United States
Department
Of Agriculture

Natural
Resources
Conservation
Service

SUPPLEMENTAL WATERSHED PLAN No. 7 & ENVIRONMENTAL EVALUATION

For Rehabilitation of the
George H. Nichols Multipurpose Dam
SuAsCo Watershed
Worcester County, Massachusetts

Prepared By:
U.S. Department of Agriculture
Natural Resources Conservation Service

FINAL
September 2009

FINAL
Supplemental Watershed Plan No. 7 & Environmental Evaluation for Rehabilitation of George H. Nichols Multipurpose Dam SuAsCo Watershed Worcester County, Massachusetts

Prepared By
U.S. Department of Agriculture
Natural Resources Conservation Service

In Cooperation With:
Massachusetts Department of Conservation and Recreation
Worcester County Conservation District
Middlesex Conservation District
Massachusetts Division of Fisheries & Wildlife

AUTHORITY

The original watershed work plan was prepared, and works of improvement have been installed, under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) as amended. The rehabilitation of the George H. Nichols Multipurpose Dam is authorized under Public Law 83-566 (as amended), and as further amended by Section 313 of Public Law 106-472.

ABSTRACT

The George H. Nichols Multipurpose Dam no longer provides the original protection planned for the watershed due to a greater than planned increase in development of the upstream drainage area. For current and future build-out development conditions the dam does not meet current Natural Resources Conservation Service design criteria for a high hazard dam. The local project sponsors have chosen to rehabilitate the dam to address the identified safety deficiencies. The purposes of the proposed rehabilitation of the George H. Nichols Dam are to maintain present level of flood control benefits and comply with current performance and safety standards. Rehabilitation of the site will require the following modifications to the structure: extending the current auxiliary spillway width from 100 feet to 350 feet and armoring the auxiliary spillway to provide scour protection. Project installation cost is estimated to be $2,900,500, of which $2,055,700 will be paid from Small Watershed Rehabilitation funds and $844,800 from local funds.

CONTACT

For further information, contact Carl Gustafson, State Conservation Engineer, USDA/NRCS, 451 West Street, Amherst, MA 01002-2953, 413-253-4362.

Supplemental Watershed Plan No. 7 & Environmental Evaluation for Rehabilitation of George H. Nichols Multipurpose Dam SuAsCo Watershed Worcester County, Massachusetts

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SUASCO WATERSHED AGREEMENT

Supplemental Watershed Plan Agreement
(Supplement No. 7)

between the

Middlesex Conservation District

and the

Worcester County Conservation District

and the

Massachusetts Division of Fisheries and Wildlife

and the

Massachusetts Department of Conservation and Recreation

(herein referred to collectively as "Sponsors")

and the

Natural Resources Conservation Service
United States Department of Agriculture
(herein referred to as "NRCS")

Whereas, the Watershed Work Plan Agreement for the SuAsCo Watershed, Commonwealth of Massachusetts, authorized under the Watershed Protection and Flood Prevention Act (Public Law 83-566, 16 U.S.C. 1001 et seq.) and executed by the Sponsors named therein and NRCS became effective the 31st day of August 1959; and

Whereas, Supplement Watershed Work Plan Agreement No. 1 executed by the Sponsors named therein and NRCS became effective the 10th day of September 1965; and

Whereas, Supplement Watershed Work Plan Agreement No. 2 executed by the Sponsors named therein and NRCS became effective the 26th day of May 1967; and

Whereas, Supplement Watershed Work Plan Agreement No. 3 executed by the Sponsors named therein and NRCS became effective the 14th day of February 1968; and

Whereas, Supplement Watershed Work Plan Agreement No. 4 executed by the Sponsors named therein and NRCS became effective the 5th day of May 1972; and

Whereas, Supplement Watershed Work Plan Agreement No. 5 executed by the Sponsors named therein and NRCS became effective the 15th day of August 1975; and

Whereas, Supplement Watershed Work Plan Agreement No. 6 executed by the Sponsors named therein and NRCS became effective the __th day of September 2009; and

Whereas, application has been made to the Secretary of Agriculture by the Sponsors for assistance in preparing a plan for rehabilitation of the works of improvement for the George H. Nichols Multipurpose Dam located in Worcester County, Commonwealth of Massachusetts, under the authority of section 14 of the Watershed Protection and Flood Prevention Act (16 U.S.C. 1012); and

Whereas, through the cooperative efforts of the Sponsors and NRCS, a Supplemental Watershed Plan – Environmental Assessment has been developed to rehabilitate the George H. Nichols Multipurpose Dam, which Plan – Environmental Assessment is annexed to and made a part of this Supplemental Watershed Plan Agreement; and

Whereas, in order to provide for rehabilitation of George H. Nichols Multipurpose Dam, it has become necessary to modify the Supplemental Watershed Plan Agreement;

Now, therefore, in view of the foregoing considerations, the Secretary of Agriculture, through NRCS, and the Sponsors, hereby agree on this Supplemental Watershed 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 Agreement and including the following:

1. The name of the Soil Conservation Service is changed to Natural Resources Conservation Service (NRCS). All references to the Soil Conservation Service, SCS, or Service, now refer to the NRCS.

2. Massachusetts Division of Fisheries and Game is changed to The Massachusetts Division of Fisheries and Wildlife. All references to the Massachusetts Division of Fisheries and Game now refer to the Massachusetts Division of Fisheries and Wildlife.

3. Massachusetts Department of Natural Resources, later called the Massachusetts Department of Environmental Management is changed to Department of Conservation and Recreation. All references to the Massachusetts Department of Natural Resources, later called the Massachusetts Department of Environmental Management now refer to the Department of Conservation and Recreation.

4. The Northeastern Worcester Conservation District, the Northwestern Worcester Conservation District and the Southern Worcester Conservation District have merged to become the Worcester County Conservation District. All references to the

5. Massachusetts General Laws Chapter 21, Section 9 of the Acts of 1983, assigned the state administration responsibility for the PL 83-566 program to the Massachusetts Division of Water Resources in the Massachusetts Department of the Environmental Management, and these responsibilities have since been assigned to the Massachusetts Department of Conservation and Recreation.

6. The Department of Conservation and Recreation agrees to continue to participate in and comply with applicable federal and state floodplain management and flood insurance programs before construction starts.

7. The Sponsors will acquire with other than Public Law 83-566 funds, all necessary land rights, easements, or right-of-ways in connection with the planned works of improvement.

8. No relocations are planned with this rehabilitation project. However, should it be determined later that relocation is needed, relocation costs will be cost-shared at following rate:

Sponsors	NRCS	Total Relocation Costs
35%	65%	$0

9. The Sponsors hereby agree that they will comply with all 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 and 49 C.F.R. Part 24) when acquiring real property interests for this federally assisted project. If the Sponsors are legally unable to comply with the real property acquisition requirements of the Act, they agree that, before any federal financial assistance is furnished, they 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 Sponsors agree that they will reimburse owners for necessary expenses as specified in 49 C.F.R. Part 24.

10. The Department of Conservation and Recreation will obtain all necessary federal, state, and local permits required by law, ordinance, or regulation for installation of the planned works of improvement. The costs of such permitting is not eligible as part of the Sponsors' cost-share requirement.

11. The Department of Conservation and Recreation will be responsible for the costs of water, mineral and other resource rights, and will acquire or provide assurance that landowners or resource users have acquired such rights pursuant to state law as may be needed in the installation and operation of the works of improvement. The costs associated with the subject rights are not eligible as a part of the Sponsors' cost-share requirement.

12. NRCS will assist the Sponsors with the installation of planned works of improvement. The percentages of total rehabilitation project costs to be paid by the Department of Conservation and Recreation (DCR) and by NRCS are as follows:

Project Costs
(Dollars)

Works of Improvement	**NRCS PL-106-472 Funds**	**Other Funds - DCR's Responsibility**	**Total Estimated Cost**
Cost Sharable Items (per PL-106-472 and NRCS policy)			
Rehabilitation of the dam (construction costs):	$1,524,300	$765,800	$2,290,100
Sponsor's Planning Costs:	n/a	$0	$0
Sponsor's Engineering Costs:	n/a	$0	$0
Sponsor's Project Administration Costs:	n/a	$55,000	$55,000
Land Rights Acquisition Costs:	n/a	$0	$0
Subtotals: Cost-Sharable Costs: **Cost-Share Percentages:**[a/]	$1,524,300 (65%)	$820,800 (35%)	$2,345,100 (100%)
Non Cost Sharable Items (per PL-106-472 and NRCS policy)[b/]			
NRCS Engineering and Project Administration Costs:	$531,400	n/a	$531,400
Federal, State and Local Permits:	n/a	$24,000	$24,000
Subtotals: Non Cost-Sharable Costs:	$531,400	$24,000	$555,400
Total Estimated Costs:	**$2,055,700**	**$844,800**	**$2,900,500**

a/ The maximum NRCS cost-share is 65% of the cost-sharable items not to exceed 100% of the construction cost. Total eligible project costs include construction, land rights, relocation, project administration, and planning services provided by the Sponsors. Not included are NRCS engineering technical assistance costs of $440,400; NRCS project administration costs of $91,000; and the local cost of permitting and ordinances.

b/ If actual non-cost-sharable item expenditures vary from these estimates, the responsible party will bear the change in costs.

13. The Department of Conservation and Recreation will be responsible for the operation, maintenance, and replacement of the works of improvement by actually performing the work or arranging for such work, in accordance with a new operation and maintenance agreement that will be entered into before issuing invitations to bid for construction work. The term of the operation and maintenance agreement will be for the 60-year evaluated life of the project. The Operation and Maintenance Agreement shall be prepared in accordance with the NRCS National Operation and Maintenance Manual. Although the sponsors' responsibility to the Federal Government for O&M ends when the O&M agreement expires upon completion of the evaluated life of measures covered by the agreement, the sponsors acknowledge that continued liabilities and responsibilities associated with works of improvement may exist beyond the evaluated life.

14. An Emergency Action Plan (EAP) currently exists for the George H. Nichols Multipurpose Dam included in this plan. The Department of Conservation and Recreation will provide leadership in developing a new EAP that is appropriate for the rehabilitated condition of this structure and will update the EAP annually with assistance from the local emergency response officials. NRCS will provide technical assistance in preparation and updating of the EAP. The purpose of the EAP is to outline appropriate actions and to designate parties responsible for those actions in the event of a potential failure of a floodwater retarding structure. The NRCS State Conservationist will ensure that a current EAP has been prepared prior to the initiation of construction.

15. The costs shown in this plan are preliminary estimates. Final costs to be borne by the parties hereto will be based on the actual costs incurred in the installation of works of improvement and the cost-share percentages stated in this agreement.

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

17. This agreement does not commit the NRCS to assistance of any kind beyond the 60-year project life.

18. A separate agreement will be entered into between NRCS and Department of Conservation and Recreation 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.

19. This rehabilitation 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 Sponsors have failed to comply with the conditions of this agreement. In this case, NRCS shall promptly notify the Sponsors in writing of the determination and the reasons for de-authorization of project funding, together with the effective date. Payments made to the Sponsors 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 Sponsors having specific responsibilities for the measure involved.

20. 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 therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

21. The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

22. By signing this agreement, the recipient assures the U.S. Department of Agriculture that the program or activities provided for under this agreement will be conducted in compliance with all applicable Federal civil rights laws, rules, regulations, and policies.

23. Certification Regarding Drug-Free Workplace Requirements (7 CFR 3021). 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 Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of guilt (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 statutes;

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 sub-recipients or subcontractors in covered workplaces).

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 violation 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 on of the following actions, within 30 calendar days of receiving notice under paragraph (4) (b), with respect to any employees 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 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.

24. Certification Regarding Lobbying (7 CFR 3018).

(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 Congress , 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 Standard 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 sub-awards 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 entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

25. 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.

(2) 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.

26. Clean Air and Water Certification.

A. Applicable if this agreement exceeds $100,000, or a facility to be used has been subject of a conviction under the Clean Air Act (42 U.S.C. 7413(c)) or the Federal Water Pollution Control Act (33 U.S.C. 1319(c)) and is listed by EPA, or is not otherwise exempt.

B. The project sponsoring organization(s) signatory to this agreement certifies as follows:
   (1) Any facility to be utilized in the performance of this proposed agreement is (____), is not (_X_) listed on the Environmental Protection Agency List of Violating Facilities.
   (2) To promptly notify the NRCS-State Administrative Officer prior to the signing of this agreement by NRCS, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which is proposed for use under this agreement is under consideration to be listed on the Environmental Protection Agency List of Violating Facilities.
   (3) To include substantially this certification, including this subparagraph, in every nonexempt sub-agreement.

C. The project sponsoring organization(s) signatory to this agreement agrees as follows:
   (1) To comply with all the requirements of section 114 of the Clean Air Act as amended (42 U.S.C. 7414) and section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1318), respectively, relating to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, issued there under before the signing of this agreement by NRCS.
   (2) That no portion of the work required by this agreement will be performed in facilities listed on the EPA List of Violating Facilities on the date when this agreement was signed by NRCS unless and until the EPA eliminates the name of such facility or facilities from such listing.
   (3) To use their best efforts to comply with clean air standards and clean water standards at the facilities in which the agreement is being performed.
   (4) To insert the substance of the provisions of this clause in any nonexempt sub-agreement.

D. The terms used in this clause have the following meanings:
   (1) The term “Air Act” means the Clean Air Act, as amended (42 U.S.C. 7401 et seq.).
   (2) The term “Water Act” means Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.).
   (3) The term “clean air standards” means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as

described in section 110 of the Air Act (42 U.S.C. 7414) or an approved implementation procedure under section 112 of the Air Act (42 U.S.C. 7412).

(4) The term "clean water standards" means any enforceable limitation, control, condition, prohibition, standards, or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. 1342), or by a local government to assure compliance with pretreatment regulations as required by section 307 of the Water Act (33 U.S.C. 1317).

