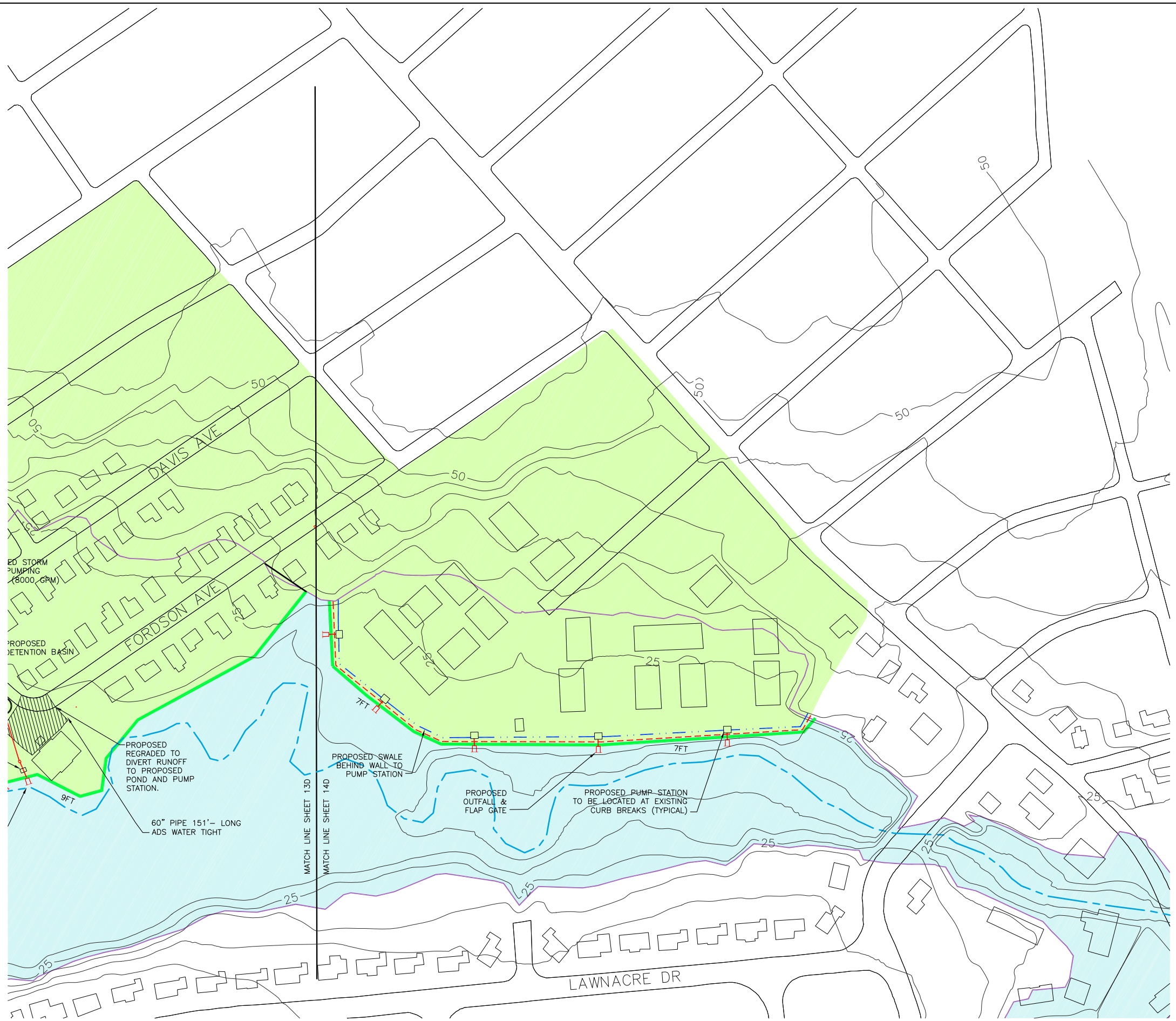
NOTES:

1. THE EXISTING STORMWATER DRAINAGE SYSTEMS LOCATION AND CONFIGURATION OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND/OR TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

2. BASE MAP DEVELOPED FROM AUTOCAD DRAWING FILE PREPARED BY NRCS AND BY USING DIGITAL AERIAL ORTHOPHOTOGRAPHY.

LEGEND:

- CENTER LINE OF STREAM
- MODELED 100 YEAR FLOOD LIMIT BASED ON FUTURE WATERSHED DEVELOPMENT PER LOCAL ZONING MAPS.
- APPROXIMATE WALL HEIGHT
- 5FT PROPOSED FLOOD WALL
- INDICATES DRAIN AT BASE OF WALL
- PROPOSED SWALE
- PROPOSED STORM WATER PUMPING STATION
- PROPOSED OUTFALL & FLAP GATE



SCALE: 1"=200'

0 100 200 400

REV. NO.	DESCRIPTION	BY	DATE

SCALE: AS INDICATED

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OPERATOR: PJS
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POCASSET RIVER WATERSHED PLAN

WILLOW BROOK APARTMENTS DRAINAGE PLAN

PROJECT NO.
32853

FIGURE NO.
9-14A

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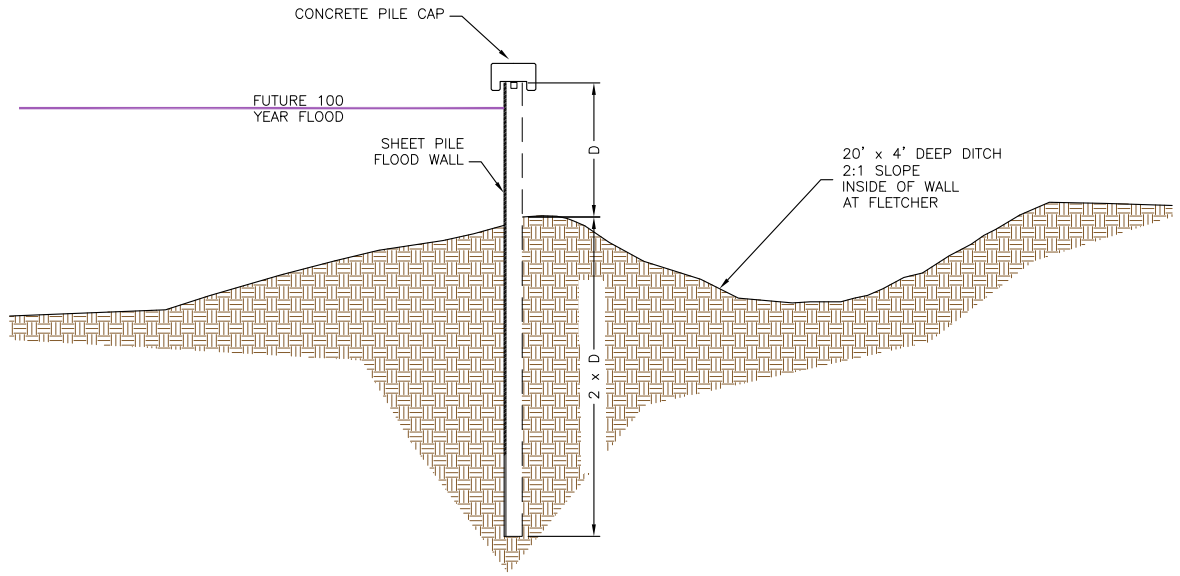
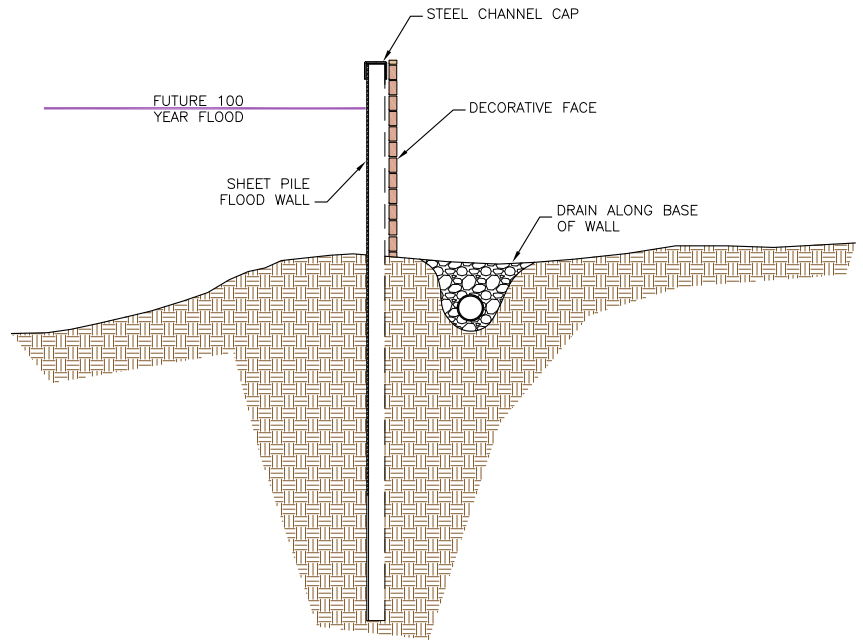


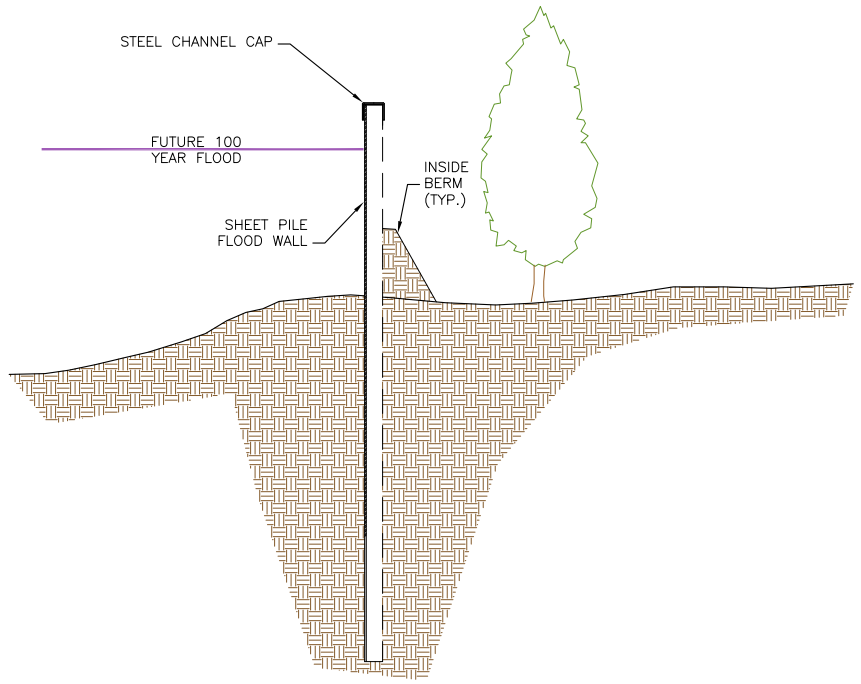
TYPICAL SHEET PILE FLOOD WALL
WITH CONCRETE CAP AND DRAINAGE DITCH

NOT TO SCALE



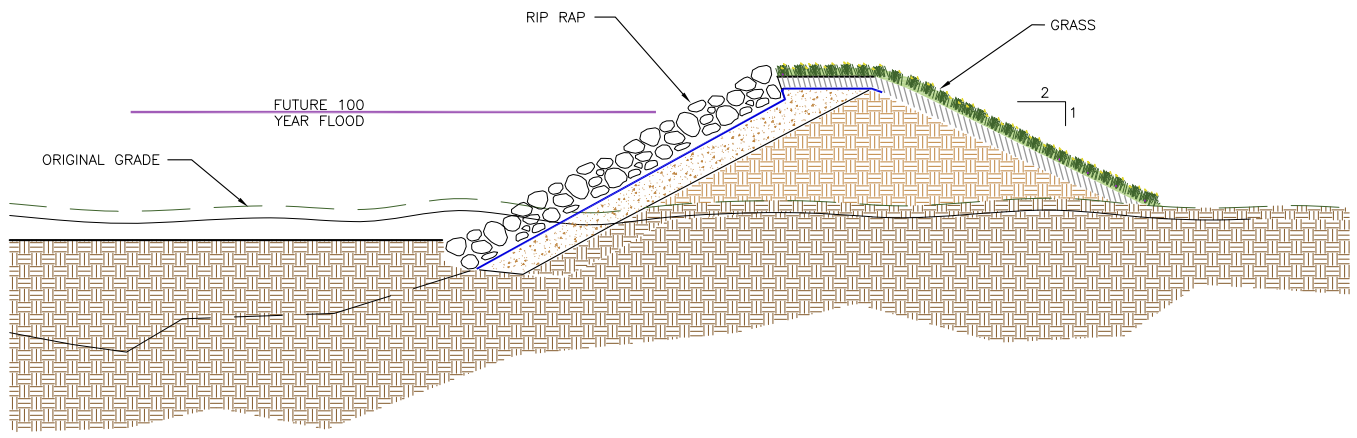
TYPICAL SHEET PILE FLOOD WALL
WITH DECORATIVE FACE AND DRAIN ALONG BASE

NOT TO SCALE



TYPICAL SHEET PILE FLOOD WALL
WITH EARTHEN BERM STEEL CAP AND PLANTING

NOT TO SCALE



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SCALE: AS INDICATED
0

GZA
GeoEnvironmental, Inc.
Engineers and Scientists
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PROJ MGR: IR
DESIGNED BY: RC
REVIEWED BY: IR
OPERATOR: PJS
DATE: 08/07/09

POCASSET RIVER
WATERSHED PLAN

SHEET PILE FLOOD WALL DETAILS

PROJECT NO.
32853.03

FIGURE NO.
9-15

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SECTION 10

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SECTION 11

LIST OF PREPARERS

This Plan/Environmental Impact Statement was prepared jointly by staff at:

- The NRCS Rhode Island Office located in Warwick, RI
- GZA GeoEnvironmental, Inc.