(5) The term "facility" means any building, plan, installation, structure, mine, vessel, or other floating craft, location or site of operations, owned, leased, or supervised by a sponsor, to be utilized in the performance of an agreement or sub-agreement. Where a location or site of operations contains or includes more than one building, plan, installation, or structure, the entire location shall be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are collocated in one geographical area.

27. Assurances and Compliance.

As a condition of the grant or cooperative agreement, the sponsor assures and certifies that it is in compliance with and will comply in the course of the agreement with all applicable laws, regulations, Executive Orders and other generally applicable requirements, including those set out below which are hereby incorporated in this agreement by reference, and such other statutory provisions as a specifically set forth herein.

State, Local, and Indian Tribal Governments: OMB Circular Nos. A-87, A-102, A-129, and A-133; and 7 CFR Parts 3015, 3016, 3017, 3018, 3021, and 3052.

Non-Profit Organizations, Hospitals, Institutions of Higher Learning: OMB Circular Nos. A-110, A-122, A-129, and A-133; and 7 CFR Parts 3015, 3017, 3018, 3019, 3021 and 3052.

28. Examination of Records.

The sponsors shall give the NRCS or the Comptroller General, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to this agreement, and retain all records related to this agreement for a period of three years after completion of the terms of this agreement in accordance with the applicable OMB Circular.

This Supplemental Watershed Plan Agreement provides for rehabilitation of George H. Nichols Multipurpose Dam. All other terms, conditions, and stipulations in the original agreement and previous supplements for the sites in the SuAsCo Watershed remain unchanged.

Middlesex Conservation District

319 Littleton Road, Suite 205
Westford, MA 01886-4133

By: _____

Title: _____

Date: _____

The signing of this supplemental watershed agreement was authorized by a resolution of the governing body of the Middlesex Conservation District adopted at a meeting held on _____.

_____
Secretary

319 Littleton Road, Suite 205
Westford, MA 01886-4133

Date: _____

Worcester County Conservation District

_____

The Medical Arts Center Building
52 Boyden Road, Room 100
Holden, MA 01520-2587

By:

Title: _____

Date: _____

The signing of this supplemental watershed agreement was authorized by a resolution of the governing body of the Worcester County Conservation District adopted at a meeting held on _____.

_____
Secretary

The Medical Arts Center Building
52 Boyden Road, Room 100
Holden, MA 01520-2587

Date: _____

Massachusetts Division of Fisheries and Wildlife

Approved by:
_____ Date: _____

Title:_____

Massachusetts Department of Conservation and Recreation

Approved by:
_____ Date: _____

Title:_____

Natural Resources Conservation Service
United States Department of Agriculture

Approved by:
_____ Date: _____
State Conservationist

Supplemental Watershed Plan No. 7 & Environmental Evaluation For Rehabilitation of the George H. Nichols Multipurpose Dam SuAsCo Watershed Massachusetts

SUMMARY OF WATERSHED PLAN

Project Name: Rehabilitation of the George H. Nichols Multipurpose Dam[1], SuAsCo Watershed

County: Worcester **State**: Massachusetts

Sponsors: Massachusetts Department of Conservation and Recreation (DCR)
Worcester County Conservation District
Middlesex Conservation District
Massachusetts Division of Fisheries & Wildlife (DFW)

Description of Recommended Plan: The weir width of the auxiliary spillway on the George H. Nichols Multipurpose Dam would be increased from 100 feet to 350 feet by extending the spillway eastward onto the existing dam embankment. The auxiliary spillway crest would remain at its existing elevation. The increased capacity of the auxiliary spillway would prevent the dam from being overtopped by the freeboard storm under current land use and watershed build-out conditions. The auxiliary spillway would be armored with articulated concrete blocks to prevent spillway erosion. The principal spillway, the main dam crest and embankment, and the size and elevation of the permanent pool above the dam would not be affected by the project. The evaluated life of the rehabilitation structure is 60 years. Compliance with the National Environmental Policy Act (NEPA) for this action is achieved through the Natural Resources Conservation Service's (NRCS's) NEPA Categorical Exclusion 15.

Resource Information:

Size of SuAsCo watershed: 241,000 acres (377 square miles)
Drainage area of the George H. Nichols Dam: 4,447 acres (6.95 square miles)
Land Use in the George H. Nichols Dam drainage area:

	Acres	% of drainage area
Agricultural	603	14
Forest	1,993	45
Developed, residential	1,212	27
Developed, commercial/industrial	47	1
Other (wetlands, open land, water, etc.)	592	13

[1] George H. Nichols Dam is identified in the original SuAsCo Watershed Plan (USDA-SCS 1958). It is designated as dam A-1 in the original work plan, as MA301 in the NRCS list of PL-566 dams, as 3-14-328-9 by the DCR Office of Dam Safety, and as MA01000 in the National Inventory of Dams database.

Land Ownership:

George H. Nichols Dam drainage area:	Private 82 %	State-Local 18 %	Federal 0 %
George H. Nichols Dam floodplain area:	Private 78 %	State-Local 18 %	Federal 4 %

Number of farms (Worcester County): 1,547

Average farm size (Worcester County): 69 acres

Prime and important farmland:

	Drainage area (acres)	Floodplain (acres)
Prime farmland	592	264
Farmland of statewide importance	494	434
Farmland of unique importance	209	797

Project Beneficiary Profile: The primary beneficiaries of the project are residential, industrial, and commercial property owners in the floodplain of the Assabet River; the towns of Northborough, Westborough, Berlin, Hudson, Stow, and Maynard; the City of Marlborough; and the Commonwealth of Massachusetts.

Characteristic	Westborough	Worcester Co.	Massachusetts	United States
Per capita income	$35,063	$22,983	$25,952	$21,587
Median annual household income	$73,418	$47,874	$50,502	$41,994
Median house value	$262,200	$149,784	$192,978	$120,467
Median age	37	36	36	35
Population	17,997	750,963	6,349,097	281,421,906
Population age 65 and over	12%	13 %	13 %	12 %
Unemployment rate	2.3%	2.8%	3.0%	3.7%
Poverty level	3.0%	6.8%	6.7%	9.2%
Minority population	12%	10 %	15 %	25 %

Note: 2000 U.S. Census Bureau data.

The secondary purpose of the George H. Nichols Multipurpose Dam is recreation. The recreational use of the 380-acre permanent pool consists of boating, canoeing, kayaking, and fishing in the summer and ice skating, hockey, and ice fishing in the winter. The rehabilitation project would not affect these uses other than to maintain the integrity of the facility for their continued use.

Wetlands: Wetlands delineated at the George H. Nichols Dam site included Bordering Vegetated Wetlands (BVWs), Banks, Land Under Water Bodies, and Riverfront Area wetland types. Within 0.5 miles of the dam, approximately 182 acres of wetlands occur upstream and 14 acres of wetlands occur downstream, as interpreted and classified by the Massachusetts Department of Environmental Protection (DEP).

Floodplains: Land uses within the 3,222-acre floodplain downstream of the dam:

	Acres	% of floodplain area
Agricultural	224	7
Forest	1,007	31
Developed, residential	314	10
Developed, commercial/industrial	297	9
Other (wetlands, open land, water, etc.)	1,380	43

Highly Erodible Land (acres):
George H. Nichols Dam drainage area: 414 acres
George H. Nichols Dam floodplain: 108 acres

Fisheries and Wildlife: The impoundment behind the dam provides fish and wildlife habitat. Eight species of fish are known to occur in the reservoir. The area is known as a migratory bird stopover area in spring and fall. Central Massachusetts' only nesting pair of osprey has been observed at the site.

Threatened and Endangered Species: No federally listed or state-protected species are known to occur in the area.

Cultural Resources: No historic properties that are listed on or eligible for listing on the National Register of Historic Places are present in the project's Area of Potential Effect. Construction will occur within the area of previous disturbance for the dam.

Problem Identification: The George H. Nichols Dam does not meet current dam design and safety criteria. Hydrologic and hydraulic modeling of the freeboard storm predicts that the dam would be overtopped by 2.7 and 2.9 feet for current land use and build-out conditions, respectively. Overtopping of the dam could lead to embankment erosion and dam failure. The models also predict that maximum permissible velocities for the auxiliary spillway would be exceeded, and erosion of the spillway slope could then occur. Dam failure from one or both of these causes would result in flood damages to approximately 370 residences, 84 industrial or commercial properties, 113 roads, two schools, one fire department, and one dam, plus utilities in the floodplain. Dam failure would also potentially cause the loss of life of residents, workers, or motorists.

Alternative Plans Considered:

Alternative 1 – Future Without Project (No Action Alternative)
The dam owner, DCR, has stated that it will rehabilitate the George H. Nichols Multipurpose Dam to meet current federal dam safety standards if federal funding assistance is not provided. DCR may choose to use rehabilitation methods other than those identified in this plan or develop its own plan to bring the dam into compliance with federal standards.

Alternative 2 – Rehabilitation (National Economic Development (NED) Alternative)
In this alternative, the George H. Nichols Dam would be rehabilitated by widening the auxiliary spillway from 100 feet to 350 feet and armoring the spillway. Federal funding assistance would be provided to the project sponsors by NRCS.

Project Purpose: Flood prevention. Rehabilitation of the George H. Nichols Multipurpose Dam is necessary to meet current state and federal safety and performance standards. The rehabilitation project would not affect the dam's secondary purpose of recreation.

Principal Project Measure: Rehabilitation of the George H. Nichols Dam involves two primary actions:

- Widening the auxiliary spillway from 100 feet to 350 feet.
- Armoring the spillway with articulated concrete blocks.

Project Cost:

	PL 83-566 funds	Other funds	Total
Structural measures			
Flood prevention	$2,055,700	$844,800	$2,900,500
Recreation	$0	$0	$0

Project Benefits: Economic benefits of the project are derived from ensuring the continued flood prevention purpose of the George H. Nichols Dam by meeting current performance and safety standards. Benefits are based on continuing flood protection to the downstream area, which has an annual benefit of $309,600. Rehabilitation would also minimize the risk of loss of life to residents and motorists traveling on downstream roadways within the breach flood area. Project benefits would continue to be derived through recreational opportunities and incidental benefits would continue to be derived through maintenance of fish and wildlife habitat, water supply for irrigation, groundwater recharge, and base flow for downstream wastewater assimilation. Net average annual equivalent benefits between the Future with Federal Project (Rehabilitation Alternative) and the Future without Federal Project (No Action Alternative) = $0.

Environmental Values Changed or Lost:

Resource	Impact
Air quality	Short-term impact from construction equipment emissions
Floodplains	No effect; no new structures in floodplain; existing floodplain hydrology maintained
Wetlands	No permanent impact to wetlands; potential temporary impact to wetlands adjacent to construction area (less than 1 acre) – wetlands to be avoided if possible and restored with native vegetation if affected by construction
Fisheries and fish habitat	No long-term effect, existing fisheries maintained; temporary disturbance near construction area
Wildlife and wildlife habitat	Potential for loss of up to 0.8 acres of wildlife habitat; temporary disruption near construction area (less than 1 acre) – disturbed areas would be re-planted with native vegetation; construction noise may cause wildlife to relocate temporarily

Resource	Impact
Threatened and endangered species	No effect
Land use	No effect
Cultural resources	No effect
Recreation	No long-term affect; temporary disruptions near construction area – noise and limited access to walking paths and bank fishing areas
Prime farmland	No effect

Major Conclusions: Rehabilitation of George H. Nichols Multipurpose Dam is necessary to minimize the risk of loss of life and property damage within the potential breach area and to allow the continuance of flood prevention benefits.

Areas of Controversy: There are no known areas of controversy.

Issues to be Resolved: None.

Permits: The site-specific need for permits and mitigation, if required, will be determined during final design. The owner (DCR) will be responsible for obtaining the necessary local, state, and federal permits, including (1) National Pollutant Discharge Elimination System (NPDES) general permit for construction, (2) U.S. Army Corps of Engineers (USACE) permit under Section 404 of the Clean Water Act of 1972, (3) Chapter 253 Permit to Construct or Alter a Dam, (4) Chapter 91 Waterways License, (5) Order of Conditions through the Massachusetts Wetlands Protection Act, and (6) Section 401 Water Quality Certification.

PURPOSE AND NEED FOR ACTION

INTRODUCTION

The George H. Nichols Multipurpose Dam (referred to hereafter as the Nichols Dam or the dam) is one of ten floodwater retarding dams built between 1962 and 1987 in the watershed of the Sudbury, Assabet, and Concord Rivers (known as the SuAsCo watershed). Nine of those dams, including the Nichols Dam, were authorized to provide flood protection benefits in a 48-square-mile subwatershed by NRCS's 1958 *Watershed Work Plan for Watershed Protection and Flood Prevention, SuAsCo Watershed*, *Middlesex and Worcester Counties, Massachusetts* and five supplemental plans[2]. The Nichols Dam, which was completed in 1970 in the Town of Westborough, Worcester County, Massachusetts (Figure 1, Appendix B), impounds the Assabet River. The dam is a multipurpose dam that provides flood control and maintains a 380-acre pool for recreation.

PURPOSE AND NEED FOR SUPPLEMENT

The George H. Nichols Multipurpose Dam was built under the Watershed Protection and Flood Prevention Act of 1954 (Public Law (PL) 83-566) for the purposes of flood prevention and recreation. The dam was constructed in 1970 in a rural setting. Since then, urban development upstream of the dam has increased the quantity of storm water runoff, and the 2004 Nichols Dam Assessment Report (USDA-NRCS 2004) determined:

> For current and build-out conditions the existing dam is overtopped by 2.2 and 2.4 feet respectively during the routing of the freeboard storm. The dam does not provide the original protection planned for the watershed.

As a result, DCR applied to NRCS in 2005 for funding assistance for rehabilitation of the dam to comply with current standards and ensure continued flood damage protection downstream of the dam.

The purpose of the proposed dam rehabilitation project is to continue to prevent flood damages by complying with current performance and safety standards. Failure of the dam would cause serious damage to homes and commercial facilities downstream of the dam and potentially result in loss of life. Rehabilitation of the dam is needed to protect downstream properties, public utilities, highways, and a railroad and to reduce the risk of loss of life. Rehabilitation of the dam would extend the service life by 60 years and ensure the continued safe service of the dam throughout its original 100-year evaluation period.

This Supplemental Watershed Plan and Environmental Evaluation was prepared to evaluate the rehabilitation of the Nichols Dam. The dam was built in accordance with the 1958 SuAsCo Watershed Plan, the 1964 Supplement No. 1, and the 1968 Supplement No. 3. An amendment to PL 83-566, the Watershed Rehabilitation Amendments of 2000 (PL 106-472), Section 313,

[2] The original Plan and the first four supplements were prepared by the Soil Conservation Service, which was the former name of the NRCS.

authorizes funding and technical assistance to upgrade dams under the U.S. Department of Agriculture (USDA) Watershed Program. The rehabilitation upgrade of the Nichols Dam is authorized under this amendment. This supplemental plan documents the planning process by which the NRCS provided technical assistance to the local sponsors, technical advisors, and the public in addressing resource issues and concerns within the Assabet River watershed downstream of the Nichols Dam. DCR cooperated in the preparation of the plan by leading the public meeting, reviewing technical studies (hydrology and hydraulic modeling, preliminary engineering), and reviewing the draft plan-EE.

WATERSHED PROBLEMS AND OPPORTUNITIES

Modeling results indicate that the auxiliary spillway does not meet all necessary design criteria for current land use and ultimate watershed build-out conditions. During a freeboard storm, pool elevation would overtop the dam by 2.7 feet under current conditions and 2.9 feet under build-out conditions, potentially leading to failure of the dam. Flow through the auxiliary spillway would exceed NRCS maximum permissible velocities, which would erode the dam slope and potentially lead to failure of the dam.

The Nichols Dam provides approximately $309,600 in average annual flood damage reduction benefits for the Assabet watershed. The beneficiaries of the structure are the Commonwealth of Massachusetts and the localities of Westborough, Northborough, Marlborough, Berlin, Hudson, Stow, and Maynard.

Primary concerns are the safety of the dam and the potential problems that failure of the dam would cause. Associated downstream hazards include residential, commercial and industrial developments, public utilities including the Westborough Wastewater Treatment Plant, main highways and local roads, and railroads. The Emergency Action Plan (EAP) for the Nichols Dam estimates that an uncontrolled breach of the dam would cause flood damages to approximately 370 residences, 84 industrial or commercial properties, 113 roads, two schools, and one fire department, plus utilities in the floodplain (GZA GeoEnvironmental 2008). The Washington Street Dam in the Town of Hudson would be overtopped and fail because it does not have the hydraulic capacity to pass the flood wave. Catastrophic failure of the Nichols Dam would also potentially cause the loss of life of residents, workers, or motorists.

Opportunities that would be realized through the implementation of this watershed rehabilitation plan are:

- Compliance with current dam safety criteria,
- Protection of human health and safety,
- Protection of infrastructure and transportation systems,
- Maintenance of flood control benefits,
- Prevention of increased flooding in the floodplain
- Protection and maintenance of recreation benefits, and
- Protection and maintenance of fish and wildlife habitat.

SCOPE OF THE ENVIRONMENTAL EVALUATION

A scoping process was used to define project needs, determine important issues and formulate alternatives. Scoping included a public meeting; written requests for input from state, local, and federal agencies; and coordination meetings with appropriate agencies. A steering committee of NRCS, DCR, and technical experts was also formed to assist in the formulation and evaluation of alternatives.

Stakeholder agencies that were contacted concerning the proposed project are:

Worcester County Conservation District
Massachusetts Department of Conservation and Recreation
Massachusetts Division of Fisheries and Wildlife
Massachusetts Department of Fish & Game, Riverways Program
Massachusetts Department of Environmental Protection
Town of Westborough (Board of Selectmen, Conservation Commission, Planning Board, Engineering Department)
Organization of the Assabet River
Massachusetts Executive Office of Energy and Environmental Affairs
Massachusetts Executive Office of Energy and Environmental Affairs, Environmental Policy Act Office
U.S. Environmental Protection Agency (EPA) Region 1, Regulatory Section
U.S. Army Corps of Engineers, Regulatory Division
Massachusetts Office of Dam Safety
Westborough Community Land Trust
Massachusetts Historical Commission
Wampanoag Tribe of Gay Head (Aquinnah)

Table A presents the results of the scoping process.

Table A – Identified Concerns

Economic, social, environmental, and cultural concerns	Degree of Concern	Degree of Significance to Decision Making	Remarks
Dam safety	High	High	Primary concern of sponsors and NRCS
Human health and safety	High	High	Primary concern of sponsors and NRCS
Flood damages	High	High	Primary concern of sponsors and NRCS
Recreation	High	Moderate	Second purpose of dam; concern locally that recreation benefits be maintained; temporary, minor impact

Table A – Identified Concerns			
Economic, social, environmental, and cultural concerns	**Degree of Concern**	**Degree of Significance to Decision Making**	**Remarks**
Fish and wildlife habitat	Moderate	Moderate	Evaluated for all NRCS projects; fish and wildlife habitat important for recreational purpose of the dam; possible minor loss of field and wood habitat (less than 1 acre).
Wetlands	Moderate	Moderate	Analysis of effects required by Clean Water Act and Executive Order 11990; minimal, temporary impact; no permanent impact.
Water Supply	Moderate	Moderate	Concern of sponsors that existing well fields not be affected.
Water quality	Moderate	Low	Evaluated for all NRCS projects; minimal, temporary impact.
Threatened and endangered species	Moderate	Low	Analysis of effects required by the Endangered Species Act; no federally protected species or state-listed species present.
Cultural resources	Moderate	Low	Analysis of effects required by National Historic Preservation Act; no historic sites present in Area of Potential Effect
Prime farm lands	Moderate	Low	Evaluated for all NRCS projects; none affected by the project.
Highly erodible cropland	Moderate	Low	Evaluated for all NRCS projects; none affected by the project.
Aesthetics	Low	Low	Minimal, temporary impact
Air quality	Low	Low	Minimal, temporary impact
Sedimentation and erosion	Low	Low	Minimal, temporary impact
Water quantity	Low	Low	No impact

AFFECTED ENVIRONMENT

The area potentially affected by rehabilitation of the Nichols Dam is the dam structure itself, the area adjacent to the dam that could be affected by construction, and the flood protection area downstream of the dam. The following discussions of existing conditions focus on these areas, plus the general project vicinity—the Town of Westborough—where appropriate.

EXISTING CONDITIONS

Original Project

The Nichols Dam was one of eight floodwater-retarding structures proposed in the 1958 SuAsCo Watershed Plan under the authority of PL 83-566. The dam was constructed in 1970 with federal assistance provided by the U.S. Department of Agriculture, Soil Conservation Service (SCS, now the NRCS). Subsequently five supplements to the original plan were prepared and approved between 1964 and 1996. Through these supplements, two of the original dams were deleted from the plan and three others were added, and as a result nine floodwater retarding structures were planned and constructed between 1962 and 1974 for watershed protection and flood prevention. As originally authorized in the 1958 Plan, Nichols Dam had the single purpose of flood prevention. In 1964, Supplement No. 1 added recreation as a purpose and increased pool storage for low-flow augmentation to support fishing along the Assabet River downstream of the dam. Massachusetts was responsible for operating the outlet gate for low-flow augmentation. Supplement No. 3, in 1968, added additional storage for floodwater retention and for recreation to support fishing, hunting, development of wildlife habitat, and other water-associated recreational uses at the dam and pool site. Concurrently with this 2009 supplement for the Nichols Dam, NRCS is preparing Supplement No. 6 for rehabilitation of the Hop Brook Floodwater Retarding Dam.

The Middlesex Conservation District and the Northeastern Worcester County Conservation District were the original local sponsoring organizations for the SuAsCo Watershed Plan. The three conservation districts in Worcester County have combined into one district, known as the Worcester County Conservation District. Through the supplemental planning process and reorganization of state agencies, by 1996 the local sponsoring organizations also included the DFW and the Massachusetts Department of Environmental Management (DEM). Further state reorganizations since 1996 have resulted in renaming DEM as DCR. DCR is the local sponsoring organization for this supplement because it is the owner of the dam and has requested funding assistance for rehabilitation of the dam from NRCS.

Since the construction of the dam, use of the impoundment has increased, and it now provides several other ancillary benefits to the community:

- Water supply for irrigation of the town golf course through pumping from the impoundment;

- Support through groundwater recharge of public drinking water wells and residential wells located along the upstream reaches of the impoundment; and

- Maintenance of base flows in the Assabet River to provide water for combination with the effluent from the Westborough Wastewater Treatment Plant located downstream.

Description of Existing Dam

The Nichols Dam was originally designed and constructed as a federal Class C dam, a hazard classification given to dams whose failure "may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads." The floodwater retarding structure consists of three major elements: the earthen embankment, the principal spillway, and the auxiliary spillway. The embankment has a total structural height of approximately 20 feet, a hydraulic height of approximately 13.5 feet, and an overall length of approximately 1,550 feet, inclusive of the auxiliary spillway. Figure 2 in Appendix B presents an aerial photo of the Nichols Dam.

The dam is located on the northeastern side of the impoundment area. The upstream side of the dam is an earthen slope. The upper portion slopes at 3 horizontal (H):1 vertical (V) from the crest to an approximately 5.5-foot wide berm. Below the berm, the slope is a more gradual 4H:1V. The top of the dam is 12 feet wide, grass covered, and extends from the east abutment to the auxiliary spillway for a total length of approximately 1,440 feet (exclusive of the auxiliary spillway) at a settled elevation of 318.5 feet (National Geodetic Vertical Datum). The downstream side of the dam is a grass-covered 3H:1V slope.

The structure consists of compacted earth fill on poorly graded, gravelly sands and silty sands, overlying compact silt that sits on the bedrock. The upper few feet of bedrock are moderately fractured. An earthen core of silt is present in the center of the embankment with a top width of 12 feet at elevation 313.0 and slopes of 1H:2V. A cutoff trench extends along the dam centerline extending into the underlying natural layers of silt and bedrock.

The principal spillway for the structure is located approximately 600 feet from the east abutment and consists of a reinforced concrete riser that leads to a 48-inch diameter reinforced concrete outlet pipe. During normal operating conditions, flow through the riser occurs through four rectangular orifices. Two orifices on each side of the riser are 6 feet wide by 9 inches high with invert elevations of 310.0 feet. During elevated impoundment conditions, additional discharge capacity is provided by 7-foot long weirs at 311.5 feet that are located along the sides of the risers above the orifices. Along the upstream side of the riser, a slide gate provides pond drain capacity through a 24-inch diameter, 16-gage, non-perforated, corrugated metal pipe which extends from the riser approximately 24 feet upstream to a reinforced concrete intake structure. The spillway discharges through a reinforced concrete impact basin to a natural stream channel with riprap-lined earthen banks.

The auxiliary spillway, which was designed to convey flows from storms greater than the 100-year flood event, is located at the western end of the embankment and is cut into the western abutment, which defines the western side of the spillway. The auxiliary spillway is a grass-lined channel with a crest elevation approximately 5.5 feet below the top of the dam. The crest of the auxiliary spillway is a 100-foot wide (perpendicular to flow) and 30-foot long (parallel to flow) level section with a 2 percent slope in the upstream approach and a downstream slope of 3.5 percent. The upstream entrance to the auxiliary spillway is located approximately 200 feet from the crest of the spillway within the normal impoundment. Downstream of the crest, the western and northern abutments of the spillway are defined by a cut slope, and the eastern and southern

sides are confined by an earthen training dike between the downstream slope of the dam and the spillway. The auxiliary channel discharges to the outlet channel approximately 850 feet downstream from the spillway crest. A catch basin with a drain system, which was added subsequent to original dam construction, is located along the downstream north side of the auxiliary spillway.

A rectangular foundation drain is present along the downstream side of the embankment with a width of approximately 5 feet and a varying height. Seepage water collected by this drain is conveyed by a 10-inch diameter, 16-gage, perforated corrugated metal pipe to outlets through the sidewalls of the principal spillway impact basin.

An 8-inch diameter underdrain is located below the auxiliary spillway and discharges to the primary spillway channel. Subsequent to the original construction of the dam, drainage tiles were added during the placement of additional fill within the area of the auxiliary spillway. These tiles discharge to the original drainage system.

A series of relief wells, observation tubes, and piezometers were installed during subsequent work in 1970 to provide hydraulic flow relief and to monitor groundwater levels in the foundation area just downstream of the dam.

Existing Structural Data

Table B provides a summary of the existing structural data for the George H. Nichols Multipurpose Dam.

Table B – Existing Structural Data – George H. Nichols Multipurpose Dam	
Year completed	1970
Drainage area	6.95 square miles (4,447 acres)[1/]
Stream	Assabet River
Purposes	Flood prevention, recreation
Dam type	Earthen embankment
Dam height	20 feet
Dam crest length	1,440 feet
Dam crest elevation (minimum)	318.5 feet
Storage:	
Total, maximum pool	3,400 acre-feet
Total, auxiliary spillway crest	2,900 acre-feet
Total, permanent pool	1,624 acre-feet
Sediment	44 acre-feet
Flood	1,276 acre-feet
Recreation	1,580 acre-feet
Principal spillway:	
Type	Reinforced concrete
Lower-stage crest elevation	310.0 feet
Upper-stage crest elevation	311.5 feet
Conduit size	48 inches

Table B – Existing Structural Data – George H. Nichols Multipurpose Dam	
Auxiliary Spillway:	
Type	Grass-lined channel
Width	100 feet
Crest elevation	313.0 feet

[1/]6.95 square miles is the revised contributing area based on NRCS 2004 assessment. Original design was 7.17 square miles.