Table 11-1, List of Preparers, identifies and lists qualifications of those individuals who were directly responsible for providing significant input to the preparation of the Plan and Environmental Assessment.

Table 11-1
List of Preparers

Name	Organization	Title	Education	Experience
Anja Ryan	GZA	Landscape Architect	BS-Landscape Architecture	Landscape Architect- 5 years
Stephen Andrus	GZA	Assistant Project Manager	BS-Civil and Environmental Engineering	Environmental Engineer-5 years
Richard A. Carlone	GZA	Project Engineer	BS and MS-Civil and Environmental Engineering	Environmental Engineer-3 years
Todd R. Greene	GZA	Senior Project Manager	BS-Civil Engineering	Environmental Engineer-15 years
Igor Runge	GZA	Senior Project Manager	Ph.D.-Civil and Environmental Engineering	Environmental Engineer-23 years
Philip P. Virgadamo	GZA	Principal	BS and MS-Civil and Environmental Engineering	Environmental Engineer-42 years
Stephen Lecco	GZA	Senior Project Manager	MS-Environmental Science	Environmental Scientist-20 years
Rosalie Starvish	GZA	Project Manager	MS-Environmental Engineering	Water Resources Engineer-6 years
Frank Vogel	NRCS	Civil Engineer	BS-Civil Engineering	Civil Engineer- 25 years
Andrew Lipsky	NRCS	State Biologist	BS-Biology	Biologist-10 years
Joseph Bachand	NRCS	Resource Conservationist	BS-Natural Resource Science	Natural Resources- 20 years
Reena Shaw	NRCS	State Economist	Ph.D.-Economics	Economist- 6 years

SECTION 12

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INDEX (CONT'D)

APPENDIX A

DISCLAIMER

DISCLAIMER

1. The Report was prepared on behalf of and for the exclusive use of the Client. The Report and the findings in the Report shall not, in whole or in part, be disseminated or conveyed to any other party, or used or relied upon by any other party, in whole or in part without the written consent of GZA.

2. The work contained in this report was performed in accordance with practices and standard of care typically exercised by members of our profession at the time of our study and under conditions similar to those we encountered while performing our study.

3. The observations described in this Report were made under the conditions stated herein. The conclusions presented in the Report were based solely upon the services described, and not on scientific tasks or procedures beyond the scope of described services or the time and budgetary constraints imposed by Client.

4. The findings and conclusions provided in this Report are based on information made available to GZA and observations made while conducting the prescribed Scope of Work. Site conditions in many of the elements are subject to change, so conditions at any given time could differ from the conditions described in the report.

5. In preparing this Report, GZA has relied on certain information provided by federal, state or local officials and other parties referenced herein, and on information contained in the files of federal, state, and/or local agencies available to GZA at the time of our services. Unless otherwise stated, GZA did not attempt to independently verify the accuracy or completeness of information reviewed or received during the course of the work.

6. Observations were made of the Site and of structures on the Site as indicated within the Report. Where access to portions of the Site or to structures on the Site was unavailable or limited, GZA renders no opinion as to the status of the processes or operations not observed.

7. In forming conclusions, GZA relied on information provided by others including facility personnel. Unless otherwise stated, GZA renders no opinion as to the validity or completeness of information or work of others.

8. Unless otherwise stated, GZA did not perform testing or analyses to determine the presence or concentration of any chemicals, oils, or other hazardous materials in the study area.

APPENDIX B

INVESTIGATIONS AND ANALYSES REPORT

APPENDIX B

INVESTIGATIONS AND ANALYSES REPORT

1.0 Introduction

This Investigation and Analyses (I&A) Report compliments the Pocasset River Watershed Plan / Environmental Impact Statement (WP/EIS). Together, they provide the information required by the Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.* The I&A Report explicitly discusses the assumptions made, methodologies used, and rationale for decisions made, which are not previously discussed in the Pocasset River WP/EIS and the Pocasset River Flood Plain Management Study. The I&A Report is designed to be used by all interested parties. Information presented in either the WP/EIS or Flood Plain Management Study is not duplicated here and where applicable, reference is made to the two documents. Items of a routine nature are not included. Supporting data developed for this study are on file at the Natural Resources Conservation Service State Office in Warwick, Rhode Island.

This NRCS study began in 2002 and has been ongoing until the date of this publication. During this time the project team has taken an in-depth look at the flooding problems in the watershed, possible mitigation measures, and possible project impacts. This study culminated in the findings published in the WP/EIS and this report. The intense effort and time expended on examining watershed wide flood problems, flood mitigation strategies, and project impacts led to the Recommended Plan, which is a collection of flood protection measures in the watershed which are feasible, the most cost effective, and provide complete benefits to project areas. The study has been coordinated with the Local Sponsoring Organization (City of Cranston and Town of Johnston), i.e. the two communities affected by flooding in the study area.

The project staff worked with other federal, state, and local agencies, individual watershed residents, private professional services consultants, and the Project Sponsors throughout the planning process. Interdisciplinary teams were utilized in the assessment and evaluation of present, Future Without-Project, and Future With-Project conditions.

2.0 Rationale for Formulation

The Pocasset River Watershed is highly urbanized and all proposed project measures will be implemented in areas which are already developed. During the evaluation process each major project site was analyzed in detail; multiple field visits were performed to ensure accurate information is presented in the WP/EIS and in this report, i.e. to ensure feasible alternatives are proposed and to ensure project impacts (environmental, social, etc.) are minimized. During this process it became clear that only a limited number of alternatives were feasible at each site, due primarily to the physical constraints imposed

by urbanized floodplains. It also became clear that negative impacts, especially environmental impacts (fish, wildlife, wetlands, etc.) from the proposed project would be minimal because of the highly urbanized character of the proposed project sites.

A discussion detailing cultural resources, socioeconomics, geology, water resources, and other environmental and social considerations can be found in Section 3 of the WP/EIS and Section I of the Flood Plain Management Study. Depths to bedrock are not expected to impact floodwall construction or the construction of other plan measures. A detailed subsurface investigation will precede final design of the flood mitigation measures described in the WP/EIS. The proposed project will not have a significant impact on water quality within the watershed.

Refer to Tables 5-1, 6-2, and 6-3 and Sections 3 and 6.3 of the WP/EIS for a discussion of resources of medium and high concern (as shown in Table 5-1 identified during scoping. Table 5-1, Evaluation of Identified Concerns, displays the economic, social, environmental, and cultural factors that are important to decision making. Table 6-3, Environmental, Economic, and Social Justification Matrix, summarizes and compares the significant differences between candidate plans with respect to those factors of medium and high significance. Section 2 of the WP/EIS provides a summary of the Project investigations and analyses. They are presented in the text of the WP/EIS where appropriate to aid a reader who is not familiar with the watershed to understand the problems, opportunities and rationale for the Project.

In general, the recommended alternative at each project site is the only alternative which is feasible (i.e. can be constructed) and which offers full protection from the design flood at that particular site. In all cases, the least cost alternative which was feasible and provided full protection from the design flood was selected at each proposed project location. The Recommended Plan is the collection of the recommended alternatives at each project Site, as described in Section 8 of the WP/EIS.

There are no known significant physical, economic, or environmental interactions between the proposed plan and any existing or planned Federal or Non-Federal projects.

2.1 Hydrology and Hydraulics

The NRCS completed a comprehensive investigation of both the existing and potential flooding conditions within the Pocasset watershed through the development of two computer simulation models as part of the Pocasset River Flood Plain Management Study (as presented in the "Technical Report") and in the WP/EIS. While a brief synopsis is provided below, the reader is referred to these documents for a full discussion of model development.

NRCS developed a hydrologic model (TR-20) to calculate direct runoff produced from various wet weather events and to route this runoff through the various streams and

reservoirs through the watershed. Results from this model were used as input into the hydraulics model (HEC-RAS), which estimates surface water profiles, and in turn, estimates flooding and areas inundated with water during rainfall events. The models were calibrated using data available from a 3.42-inch rainfall event that occurred on 21-22 March 2001. Great effort went into development and calibration of the model, and the model has undergone multiple reviews and iterations before being finalized. This model was used by NRCS in their development of the "Pocasset River Watershed: Flood Plain Management Study" (NRCS 2006a). Following calibration, the models were used in a prognostic fashion to estimate maximum water level elevations during the 100-year, 24-hour design storm (7.0 inches).

In fall of 2004, after a bid process, NRCS contracted GZA GeoEnvironmental, Inc., with EA Engineering, Science, and Technology (EA) as a subcontractor to perform a model update and prepare selected preliminary designs, to include impact analysis and engineering drawings, for the Pocasset River Watershed Plan. As work progressed, the contract was expanded and GZA was contracted to prepare the Watershed Plan / Environmental Impact Statement, with assistance and guidance from NRCS.

For this study, the original TR-20 and HEC-RAS computer models were revised to more accurately simulate actual conditions. From a review of both of the initial and revised NRCS models, it was collectively determined (by NRCS, GZA, and EA) that the existing TR-20 model should be revised to include the restricting effects of all the various manmade structures along the river length (instead of just including the inline weirs that the NRCS had originally modeled). The decision was also made to update the hydrology model using NRCS's newly released "WinTR-20" software. Revisions to the hydraulic model were also necessary to reflect the changes to the hydrology model. The specific revisions to each model are described in the Pocasset River Flood Plain Management Study Technical Report.

After several iterations in the model format and input parameters, the final model was calibrated using the storm event of October 14-15, 2005, as described in the Pocasset River Flood Plain Management Study Technical Report. On October 14 and 15, 2005 heavy rainfall that approximated the 100-year 24-hour design storm (ranging from approximate 6.5 to 8 inches in 24 hours throughout the watershed) caused extensive flooding in the Pocasset watershed.

The WinTR-20 and HEC/RAS computer simulation models were paramount in evaluating the flooding potential in the various reaches of the Pocasset River. The use of these models in a prognostic fashion formed the backbone of the formulation of alternatives discussed in detail in Section 6.

The NRCS and GZA, its technical consultant, have used the calibrated model in a diagnostic and prognostic fashion to simulate water surface profiles during existing and future build-out scenarios based on local comprehensive zoning plans for the affected

communities. Model results identified existing properties along the flood-plain corridor that would require high-water protection and additional properties that would likely be affected if the "build-out scenario" becomes a reality.

Drainage Behind Floodwalls

Drainage behind flood walls is important to prevent the accumulation and stagnation of stormwater. Stormwater can be collected by storm sewers or by overland flow. Once the stormwater has been collected, it can be conveyed to the river by pumping stations or infiltrated into the ground. The utilization of existing storm sewers and overland runoff was emphasized at all floodwall sites to minimize construction costs.

Sub drainage areas behind the floodwalls were delineated based on topography and best professional judgment. Runoff hydrographs were calculated using WIN TR-55. WIN TR-55 was used in order to be consistent with the flood hydrology model. WIN TR-55 and WIN TR-20 use the same runoff model, WIN TR-20 differs only in the inclusion of structures. Runoff is assumed to occur uniformly over sub areas and pipes were sized based on percentages of the sub area draining to catch basins (using peak instantaneous flow). This design method is conservative. One hundred percent capture was assumed for pipe sizing and this assumption is conservative. Pipe sizing was evaluated using Flowmaster software from Haestad Methods. In roadways, catch basins were placed a maximum of 250 feet apart and 150 feet apart in parking areas. Drainage designs assume that storage and/or pumping is needed only after flood waters have reached the invert of the discharge pipes, which are to be located at the base elevation of the floodwalls. The timing of this was determined by evaluating the hydrograph from the unsteady HEC-RAS model for the design event.

Detailed topographic information was not available to calculate invert elevations and invert elevations were only checked for feasibility. After detailed topography is available the design must be rechecked, and designs may need to be altered. Pipe slopes were set at the average slope of the sub area. Groundwater data were gathered from USGS groundwater maps and are approximate. Detailed investigations may show that drainage designs must be altered due to the water table. Depending on groundwater findings, gravel drains may be required along the inside of the wall to prevent groundwater from backing up behind the wall. Drainage designs assume that drainage structures will have no downstream effect. This must be checked using the river hydrologic model before final design. Pump selection assumes that 3 phase 460 volt power will be available where required.

For design, a minimum allowable velocity at peak flow of 2 ft/s was used to prevent settling in the pipes and a maximum velocity at peak flow of 15 ft/s was used to prevent scouring in the pipes. At pump stations, contingency is provided by specifying multiple pumps and generators. Variable frequency drives (VFD) are provided for pumps at all locations.

3.0 Evaluation Process

3.1 Considered Alternatives

The initial alternatives analysis was limited to the following considerations (see the WP/EIS for a discussion of all alternatives considered, including alternatives which were deemed not feasible and removed from consideration):

- Property buyout
- Floodwalls
- Constraint removal (Bridge Modification)
- Reservoir modification
- Dry flood proofing
- Elevation of homes
- Bypass culvert (on Simmons Brook)

Of the alternatives listed above, only floodwalls and the bypass culvert required hydraulic analysis using the Pocasset River Watershed hydrologic/hydraulic computer simulation model to evaluate their effects on flood heights. Bridge removal (except at Second Mill Street and Atwood Avenue) and reservoir modification were not found to be effective in decreasing flood heights.

As described in the WP/EIS, the future build out scenario (assumes full build out based on local comprehensive zoning plans for the affected communities) was used as the design condition in the watershed model. The primary purpose in employing floodwalls and the bypass culvert is to prevent water during flood conditions from reaching buildings.

3.2 Floodwall Breach or Overtopping

The floodwalls are designed to provide protection from the 100-year future build out flood event, with a freeboard of one foot. Failure of one or more of the floodwalls would result in an area flooded that is essentially the same as without the floodwalls. Differences may include a much shorter duration of flooding and the potential for an initial surge adjacent to the floodwall. The duration of flooding could, depending on the volume of floodwater behind portions of the floodwall, be longer than natural conditions if water must be evacuated by interior drainage. Unless failure was sudden and total, damages would be approximately the same as without project conditions. Risk to loss of life from failure of any floodwall would only be significant if the failure was sudden.

The area inundated by flood waters that exceed the 100-year, 24-hour design flood and either flow around the ends or overtop the floodwalls is expected to be the same as during existing conditions prior to construction of the floodwalls. Even though one foot of freeboard was used as a safety factor in the design of all flood walls, this may or may not

contain the events exceeding the design event. There is no reason to expect that the Recommended Plan conditions will be more severe than the existing conditions. Therefore, it was assumed that negligible differences would exist between with and without Recommended Plan conditions for the slightly greater 500-year flood.

3.3 High Hazard Areas

Using the modeled 100-year flood elevation and the surveyed elevations of each building within the 500-year floodplain, all buildings subject to hazardous conditions were identified. High Hazard Areas were determined by the Local Sponsoring Organization (City of Cranston and Town of Johnston). Seven large High Hazard Areas have been identified which the sponsor feels need to be addressed. High Hazard Classification is based on a consideration of depth and velocity of flood flows (additional isolated High Hazard Areas were also identified). Areas of the floodplain where depth is greater than 3 feet, velocity of floodwater is greater than 5 feet per second, or where the product of the depth and velocity exceeds 7, are defined as High Hazard Areas. In addition, to be considered a High Hazard Area, the area must be used for overnight occupation. Other structures subject to High Hazard conditions do exist within the floodplain. These are primarily commercial use buildings and the proposed recommended measures reflect the high hazard conditions (i.e. were chosen to with stand high hazard conditions).

3.4 Engineering and Economics

The plan formulation and design process is described in the WP/EIS. The economic procedures used to analyze the Pocasset River Watershed were derived primarily from *Principles and Guidelines* and the NRCS's *Water Resources Handbook for Economics*. The United States Army Corps of Engineers computer modeling program HEC-FDA was used to calculate flood damages. The HEC-FDA model was also used for development of cost to benefit ratios.

3.5 Damage and Benefit Analysis

Benefits will accrue through the reduction of flood damages to urban properties. All benefits will fall in the Inundation Reduction Benefit category. Since floodplain activities and current methods of operation within the flood plain are not expected to change, there are no locational or intensification benefits.

The benefits were derived from reductions in physical damages to structures and contents, based on future with and without project basis. Investigations revealed no significant differences between the future with and without project conditions other than the reduction of flood damages. It is unlikely that the project will stimulate any significant change in flood plain activities. Projections for future flood plain usage are based on local comprehensive zoning plans assuming full buildout.

3.6 Risk and Sensitivity Analysis

The *Principles and Guidelines* document indentifies four major problems in computing flood reduction benefits:

1. Income
2. Intensification benefits(changes in flood plain landuse)
3. Risks
4. Sensitivity analysis

Since neither income losses nor intensification benefits were claimed as National Economic Development (NED) benefits, the problems in these areas were avoided. The floodplain occupants are assumed risk neutral.

Since many of the more conjectural assumptions made during the analysis were made so that there was no effect on future damages, the economic benefit model is relatively insulated from any downward pressures originating with such assumptions. Examples of these types of assumptions include: no change in future floodplain landuse, no intensification of floodplain activities, and no change in land values. In addition, building content value was assumed equal to 50% the value of the structure.

The break-even year for the recommended plan, at a discount rate of 4.88%, is 15 years. In addition, net benefits fall to zero when the discount rate is set at .01 percent for a 50-year design period.

Project formulation was conducted within the framework of net benefit maximization. As described in the WP/EIS, a large number of flood mitigation measures were examined. Each flood mitigation measure was examined for engineering feasibility (provided full protection at the future buildout 100-year storm) and economic feasibility (lowest cost alterative). This analysis included whether or not floodwalls should be used to protect large areas versus measures at individual properties (flood proofing, relocation, etc). In general, where affected properties were clustered, floodwalls were selected as the recommended alterative due both to engineering and economic feasibility. As required, the plan provides for protection of all affected properties within the watershed, including High Hazard areas. Alternatives were considered on a site-by-site basis and the combination of lowest cost measures, which provide full flood protection from the 100-year design storm, is the recommended plan. As stated earlier, the recommended plan provides protection from the design storm of all affected structures in the watershed.

Risk and Uncertainty

Risk is associated with events that have relatively well known probabilities of occurrence. A good example of risk in a flood prevention project is the probability of particular floods, i.e. the 1 percent chance flood.

Uncertainty differs from risk in that the probability of occurrence is not quantified. Uncertainty arises from cost estimates, land use changes, measurement errors, and unpredictable economic and social change.

Standard storm frequency analysis has been used to account for the risk associated with flood events. Measurement error associated with stream cross sections and building elevations has been minimized by using standard survey techniques and checking of computations and results. Forecasts of future conditions have been made using local and regional projections.

There is uncertainty that the benefits will be attained, especially over a typical 30-year evaluation period. Some businesses will not last that long, and there is always a chance that changing economic conditions could result in altering of the floodplain.

There is risk and uncertainty associated with some of the planned measures. Some floodwalls and nonstructural measures include closures that must be installed in order to provide the planned level of protection. There is a risk of a floodwall overtopping during a flood of greater magnitude than the design event.

The only known area in the Pocasset River Watershed Plan that poses some risk and uncertainty for cultural resource concerns is the area sited for mtigation measures in the Reservoir Avenue section of Cranston. NRCS recognizes that additional consultation with the State Rhode Island Historical Preservation & Heritage Commission (HPHC) will be required after the archaeological survey and evaluation of this location has been completed. The results of this survey may determine that additional modifications or alternatives to proposed mitigation measures are needed.

A portion of the existing unnamed tributary to the Pocasset River near Fordson Avenue is proposed to be relocated as part of a separate federally-funded project, as described in Section 6.3.7.3 of the WP/EIS. If this project does not occur prior to implementation of the proposed Riverview Terrace Floodwall project, it will be completed concurrently with the proposed floodwall.

At Reservoir Avenue, a surface water elevation increase of up to 1 foot continues approximately 3,300 feet upstream. Two residential structures, 27 and 37 Tudor Street, may be impacted by this increase. Impacts to these two properties will be examined in detail during the design phase.

Approximately 400 feet of stream would be relocated to the southwest to join with the Pocasset River (Figure 9-11). Currently, the unnamed stream enters the Fordson Avenue residential area through piping that eventually outlets to the Pocasset River. The stream would still outlet to the River, but further to the north. The relocated stream would be an open channel approximately 900 feet in length. Details of the stream geometry, hydraulics, and associated wetland mitigation will be provided during the

design/permitting phase of that project. Initial meetings have been held with RIDEM to discuss this proposal. In summary, approximately 400 feet of stream would be replaced by 900 feet of new stream within an open channel.

Reconstruction of the Atwood Avenue Bridge and Second Mill Street Bridge are projects within the project area that have a reasonable chance of occurring. Both are proposed by others and all are integrated into the overall plan of reducing flooding within the developed portions of the watershed. If either project is not completed, flooding will continue to occur at each area; however, neither project is necessary for successful implementation of the Recommended Plan.

Relationship to Existing Utilities

Floodwalls and associated drainage were sited to minimize conflicts with existing utilities to the extent practicable. In some instances utility relocation may be required where conflicts between the proposed location of floodwalls and existing utilities were unavoidable.

Floodwall Heights

Floodwall heights were determined utilizing best engineering judgment using the 100-year, 24-hour storm with future build out flood elevations, topography, and flood wall placement in HEC-RAS. Final heights of floodwalls could change depending on precisely where they are placed in final design.

3.7 Problem and Opportunity

The primary problem in the watershed is associated with damage from floodwater. Average annual physical damage costs for the design amount to $2.4 million and occur to residential, commercial, industrial, and public properties. Average annual damages to industrial/commercial property are $0.8 million and damages to residential property are $1.6 million. A total of 481 structures are affected by flooding in the Pocasset River watershed, 432 residential and 49 commercial/industrial.

HEC-FDA, the computer modeling program used in the economic analysis, calculates damages by user defined damage reaches. Due to the complexity of the proposed measures, it was not feasible to define each proposed measure as its own damage reach. Therefore, some measures span more than one damage reach and more than one measure are included in a single damage reach. Damages for each measure were calculated using separate groupings with HEC-FDA damage reaches.

4.0 National Economic Development Account

4.1 Costs

The unit cost estimates are based on Rhode Island Department of Transportation (RIDOT) bid prices for similar work, current published values, and quotes from manufacturers. Cost estimates are subject to change. Prices of individual components of cost estimates may be subject to large price fluctuations. Cost estimates for non-structural measures are based on information in the FEMA document titled *Engineering Principles and Practices of Retrofitting Flood Prone Residential Structures*, dated 2001. Detailed geotechnical investigations, including borings to determine water table depth and bedrock depth, are required before final design. Findings from these could change cost estimates considerably. It is assumed in cost estimates that boulders greater than 5 ft in diameter will not be encountered at any site. This cost estimate assumes that existing utilities will not have to be realigned or removed. All cost estimates are at their 2007 value. Operation, maintenance, and replacement costs were based on cost estimates from other watershed plans and were provided by NRCS.

The average annual and annualized equivalents of project costs were computed with a Microsoft Excel Spreadsheet Template developed by NRCS. The life of the PL 566 Component is 50 years and the installation period is 5 years. The interest rate used in the project analysis is 4.625%. All costs and benefits occurring in the installation period have been discounted to the beginning of the period of analysis. The annualized costs over the period of analysis are $1,427,790 and the annualized benefits over the period of analysis are $4,535,295, giving a cost benefit ratio of 3.18.

4.2 Benefits

The sole purpose of this project is flood prevention and subsequent reduction or elimination of property damage. The computer simulation model and methodology used to estimate flood related damages are described earlier in this I&A report. The benefits for each alternative were determined on a with and without project basis and are damage reduction benefits. The project is not located in an area of persistent underemployment or unemployment and consequently, it is not eligible for benefits associated with the utilization of unemployed or underemployed labor resources.

Other direct benefits are derived as incidental effects of a project that increase economic efficiency beyond that captured by the direct effects for which the plan was formulated. No such benefits were quantified. Other direct costs are defined as costs directly associated with a project, but for which no implementation outlays are made. One example of this may be project induced flood damages. No other direct costs were identified.

The following are the annualized costs and benefits for the project and the project cost-benefit ratio for the entire period of analysis:

- Annualized costs: $1,427,790
- Annualized benefits: $4,535,295
- Cost-benefit ratio: 3.18

5.0 Environmental Quality Account

As described in Section 6.3 of the WP/EIS (Effects of Alternative Plans), impacts of the proposed plan are negligible. The following formulation process was used in developing the recommended alternative at each project Site:

- At each Site, each of the flood mitigation measures discussed in Section 6.1 (including no action) were first analyzed for physical feasibility (the measure could be constructed and if constructed would control flooding).
- If a flood protection measures was deemed feasible for a given Site, it was given a ranking from 0 to 5 (with 5 being the highest) in three categories: costs (economic account), human health and safety (social account), and net loss of flood plain (environmental account). The three categories were then summed and the highest ranking alternative chosen as the Recommended Alternative at each Site. The Site rankings for each flood mitigation alternative, along with the rationale for the ranking system used, are displayed in Table 6-2.

Impacts were evaluated by field visits to proposed project locations and through the examination of existing data and mapping of the project area. Since there will be no permanent impact on wetlands and a negligible impact on areas of upland wildlife habitat, no mitigation is required. It is believed that the Recommended Plan does not pose a significant environmental impact.