Physical Features and Environmental Factors

Project Location: The Nichols Dam is located in the western section of the Town of Westborough in Worcester County, Massachusetts. The Assabet River begins as a small stream from the headwaters located at the Nichols impoundment in Westborough. From the Nichols dam, the Assabet flows through suburban residential neighborhoods to wetlands near Route 9. The Westborough Wastewater Treatment Plant discharges into the river just before the river flows under Route 9 (OAR 2009a). The Assabet River flows north for approximately 30 miles from the Nichols Dam to its confluence with the Sudbury River in Concord, Massachusetts. The Assabet and Sudbury Rivers form the Concord River which flows north 15.5 miles to its confluence with the Merrimack River in Lowell, Massachusetts. The SuAsCo Watershed encompasses a large network of tributaries that drain approximately 377 square miles in Middlesex and Worcester counties.

Climate: The average annual precipitation for Worcester County is 49.2 inches, and the average seasonal snowfall is 59.7 inches. In winter, the average temperature is 26.2 degrees Fahrenheit (ºF), and the average daily minimum is 18.4 ºF. In summer, the average temperature is 67.7 ºF, and the average daily maximum temperature is 76.9 ºF. The average (50 percent) freeze-free period of 172 days extends from April 27 through October 16 (USDA-NRCS 2008a).

Geology and Soils: The dam is generally located at the boundary between the Marlboro foundation (Ozm) of Mafic Rocks and Avalon Granite (Zsg). The boundary between the two formations crosses below the dam between the primary spillway and the auxiliary spillway. The dam is generally underlain by two distinct soil types derived from glacial depositions; a deposit of sand and gravel and a till. The sand and gravel deposit is generally upstream of the dam and towards the west of the primary spillway. A similar deposit is also located along the eastern side of the normally impounded area. Bedrock at the dam is a variety of gradations between gneisses and schists.

According to the NRCS soil survey for Worcester County, several major soil types are located within the area surrounding the dam (USDA-SCS 1985). Mapped soils at the site are primarily Udorthents, smoothed. These areas consist of man-made landforms over firm loamy basal till. Other soils adjacent to the dam include Scarboro, Walpole, Sudbury, Ningret, Agawam, Paxton, and Merrimac fine sandy loams; Hinckley sandy loam; Swansea muck; and Whitman loam.

The original design geology as interpreted from the boring logs provided on the as-built drawings indicated a variety of soil materials along the alignment of the dam and dikes. These materials varied from poorly graded silty sands and silt to poorly graded sands and gravel over

bedrock. Although there was observed variation across the site, all foundation soils appeared to represent a granular type material with variable amounts of gravels and silts, which is typical of the glacial environment that is prominent in the area, or weathered rock and bedrock near the abutments (H&S Environmental 2009).

Topography: The SuAsCo watershed lies within an area of previous glaciation, and many glacial features are present. In addition, the watershed is characterized by the prevalence of swamps, ponds, and lakes. The drainage pattern is dendritic with many tributary streams. Within the SuAsCo watershed, the Assabet River has a steeper gradient than the lower Sudbury and upper Concord Rivers and as a result has a more rapid runoff of floodwaters (USDA-SCS 1958).

Prime Farmland: Prime farmland is protected by the Farmland Protection Policy Act in order to "minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses" (USDA-NRCS 2008b). Soils that are designated as prime farmland and are present in the Nichols Dam drainage area are the Agawam, Paxton, Merrimac, and Hinckley series sandy loams. Table C presents the acreages of soils designated as prime farmland, farmland of statewide importance, or farmland of unique importance in the Nichols Dam drainage area and the downstream floodplain.

Table C – Important Farmland Soils

Soil Designation	Drainage Area (acres)	Floodplain (acres)
Prime Farmland	592	264
Farmland of statewide importance	494	434
Farmland of unique importance	209	797

Source: Massachusetts Geographic Information System (MassGIS 2008a)

Highly Erodible Land: As summarized in Table D, approximately 9 percent of the Nichols Dam drainage area and less than 5 percent of the downstream floodplain are highly erodible lands.

Table D – Highly Erodible Land

	Drainage Area		Floodplain	
	Acres	Percent	Acres	Percent
Highly erodible land	414	9	108	3
Potentially highly erodible land	924	21	405	13
Not highly erodible land	3,109	70	2,709	84

Source: MassGIS (2008a)

Water Quality: The Assabet River is designated by the state as a Class B Warm Water Fishery, which is defined as waters designated "as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation" (DWM 2005). The Organization for the Assabet River (OAR) conducts monthly water quality monitoring of the Assabet River at Route 9 in Westborough (above the first wastewater treatment plant). Recently available water quality data for the Assabet River headwaters are presented in Table E (OAR 2009b). Three municipal

drinking water wells are located in the Headwaters Conservation Area adjacent to the southwestern shoreline of the reservoir (Town of Westborough 2003).

Table E – Water Quality and Stream Health, Assabet River Headwaters, October 25, 2008			
Parameter	**Result**	**Parameter**	**Result**
Total nitrogen	0.24 mg/L	pH	7.1
Total phosphorus	0.018 mg/L	Water temperature	10.4 ºC
Total suspended solids	3 mg/L	Streamflow	4.0 cfs
Dissolved oxygen	10.1 mg/L	Habitat availability (0-20)	17

Note: mg/L = milligrams/liter; cfs = cubic feet per second; ºC = degrees Celsius (centigrade)
Source: OAR (2009b)

In summer 2001 surveys of the pool above Nichols Dam, DWM found high pH and high dissolved oxygen concentrations in surface waters and low dissolved oxygen concentrations at depths greater than 8 feet, conditions indicative of nutrient enrichment (DWM 2005). Total phosphorus concentrations in the pool were not high, but there was evidence of phosphorus release from anoxic sediments.

The release from Nichols Dam forms the headwaters of the Assabet River. Under drought conditions, the river for about 1.2 miles downstream of the dam is dry (DWM 2005). DWM (2005) summarized water quality in the Assabet River:

> Historically, wastewater discharges and water withdrawals for public supply have deleteriously affected the Assabet River. A nutrient TMDL for the Assabet River was completed in 2004... Implementation of the TMDL requires removal of total phosphorus to 0.1 mg/L in the effluent of the major municipal wastewater treatment plants and evaluation of the feasibility of sediment remediation to reduce phosphorus flux from the sediments.

Wetlands: Assabet Swamp begins at the impoundment of the dam and extends southwest from Arch Street forming the headwaters of the Assabet River (Town of Westborough 2003). Vernal pool habitat is located along a trail from the Headwaters Conservation Area to the boat ramp (Reid 2006, Westborough Community Land Trust 2009).

Wetlands on both sides of the dam where project construction could be located were field-delineated in February 2009 (Figure 3, Appendix B). State-regulated wetland resources identified at the site, as defined in the Massachusetts Wetlands Protection Act Regulations 310 CMR 10.00 (Regulations), include Bordering Vegetated Wetlands (BVW), Banks, Land Under Water Bodies (LUWB), and Riverfront Area, as described below. These wetland resources are associated with, or adjacent to, the impoundment and principal spillway.

The boundary of the BVW is generally situated at the toe of slope associated with the fill area for the dam and associated spillways. The only resource area that intersects the dam is the primary spillway as it passes underneath the dam through a concrete culvert. There are two categories of BVWs at the site and both meet the definition of a Freshwater Wetland according to the Regulations and, therefore, a 100-foot Buffer Zone is applied. The first is the wooded area

located to the southeast of the dam adjacent to a boat ramp. This wooded area is dominated by red maple (*Acer rubrum*) trees. A small stream flows through this BVW and enters the impoundment to the southeast of the boat ramp. The other category of BVW on the site is fringing emergent wetlands adjacent to the impoundment and principal spillway. These emergent wetlands are dominated by broadleaf and narrowleaf cattail (*Typha latifolia* and *T. angustifolia*, respectively), and numerous sedge and rush species. These BVWs generally occur where surface water from the impoundment or primary spillway overflow onto the land surface for significant portions of the year.

Bank wetland resources at the site include the Banks along the impoundment upstream of the dam and Banks along the principal spillway downstream of the dam. These banks are vegetated and are comprised of mineral soil material. Woody Bank vegetation includes red maple trees and sweet pepperbush (*Clethra alnifolia*), winter berry (*Ilex verticillata*), and arrowwood (*Viburnum dentatum*) shrubs. Emergent vegetation includes sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), and sphagnum moss (*Sphagnum* sp.).

Land Under Water Bodies includes land under the impoundment and land under the principal spillway. This LUWB is generally comprised of mineral soil material.

A Riverfront Area is defined as the area of land between a river's mean annual high water line and a parallel line measured 200 feet horizontally from said high water line. The primary spillway (Assabet River) is defined as a River as it is a perennial body of water that empties into another River. The boundary of the Riverfront Area associated with the spillway extends landward 200 feet from the mean annual high water line.

Fish and Wildlife Resources: The reservoir is maintained by DFW as migratory shorebird habitat, and dead standing trees in the reservoir provide nest sites for a great blue heron (*Ardea herodias*) rookery. The Assabet Headwaters Reservation provides habitat to the only nesting pair of ospreys (*Pandion haliaetus*) in central Massachusetts (Town of Westborough 2003; OAR 2009a). Waterfowl use the Nichols pond during migration. The Westborough Community Land Trust provides bird walks at the reservoir during spring and fall passerine migration (Westborough Community Land Trust 2009).

A 1974 natural resources inventory of the Town of Westborough found white-tailed deer (*Odocoileus virginianus*), eastern cottontail rabbit (*Sylvilagus floridanus*), gray and red squirrels (*Sciurus carolinensis*, *S. vulgaris*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginianus*), striped skunk (*Mephitis mephitis*), and many species of birds, reptiles, amphibians, and small mammals (Town of Westborough 2003).

The permanent impoundment formed by the Nichols Dam supports eight species of fish and is a popular fishing site. DFW considers the impoundment "one of the most productive largemouth bass waters in the state" (Town of Westborough 2003). Table F presents the species of fish known to occur in the reservoir.

Table F – Fish Species Observed at the Nichols Site	
Common Name	**Scientific Name**
Black crappie	*Pomoxis nigromaculatus*
Brown bullhead	*Ameiurus nebulosus*
Golden shiner	*Notemigonus crysoleucas*
Largemouth bass	*Micropterus salmoides*
Pumpkinseed	*Lepomis gibbosus*
White sucker	*Catostomus commersoni*
White catfish	*Ameiurus catus*
Yellow perch	*Perca flavescens*

Threatened and Endangered Species: There are no federally listed or proposed, threatened or endangered species or critical habitat in the project area (FWS 2009). A search of the Massachusetts Natural Heritage and Endangered Species Program (NHESP) database using MassGIS showed that there are no rare, threatened, or endangered species or unique natural communities present within the project area (NHESP 2009).

Floodplain: The floodplain in Westborough downstream of Nichols Dam is shown in Figures 4-9, Appendix B. Downstream of Northborough, Nichols Dam becomes a smaller influence on the floodplain of the Assabet River, which is controlled by multiple other dams in the watershed. The floodplain would not be affected by the rehabilitation of the dam.

Air Quality: Westborough falls within the Boston-Lawrence-Worcester area as defined by EPA, which is a nonattainment area for 8-hour ozone. The area is in attainment for all other criteria pollutants (EPA 2009).

Recreation: The 380-acre permanent pool is used for fishing, boating, canoeing, and kayaking in the summer and ice skating, ice fishing, and hockey in the winter. Trails around the dam provide opportunities for hiking.

Cultural and Historic Resources: The Area of Potential Effect (APE) for the project is the access road into the site and the project construction area. The entire APE was previously disturbed for construction of the dam. Other than the dam itself there are no structures within the APE. No historic properties that are listed or eligible for listing on the National Register of Historic Places are present within the project's APE (NPS 2008). The Massachusetts State Historic Preservation Officer (SHPO) concurred with the determination that there are no historic properties in the APE.

Land Use: In the 1958 watershed plan, the SuAsCo watershed is described as 10 percent developed and 90 percent cropland, grassland, forest, and open water. In the 50 years since, the area has developed as a residential area for Boston and Worcester commuters. At the time of the dam's design, land use in the dam's drainage area consisted of approximately 58 percent forest, 24 percent agriculture, and 5 percent urban. Current land use in the Nichols Dam drainage area (based on 1999 data in Massachusetts Geographic Information System (MassGIS)) is summarized in Table G; 27 percent of the area is residential, mostly low to medium density. Land in the drainage area is predominantly privately owned (82 percent), with the rest being

state- or local government-owned. The land immediately surrounding the pond is managed as an annex to Quinsigamond State Park (Town of Westborough 2003). The annex is approximately 469 acres and connects the Westborough Country Club with the Headwaters Conservation Area.

Table G also summarizes land use under ultimate build-out, as projected from zoning (NRCS 2003). Residential, commercial, and industrial development is projected to increase by about 150 percent in the area, and will result in a similar loss of forested land cover and agricultural land. Current and build-out land use maps of the Nichols drainage area are presented in Figures 10 and 11 in Appendix B.

Table G – Land Use in the Nichols Dam Drainage Area

	Current		Ultimate Build-out	
Land Use	**Acres**	**Percent**	**Acres**	**Percent**
Residential	1,212	27	2,850	64
Forest	1,993	45	619	14
Agricultural	603	14	201	5
Commercial, industrial	47	1	267	6
Other (wetlands, open land, water, etc.)	592	13	510	11

Source: NRCS (2003)

Land use in the Nichols Dam floodplain is summarized in Table H. Commercial and industrial development is a higher percentage of land use in the floodplain than in the dam drainage area because of the historical growth of towns along the region's rivers. Land in the floodplain is mostly privately owned (78 percent), with smaller proportions of state- or local government-owned (18 percent) and federally owned (4 percent) land. Future land use in the floodplain is not expected to change significantly because of zoning restrictions on floodplain development.