Refer to Table 1 for a summary of the effects of the Recommended Plan on resources of National Recognition.

Table 1: Effects of the Recommended Plan on Resources of Principle National Recognition

Types of Resources	Principle Sources of National Recognition	Measurements of Effects
Air Quality	Clean Air Act, as Amended (42 USC 1857h-7 et seq)	No change in air quality classification
Areas of Particular Concern Within the Coastal Zone	Coastal Zone Management Act of 1972, as Amended (16 USC 1451 et seq)	Not Present in Planning Area
Endangered and Threatened Species Critical Habitat	Endangered Species Act of 1973, as Amended (16 USC 1531 et seq)	Not Present in Planning Area
Fish and Wildlife Habitat	Fish and Wildlife Coordination Act (16 USC Sec 661 et seq)	No Significant Long Term Impact
Floodplains	Executive Order 11988, Floodplain Management	47 Acre Reduction in Flood Plain (primarily developed)
Historic and Cultural Properties	National Historic Preservation Act of 1966, as Amended (16 USC sec 407et seq)	Flood Wall at Rich Box Facility will be constructed to match existing historic building. Archaeological survey to be conducted at proposed detention basin site near Reservoir Ave.
Prime and Unique Farmland	CEQ Memorandum of August 1, 1980: Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act	No Effect
Water Quality	Clean Water Act of 1977 (33 USC 1251 et seq)	Present Water Quality Classification of the Pocasset River Will Not Change
Wetlands	Executive Order 11990, Protection of Wetlands (42 FR 26961); Clean Water Act of 1977 (33 USC 1251 et swq); Food Security Act of 1985	No direct wetlands impacts. Approximately 5 Acres of floodplain wetlands restored
Wild and Scenic Rivers	Wild and Scenic Rivers Act, as Amended	Not Present in Planning Area

Types of Resources	Principle Sources of National Recognition	Measurements of Effects
	(16 USC 1271 et seq)	

7.0 Cost Allocation

The purpose of the project is flood prevention. All of the costs are allocated for this purpose.

8.0 Cost Sharing

For the PL 566 component of the Recommended Plan, the federal government, through NRCS, will be responsible for 100 percent of the costs of engineering services, project administration and construction of the structural measures; 100 percent of the composite costs of construction, engineering services, and project administration for nonstructural measures; and 75 percent of the building fair market value costs, and 89.8 percent of the cost of relocation assistance payments.

All remaining costs of the PL 566 component of the Recommended Plan are the responsibility of the Sponsor. These include 10.2 percent of the cost of relocation assistance payments and 25 percent of the building fair market value costs; all of the land rights costs for acquisition, easements, permits, and relocations and modifications of utilities associated with structural measures; all of the project administration costs for structural measures the Sponsor incurs; and operation, maintenance, and replacement costs for the life of the project.

APPENDIX C

AGENCY LETTERS

EXECUTIVE CHAMBER

JOHN O'LEARY
MAYOR

CITY OF CRANSTON
RHODE ISLAND

January 10, 2001

Kenneth E. Hitch, P.E.
Chief, Engineering/Planning Division
Department of the Army
New England District, Corps of Engineers
696 Virginia Road
Concord, Massachusetts 01742-2751

Dear Mr. Hitch:

I have received your correspondence of January 5, 2001, (attached) and officially request that the Army Corps of Engineers suspend the Section 205 Pocasset River Feasibility Study.

The City of Cranston appreciates the Corps efforts and is reassured by your positive preliminary findings. However, as you are aware, we have been fortunate enough to secure funding for a full analysis of the entire basin through the Natural Resources Conservation Service (NRCS) and plan to proceed in this fashion as a means of minimizing potential costs to the City.

In closing I would like to thank your office for providing NRCS with the relevant technical information generated through your study. We will be sure to keep you abreast of the progress that we make.

Sincerely,

J. O'Leary

Mayor John O'Leary

CC: Mayor William Macera
Senator Thomas Izzo
Pam Pogue, State Floodplain Coordinator
Joe Bachand, NRCS
Raimo Liias, Corps of Engineers

869 Park Avenue Cranston • Rhode Island 02910 Phone (401) 461-1000 Fax (401) 941-7644

WILLIAM R. MACERA
MAYOR

TEL. (401) 553-8800
FAX. (401) 331-4271

EXECUTIVE CHAMBERS

TOWN HALL
1385 HARTFORD AVENUE
JOHNSTON, RHODE ISLAND 02919

January 24, 2001

Mr. Kenneth E. Hitch
Chief, Engineering/Planning Division
Department of the Army
New England District, Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

RE: Pocasset River Project

Dear Mr. Hitch:

Thank you for your correspondence, dated January 5, 2001, explaining the status of the Corps' analysis of this project. As you know, the Town of Johnston has worked cooperatively with the City of Cranston to secure the most thorough, yet cost-effective, approach to investigating how to solve the flooding and flood damage along the Pocasset.

We have been extremely fortunate in that the USDA Natural Resources Conservation Service has agreed to undertake this phase of the project, at no cost to the communities. This was made possible by a substantial Federal appropriation to that Agency for this purpose, sponsored by Senator Jack Reed, which is being applied through the Small Watershed Program.

At this time, therefore, the Town of Johnston and City of Cranston have jointly agreed that we will pursue this project through the NRCS, rather than the Corps Section 205 program at this time.

Before closing, however, I want to thank you for the assistance and energy your office has provided to date. Your staff has been well informed and helpful to local officials. And, most impressively, they have been extremely cooperative and accommodating as we have weighed our financial and programmatic options, and elected to proceed with a different federal agency. In particular, Barbara Blumeris and Raino Liias have been outstanding. Further, we appreciate the Corps' willingness to provide NRCS with the technical information already developed.

Thank you, once again, for your assistance to date. On behalf of the Town of Johnston, I look forward to working with your agency in the future.

Yours truly,

William R. Macera

William R. Macera
Mayor

cc: Mayor John O'Leary (Cranston)
Senator Thomas Izzo (Cranston)
Pam Pogue, RI EMA
Joe Bachand, USDA NRCS
Raimo Liias, Corps of Engineers
US Senator Jack Reed
Local Senators and Representatives

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File copy

USDA United States Department of Agriculture
Natural Resources Conservation Service
60 Quaker Lane, Suite 46
Warwick, RI 02886-0111
401-828-1300 (Phone)
401-828-0433 (FAX)

June 18, 2001

Mr. John Brown
Narragansett Indian Tribal Historical Preservation Officer
P.O. Box 700
Wyoming, RI 02898

RE: Flood study along the Pocasset River in Johnston and Cranston, RI

Dear Mr. Brown:

The Natural Resources Conservation Service (NRCS) is in the process of conducting a study of flooding problems along the Pocasset River in Johnston and Cranston, RI. Over the years as the Pocasset River watershed has become more urbanized the area of land subject to flooding has increased. The two municipalities requested that NRCS work with them in assessing the area subject to flooding, the damage being done by the flooding, and develop proposals to reduce future flood damage.

The first component of this study is to document the impact of flooding on cultural resources, homes, businesses, roads, etc. in the area. Bennett Horter, Cultural Resources Specialist with NRCS, will be visiting the Pocasset River watershed in the next few weeks to gather information on the cultural resources component.

We are anxious to learn of any cultural resources sites in the flood area that are of high sensitivity to the Narragansett Tribe and are endangered by the flooding. Enclosed please find a map showing the approximate area subject to flooding. We would appreciate receiving any information you can provide about sensitive sites in this area that are subject to flood damage.

A later phase of this project involves developing multiple alternatives to reduce flood damage to properties along the Pocasset River. The treatment options may include actions such as: flood proofing buildings or archaeological sites to reduce further damage; purchasing and then demolishing flood prone buildings from willing sellers; constructing flood water retention basins in the headwaters of the watershed; enlarging undersized culverts at selected road crossings; etc. These options will be analyzed for their contribution to reducing the flood problems, their cost to implement, and their cultural resources and environmental impacts. As part of the on-going consultation process with your office, we will be contacting you later in the year for your input on the treatment alternatives. Once the treatment alternatives are developed and analyzed, they will be presented to the Town of Johnston and City of Cranston for their consideration. Presentation of that information will mark the completion of this study.

In the future the municipalities may elect to go forward with implementation of some of the alternative treatments. At that time more in-depth examination of any significant cultural resources sites may be needed.

If you have any questions about this project, please call me at 822-8830, or write me at the address above.

Thank you for assisting us in evaluating the impact of flooding along the Pocasset River.

Sincerely,

Everett Stuart

Everett Stuart
Cultural Resources Coordinator, RI-NRCS

Enclosure: map

United States Department of Agriculture

USDA

NRCS Natural Resources Conservation Service

60 Quaker Lane, Suite 46, Warwick, Rhode Island 02886, phone 401.828.1300, fax 401.828.0433

Subject: ENG-PL-566-Pocasset River Watershed Flood Study, Cranston/Johnston, RI.

Date: December, 6 2001

To: Lamont Robbins - Team Leader
USDA, Natural Resources Conservation Service
Design Center/Soil Mechanics
P.O. Box 6567
Fort Worth, Texas 76115

File Code: 210-5

This memo is to request the assistance of John Fripp, Engineer on your staff, to peer review a HEC-RAS Model of the Pocasset River and its Major Tributaries located in Cranston and Johnston, RI.

The HEC-RAS model has been developed by Clyde Giaquinto, Hydrologist on the Syracuse NRCS staff. Approximately 18 river miles are in the model, with almost 1200 cross-sections and over 40 road/bridge/or weir crossings.

At this time it is not anticipated that John will need to travel to RI for this review, however should travel be necessary RI will cover the necessary accommodations. It is anticipated that approximately 5 Days will be needed for review.

We will have Clyde Electronically transmit the files for John's review. Please let myself or Joseph Bachand, Project Coordinator know if you can help us out.

Judith M. Doerner
State Conservationist

cc: Joseph Bachand, RC, NRCS, Warwick, RI
Clyde Giaquinto, CE, NRCS, Syracuse, NY
Wait Grajko, SCE, NRCS, Syracuse, NY
Joseph Polulech SCE, NRCS, Tolland CT

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STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

MILITARY STAFF
EMERGENCY MANAGEMENT AGENCY
FLOODPLAIN MANAGEMENT PROGRAM
645 New London Avenue
Cranston, RI 02920-3097
(401) 946-9996

LINCOLN ALMOND
Governor

MG REGINALD A. CENTRACCHIO
Director

ALBERT A. SCAPPATICCI
Executive Director

PAMELA M. POGUE
National Flood Insurance Program Manager

March 18, 2002

Mr. Joseph Bachand
Engineer
Natural Resource Conservation Service
60 Quaker Lane
Warwick, Rhode Island 02886

Dear Mr. Bachand:

This letter is being sent to you to invite you to a critical meeting concerning the flooding problems that have been experienced in the Pocassett River Watershed. As you are hopefully aware by now, the Pocasset River has experienced at least five major flood events in the past 20 years. Commercial and residential properties have been severely damaged. Additionally, the repetitive flooding problem also poses serious public health, environmental and safety issues.

In order to address the repetitive flooding in this watershed, in October 1999, Senator Jack Reed requested a Senate appropriation of $500,000 to be earmarked for the Natural Resources Conservation Services's (NRCS) budget for FY 2001 to complete a Watershed Plan for the Pocasset River. For over a year, NRCS and their field crews have been surveying cross sections along the River and its tributaries. The data that has been collected will be used to develop present and future hydrologic and hydraulic models of the watershed. The models will be used to evaluate a range of alternatives that could alleviate flood damages along the River.

On March 7th, NRCS presented the flood study findings and potential flood mitigation alternatives to local government officials from Cranston and Johnston. On the 12th of March, a public meeting was held and NRCS again presented the study findings and proposed flood mitigation alternatives.

Prior to the Watershed Plan being implemented, the project must have a sponsor(s) and a signed watershed agreement. **Therefore, a meeting is scheduled for April 8th at 10:00 a.m. and will held at the Rhode Island Emergency Management Agency's Emergency Operations Center to discuss the Watershed State Sponsorship Process and Program Criteria.** This meeting is critical for you to attend. Without a Watershed Sponsorship agreement, solving the flooding issues of the Pocasset River cannot occur.

Please contact me at 462-7114 to let me know that you will be able to attend. If for some reason you are unable to attend, please designate a representative from you agency to attend this very important meeting. Again, I stress, without a State Sponsor for the Watershed Program Agreement for the Pocassett River, there will be no additional financial funding, and therefore no mitigation solutions for this serious flood problem. We look forward to seeing you at the meeting.