Table H – Land Use in the Nichols Dam Floodplain

Land Use	**Acres**	**Percent**
Forest	1,007	31
Residential	314	10
Commercial, industrial	297	9
Agricultural	224	7
Other (wetlands, open land, water, etc.)	1,380	43

Source: 1999 data, MassGIS (2008a)

Socioeconomic: The Town of Westborough, population 17,997 in 2000, is located in Worcester County, Massachusetts, approximately 30 miles west of Boston and 12 miles east of Worcester. Population in the SuAsCo watershed has increased as the area has become more of a commuter community for the cities of Boston and Worcester. Socioeconomic characteristics of Westborough and Worcester County−plus the state and the nation for comparison−from the United States Census in 2000 are presented in Table I.

Environmental Justice: Executive Order 12898 *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* requires that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as

appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations" (Council on Environmental Quality 1997). Environmental Justice neighborhoods are defined as neighborhoods with minority, non-English speaking, low-income and/or foreign born populations. According to MassGIS data derived from the 2000 U.S. Census, Westborough has no environmental justice populations that could be affected by project construction (MassGIS 2008b). As shown in Table I, minority groups constitute approximately 12 percent of the population in Westborough, and 3 percent of all town families are families in poverty. There would be no adverse effects to environmental justice communities downstream of Westborough because the project has no adverse effects downstream of the dam and only benefits downstream communities.

Recreation: The reservoir is popular for fishing, and large ice fishing derbies are held each winter that attract fishermen from throughout the region. Parking space and a boat launch are provided for fishing enthusiasts off Mill Road. In addition to fishing, the open space surrounding the reservoir provides a popular area for nature walks and hiking on trails that will connect to the developing Westborough Charm Bracelet Trail, a 28-mile walking trail. Adjacent to the southwestern shoreline of the reservoir is the Headwaters Conservation Area, approximately 100 acres of open space that protects the town water supply. The area is used for recreation such as dog-walking, hiking, and cross-country skiing (OAR 2009a; Town of Westborough 2003).

Table I – Summary of Socioeconomic Characteristics								
	Westborough		**Worcester Co.**		**Massachusetts**		**United States**	
Population and Race	**17,997**		**750,963**		**6,349,097**		**281,421,906**	
White	15,869	88.2%	672,915	89.6%	5,367,286	84.5%	211,460,626	75.1%
Black/African American	259	1.4%	20,498	2.7%	343,454	5.4%	34,658,190	12.3%
Asian	1,456	8.1%	19,700	2.6%	238,124	3.8%	10,242,998	3.6%
Other	142	0.8%	22,037	2.9%	236,724	3.7%	15,359,073	5.5%
Native American	24	0.1%	1,896	0.3%	15,015	0.2%	2,475,956	0.9%
Hispanic or Latino of any race	587	3.3%	50,864	6.8%	428,729	6.8%	35,305,818	12.5%
Age								
Median age	37.4		36.3		36.5		35.3	
Over 18 years of age	12,885	71.6%	558,515	74.4%	4,849,033	76.4%	209,128,094	74.3%
Over 65 years of age	2,085	11.6%	97,969	13.0%	860,162	13.5%	34,991,753	12.4%
Language Spoken At Home								
English only	13,842	82.7%	595,964	85.0%	4,838,679	81.3%	215,423,557	82.1%
"less than very well"	927	5.5%	41,876	6.0%	459,073	7.7%	21,320,407	8.1%
Spanish	511	3.1%	42,732	6.1%	370,011	6.2%	28,101,052	10.7%
Indo-European	1,497	8.9%	42,780	6.1%	529,784	8.9%	10,017,989	3.8%
Asian-Pacific	719	4.3%	13,472	1.9%	171,253	2.9%	6,960,065	2.7%
Other languages	162	1%	6,209	0.9%	44,522	0.8%	1,872,489	0.7%
Disability Status								
Population five years of age and older	2,258	14.1%	129,290	18.8%	1,084,746	18.5%	54,314,427	19.3%
Education								
High school graduate or higher	93.4%		83.5%		84.8%		80.4%	
High school including GED	2,093	17.5%	149,639	30.2%	1,165,489	27.3%	52,168,981	28.6%
Associates degree	828	6.9%	39,063	7.9%	308,263	7.2%	11,512,833	6.3%
Bachelor's degree	3,499	29.3%	82,648	16.7%	834,554	19.5%	28,317,792	15.5%
Graduate or professional degree	2,852	23.9%	50,857	10.3%	583,741	13.7%	16,144,813	8.9%
Employment, Class of Worker and Commuter Status								
Labor force pool (population > age 16)	8,974	67%	383,764	66.3%	5,010,241	78.9%	217,168,077	77.2%
Employed	8,671	64.7%	366,942	63.4%	3,161,087	63.1%	129,721,512	59.7%
Unemployment	303	2.3%	16,324	2.8%	150,952	3.0%	7,947,286	3.7%
Private for profit workers	6,385	73.6%	264,676	72.1%	2,197,138	69.5%	92,499,904	71.3%
Self-employed workers – includes agriculture, forestry, fishing, hunting	612	7.1%	21,649	5.9%	204,770	6.5%	3,290,170	5.5%

Table I – Summary of Socioeconomic Characteristics								
	Westborough		**Worcester Co.**		**Massachusetts**		**United States**	
Non-profit workers	667	7.7%	30,731	8.4%	331,510	10.5%	9,294,457	7.2%
Government	1,014	11.6%	49,621	13.6%	425,573	13.5%	18,923,353	14.6%
Federal	123	1.4%	6,220	1.7%	66,653	2.1%	3,550,266	2.7%
State	255	2.9%	15,309	4.2%	122,041	3.9%	6,153,845	4.7%
Local	636	7.3%	28,092	7.7%	236,879	7.5%	9,219,242	7.1%
Occupation								
Management, professional and related occupations	4,998	57.6%	137,980	37.6%	1,298,704	41.1%	43,646,731	33.6%
Service occupations	801	9.2%	50,834	13.9%	444,298	14.1%	19,276,947	14.9%
Sales and office occupations	1,973	22.8%	93,718	25.5%	818,844	25.9%	34,621,390	26.7%
Production, transportation, and material moving occupations	539	6.2%	53,990	14.7%	356,723	11.3%	18,968,496	14.6%
Construction, extraction, and maintenance occupations	360	4.2%	29,835	8.1%	235,876	7.5%	12,256,138	9.4%
Commuting to Work								
Worked in county of residence	4,644	54.3%	266,814	74.0%	2,067,368	66.6%	94,042,863	73.3%
Worked outside county of residence	3,749	43.8%	84,873	23.6%	934,388	30.1%	29,600,841	23.1%
Worked outside the state of residence	160	1.9%	8,656	2.4%	101,081	3.3%	4,635,524	3.6%
Housing								
Number of households		6,534		284,218		2,443,580		105,480,101
Number of housing units		6,773		298,159		2,621,989		115,904,641
Occupied	6,534	96.5%	283,927	95.2%	2,443,580	93.2%	105,480.101	91.0%
Owner occupied	3,616	64.4%	182,104	52.6%	1,508,052	61.7%	69,815,753	66.2%
Income								
Median annual household income		$73,418		$47,874		$50,502		$41,994
Median family income		$94,610		$53,394		$61,664		$50,046
Per capita income		35,063		$22,983		$25,952		$21,587
FT*, year-round male median income		$66,157		$42,261		$43,048		$37,057
FT*, year-round female median income		$40,030		$30,516		$32,059		$27,194
Poverty								
Number of families	133	3.0%	13,100	6.8%	105,619	6.7%	6,620,945	9.2%

Source: 2000 Census data, U.S. Census Bureau (2008) * FT = Full-time

STATUS OF OPERATION AND MAINTENANCE

DCR is responsible for operation and maintenance of Nichols Dam. Site inspections of the dam occurred on May 5, 2008, by DCR and on July 11, 2008, by NRCS's consultants, H&S Environmental. In general, the dam was found to be in "Satisfactory" condition, with grass and weeds in need of routine maintenance, and areas requiring minor maintenance activities. The surveyed elevations showed no significant settlement or erosion along the structure that would limit the function of the dam. Some vegetation has become established in the approach area of the principal spillway, and other areas were devoid of vegetation due to the establishment of social pathways resulting from bicycle and/or pedestrian traffic. A pipe video inspection of the inaccessible portions of the foundation drains, principal spillway outlet pipe, auxiliary spillway drain, and toe drain east of the spillway was completed on July 31, 2008. The inspection determined that the principal spillway pipe appeared to be in good condition with no deficiencies. The 8-inch corrugated metal pipe foundation drains were inspected to 3 feet into the pipe at the impact basin. Ninety degree bends in the pipe prevented further inspection. The gutter drain between the embankment west of the spillway and the auxiliary spillway berm did not display any significant deficiencies until 291 feet into the pipe where sand and gravel accumulations filled approximately 30 percent of the pipe diameter. The 12-inch toe drain east of the spillway was inspected from the downstream end to a length of approximately 180 feet where an obstruction prevented further inspection. Sand deposits were found in two locations along the length of the pipe. The auxiliary spillway drain pipe was not accessible for video inspection due to sediment accumulation at the outlet end of the pipe.

SEDIMENTATION

Nichols Dam was designed with 44 acre feet of sediment storage capacity for a 50-year period. A minor amount of sediment has accumulated at the main stream inlet to the pool and promoted the growth of an emergent wetland. The wooded areas around the pool provide a buffer against erosion and sediment transport, keeping sediment delivery very low. No sediment removal has occurred in the past, and none is presently scheduled or expected for the foreseeable future. Using current NRCS standard procedures, the sediment storage volume required for the first 40 years (dam construction to dam rehabilitation projected for 2010) is estimated to be 17.1 acre-feet. The additional sediment volume over the remaining 60-year period, assuming 20 years to watershed build-out, is estimated to be 25.5 acre-feet. The total estimated volume, 42.6 acre-feet, is less than the original 50-year sediment storage design capacity of 44 acre-feet.

BREACH ANALYSIS AND HAZARD CLASSIFICATION

As defined in Section 520.21(e) of the NRCS Title 210 National Engineering Manual, Nichols Dam is classified as a Class C (high hazard) dam "where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads." The original NRCS hazard classification was also a Class C structure. Under Commonwealth of Massachusetts Dam Safety Rules and Regulations, 302 CMR 10.00, the dam is classified as a Class I (High) hazard structure and a "Large" size structure because it has a storage capacity greater than 1,000 acre feet. The inundation map in the Emergency Action Plan (GZA GeoEnvironmental 2008) indicates that failure of the dam would result in inundation

of and damage to residences, major utilities, and infrastructure. Failure of the dam would likely lead to loss of life.

Failure of the dam at maximum pool will likely cause loss of life and serious damage to homes, industrial or commercial facilities, important public utilities, roads, and railway tracks. As discussed in the *Consequences of Dam Failure* section of this report, failure of the dam under wet weather conditions is anticipated to affect approximately 450 structures in the Towns of Westborough, Northborough, Berlin, Hudson, Stow, and Maynard and the City of Marlborough.

A comprehensive hydrologic and hydraulic analysis was performed in 2003 to evaluate the capacity of the Nichols Dam under current and build-out conditions (see Appendix C, Investigations and Analysis Report). The analysis included development of a Water Resource Site Analysis Integrated Development Environment (SITES IDE) model to predict maximum water surface elevation under a series of design storms. Design storms were established based on NRCS and Massachusetts dam design criteria. The model applies user-specified rainfall, runoff, and watershed hydrologic data to develop inflow hydrographs. Hydrographs are then routed through the various control structures associated with the dam to predict maximum water level, potential embankment erosion, and other potential structure failures.

Results of the hydrologic and hydraulic analysis indicated that the auxiliary spillway is undersized under current conditions and does not meet NRCS criteria, as specified in Technical Release 60 (TR-60). With the spillway design hydrograph (SDH), flow passes the auxiliary spillway at a velocity of 8.3 feet per second, which exceeds the TR-60 maximum velocity criteria and is erosive to vegetative cover. With the freeboard hydrograph (FBH), pool elevation over tops the dam by 2.7 feet.

For build-out conditions, the auxiliary spillway does not pass TR-60 criteria for freeboard and earthen spillway design. During the SDH storm, flow passes the auxiliary spillway at a velocity of 8.7 feet per second, which can erode vegetative cover and exceeds the TR-60 maximum velocity criteria. During the FBH storm, the water surface elevation overtops the dam by 2.9 feet.

Table J summarizes the hydrologic and hydraulic analyses for the original design and for current and build-out conditions.

A breach analysis was conducted by GZA Geo Environmental (GZA) to estimate the inundation areas and corresponding time to flood downstream as a result of failure of the Nichols Dam (GZA 2008) (see Appendix C for methodology and details of analysis). A National Weather Service computer model (DAMBRK, Version 3.0) was used to predict the hypothetical dam break wave formation at Nichols Dam and its downstream progression along the Assabet River. The spillway design flood (SDF) for the dam based on its current size (Large) and hazard (High) classifications is the ½ probable maximum flood (PMF). The wet weather scenario used an SDF outflow of 3,800 cfs and a peak SDF reservoir elevation of 1.4 feet below the top of the dam at the time of the dam failure.