Sincerely,

Pamela Pogue
State National Flood Insurance Program Manager
Rhode Island Emergency Management Agency

Cc: Judy Doerner, State Conservationist, NRCS
Albert Scappaticci, RI Emergency Management Agency
Mayor John O'Leary, City of Cranston
Mayor William R. Macera, Town of Johnston
George Corrente, Building Operations Director, Town of Johnston
Kevin Flynn, Planning Director, City of Cranston
Jeanne M. Tracey-McAreavey, Town Planner, Town of Johnston
Steve Eichenauer, Legislative Aid, U.S. Senator Jack F. Reed
Ian Lang, Legislative Aid, U.S. Senator Lincoln D. Chafee
Howard Tillinghast, Legislative Aid, U.S. Representative James R. Langevin
Senator Thomas J. Izzo, State Senator, Cranston
Senator Aram Garabedian, State Senator, Cranston, Warwick, West Warwick
Senator Joseph M. Polisena, State Senator, Johnston
Jan Reitsma, Director, Department of Environmental Management
Ed Parker, Chief Engineer, RI Department of Transportation
Bruce Vild, Department of Administration, Statewide Planning
Ken Payne, Rivers Council
Guy LeFebvre, Pawtuxet River Association
Kevin Merli, Director, Division of Mitigation, FEMA, Region I
Mike Goetz, Federal Emergency Management Agency, Region I
John R. Kennelly, Deputy Chief, U.S. Army Corps of Engineers

Stephen P. Laffey
Mayor

Kevin M. Flynn
Planning Director

MAR 2 2 2004

William R. Guglietta, Esq.
Chairman

Paul M. Petit
Vice-Chairman

Jerome Baron
Stephen Devine
Ellen O'Hara
Charles Rossi
Marco Schiappa, P.E.

PLANNING COMMISSION
Cranston City Hall
869 Park Avenue Cranston, RI 02910

March 8, 2004

Ms. Judith Doerner
State Conservationist
United States Department of Agriculture
Natural Resources Conservation Service
60 Quaker Lane (Suite 46)
Warwick, RI 02886

Dear Ms. Doerner:

Thank you for the opportunity to review and comment on the Natural Resources Conservation Services' (NRCS) Draft Pocasset River Floodplain Management Study. It clearly represents the expenditure of a significant amount of effort and your office is to be commended for the work completed.

In reviewing the draft, I find that it is thorough in regards to structural approaches for controlling the flow of floodwaters and for the protection of property but lacking in discussion on:

- The specific geographical origin of these floodwaters including identification of existing facilities of particular concern.
- Actions that can be taken to control the source of existing discharges at facilities of particular concern;
- Assessment of current municipal floodplain management regulations and the effectiveness of their implementation;
- Specific regulatory actions that could be instituted to improve the effectiveness of local floodplain management; and
- The downstream impact of the proposed actions on flooding within the Pawtuxet River Watershed;

Inclusion of this content is essential if the study is to be comprehensive and paint a truly accurate picture of the problems and opportunities facing the watershed, whereas excluding it could compromise the overall legitimacy of the effort and result in future duplications of effort.

Floodwater Origins and Facilities of Concern

Understanding the origin of increased volume of floodwaters is critical to addressing the larger problem and targeting municipal response. To assist with this it would be very helpful to depict the quantities of water delivered to the Pocasset by its various tributaries, as well as the volume carried at critical points such as at its crossings with Route 6, Plainfield St., Cranston St., Reservoir Ave., Pontaic Ave. and at its confluence with the Pawtuxet.

Over the course of the project there was much discussion regarding the identification of existing "facilities of concern" whose size and nature produce stormwater discharges that are believed to have significant impacts on flooding within the Pocasset watershed. Specific facilities discussed for analysis include the now impervious, 154 acre, and ever-expanding Central Landfill site as well as several large

commercial developments in Johnston. I would like to review the outcomes of NRCS' analysis of these facilities.

Mitigating Facilities of Concern

In building on this theme it is also worth noting that whereas the draft report provides a thorough set of recommendations for controlling floodwaters once they enter the system; it does not address opportunities for source reduction or discharge control at existing facilities of concern. Mitigation actions of these sorts can be just as viable as those proposed, perhaps even more so, and deserve to be considered in the final evaluation. Not including analysis of these options seems to disregard an entire approach to problem solving within the watershed and could be a point of criticism into the future.

It would seem to me that substantial source reduction of floodwaters could and should have a positive effect on the level and expense of downstream mitigation. This would be viewed as beneficial to the communities who may be asked to foot the bill.

Local Floodplain Management

Whereas state and federal guidelines establish criteria and procedures for floodplain controls, the primary responsibility for floodplain management in this case falls upon the local municipalities. As such the appropriateness of municipal regulations and the effectiveness of their implementation at the local level can play a very large role in the correction *or creation* of a flooding problem. Given the above it seems fundamental that this study include a proper assessment of current municipal regulations and their implementation however no such analysis is included in the current draft.

Actions To Improve Local Management

The logical outgrowth of assessing the effectiveness of municipal floodplain management is the formulation of specific recommendations for improving local regulations and their implementation. Although the draft does recommend the establishment of a joint stormwater management district it also appears to fall short in this regard. For example, whereas the establishment of the district simply provides a vehicle for coordinated management, neither the discussion nor the recommendation itself provides guidance as to what specific local regulatory actions/improvements may be needed to ensure proper management.

Impact on the Pawtuxet

Implementing the recommendations of the plan will obviously have positive impacts in the Pocasset Watershed. However, from a larger community wide perspective it is imperative that we also ensure that these improvements will not come at the cost of higher flooding probabilities downstream along the Pawtuxet. This question comes as an obvious follow-up to the draft and must be answered by the final. The last thing we want to do is to solve a problem in one area by creating one in another.

I hope this feedback proves useful and I look forward to assisting further in necessary.

Sincerely,

Kevin Flynn

Cc Joe Bachand, Robin Muksian Schutt, and Jared Rhodes

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
HISTORICAL PRESERVATION & HERITAGE COMMISSION
Old State House • 150 Benefit Street • Providence, R.I. 02903-1209
TEL (401) 222-2678 FAX (401) 222-2968
TTY (401) 222-3700 Website www.preservation.ri.gov

12 May 2009

Reena L. Shaw
Cultural Resource Coordinator
Natural Resources Conservation Service
60 Quaker Lane, Suite 46
Warwick, Rhode Island 02886

Re: Flood Mitigation Measures
Pocasset River
Cranston and Johnston, Rhode Island

Dear Ms. Shaw:

The Rhode Island Historical Preservation and Heritage Commission (RIHPHC) staff has reviewed the information you have provided regarding the proposed flood mitigation measures along the Pocasset River in the City of Cranston and Town of Johnston, Rhode Island. The last correspondence between our offices regarding this projects appears to date from 2002.

Our March 20, 2002 response to a submission of this project from NRCS indicated that "we need to confirm that no significant properties will be affected by these actions [building removal and floodproofing]." No properties identified for removal, and only two properties identified for floodproofing in the materials that you submitted appear at this time to be historic. These are the Pocasset Mill, at 75 Pocasset Street, in Johnston, and a brick building located to the west, which fronts along Plainfield Street. Both of these buildings were part of the Pocasset Mill complex, which is considered potentially eligible for listing in the National Register of Historic Places. The Pocasset Mill building is currently undergoing a rehabilitation project for which federal and state tax credits are proposed to be used. Any alterations to these buildings will need to be reviewed and approved by this office.

The RIHPHC staff archaeologist has reviewed the areas where ground-disturbance will occur, and has concluded that this project will have no effect on any significant archaeological resources (those listed on or eligible for listing on the National Register of Historic Places), with one exception. It appears that a detention basin is to be constructed in the Reservoir Avenue section of the project. Prior to this, the area to be impact should have an archaeological survey to determine if any significant Native American archaeological resources are present.

These comments are provided in accordance with Section 106 of the National Historic Preservation Act. If you have any questions, please contact Jeffrey Emidy, Project Review

Coordinator, or Charlotte Taylor, Staff Archaeologist at this office.

Very truly yours,

FOR Edward F. Sanderson, Executive Director
Deputy State Historic Preservation Officer

cc: Frank Vogel, Project Engineer, NRCS
John Brown, NTHPO

APPENDIX D

PUBLIC PARTICIPATION INFORMATION

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
60 Quaker Lane, Suite 46
Warwick, Rhode Island 02886
Phone: 401.828.1300
Fax: 401.828.1300

AGENDA

Pocasset River Watershed Project

Steering Committee Meeting

March 17, 2005
1:30-4:00 PM

USDA Conference Room
60 Quaker Lane
Warwick, Rhode Island 02886

Welcome	Eric Scherer
Pocasset River Flood Plain Management Study	NRCS Staff
Contents	Bachand/Schmidt
CD Version	Joe Bachand
Using ARC Map with GIS Layers	Schmidt/Tuthill
Pocasset River Watershed Plan/Draft EIS	
Update on Plan Development	Joe Bachand
Update on Alternative Preliminary Design/Analysis	GZA/EA
Draft EIS Development	Joe Bachand
Community Ordinances	All
Questions	

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DEPARTMENT OF PUBLIC WORKS

MAKRAM H. MEGALLI, P.E.
Director

MERRICK A. COOK, JR., Administrative Officer
Planning & Economic Development
LORRAINE CARUSO, P.E. Town Engineer
BEN NASCENZI, Building / Zoning Official
ARNOLD VECCHIONE, Maintenance Superintendent

JOSEPH M. POLISENA
Mayor

RECEIVED
MAY 18 2009
GZA

May 8, 2009

Igor Runge
GZA GeoEnvironmental
One Edgewater Drive
Norwood, MA 02062

Re: Pocasset River Flood Central Project
Steering Committee Meeting of April 30, 2009

Dear Mr. Runge,

On behalf of his Honor Mayor Polisena, we thank you for attending the meeting of April 30, 2009 to review the initial report and the time line regarding the Pocasset River Flood Control Project.

Enclosed herewith, please find a copy of the sign in sheet for the attendees of the meeting hosted by the Town of Johnston at the Senior Citizens Center.

Sincerely,

Makram H. Megalli, P.E.
Director

enclosure

100 Irons Avenue, Johnston, RI 02919 Tel: 401-231-4000. Fax: 401-231-4186

Town of Johnsotn

Pocasset River Flood Control Project

Meeting April 30, 2009

SIGN-IN SHEET

Name	Organization please print	Telephone
MAYOR Joseph Polisi	Town of Johnston	553-8500
Makram Megalli	" " - (DPW Dir.)	231-4000
Arnold Vecchione	Town of Johnston	641-5126
MAYOR Allan Fung	Cranston	780-3110
Ernest Pitochelli	Councilman	943-4435
GERALD CORAY	CITY of CRANSTON	780-3167
CHRISTOPHER ALBERT	OFFICE of Senator Reed	528-5200
IGOR RUNGE	GZA GEOENVIRONMENTAL	427-2710
FRANK VOGEL	USDA/NRCS	822-8823
NICHOLAS A. PISANI	DEM/ FWW PROGRAM	222-4700 x7123
Rick Carlone	GZA	421-4170
Michelle Bennett	RIEMA	462-7048
Russ Chateauneuf	RIDEM	222-4700 EXT. 7700
Pooh Vongthamdy	USDA-NRCS	
MARGHERITA PRYOR	U.S. EPA-NEW ENGLAND	617-918-1597
Vean Lynch	NRI Conservation District	401-369-8235
Gino DeMarco	NRICD	949-1480
Dick Wene	NRICD	949-1480
Tony Simon	Office of Senator Whitehouse	453-5294
LORRI CARUSO	JOHNSTON TOWN ENG.	231-4065
JOHN LANNI	CRANSTON CITY COUNCIL	946-7323
MARIO ACETO	CRANSTON CITY COUNCIL	944-6672

APPENDIX E

AIR EMISSION CALCULATIONS

NRCS Rhode Island Flood Control Project
Construction Project Data

Fletcher Avenue Flood Wall Construction Project

Project Duration: 100 days
Shifts per day: 1

On-Site Construction Equipment

Item	Fuel Type	Horse Power (Est.)	Usage Factor (%)	Number	Days	Hours per Day
Crane	Diesel	213	100%	1	60	6.5
Pneumatic Hammer with diesel compressor	Diesel	170	100%	1	60	6.5
Loader	Diesel	330	100%	1	40	6.5
Excavator	Diesel	345	100%	1	100	6.5
Dozer	Diesel	335	100%	1	40	6.5
Water truck	Diesel	300	10%	1	20	6.5

Mobile Trucks

Item	Fuel Type	Horse Power (Est.)	Days	trips per day	Load/ Unload time per trip (hours)	Trip distance (miles one way)	Trip time (minutes one way)	Gross weight (tons)
Dump (10 Wheeler)	Diesel	350	30	12	1	15	30	30
Truck 18 Wheeler	Diesel	450	60	1	1	15	30	40

Employee Commuting

Item	Number of Vehicles	Fuel Type	Horse Power (Est.)	trips per day	Trip distance (miles one way)	Trip time (minutes one way)	Days
Employee Commuting	3	Gasoline	150	2	15	30	100

Fugitive Dust Data

Silt Content	30%
Work Days per Month	20
Work Days Total	100
Hours per work day	6.5
Size (acres)	3
% Disturbed	50%
% dust suppression	50%

Park Place Apartments Flood Wall Construction Project

Project Duration: 50 days
Shifts per day: 1

On-site Construction Equipment

Item	Fuel Type	Horse Power (Est.)	Usage Factor (%)	Number	Days	Hours per Day
Crane	Diesel	213	100%	1	20	6.5
Pneumatic Hammer with diesel compressor	Diesel	170	100%	1	20	6.5
Loader	Diesel	330	100%	1	20	6.5
Excavator	Diesel	345	100%	1	50	6.5
Dozer	Diesel	335	100%	1	20	6.5
Water truck	Diesel	300	10%	1	10	6.5

Mobile Trucks

Item	Fuel Type	Horse Power (Est.)	Days	trips per day	Load/ Unload time per trip (hours)	Trip distance (miles one way)	Trip time (minutes one way)	Gross weight (tons)
Dump (10 Wheeler)	Diesel	350	10	12	1	15	30	30
Truck 10 Wheeler	Diesel	450	30	1	1	15	30	30

Employee Commuting

Item	Number of Vehicles	Fuel Type	Horse Power (Est.)	trips per day	Trip distance (miles one way)	Trip time (minutes one way)	Days
Employee Commuting	3	Gasoline	150	2	15	30	50

Fugitive Dust Data

Silt Content	30%
Work Days per Month	20
Work Days total	50
Hours per work day	6.5
Size (acres)	0.5
% Disturbed	75%
% dust suppression	50%

South Bennet Drive Structural Measures Construction Project

Project Duration: 60 days
Shifts per day: 1

On-site Construction Equipment

Item	Fuel Type	Horse Power (Est.)	Usage Factor (%)	Number	Days	Hours per Day
Loader	Diesel	330	100%	1	60	6.5
Excavator	Diesel	345	100%	1	60	6.5
Dozer	Diesel	335	100%	1	60	6.5
Paver	Diesel	210	100%	1	5	6.5
Water truck	Diesel	300	25%	1	60	6.5

Mobile Trucks

Item	Fuel Type	Horse Power (Est.)	Days	trips per day	Load/ Unload time per trip (hours)	Trip distance (miles one way)	Trip time (minutes one way)	Gross weight (tons)
Dump (10 Wheeler)	Diesel	350	60	25	1	15	30	30
Asphalt Truck	Diesel	350	5	12	1	15	30	30

Employee Commuting

Item	Number of Vehicles	Fuel Type	Horse Power (Est.)	trips per day	Trip distance (miles one way)	Trip time (minutes one way)	days
Employee Commuting	3	Gasoline	150	2	15	30	60

Fugitive Dust Data

Silt Content	30%
Work Days per Month	20
Work Days total	50
Hours per work day	6.5
Size (acres)	5
% Disturbed	50%
% dust suppression	50%

Note:
As a conservative assumption, on-site construction equipment usage factor assumed to be 100% unless noted.

NRCS Rhode Island Flood Control Project

Emission Factors

On-Site Construction Equipment

Item	Fuel Type	Horse Power (Est.)	Emission Factors (g/brake horsepower-hour)					
			NOX	VOC	CO	SOX	PM10	PM2.5
Crane	Diesel	213	8.380	0.680	2.700	0.930	0.400	0.400
Pneumatic Hammer with diesel compressor	Diesel	170	14.071	1.141	3.028	0.930	0.999	0.999
Loader	Diesel	330	9.250	1.560	6.940	0.930	0.790	0.790
Excavator	Diesel	345	7.940	0.710	4.130	0.930	0.490	0.490
Dozer	Diesel	335	7.940	0.710	4.130	0.930	0.490	0.490
Water truck	Diesel	300	7.940	0.710	4.130	0.930	0.490	0.490
Paver	Diesel	210	7.940	0.710	4.130	0.930	0.490	0.490

Note:
Emission factors for on-site construction equipment obtained from U.S. EPA's NONROAD2008 emission factor program.
Diesel compressor emission factors obtained from AP-42 Section 3.3 Stationary Internal Combustion Sources Table 3.3-1 for diesel engines since data was not provided in NONROAD2008.
SOX emission factors obtained from AP-42 Section 3.3 Stationary Internal Combustion Sources Table 3.3-1 for diesel engines since data was not provided in NONROAD2008.
Emission factors represent the worst case un-controlled factors contained in the NONROAD2008 and AP-42 databases.

Mobile Vehicles

Item	Fuel Type	Vehicle Type	Estimated Average Speed (mph)	Moving Emission Factors (g/vehicle-mile)						Stationary Emission Factors (g/vehicle-hour)					
				NOX	VOC	CO	SOX	PM10	PM2.5	NOX	VOC	CO	SOX	PM10	PM2.5
Dump (10 Wheeler)	Diesel	HDV8B	20	3.1060	0.4920	1.1870	0.5023	0.1589	0.1043	13.1525	2.7050	9.6700	1.2558	0.2758	0.2608
Truck 18 Wheeler	Diesel	HDV8B	20	3.1060	0.4920	1.1870	0.5023	0.1589	0.1043	13.1525	2.7050	9.6700	1.2558	0.2758	0.2608
Truck 10 Wheeler	Diesel	HDV8B	20	3.1060	0.4920	1.1870	0.5023	0.1589	0.1043	13.1525	2.7050	9.6700	1.2558	0.2758	0.2608
Asphalt Truck	Diesel	HDV8B	20	3.1060	0.4920	1.1870	0.5023	0.1589	0.1043	13.1525	2.7050	9.6700	1.2558	0.2758	0.2608
Employee Commuting	Gasoline	LDGV, LDGT1, LDGT2	20	0.5164	0.5412	14.4003	0.0073	0.0233	0.0107	NA					

Note:
Emission factors for motor vehicles obtained from EPA's MOBILE6.2 emission factor program.
Moving emission factors based on the average speed for the vehicles assumed to be approximately 20 mph.
Stationary emission factors based on assuming an idling speed of 2.5 mph times the MOBILE6.2 emission factor for that speed (in g/vehicle-mile) to obtaned g/vehicle-hour.
Year 2 was determined as the worst case construction year which is anticipated to be 2013.
Employee Commuting motor vehicles assumed to be a composite of light duty gasoline vehicles and light duty gasoline trucks.
MOBILE6.2 inputs obtained from the Rhode Island Department of Environmental Management.
Stationary emission factors for Employee Commuting vehicles does not apply. Employees assumed to not drive their vehicles once they are on-site.
HDV8B in MOBILE6.2 represents diesel trucks greater than 60,000 pounds in gross vehicle weight.
Stationary emission factors for PM10 and PM2.5 are for PM exhaust emissions only. Moving PM emission factors also include brake and tire PM emissions.

NRCS Rhode Island Flood Control Project

Construction Emissions Calculations

Fletcher Avenue Flood Wall Construction Project

On-Site Construction Equipment

	4	5	6	7	8	9
Item	**Emissions (tons per year)**					
	NOX	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**
Crane	0.767	0.062	0.247	0.085	0.037	0.037
Pneumatic Hammer with diesel compressor	1.028	0.083	0.221	0.068	0.073	0.073
Loader	0.875	0.148	0.656	0.088	0.075	0.075
Excavator	1.963	0.176	1.021	0.230	0.121	0.121
Dozer	0.762	0.068	0.397	0.089	0.047	0.047
Water truck	0.034	0.003	0.018	0.004	0.002	0.002
Total	**5.430**	**0.540**	**2.560**	**0.565**	**0.355**	**0.355**

Mobile Vehicles

	5	6	7	8	9	10	11	12	13	14	15	16
Item	**Moving Emissions (tons per year)**						**Stationary Emissions (tons per year)**					
	NOX	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**	**NOX**	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**
Dump (10 Wheeler)	0.018	0.003	0.007	0.003	0.001	0.001	0.005	0.001	0.004	0.000	0.000	0.000
Truck 18 Wheeler	0.003	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000
Employee Commuting	0.005	0.005	0.143	0.000	0.000	0.000						
Total	**0.027**	**0.009**	**0.151**	**0.004**	**0.001**	**0.001**	**0.006**	**0.001**	**0.004**	**0.001**	**0.000**	**0.000**

Park Place Apartments Flood Wall Construction Project

On-Site Construction Equipment

	4	5	6	7	8	9
Item	**Emissions (tons per year)**					
	NOX	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**
Crane	0.256	0.021	0.082	0.028	0.012	0.012
Pneumatic Hammer with diesel compressor	0.343	0.028	0.074	0.023	0.024	0.024
Loader	0.437	0.074	0.328	0.044	0.037	0.037
Excavator	0.981	0.088	0.510	0.115	0.061	0.061
Dozer	0.381	0.034	0.198	0.045	0.024	0.024
Water truck	0.017	0.002	0.009	0.002	0.001	0.001
Total	**2.416**	**0.246**	**1.202**	**0.257**	**0.159**	**0.159**

Mobile Vehicles

	5	6	7	8	9	10	11	12	13	14	15	16
Item	**Moving Emissions (tons per year)**						**Stationary Emissions (tons per year)**					
	NOX	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**	**NOX**	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**
Dump (10 Wheeler)	0.006	0.001	0.002	0.001	0.000	0.000	0.002	0.000	0.001	0.000	0.000	0.000
Truck 10 Wheeler	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Employee Commuting	0.003	0.003	0.071	0.000	0.000	0.000						
Total	**0.010**	**0.004**	**0.074**	**0.001**	**0.001**	**0.000**	**0.002**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**

South Bennet Drive Structural Measures Construction Project

On-Site Construction Equipment

	4	5	6	7	8	9
Item	**Emissions (tons per year)**					
	NOX	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**
Loader	1.312	0.221	0.985	0.132	0.112	0.112
Excavator	1.178	0.105	0.613	0.138	0.073	0.073
Dozer	1.143	0.102	0.595	0.134	0.071	0.071
Paver	0.060	0.005	0.031	0.007	0.004	0.004
Water truck	0.256	0.023	0.133	0.030	0.016	0.016
Total	**3.949**	**0.457**	**2.356**	**0.441**	**0.275**	**0.275**

Mobile Vehicles

	5	6	7	8	9	10	11	12	13	14	15	16
Item	**Moving Emissions (tons per year)**						**Stationary Emissions (tons per year)**					
	NOX	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**	**NOX**	**VOC**	**CO**	**SOX**	**PM10**	**PM2.5**
Dump (10 Wheeler)	0.077	0.012	0.029	0.012	0.004	0.003	0.022	0.004	0.016	0.002	0.000	0.000
Asphalt Truck	0.003	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000
Employee Commuting	0.003	0.003	0.086	0.000	0.000	0.000						
Total	**0.083**	**0.016**	**0.116**	**0.013**	**0.004**	**0.003**	**0.023**	**0.005**	**0.017**	**0.002**	**0.000**	**0.000**

Note:
Paving activities for the South Bennet Drive project will be conducted with hot mix asphalt which has negligable VOC emissions. Therefore, these emissions were not calculated and were assumed to be zero for purposes of this Conformity Analysis

NRCS Rhode Island Flood Control Project

Operational Emissions

Emergency Engine Description:	Caterpillar 30 kW Diesel Generator Set		
Maximum Rated Capacity of Emissions Unit:	**0.3836**	MM Btu/hr	
Combustion Method:	Internal Combustion - Compression Ignition		
Primary Fuel Type:	Diesel	% Sulfur: 0.05	% Ash: N/A
Maximum Fuel Consumption Rate:	**0.0028**	10^3 gal/ hour	
Actual Annual Fuel Consumption:	**0.0336**	10^3 gallons/ year	
Number of Generators:	**8**		

Pollutant	Emission Factors ($lb/10^3$ gal)	Emission Rate (lbs/hr)	Potential Emissions (tons/yr)	Actual Emissions (tons/yr)
NOX	215.00	0.602	21.094	0.029
VOC	3.56	0.010	0.350	0.000
CO	30.88	0.086	3.030	0.004
SOX	39.73	0.111	3.898	0.005
PM10	12.79	0.036	1.255	0.002
PM2.5	12.79	0.036	1.255	0.002

Note:

NOX, VOC, CO and PMemission factors based on Manufacturer's data and SOX is based on AP-42.

Operation of these emergency generators will start in Year 3.

Actual emissions based on assuming the 8 emergency generators will operation a total of 96 hours per year.