Table J – Hydrologic and Hydraulic Analyses Summary			
	Original Design	**Current Conditions**	**Build-out Conditions**
Comparison elevations			
Crest of principal spillway (elevation, feet)	310.0	310.0	310.0
Riser crest (elevation, feet)	311.5	311.5	311.5
Crest of auxiliary spillway (elevation, feet)	313.0	313.0	313.0
Top of dam low point (elevation, feet)	318.5	318.5	318.5
Bottom width of auxiliary spillway (feet)	100	100	100
PSH (principal spillway hydrograph)[1/]			
Maximum water elevation (feet)	311.9	313.25	313.53
Drawdown (days)	—	>10	>10
Starting pool elevation for SDH and FBH	310.0	311.0	311.0
SDH (spillway design hydrograph)[2/ 3/]			
Maximum water elevation (feet)	314.1	315.5	316.03
Maximum velocity (feet per second)	—	8.3	8.7
FBH (freeboard design hydrograph)[2/]			
Maximum water elevation (feet)	320.0	321.2	321.4
Available freeboard (feet)	0.0	-2.7	-2.9

[1/] Source: NRCS 2004. Based on assessment using TR-60 1985 design criteria.
[2/] Source: H&S Environmental 2009. Build-out Conditions values based on assessment using TR-60 2005 design criteria.
[3/] When adjusted for 24-hour distribution requirement of the 2005 TR-60 update, SDH values for build-out conditions are maximum water elevation = 316.1 feet, maximum velocity = 8.8 feet per second.

GZA's wet weather scenario modeling determined that the maximum discharge through the Nichols Dam breach opening is approximately 15,000 cfs and occurs 0.5 hours from the beginning of the simulation. The peak dam flow is expected to be an order of magnitude greater than the FEMA 500-year flood. Peak flood depth over initial conditions ranges from approximately 4 feet downstream of the Nichols Dam to about 2 feet downstream of the Tyler Dam. Peak flood depth over initial conditions increases to approximately 3 feet just downstream of the Washington Street Dam and dissipates to approximately 1.5 feet at the downstream corporate limit of the Town of Maynard. Inundation maps presenting the results of the DAMBRK modeling are located in Appendix B, Figures 4-9.

Results from the dam breach analysis were used to update the EAP for the Nichols Dam. The EAP provides appropriate actions in the case of dam failure and is updated annually by DCR.

POTENTIAL MODES OF DAM FAILURE

Several potential modes of failure for dams were examined for the Nichols Dam:

Sedimentation: Excessive sedimentation can reduce flood storage volume and clog spillways, reducing the hydraulic efficiency of the dam. Sedimentation of the Nichols Dam over the past 39 years has been minimal, and failure due to sedimentation is not probable.

Hydrologic Capacity: Hydrologic failure of a dam can occur by breaching the auxiliary spillway or overtopping the dam during a storm event. The integrity and stability of the auxiliary spillway and embankment is dependent on depth, velocity, and duration of flow; vegetative cover; and resistance to erosion. As discussed in the previous section, *Breach Analysis and Hazard Classification*, the dam does not meet current dam safety design criteria for a high hazard dam. Therefore, the potential for failure due to a deficiency in hydrologic capacity at the dam is considered high.

Seepage: Embankment and foundation seepage can contribute to failure of an embankment by removing (piping) soil material through the embankment or foundation. As the soil material is removed, voids can be created, allowing ever increasing amounts of water to flow through the embankment or foundation until the dam collapses due to the internal erosion. Seepage that increases with an increase in pool elevation is an indication of a potential problem, as is stained or muddy water. Foundation and embankment drainage systems can alleviate the seepage problem by removing the water without allowing soil to be transported away from the dam.

No visible signs of seepage were observed during the inspection conducted in 2008 (H&S Environmental 2009a). However, some indications of possible concerns exist, including areas of brush development, areas of eroded paths, and areas of exposed granular surfaces. There were no additional investigations performed as part of this evaluation that could evaluate the condition of the embankment around the pipe or the current condition of the concrete cradle and anti-seep collars which are embedded within the embankment of the dam. However, there was no outward evidence of sinkholes, seepage, or other surface anomalies which would indicate embankment instability.

Seismic: The integrity and stability of an earthen embankment are dependent on the presence of a stable foundation. Foundation movement through consolidation, compression, or lateral movement can cause the creation of weak zones or voids within an embankment, separation of the principal spillway conduit joints, or in extreme cases, complete collapse of the embankment. Central Massachusetts is not an area of significant seismic risk, and there is low potential for seismic activity to cause the failure of the dam.

Embankment Slope Failure: An embankment slope failure allows increased saturation, weakens the integrity of the dam during large storms, and could result in a catastrophic failure. Slope failure can also create slides and sloughing that lower the top of the dam elevation so that overtopping may occur during large storms.

The Nichols Dam shows no visible signs of slope failure, sloughing, or any other noticeable indications of instability on the embankments. The embankments of the dam are grass covered. Recent inspection of the dam noted tire ruts resulting from mowers. Pathways were observed along the crest, upstream and downstream slopes of the dam, and the auxiliary spillway. Areas devoid of vegetation along the paths are thought to be the result of foot traffic. Some erosion and vertical faces were noted along most of the waterline on the upstream slope. Maintenance at the dam includes mowing and control and clearing of woody vegetation along the dam embankment and spillways (H&S Environmental 2009a). Embankment slope failure presents a low potential mode of failure for Nichols Dam.

Material Deterioration: Materials used in the principal spillway system are common construction materials, but they are subject to weathering and chemical reaction due to natural elements within the soil, water, and atmosphere. As a result of this weathering, concrete components can deteriorate and crack, metal components can rust and corrode, and leaks can develop. Embankment failure can occur from internal erosion caused by these leaks.

Based on the results of the site inspection in 2008 (H&S Environmental 2009b), the structure appears to be in satisfactory condition with no evidence of deterioration on any materials that would require structural repair at this time. A video inspection of the foundation drains, principal spillway outlet pipe, auxiliary spillway drain, and other drains located at the site was completed on July 31, 2008. The inspection determined that the principal spillway pipe appeared to be in good condition with no deficiencies. The 8-inch corrugated metal pipe foundation drains were inspected to 3 feet into the pipe at the impact basin, where 90-degree bends in the pipe prevented further inspection. The gutter drain between the embankment west of the spillway and the auxiliary spillway berm, toe drain east of the spillway, and the auxiliary spillway were only partially accessible for video inspection due to sediment accumulations. As a result, the potential failure of the existing dam due to deteriorating components is judged to be low. However, the dam should continue to be monitored, especially after significant storm events, because of the age of existing structural components.

CONSEQUENCES OF DAM FAILURE

Historically, pool elevation at the Nichols Dam has never reached the level of the auxiliary spillway, but modeling indicates that the auxiliary spillway would discharge during the 100-year precipitation event (10-day drawdown simulation) under current or build-out conditions. Failure of the Nichols Dam under more-extreme wet weather conditions is anticipated to impact approximately 450 structures, the majority of which are located in the towns of Northborough and Hudson. Most of these structures would have already experienced the effects of flooding resulting from the ½ PMF design storm prior to the dam breach. The structures are primarily private residences but also include commercial and industrial buildings.

Within the Town of Westborough, dam break flooding of the Assabet River under wet weather conditions is expected to impact approximately 15 residential structures, 10 commercial structures, and eight roads, including Route 9 and Route 135.

The Town of Northborough would experience flooding along the Assabet River that would impact approximately 75 residential structures, five commercial structures, and 17 roads, including Route 20 and Route 135.

The City of Marlborough would experience flooding along the Assabet River, although no impacts to residential or commercial structures are anticipated. Flooding would affect seven roads, including Route 290 and Interstate 495. Tyler Dam, a flood control structure in Marlborough would have sufficient hydraulic capacity to pass the wet weather dam break flood wave as well as the wet weather base flow in the Assabet River. Tyler Dam is also anticipated to assist in dissipating the peak flow of the flood wave.

Within the Town of Berlin, approximately five residential structures, four commercial structures, and four roads along the Assabet River are anticipated to experience flooding as a result of the wet weather dam break.

Within the Town of Hudson, the wet weather dam break flood is anticipated to impact approximately 220 residential structures and 30 commercial structures along the Assabet River. Approximately 48 roads are expected to flood, including Route 85, Route 62, and Interstate 495. Two schools and the Hudson Fire Department are expected to experience flooding. The Washington Street Dam, in the Town of Hudson, does not have the hydraulic capacity sufficient to pass the wet weather dam break flood wave. As a result, the Washington Street Dam is anticipated to be overtopped and to fail.

Within the Town of Stow, wet weather dam break flooding is anticipated to affect approximately 15 residential structures, 20 commercial structures, and six roads, including Route 62.

Within the Town of Maynard, the wet weather dam break flooding is anticipated to impact approximately 40 residential structures, 15 commercial structures, and 23 roads, including Route 62, Route 27, Route 117, and Route 27.

The damages from a 100-year flood event without the Nichols Dam in place are estimated to be $5,158,650. A catastrophic breach of the dam would affect an area larger than the 100-year floodplain, so the damages from a breach would far exceed the damages sustained from a 100-year flood event without the dam in place, and it would likely include the loss of lives.

ALTERNATIVES

FORMULATION PROCESS

NRCS and DCR jointly developed a wide range of nonstructural and structural measures for flood protection downstream of Nichols Dam. Alternatives were developed that are ineligible for financial assistance under PL 83-566 as amended by PL 106-472 as well as alternatives that are eligible for federal funding. To be eligible for federal assistance, an alternative must meet the requirements of PL 106-472.

The following alternatives were considered:

- Future Without Project—the most probable future conditions to be realized if the federally funded NED Alternative is not implemented.
- Decommissioning—controlled breaching of the dam so that it no longer stores floodwater.
- Rehabilitation of the dam (NED Alternative).
- Other dam rehabilitation alternatives.
- Relocation of at-risk buildings in the downstream breach inundation area.
- Floodproofing of at-risk buildings in the downstream breach inundation area.

The principal spillway outlet structure and the control elevation of the auxiliary spillway would not be modified in any of the alternatives. The flood profiles of storms less frequent than the design storms would not be affected by proposed rehabilitation measures and were not included in the alternatives analysis.

Alternatives that would provide no additional benefits but would cost substantially more than the NED Alternative were eliminated from detailed analysis. The Future Without Project Alternative was used to evaluate the remaining feasible rehabilitation alternative, which is the NED Alternative.

The alternatives evaluation period was established as 60 years to provide continuing safe service for the original 100-year SuAsCo watershed planning period. The period of analysis is 61 years to allow for 1 year of design and construction. All alternatives were developed to function for a minimum of 60 years with proper maintenance.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Structural and nonstructural measures that were considered but eliminated from detailed study are described in the following paragraphs.

Decommissioning

Decommissioning would require taking the dam out of service through a full or partial breach of the dam. Decommissioning would eliminate flood storage behind the dam and eliminate the flood protection provided by the dam. Without further mitigation, downstream properties would be subject to increased flooding, increased property damage, and increased risk of loss of life. There would be construction costs and impacts related to the dam breach, but there would be no long-term dam maintenance and repair costs.

Decommissioning would not meet the sponsors' objective to maintain the downstream flood damage reductions provided by the existing project. To meet this objective, decommissioning would have to be supplemented by other measures such as floodproofing or relocation. As shown below, relocation and floodproofing would cost more than twice as much as the structural

cost of rehabilitation, so the decommissioning alternative was eliminated from detailed study because it was not considered to be a reasonable alternative due to cost.

Decommissioning of the George H. Nichols Multipurpose Dam would also severely reduce the benefits of the second purpose of the project, recreation, and of incidental uses of the site that have developed over the life of the project, including irrigation, well recharge, and downstream wastewater assimilation. Loss of these services would result in adverse impacts to the community and surrounding area.

Increase the Height of the Dam

Increasing the height of the dam to provide the additional protection from overtopping during a storm event, while possible, would still result in exit velocities that exceed the acceptable velocities for vegetated spillways and would require armoring within the existing spillway. In addition, the length of the dam would likely increase, and a number of dikes would likely have to be constructed around the project perimeter to contain the impoundment at the new level. Increasing the height of the dam would also increase the hydrostatic pressures within the foundations, likely leading to increased seepage under full pool conditions. To offset this concern, a foundation treatment or positive cutoff within the embankment would need to be constructed. This alternative would also require additional costs for purchasing additional properties that could be impacted by the new impoundment limits. Construction to increase the height of the dam and create additional dikes would also create significant additional environmental and community impacts. Raising the height of the dam is not considered a reasonable alternative because of an obvious substantially higher cost of construction, greater environmental impact, and potential structural implications.

Armor the Embankment and Spillway

The upstream slopes, crests, and downstream slopes of the dam could be armored to protect against erosion of the structure when flood flows pass over the auxiliary spillway crest or over the dam crest. The construction cost of this alternative is estimated at $5.1 million, which is more than 200 percent higher than the cost of the NED Alternative. This alternative, therefore, is not considered to be reasonable because of excessive cost.

Relocation

Land downstream of the dam that would be affected by failure of the dam would be purchased and the residences or businesses relocated out of the flood area. The Nichols Dam provides approximately 10.9 percent of the flood damage reduction benefits in the SuAsCo watershed. A major property that would be affected if the dam were to fail is Clock Tower Plaza/Place, which is valued at approximately $40 million. The proportioned cost of that property to the Nichols Dam is then $4.4 million (10.9 percent of $40 million). When costs for protecting roads and other infrastructure, other property purchases, and relocation are added to this cost, the cost of this nonstructural alternative far exceeds the cost of structural alternatives to rehabilitate.

Floodproofing

To protect areas that would be affected by failure of the dam, individual properties could be floodproofed or floodwalls could be constructed along the river downstream of the dam. The area protected by the dam includes the area along Route 9 in Westborough and Route 20 in Northborough as well as portions of the Towns of Marlborough and Hudson. Floodwalls would be required around major arteries such as Route 9, South Street, Brigham Street, Route 20, Hudson Street and Route 35 as well as developed areas along the Assabet River. Several miles of floodwalls with several penetrations would be required at a cost of more than $15 million. This alternative is unreasonable, because the cost is more than 500 percent higher than the cost of the structural alternative considered for final analysis, there are no additional flood protection benefits, and the environmental impacts of project construction would be greater.