NRCS Rhode Island Flood Control Project

Fugitive Dust Emissions

Fletcher Avenue Flood Wall Construction

Item	Result	Units	Note
TSP Heavy Construction Emission Factor =	1.2	tons / acre / month	Obtained from AP-42 Section 13.2.3 Heavy Construction Operations
Days in a month =	30	days	AP-42 emission factor derrived assuming 30 days of activity per month
AP42 Soil Silt Content =	30%		Soil silt content assumed in AP42 emission factor
On-Site Soil Silt Content =	30%		
Average number of workdays per month =	20	days	
Number of hours in a workday =	6.5	hours	
Total number of work hours per month =	130	hours	
Size of Construction Site =	3	acres	Does not include access roads
Percentage of Construction Site disturbed =	50%		Percentage of Construction Site disturbed at any given time
Percentage of Dust Suppression =	50%		
Ratio of TSP that is PM2.5 =	0.08		AP-42 (0.5 PM10/TSP ratio times 0.15 PM2.5/PM10 ratio)
Site-Specific Peak-hour PM2.5 Construction Emission Rate =	0.7	lbs/hr	TSP Heavy Construction Emission Factor *(Average number of workdays/ Days in a month) / Total number of hours per month * 2000 lb/ton * Size of Construction Site * Percentage of Construction Site disturbed * (1-Percentage of Dust Supression) * (On-site Soil Silt Content / AP42 Soil Silt Content) *Ratio of TSP that is PM2.5
Ratio of TSP that is PM10 =	0.50		AP-42
Site-Specific Peak-hour PM10 Construction Emission Rate =	4.6	lbs/hr	TSP Heavy Construction Emission Factor *(Average number of workdays/ Days in a month) / Total number of hours per month * 2000 lb/ton * Size of Construction Site * Percentage of Construction Site disturbed * (1-Percentage of Dust Supression) * (On-site Soil Silt Content / AP42 Soil Silt Content) *Ratio of TSP that is PM10
Construction project duration	100	days	
PM-2.5 Emissions =	**0.225**	**tons**	
PM-10 Emissions =	**1.5**	**tons**	

Park Place Apartments Flood Wall Construction

Item	Result	Units	Note
TSP Heavy Construction Emission Factor =	1.2	tons / acre / month	Obtained from AP-42 Section 13.2.3 Heavy Construction Operations
Days in a month =	30	days	AP-42 emission factor derrived assuming 30 days of activity per month
AP42 Soil Silt Content =	30%		Soil silt content assumed in AP42 emission factor
On-Site Soil Silt Content =	30%		
Average number of workdays per month =	20	days	
Number of hours in a workday =	6.5	hours	
Total number of work hours per month =	130	hours	
Size of Construction Site =	0.5	acres	Does not include access roads
Percentage of Construction Site disturbed =	75%		Percentage of Construction Site disturbed at any given time
Percentage of Dust Suppression =	50%		
Ratio of TSP that is PM2.5 =	0.08		AP-42 (0.5 PM10/TSP ratio times 0.15 PM2.5/PM10 ratio)
Site-Specific Peak-hour PM2.5 Construction Emission Rate =	0.2	lbs/hr	TSP Heavy Construction Emission Factor *(Average number of workdays/ Days in a month) / Total number of hours per month * 2000 lb/ton * Size of Construction Site * Percentage of Construction Site disturbed * (1-Percentage of Dust Supression) * (On-site Soil Silt Content / AP42 Soil Silt Content) *Ratio of TSP that is PM2.5
Ratio of TSP that is PM10 =	0.50		AP-42
Site-Specific Peak-hour PM10 Construction Emission Rate =	1.2	lbs/hr	TSP Heavy Construction Emission Factor *(Average number of workdays/ Days in a month) / Total number of hours per month * 2000 lb/ton * Size of Construction Site * Percentage of Construction Site disturbed * (1-Percentage of Dust Supression) * (On-site Soil Silt Content / AP42 Soil Silt Content) *Ratio of TSP that is PM10
Construction project duration	50	days	
PM-2.5 Emissions =	**0.113**	**tons**	
PM-10 Emissions =	**0.75**	**tons**	

South Bennet Drive Structural Measures Construction

Item	Result	Units	Note
TSP Heavy Construction Emission Factor =	1.2	tons / acre / month	Obtained from AP-42 Section 13.2.3 Heavy Construction Operations
Days in a month =	30	days	AP-42 emission factor derrived assuming 30 days of activity per month
AP42 Soil Silt Content =	30%		Soil silt content assumed in AP42 emission factor
On-Site Soil Silt Content =	30%		
Average number of workdays per month =	20	days	
Number of hours in a workday =	6.5	hours	
Total number of work hours per month =	130	hours	
Size of Construction Site =	5	acres	Does not include access roads
Percentage of Construction Site disturbed =	50%		Percentage of Construction Site disturbed at any given time
Percentage of Dust Suppression =	50%		
Ratio of TSP that is PM2.5 =	0.08		AP-42 (0.5 PM10/TSP ratio times 0.15 PM2.5/PM10 ratio)
Site-Specific Peak-hour PM2.5 Construction Emission Rate =	1.2	lbs/hr	TSP Heavy Construction Emission Factor *(Average number of workdays/ Days in a month) / Total number of hours per month * 2000 lb/ton * Size of Construction Site * Percentage of Construction Site disturbed * (1-Percentage of Dust Supression) * (On-site Soil Silt Content / AP42 Soil Silt Content) *Ratio of TSP that is PM2.5
Ratio of TSP that is PM10 =	0.50		AP-42
Site-Specific Peak-hour PM10 Construction Emission Rate =	7.7	lbs/hr	TSP Heavy Construction Emission Factor *(Average number of workdays/ Days in a month) / Total number of hours per month * 2000 lb/ton * Size of Construction Site * Percentage of Construction Site disturbed * (1-Percentage of Dust Supression) * (On-site Soil Silt Content / AP42 Soil Silt Content) *Ratio of TSP that is PM10
Construction project duration	60	days	
PM-2.5 Emissions =	**0.135**	**tons**	
PM-10 Emissions =	**0.9**	**tons**	

NRCS Rhode Island Flood Control Project

Project-Wide Emissions Summary

Item	Emissions (tons per year)					
	NOX	VOC	CO	SO2	PM10	PM2.5
Fletcher Avenue Flood Wall Construction Project						
- Construction Emissions	5.462	0.550	2.716	0.569	0.356	0.356
- Fugitive Emissions	-	-	-	-	1.500	0.225
Fletcher Avenue Total	**5.462**	**0.550**	**2.716**	**0.569**	**1.856**	**0.581**
Park Place Apartments Flood Wall Construction Project						
- Construction Emissions	2.428	0.250	1.278	0.258	0.160	0.159
- Fugitive Emissions	-	-	-	-	0.750	0.113
Park Place Total	**2.428**	**0.250**	**1.278**	**0.258**	**0.910**	**0.272**
South Bennet Drive Structural Measures Construction Project						
- Construction Emissions	4.055	0.478	2.489	0.456	0.280	0.278
- Fugitive Emissions	-	-	-	-	0.900	0.135
South Bennet Drive Total	**4.055**	**0.478**	**2.489**	**0.456**	**1.180**	**0.413**
Operational Emissions (Project-wide)	**21.094**	**0.350**	**3.030**	**3.898**	**1.255**	**1.255**
Project-wide Total	**33.039**	**1.627**	**9.513**	**5.181**	**5.200**	**2.520**
Conformity Determination						
De Minimus Limit	**100**	**50**	-	-	-	-
Exceed De Minimus Limit?	**NO**	**NO**	-	-	-	-

Note:
As a conservative estimate, operational emissions were assumed to occur in Year 2, which was determined to be the worst-case construction year even though Pump Station emergency generators will not start operation until Year 3. Operational Emissions consists of 8 Caterpillar 30 kW emergency generator sets operating at the various Pump Stations.

APPENDIX F

PHOTOGRAPHS

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 1: Atwood Avenue Bridge, Johnston, RI; October 15, 2005.

Photo No. 2: Rotary Drive: Rotary Drive, Johnston RI; October 15, 2005.

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 3: Morgan Mill Road, Johnston, RI; October 15, 2005.

Photo No. 4: South Bennett Drive, Johnston, RI; March 2, 2007

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 5: River Drive, Johnston, RI; October 15, 2005.

Photo No. 6: Park Place Apartments, Johnston, RI; March 2, 2007.

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 7: Park Place Apartments, Johnston, RI; March 2, 2007

Photo No. 8: River Avenue, Johnston, RI; March 2, 2007.

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 9: Fletcher Avenue, Cranston, RI; October 15, 2005.

Photo No. 10: Fletcher Avenue, Cranston, RI; March 2, 2007.

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 11: Reservoir Avenue, Cranston, RI; October 15, 2005

Photo No. 12: Fordson Avenue, Cranston, RI; October 15, 2005.

PHOTOGRAPHS OF CRITICAL FLOODING AREAS
POCASSET RIVER WATERSHED, RHODE ISLAND

Photo No. 13: Riverview Terrace, Cranston, RI; March 2, 2007.

Photo No. 14: Willowbrook Apartments, Cranston, RI; March 2, 2007.

APPENDIX G

EXAMPLE OPERATION AND MAINTENANCE PLAN AND AGREEMENT

OPERATION AND MAINTENANCE PLAN

FLOODWATER RETARDING AND WATER SUPPLY STRUCTURE A-6-h
Anytown, Anystate

This document supplements the Operation and Maintenance Agreement signed by the USDA, Natural Resources Conservation Service and the Anycounty Conservation District, Moose Hill Water District and Anytown, Anystate dated **April 30, 2003.** It may be revised by mutual consent of all signatory parties.

This plan defines responsibilities for operating, inspecting, and maintaining floodwater retarding and water supply structure A-6-h. These responsibilities shall remain in effect for the program life of 100 years from the date the structure is determined complete by NRCS. After the expiration of this O&M Plan, the Sponsors may still continue to be liable until the structure is removed or modified to eliminate potential hazards.

Description of the Practice:

Floodwater retarding and water supply structure A-6-h, is located approximately 5 miles southwest of Anytown on Cobb Brook, which is a tributary to the Main River in Anycounty, Anystate. This structure was designed as a high hazard dam. The dam is owned by the Moose Hill Water District, and serves as a supplemental water supply for Anytown, Anystate. The dam is a homogenous earth structure, 350 feet long, with a height of 23 feet. The principal spillway inlet is a rectangular concrete drop box, 4 feet by 9 feet, 23 feet high. The spillway outlet is a 48-inch diameter concrete conduit with a concrete impact basin. A 100-foot wide grassed auxiliary spillway is located on the east abutment. Access to the water supply elements is through a metal bulkhead located in the west abutment of the dam.

Estimated Annual O&M Costs:

The Moose Hill Water District is responsible for financing the operation and maintenance activities for floodwater retarding structure A-6-h. Funds for these activities will be obtained from assessments to the District's water users and will be held in an operation and maintenance escrow account until needed. It is estimated that the average annual cost of maintenance will be $4,500 for this structure. Estimated annual O&M costs are as follows (unused amounts will be added to escrow account each year):

Vegetation (mowing, liming, fertilizing)	$ 2,500
Debris removal	$ 500
Concrete repair/replacement	$ 500
Metalwork (trash racks, railings, drainage)	$ 500
Unforeseen and long term maintenance needs (escrow account)	$ 500

Operation:

The Moose Hill Water District will be responsible for all operation activities. The Anycounty Conservation District and Anytown will assist in the coordination of any required reservoir drawdown and other operation activities to be coordinated with other structures in the watershed.

Maintenance along the shoreline of the reservoir may require the operation of the slide gate to lower the water level for short periods of time to complete the needed maintenance. The principal spillway slide gate and the gate in the water supply bulkhead shall be opened and closed once each year, as a minimum, to ensure proper operation.

Maintenance:

It is the responsibility of the Moose Hill Water District to ensure that the following operation and maintenance items, as a minimum, are addressed annually. The Anycounty Conservation District and Anytown will assist in the coordination of O&M activities and will participate in the inspections.

(1) Vegetation - The dam, auxiliary spillway, and earthen dikes will be established to a native grass cover. Reshape, if necessary, and reseed all bare areas or areas of poor stand, including areas damaged by erosion, freezing, or drought using the original seed mixture. Lime and fertilize as necessary to maintain a vigorous stand.

(2) Trees, Brush, Woody Growth - Control weeds, brush, and woody vegetation on the dam and auxiliary spillway. Woody vegetation, trees, and large shrubs on the embankment, in the outlet channel flow area, and within 10 feet of all concrete structures shall be controlled by spraying or removal. This vegetation shall be killed or removed before it reaches 1 foot in height, or 1 inch in diameter (stalks of woody growth). All pesticide application shall be done in accordance with applicable Federal, State, local, and tribal laws and regulations.

(3) Debris Removal - The auxiliary spillway, principal spillway and both slopes of the dam shall be kept clear of trees, logs, debris, trash, and other obstacles, which will interfere with the proper functioning of the structure.

(4) Embankment and Earth Fill Areas - All soil removed from the embankment, auxiliary spillway, and other earthen appurtenances by erosion, vandalism, rodents, vehicles or other causes shall be replaced to the original slopes and grades. All earthfill shall be an approved material that is compacted and graded to prevent ponding or concentrated drainage. The entire length of the dam shall be visually inspected for cracks and rilling. If and when encountered, the dimensions and locations of major eroded areas shall be recorded and promptly submitted to NRCS for evaluation and recommendations for repair.

(5) Metalwork - All metalwork shall be visually inspected and repaired or replaced if it is damaged or improperly removed. All painted surfaces shall be cleaned and painted when rust starts to appear or the paint system shows signs of peeling or heavy oxidation.

(6) Concrete - Concrete shall be visually inspected for spalls, cracks, misalignment, or structural breakage. Spalls deeper than 1-inch and cracks less than 0.25 inch shall be repaired with cement mortar and sealing compound respectively. Cracks greater than 0.25 inch, misalignments of more than 0.5 inch, and any structural breakage shall be measured and repaired in accordance with NRCS recommendations. Exposed joints shall be visually inspected. Any joints where the sealing compound or joint filler is missing shall be repaired with materials similar to that used in the original construction. Any joints found to have opened more than 1-inch shall be measured and promptly repaired in accordance with NRCS recommendations.