DESCRIPTION OF ALTERNATIVE PLANS

The following alternatives were developed in detail and are evaluated in this Supplemental Watershed Plan and Environmental Evaluation.

Alternative 1 - Future Without Project (No Action Alternative)

The Future Without Project Alternative or No Action Alternative depicts the most probable future conditions to be realized in absence of any of the alternative plans studied. DCR, the owner of the dam, and the agency under which the Commonwealth's dam regulations are implemented, has determined that it would rehabilitate the dam to meet current federal dam safety standards without federal funds. DCR may use other alternative rehabilitation methods identified in the Phase II report (H&S Environmental 2009b) or develop its own plan to bring the dam into compliance with federal standards, but for the purposes of comparing this alternative to the NED Alternative, it is assumed that DCR would implement the same plan as described in Alternative 2. This assumption was made because the recommended plan is the most cost-effective and least environmentally damaging of all plans considered.

Alternative 2 – Rehabilitation (NED Alternative): Widen and Armor Auxiliary Spillway

A site layout of the rehabilitation alternative is provided in Figure 2, Appendix B. The width of the auxiliary spillway would be increased from 100 feet to 350 feet to bring the structure into compliance with the federal freeboard design criteria and prevent overtopping of the dam. However, exit velocity in the auxiliary spillway would still exceed federal design criteria and would be erosive to the existing grass-covered slope. The auxiliary spillway would be armored, therefore, to protect against erosion and stabilize the structure. The armoring would provide scour protection for the predicted velocity of 7.2 feet per second, which exceeds the allowable velocities for earthen spillways. Articulated concrete blocks (ACBs) are cost-effective solutions that decrease the impact to the structure (i.e., shallow depth of construction, limited staging areas required) and improve ease of maintenance through the ability to replace damaged blocks and maintain or improve current aesthetics. ACBs are suited for channel velocities in excess of 20 feet per second. Armoring of the northern slope of the auxiliary spillway with ACBs or rip rap

may also be required, as to be determined by flow modeling in final design. This additional armoring could affect up to 0.8 acre of wood and field along the northern edge of the spillway.

Construction of an ACB type system requires the removal of the vegetation and organic topsoil layers, excavation to the subgrade elevation to enable installation of the bedding layer, installation of the drainage layer, placement of the ACBs which are typically fashioned into mats, and placement of infill materials. The drainage layer, which is an integral part of the system typically, consists of a geotextile designed to filter the embankment soils, and a crushed stone drainage media. Grading and placement of this layer is critical so as to enable the proper placement of the ACBs in intimate contact with the drainage layer. Should flow occur between the drainage layer and the ACB units, laboratory testing has shown that the blocks can lift and degrade the system.

The limited disturbance required for installation, low frequency of use leading to reduced maintenance costs, overall cost savings, and the ability to cover the ACBs with a layer of sacrificial loam and seed to maintain the natural appearance of the area are significant benefits to using ACBs in this location.

In order to widen the auxiliary spillway to the necessary 350 feet, the auxiliary spillway will need to extend onto filled portions of the dam embankment. Standard NRCS design requirements specify that the auxiliary spillway be cut into native ground; however, this is not a practical alternative for the Nichols site because of constraints of the general topography surrounding the impoundment. Given the apparent similarities between the embankment and the native soils, the recommended plan is to widen the existing auxiliary spillway to extend from the east side of the existing auxiliary spillway to the west of the primary spillway, as depicted on Figure 2 in Appendix B.

COMPARISON OF ALTERNATIVES

Table K summarizes and compares the two alternative plans. Refer to the *Environmental Consequences* section for additional information on the effects of each alternative.

Table K – Summary and Comparison of Candidate Plans

Effects	Alternative 1 Without Project	Alternative 2 (NED)
Measures	Widen auxiliary spillway by 250 feet; armor spillway with ABCs	Widen auxiliary spillway by 250 feet; armor spillway with ABCs
Project investment	$2,900,500	$2,900,500
National Economic Development Account[1/]		
Beneficial, annual	—	$158,900
Adverse, annual	—	$158,900
Net beneficial	—	$0

Table K – Summary and Comparison of Candidate Plans		
Effects	**Alternative 1 Without Project**	**Alternative 2 (NED)**
Environmental Quality Account		
Wetlands	No permanent impact to wetlands; potential for less than 1 acre of temporary disturbance during construction; impacts will be avoided if possible and restored with native vegetation if affected by construction	No permanent impact to wetlands; potential for less than 1 acre of temporary disturbance during construction; impacts will be avoided if possible and restored with native vegetation if affected by construction
Fish and wildlife habitat	Continued availability of storage for fish and wildlife habitat; potential for loss of up to 0.8 acres wildlife habitat; temporary disturbance near construction area (less than 1 acre).	Continued availability of storage for fish and wildlife habitat; potential for loss of up to 0.8 acres wildlife habitat; temporary disturbance near construction area (less than 1 acre).
Regional Economic Development Account		
Beneficial, annual		
Region	—	$158,900
Rest of Nation	—	$0
Adverse, annual		
Region	—	$57,400
Rest of Nation	—	$101,500
Net Beneficial		
Region	—	$101,500
Rest of Nation	—	($101,500)
ARRA[2/] funds to stimulate local economy	$0	$2,055,700
Other Social Effects Account		
Dam safety	Reduced threat of dam failure	Reduced threat of dam failure
Human health and safety	Reduced threat to life from dam failure	Reduced threat to life from dam failure
Flood damages	Reduced threat of flood damages from dam failure	Reduced threat of flood damages from dam failure
Recreation	Continued recreation benefits	Continued recreation benefits
Water supply	Continued groundwater recharge of community and private wells	Continued groundwater recharge of community and private wells

[1/] Per sections 1.7.2(a)(4)(ii) and 2.1.1(b)(2) of the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" (P&G), U.S. Water Resources Council, March, 1983, allowing for abbreviated procedures, damage reduction benefits have not been estimated because they are the same for both alternatives, and no net change in benefits occurs when comparing the two candidate plans to each other. The federally assisted alternative (Alternative 2) is displayed within a zero-based accounting context that credits local costs avoided (Adverse, annual) as adverse beneficial costs (Beneficial, annual) consistent with P&G 1.7.2(b)(3). Net benefits are zero because the total project cost is equal to the claimed benefits and the resulting B/C ratio is 1.0:1.0.

[2/] American Recovery and Reinvestment Act of 2009

ENVIRONMENTAL CONSEQUENCES

The following is a description of the effects that each alternative will have on the natural and human environment, focusing on concerns identified during the scoping process determined to be of moderate or high significance to decision making (see Table A). Resources or concerns that were rated of low significance to decision making or that are not affected by either alternative (e.g., climate, geology) are not included in this section. For each resource topic, the present conditions are summarized to provide a better understanding of the effects. Because the dam would be rehabilitated under both alternatives (by DCR with no federal funding under Alternative 1 and by the sponsors with partial federal funding under Alternative 2), the effects of the alternatives are the same for all resource categories.

DAM SAFETY

- **Present Conditions:** The dam does not meet current safety standards for a dam in this location and there is a risk of the dam failing from overtopping during a large storm. The flood pool elevation would overtop the dam by 2.7 to 2.9 feet in current and build-out conditions, respectively, for the freeboard storm. Modeling results indicate that the auxiliary spillway does not meet all necessary design criteria for current and ultimate build-out conditions, and discharge velocity would create erosive forces on the spillway slope. The risk of failure is low, but the consequences of failure would be catastrophic.
- **Alternative 1—Future Without Project (Rehabilitation by DCR):** Widening the auxiliary spillway would reduce flood pool elevation during freeboard storm events and prevent overtopping of the dam. Armoring the auxiliary spillway would prevent erosion of the spillway if storm flows pass down the spillway. The rehabilitation would bring the dam into compliance with federal and state criteria, and the threat of the dam failing during large storms would be reduced.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

HUMAN HEALTH AND SAFETY

- **Present Conditions:** The dam is structurally safe; however, there is a threat of failure from overtopping of the dam or erosion of the auxiliary spillway during large storms. There is a significant threat from dam failure to human life and safety for residents, motorists, and other people using downstream facilities.
- **Alternative 1—Future Without Project (Rehabilitation by DCR):** The threat of loss of life or unsafe conditions from the dam failing would be reduced through rehabilitation designed to bring the dam into compliance with safety criteria. Flood protection would continue for residents, motorists, and other persons using downstream facilities.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

FLOOD DAMAGES

- **Present Conditions:** Failure of the dam also poses a significant threat of damages to private property, roads, and utilities in the breach inundation area.
- **Alternative 1—Future Without Project (Rehabilitation by DCR):** The threat of property damage from the dam failing would be reduced through rehabilitation designed to bring the dam into compliance with safety criteria. Flood protection would continue for private property, roads, and utilities in the breach inundation area.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

WATER SUPPLY

- **Present Conditions**: The pool above Nichols Dam helps maintain groundwater levels for town drinking water wells located adjacent to the pool.
- **Alternative 1—Future Without Project (Rehabilitation by DCR)**: There would be no effect on water supply because the pool would be maintained at its present elevation.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

WATER QUALITY

- **Present Conditions**: The pool above Nichols Dam shows evidence of nutrient enrichment. The influence of the pool on downstream water quality is not well documented.
- **Alternative 1—Future Without Project (Rehabilitation by DCR)**: There would be minor, temporary impacts to water quality due to an increase in turbidity in the pool and the Assabet River during construction. The DCR or its contractor would be required to obtain an NPDES general permit for construction, which would require preparation of an erosion and sediment control plan and installation of best management practices to minimize sediment discharge to the pool and the river.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

WETLANDS

- **Present Conditions:** Wetland resources identified at the site include BVWs, Bank, LUWB, and Riverfront Area.
  Alternative 1—Future Without Project (Rehabilitation by DCR): No wetlands would be permanently impacted as a result of the installation of the armoring system. Temporary impacts to wetlands during construction will be avoided if possible, but there is the potential for minor, temporary impacts (less than 1 acre) to wetlands for access, staging, etc. Removal of wetland vegetation may be required for temporary construction activity at the entrance to the auxiliary spillway or for temporary access across the principal spillway. These temporarily disturbed areas would be re-graded to pre-construction contours and re-planted with native vegetation.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

FISH AND WILDLIFE HABITAT

- **Present Conditions:** The pool provides habitat for fish, waterfowl, and other birds, and it provides storage for low-flow augmentation of fish habitat in the Assabet River downstream of the dam. The area at the dam is mown and provides low-value habitat.
- **Alternative 1—Future Without Project (Rehabilitation by DCR):** Except for possible temporary, minor increases in turbidity near the construction area, which would be minimized by best management practices for control of erosion and sediment runoff, fish habitat would not be affected. By protecting the dam against failure, rehabilitation would ensure the continued, long-term presence of the fish and wildlife habitat in the pool and the availability of water for low-flow augmentation to support fish habitat in the Assabet River downstream of the dam. Up to 0.8 acre of field and wood habitat could be permanently lost if armoring of the northern bank of the auxiliary spillway is required. There could also be minor, temporary disturbances to wildlife due to noise from construction.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

AIR QUALITY

- **Present Conditions**— The project area falls within the Boston-Lawrence-Worcester area as defined by EPA. This is a Nonattainment Area for 8-hour ozone. The area is in attainment for all other criteria pollutants (USEPA 2009).
- **Alternative 1—Future Without Project (Rehabilitation by DCR):** No permanent impacts are anticipated. Minor, temporary impacts are expected due to emissions from construction equipment.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

RECREATION

- **Present Conditions:** Recreation is the second purpose of the Nichols Dam. Available recreation includes fishing on the pool, hiking and bird watching around the pool, and fishing in the Assabet River downstream of the dam.
- **Alternative 1—Future Without Project (Rehabilitation by DCR):** Access to the hiking trail across the top of the dam would be restricted temporarily during construction. Access to the pool and the downstream river for fishing would not be affected. By protecting the dam against failure, rehabilitation would ensure the continued presence of the dam and pool with long-term storage for in-pool and downstream recreation benefits.
- **Alternative 2—NED Rehabilitation Plan:** Same as Alternative 1.

CUMULATIVE IMPACTS

Construction of the Nichols Dam in 1970 had long-term direct effects on the environment through the excavation of the site, filling of the structure, and development of a permanent impoundment behind the dam that now provides recreational opportunities, fish and wildlife habitat, and other incidental benefits. Rehabilitation of the dam under either alternative would occur within the area disturbed for construction of the existing structure and, therefore, would

have no cumulative impact on the environment other than the minor, temporary construction-related impacts described above.

Since construction, the dam has indirectly affected the natural environment by permanent flooding of the 380-acre area of the normal pool, by temporary inundation of the floodplain upstream of the dam during rain events, and by trapping sediment that would otherwise move downstream during rain events. The dam has also altered the hydrology of the Assabet River by reducing downstream peak flows during storm events, and consequently protecting property and people in otherwise floodprone areas. Rehabilitation of the dam under either alternative would not change the hydrology of the Assabet River except for protecting the downstream area from catastrophic flooding that could occur if the dam were to fail. There would be no long-term, cumulative effects from the rehabilitation project.

Future actions in the watershed not related to this project include continued changes to upstream and downstream land use as a result of residential, industrial, and commercial development. Rehabilitation of Nichols Dam would not affect future development, but it would allow the dam to safely pass storm flows under build-out conditions.

CONTROVERSY

There are no known areas of controversy.

RISK AND UNCERTAINTY

The areas of risk and uncertainty associated with this project lie in the accuracy of predicting flood flows and flood elevations, estimating costs associated with each alternative, estimating property values and damage costs and benefits. The uncertainty of flood flows and water surface elevations has the potential for increased damages as development of residential and commercial property alters land use. It is possible that these uncertainties could lead to increased risk to human life in the event of a dam breach regardless of rehabilitation or no action. Hydrologic methods and computer modeling used in this analysis are consistent with the standards of practice at this time. The potential impacts for each alternative are estimated using techniques that relate potential damage to lost opportunity. However, these methods are in part based on professional judgment and actual experiences could be different.