(7) Fences - Inspect all fences and gates at least once each year, and replace posts, wires, and fasteners, as needed.

(8) Gate valves - The principal spillway slide gate and water supply gates will be kept in working order. As a minimum, each gate shall be operated at each annual inspection.

Excessive force shall not be used when operating gates. Repair or replace all nonfunctional hardware such as stem guides, anchors, and anchor bolts.

(9) Auxiliary Spillway - The auxiliary spillway shall be visually inspected both annually and after severe storm events. If auxiliary spillway flows occur and damage occurs, the dimensions and locations of damaged areas shall be recorded and repaired in the manner as described above for the embankment and earth fill areas.

(10) Rock Riprap - Rock riprap on the upstream slope that is dislodged shall be replaced or moved back into its original configuration. Any damaged grouted rock riprap shall be repaired promptly.

(11) Outlet Channel - The water surface in the outlet channel shall be monitored during periods of full pipe discharge. When the water surface in the channel rises to within 6 inches of the pipe conduit invert elevation during flow periods, the outlet channel shall be cleared of trees, silt, or other debris, which caused the rise in water surface. The foundation drain outlet shall be kept open and free of debris and the rodent guard maintained in place.

(12) Access Road - Maintain the access road to the dam in drivable condition. Remove any obstructions to the passage of vehicles and add fill as needed to prevent ponding of water.

(13) Easements/landrights – The terms and conditions of all easements and landrights documents shall be checked for potential violations.

(14) Replacement of Components - The following items are not expected to retain operational capability for the 100-year program life of the dam and are anticipated to be replaced. Timing for replacement should be evaluated during annual O&M inspections.

- trash racks;
- slide gate hardware (stems, stem guides, etc.);
- fences/gates; and
- rodent guards.

A schedule for corrective actions shall be developed for completion of identified maintenance work in a timely manner.

Personnel:

All personnel involved in conducting inspections and performing O&M activities shall be properly trained and equipped. NRCS may assist in training sponsor employees. NRCS shall accompany the sponsor(s) on inspections for the first 3 years after completion of the structure. After the first three annual inspections, NRCS may continue to provide employees to accompany the sponsor during subsequent O&M inspections, if requested by the sponsors and if NRCS resources are available.

O&M Inspections:

Four types of inspections are required to ensure that the flood control and water supply structure functions as designed.

(1) **Monitoring** of the dam will be accomplished to identify and report abnormal conditions between scheduled inspections. Trained personnel of the Moose Hill

Water District will perform monitoring while carrying out their routine duties. Irregularities are to be reported to the water department director.

(2) **Special** inspections will be conducted immediately following severe storms, earthquakes, initial filling of the reservoir, vandalism, and other significant events.

(3) **Annual** inspections will be accomplished in May or June by a qualified engineer using an inspection checklist approved by NRCS. For the first 3 years after installation of the structure, an NRCS engineer shall participate in the annual inspections.

(4) **Formal** inspections shall be conducted at least once every 5 years. These inspections are to be accomplished under the leadership of a registered professional engineer licensed in the State with assistance from other specialists as needed. The State Dam Safety Office will be invited to participate in this inspection. The purpose of the inspection is to determine the safety and structural integrity of the dam, and to determine whether the dam meets the current NRCS and State Dam Safety Agency criteria.

Records:

The Moose Hill Water District shall maintain the following records in a permanent file at the Moose Hill Water District office: a record of all significant actions taken; the cost of performance and completion dates; as-built drawings; permits; and related material. Copies of all inspection reports shall be provided to NRCS and the Anycounty Conservation District.

Hazard Concerns:

This structure is classified as a "high hazard" dam by NRCS and the State Dam Safety Agency. The specific hazard concerns associated with structure A-6-h are located in the downstream flood area. In addition to possible loss of life, a breach of the dam would affect the following:

- 1600 feet of highway 27;
- 3 houses at the lower end of the Elmwood Heights subdivision;
- 3 houses located along the east side of Chestnut Street;
- The Anytown bowling alley and adjacent parking lot; and
- Eddie's carwash and coffee shop.

The Emergency Action Plan (EAP) for this structure outlines a sequential list of contingencies to be followed in the event this structure is subject to imminent failure or periods of high water flow. The Director of the Water department is responsible for ensuring that this plan is reviewed and updated annually. Copies of the updated plan shall be provided to NRCS and to the Director, State Dam Safety Office.

Violations

If NRCS determines that the Moose Hill Water District has failed to comply with the provisions of this O&M Plan, the Moose Hill Water District agrees to reimburse the Federal government for the financial assistance provided for the installation of structure A-6-h. The Federal government also shall have the right to take any further action it deems necessary as per the O&M Agreement.

Anycounty Conservation District
By: **/s/ Fred Smith** Title: **Chairman**

This action was authorized at an official meeting of the Sponsor named immediately above on

Date: **April 5, 2003** Location: **Anytown, Anystate.**
Attest: **/s/ Mary Wright** Title: **Secretary**

Moose Hill Water District
By: **/s/ Janice Jones** Title: **Director**

This action was authorized at an official meeting of the Sponsor named immediately above on

Date: **April 11, 2003** Location: **Anytown, Anystate**
Attest: **/s/ Paula Davis** Title: **Treasurer**

Anytown, Anystate
By: **/s/ Henry Parsons** Title: **Mayor**

This action was authorized at an official meeting of the Sponsor named immediately above on

Date: **April 21, 2003** Location: **Anytown, Anystate**
Attest: **/s/ Ethel Crane** Title: **Executive Secretary**

USDA, Natural Resources Conservation Service
By: **/s/ Elizabeth Jeffrey** Title: **State Conservationist**
Date: **April 30, 2003**

OPERATION AND MAINTENANCE AGREEMENT
MOUNT PLEASANT WATERSHED
ANYSTATE

This Agreement made on **April 30, 2003** is between the United States Department of Agriculture, Natural Resources Conservation Service, hereinafter referred to as NRCS, and the following organizations, hereinafter referred to as the Sponsors:

- Anycounty Conservation District
- Moose Hill Water District
- Anytown, Anystate

The Sponsors and NRCS agree to carry out the terms of this agreement for the operation and maintenance (O&M) of the following structures to be installed in the **Mount Pleasant Watershed** in **Anystate**. These structures are a part of the Mount Pleasant Watershed Plan that was approved April 4, 2000 under the authority of Pubic Law 83-566.

- **Floodwater retarding structure A-4-a;** located on Meadow Brook approximately 5 miles southwest of Anytown.
- **Floodwater retarding and water supply structure A-6-h;** located on Cobb Brook approximately 2 miles northeast of Anytown.
- **Floodwall structure A-1;** located along the Main River in downtown Anytown.

The Sponsors' responsibility for O&M begins when a structure is determined complete by NRCS. This responsibility shall include the replacement of any component of the structures as needed. This O&M Agreement remains in effect for the program life of 100 years from the date the last structure covered by this Agreement is completed, as determined by NRCS. After the expiration of this O&M Agreement, the Sponsors may still continue to be liable until the structures are removed or modified to eliminate potential hazards.

General

A. The Sponsors shall:

(1) Complete all maintenance, repair, or replacement activities within a reasonable time after the identification of such need;
(2) Obtain prior NRCS approval of all plans, designs, and specifications for any planned alteration to the structures;
(3) Be responsible for the replacement of structure components that have a design life of less duration than the program life of the structure as specified in the O&M Plan;
(4) Prohibit the installation of any structure or facility that will interfere with the operation or maintenance of the structures;
(5) Notify NRCS of any proposed agreement with other parties for the operation or maintenance of all or any part of the structures, and provide NRCS with a copy of the executed agreement. Such agreements will not negate the sponsors' responsibilities as stated in this agreement;
(6) Comply with the property management standards set forth in the NRCS Contracts, Grants, and Cooperative Agreements Manual, the National Watershed Manual, and all applicable Federal, State, local, and tribal laws and regulations.

(7) Provide NRCS personnel or its agents the right of free access to the structure sites at any reasonable time for the purpose of carrying out the terms of the agreement;
(8) Comply with Federal, State, local, and tribal laws and regulations in the operation and maintenance of the structures; and
(9) Consider air and water quality, sediment control, and other environmental concerns in the operation and maintenance of the structures.

B. Anytown, Anystate shall:

(1) Be responsible for inspecting, operating and performing, or having performed, all operation, maintenance, and replacement activities associated with floodwater retarding structure A-4-a and floodwall structure A-1 and their components, as described in the O&M Plans;
(2) Assure that an Emergency Action Plan is prepared prior to construction of floodwater retarding structure A-4-a and that the plan is reviewed and updated annually;
(3) Establish an escrow account for operation, maintenance, and replacement of structures/components.

C. Moose Hill Water District shall:

(1) Be responsible for inspecting, operating and performing, or having performed, all operation, maintenance, and replacement activities associated with floodwater retarding and water supply structure A-6-h and its components, as described in the O&M Plan;
(2) Assure that an Emergency Action Plan is prepared prior to construction of floodwater retarding and water supply structure A-6-h and that the plan is reviewed and updated annually; and
(3) Establish an escrow account for operation, maintenance, and replacement of structures/components.

D. The NRCS shall:

Upon request of the sponsor(s), and to the extent that its resources permit, provide consultative assistance in the operation, maintenance, and replacement of structures.

Operation and Maintenance Plan

An O&M Plan for floodwater retarding and water supply structure A-6-h is attached to and is incorporated as part of this agreement. An amendment to this agreement incorporating the O&M Plans for flood water retarding structure A-4-a and floodwall structure A-1 will be prepared prior to execution of fund obligating documents.

Inspections and Reports

The Sponsor shall inspect the structures as specified in the O&M Plans.

NRCS may inspect the structures at any reasonable time during the period covered by this agreement. At the discretion of the State Conservationist, NRCS personnel may assist the Sponsor while conducting the inspections.

The Sponsor responsible for conducting the inspections shall prepare a written report of each inspection and provide a copy to the NRCS District Conservationist within 30 days from the date the inspection was conducted. The report shall include the following:

- Date(s) of inspection;
- Names of inspectors and participants.
- Features of the practice that were inspected;
- Description of conditions observed;
- Maintenance work required; and
- Planned maintenance work schedule.

Any unusual circumstances observed between annual inspections shall be reported immediately to the local NRCS District Conservationist.

Records

The Sponsor responsible for O&M of specific structures shall retain a record of all inspections and O&M performed including, costs and completion dates. Records shall be made available to NRCS upon request.

Financial Plan

The following are anticipated average annual costs for O&M and the method of financing that the sponsors will use to obtain funds. The O&M Plan for each structure will contain individual component costs, along with an amount to be placed into an escrow account to be used for O&M activities. All costs will be updated at least once every 5 years to account for inflation using the Bureau of Reclamation's Water Resources Construction Cost Index, and to adjust the amount to be added to the escrow account.

Floodwater retarding structure no. A-4-a - $3,500/year – financed through local property taxes on all classes of property in Anytown, Anystate.

Floodwater retarding and water supply structure no. A-6-h - $4,500/year – financed by the Moose Hill Water district through assessments made to its water users.

Floodwall structure no. A-1 - $ 2,000/year - financed through local property taxes on all classes of property in Anytown, Anystate.

Violations

This O&M Agreement is a legally binding contract which shall be enforced as necessary to protect the interests of the government and the general public.

If NRCS determines that the sponsor(s) fail to comply with the provisions of the O&M Agreement and O&M Plan(s), the sponsor(s) will reimburse the Federal government for the financial assistance provided by NRCS, and the appropriate portions of USDA financial assistance provided for other practices that will be adversely affected by the violation. The Federal government shall have the right to take any further actions it deems necessary.

Review and Revision of this Agreement

This agreement and associated O&M Plans shall be reviewed at least once every 5 years by the sponsors and NRCS. This O&M Agreement and associated O&M Plans may be revised by mutual consent of both the sponsors and NRCS.

Anycounty Conservation District

By: **/s/ Fred Smith** Title: **Chairman**

This action was authorized at an official meeting of the Sponsor named immediately above on

Date: **April 5, 2003** Location: **Anytown, Anystate**
Attest: **/s/ Mary Wright** Title: **Secretary**

Moose Hill Water District

By: **/s/ Janice Jones** Title: **Director**

This action was authorized at an official meeting of the Sponsor named immediately above on

Date: **April 11, 2003** Location: **Anytown, Anystate**
Attest: **/s/ Paula Davis** Title: **Treasurer**

Anytown, Anystate

By: **/s/ Henry Parsons** Title: **Mayor**

This action was authorized at an official meeting of the Sponsor named immediately above on

Date: **April 21, 2003** Location: **Anytown, Anystate**
Attest: **/s/ Ethel Crane** Title: **Executive Secretary**

USDA, Natural Resources Conservation Service

By: **/s/ Elizabeth Jeffrey** Title: **State Conservationist**