Uncertainties with the analysis of environmental impacts lie with the identification of wetland areas and the risk of invasive species colonizing areas of revegetation. Trained wetland specialists identified wetland areas using standard, well-accepted protocols. The sponsors will be responsible for verifying wetlands and consulting with DEP as required before construction. Native species will be used for planting to minimize introduction of invasive species, but introduction could occur from adjacent areas.

Within the context of this study, all alternatives were considered on a comparable basis. There does not appear to be any area that would have resulted in a different decision by using different procedures or conducting more intensive studies.

CONSULTATION AND PUBLIC PARTICIPATION

PROJECT SPONSORS

Local sponsoring organizations of the SuAsCo watershed plan and Supplement No. 7 are Worcester County Conservation District, Middlesex Conservation District, DCR, and DFW.

PLANNING TEAM

An interdisciplinary planning team provided for the administration of this project through the NRCS nine-step planning process according to the procedures in the NRCS National Planning Procedures Handbook. Some of the tasks undertaken by the planning team include preliminary investigations, hydrologic and engineering analysis, economic analysis, formulation and evaluation of alternatives, and preparation of the Supplemental Watershed Plan and Environmental Evaluation. The planning team included representatives of the NRCS Massachusetts state office, the NRCS National Water Management Center, DCR, and technical consultants under contract to NRCS.

The planning team toured the project site on November 28, 2007, and conducted an initial project planning meeting on November 29, 2007. Additional team meetings or conference calls were held in April, May, September, and November 2008.

PUBLIC PARTICIPATION

A public meeting was held in Westborough on February 19, 2009, to explain the Watershed Rehabilitation Program, obtain public input on the project, and scope resource problems, issues, and concerns of local residents associated with the Nichols Dam project area. The meeting was widely advertised to reach everyone in the watershed including minorities. NRCS distributed a press release on February 4, 2009, that resulted in articles about the meeting in the Westborough News on February 6, 2009, and the MetroWest Daily News on February 16, 2009. The meeting was recorded by Westborough community access cable television for broadcast on the local access channel.

Potential alternative solutions to bring the Nichols Dam into compliance with current dam safety criteria were presented at the public meeting. A fact sheet summarizing the planned rehabilitation projects at six dams in the SuAsCo watershed was distributed at the meeting. One member of the public, the chairman of the Westborough Community Land Trust, attended the meeting. He expressed willingness to work with NRCS on notifying the public through the Trust's web site of the construction period and temporary effects on access to the trail. No verbal or written comments have been received in the intervening time to the publishing of this Plan.

AGENCY CONSULTATION

Consultation under the Endangered Species Act is not required. Through access to the U.S. Fish and Wildlife Service's (FWS's) threatened and endangered species web site database, it was

determined that no federally listed threatened or endangered species or critical habitat are present in the project area. It was determined from MassGIS that no habitat for state-protected species lies in the Nichols Dam project area.

A site visit was held with USACE and EPA to discuss the project and permit requirements.

Consultations with the Massachusetts SHPO and the Tribal Historic Preservation Officer (THPO) of the Wampanoag Tribe of Gay Head (Aquinnah) were conducted to determine the presence of any cultural or historic resources within the proposed project area. The SHPO concurred with the determination of no effect to historic properties on July 17, 2009. A response was not received from the THPO.

PROVISIONS OF THE PREFERRED ALTERNATIVE

PREFERRED ALTERNATIVE

Alternative 2, rehabilitation of the Nichols Dam with PL 83-566 funding, is the preferred alternative. The auxiliary spillway would be modified to meet current safety standards for a high hazard dam and maintain the service life and flood prevention purpose of the dam for the original 100-year planning period. The rehabilitation will consist of (1) widening the auxiliary spillway from 100 to 350 feet to increase the capacity of the spillway and prevent overtopping of the dam during freeboard storm events and (2) armoring the spillway to safely pass the SDH and FBH storm discharge flows. Estimated construction cost is $2,290,100 and total installation cost, including engineering and administration is $2,900,500.

Table L compares structural data from the original as-built structure, the existing structure, and the planned rehabilitation.

Table L – Comparison of Structural Data

George H. Nichols Multipurpose Dam	Unit	As Built	Existing Conditions	Planned
Surface area (principal spillway crest)	acres	380	380	380
Elevation, top of -dam (effective)	feet	318.5	318.5	318.5
Length of dam	feet	1,440	1,440	1,440
Principal spillway	type	standard drop inlet	standard drop inlet	standard drop inlet
Elevation, principal spillway crest	feet	310.0	310.0	310.0
Pipe diameter, principal spillway	inches	48	48	48

Table L – Comparison of Structural Data				
George H. Nichols Multipurpose Dam	**Unit**	**As Built**	**Existing Conditions**	**Planned**
Auxiliary spillway	type	grass-lined channel	grass-lined channel	armored with articulated concrete blocks covered by sacrificial soil/grass layer
Elevation, auxiliary spillway	feet	313.0	313.0	313.0
Bottom width, auxiliary spillway	feet	100	100	350
Storage, permanent pool	acre-feet	1,624	1,624	1,624
Storage, auxiliary spillway crest	acre-feet	2,900	2,900	2,900
Storage, maximum pool	acre-feet	3,400	3,400	3,400

RATIONALE FOR ALTERNATIVE PREFERENCE

Alternative plans were formulated as required by NRCS policy, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (U.S. Water Resources Council 1983), and the National Environmental Policy Act. According to P&G, an alternative that reasonably maximizes net national economic development benefits is to be formulated. This alternative is to be identified as the NED Plan. Alternative 2 is the NED Plan.

Alternative plans were formulated in consideration of the purposes of the project and concerns expressed during the public scoping process. Formulation of the alternative plans gave consideration to four criteria: completeness, effectiveness, efficiency, and acceptability. Alternatives 1 and 2 are the same project, with the only difference being the use of federal funds for a portion of the project costs, and both alternatives meet all four of these criteria. Both alternatives maintain the present level of flood control benefits and comply with current performance and safety standards. Both alternatives produce the same monetary benefits, but the net average annual equivalent benefits between the Future with Federal Project (NED Alternative) and the Future without Federal Project (No Action Alternative) is $0.

PERMITS, COMPLIANCE AND REQUIREMENTS PRIOR TO CONSTRUCTION

Potential Permits Needed

Permitting needs will be determined in final design. Federal and state permitting requirements may include: (1) NPDES general permit for construction, (2) USACE permit under Section 404 of the Clean Water Act of 1972, (3) Chapter 253 Permit to Construct or Alter a Dam, (4) Chapter 91 Waterways License, (5) Order of Conditions through the Massachusetts Wetlands Protection

Act, and (6) Section 401 Water Quality Certification. DCR is responsible for obtaining all permits.

Compliance with Local, State and Federal Laws

The sponsors will comply with all applicable local, state, and federal laws in the installation of this project. Under the conditions of the NPDES general permit for construction, the sponsors or their contractor will prepare a stormwater pollution and prevention plan, including an erosion and sediment control plan. In the event that cultural resources are discovered during project installation, construction will be halted in that area, and the resources will be evaluated in accordance with NRCS General Manual 420 part 401.

Mitigation

It is expected that most construction activities would be confined to existing disturbed and cleared areas. No permanent impacts to wetlands are expected, so no wetlands mitigation would be required. Removal of wetland vegetation may be required for temporary construction activities; these disturbed areas would be re-graded to pre-construction contours and re-planted with native wetland vegetation. The sponsors would be responsible for preparing an approved sediment and erosion control plan to minimize erosion of disturbed soils and sediment runoff into the pool and Assabet River. The sponsors would also be responsible for ensuring that the sediment and erosion control plan is implemented and maintained during construction and that the site is stabilized after construction. After construction, all temporarily disturbed areas will be re-graded to pre-construction contours and reseeded with native species as per NRCS Critical Area Seeding Standard 342.

Operation, Maintenance and Replacement

The project will be operated and maintained by the owner. A new Operation and Maintenance (O&M) Agreement will be developed for the remaining 60-year program life of the structure and signed by DCR before the Project Agreement is signed. O&M activities include but are not limited to inspection, maintenance, and repair of the principal spillway, dam, vegetation, and the auxiliary spillway. Based on data from DCR, it is estimated that O&M activities and replacement costs will total about $15,700 per year.

Project Agreement

DCR and NRCS will enter into a Project Agreement in accordance with the NRCS National Contract Grants and Agreement Manual before any work is initiated by either the owner or the NRCS.

Emergency Action Plan

DCR has prepared an EAP for the Nichols Dam for the case where the dam is compromised and/or likely to fail. The EAP identifies areas at risk and dam conditions that would initiate emergency notification procedures. It outlines appropriate actions in the event of a potential

failure of the dam and designates the parties responsible for those actions. The owner will review and update the EAP annually, in consultation with local emergency response officials. NRCS, if requested, may provide technical assistance in updating the EAP.

COST, INSTALLATION AND FINANCING

The construction associated with the project will be financed jointly by DCR and NRCS. NRCS will use funds appropriated for this purpose. The eligible project costs including construction, engineering, and project administration to be paid by DCR and NRCS are as follows:

	DCR	NRCS	Estimated Total Cost
Rehabilitation of George H. Nichols Multipurpose Dam	$844,800	$2,055,700	$2,900,500

NRCS cost share shall be 65 percent of the total eligible project cost, not to exceed 100 percent of the actual construction costs. An amount up to the percentage rate specified may be satisfied by DCR through the cost of engineering (permitting) and construction. Real property acquisition could also be used as a portion of DCR's cost-share, but is not expected to be required for this project. The decision on specific DCR-funded components will be negotiated between DCR and NRCS and will be included in the Project Agreement executed before implementation.

NRCS is responsible for the engineering services and project administration costs it incurs. These costs are not used in the calculation of the federal cost share, but they are included in the estimated installation cost (Table 1, Appendix A). Also, costs of federal, state, and local permits are the responsibility of DCR and are not counted toward the local cost share. See Table 2 in Appendix A for a complete description of the total rehabilitation cost.

The furnishing of financial and other assistance by NRCS is contingent on the continuing availability of appropriations by Congress from which payment may be made and shall not obligate NRCS if Congress fails to so appropriate.

ENVIRONMENTAL EVALUATION

Under NRCS regulations for implementing NEPA, the proposed action qualifies as a categorical exclusion (7 CFR 650.6(15)):

> Exclusion No. 15 - Repairing or improving (deepening/widening/armoring) existing auxiliary/emergency spillways associated with dams, originally constructed to NRCS standards, in order to meet current safety standards. Work will be confined to the dam or abutment areas, and no major change in reservoir or downstream operation will result.

FINDINGS

I have considered the effects of this proposed action on resource, economic, and social considerations; special environmental concerns; and extraordinary circumstances criteria in the instructions for form NRCS-CPA-52. I find, for the reasons stated below, that the selected alternative is categorically excluded from further environmental analysis and there are no extraordinary circumstances. No additional environmental analysis is required.

Christine S. Clarke — State Conservationist — 9/10/09

Signature — Title — Date

RATIONALE

The recommended action will protect human health and safety and the infrastructure and transportation system in the watershed by extending the life of the dam and bringing the structure up to current performance and safety standards. Existing flood control benefits will be maintained. The primary beneficiaries of the project are residential, industrial, and commercial property owners in the floodplain of the Assabet River; the towns of Northborough, Westborough, Berlin, Hudson, Stow, and Maynard; the City of Marlborough; and the Commonwealth of Massachusetts.

The proposed action will not permanently affect wetlands. Construction may temporarily disturb less than one acre of wetlands, but disturbed areas will be restored if they cannot be avoided.

There are no historic properties in the project area, which was previously disturbed for construction of the dam. The State Historic Preservation Officer has concurred with a determination of no effect on historic resources.

No federally protected threatened or endangered species or state-listed rare species will be affected by the project.

No impacts to floodplains, land use, prime farmland, park lands, wild and scenic rivers, or ecologically critical areas will result from the recommended action. Fish and wildlife habitats may be temporarily disturbed during construction, but will not be permanently affected by the project. Water quality and air quality may be temporarily affected by construction, but will not be permanently affected by the project. Best management practices will be employed to

minimize soil erosion and stream sedimentation, and all disturbed areas will be restored and revegetated with native species after construction.

No significant adverse environmental impacts will result from the proposed action, and there are no extraordinary circumstances.

REFERENCES

Council on Environmental Quality. 1997. *Environmental Justice: Guidance Under the National Environmental Policy Act*. Washington, D.C.

GZA GeoEnvironmental. 2008. *George H. Nichols Dam (aka Assabet River Dam), Westborough, MA, Emergency Action Plan*. Prepared for Massachusetts Department of Conservation & Recreation, Boston Massachusetts.

H&S Environmental. 2009a. *SuAsCo Watershed, George H. Nichols Multipurpose Dam, Phase 1 Report*. Prepared for the NRCS, Amherst, Massachusetts. January 28, 2009.

H&S Environmental. 2009b. *SuAsCo Watershed, George H. Nichols Multipurpose Dam, Draft Phase II Report*. Prepared for the NRCS, Amherst, Massachusetts. April 13, 2009.

Massachusetts Division of Watershed Management (DWM). 2005. *SuAsCo Watershed 2001 Water Quality Assessment Report*. Report No. 82-AC-1. Available [online]: http://mass.gov/dep/water/resources/wqassess.htm#wqar. Accessed on November 14, 2008.

Massachusetts Geographic Information System (MassGIS). 2008a. *Massachusetts Geographic Information System, 1999 Land Use Data*. Available [online]: http://www.mass.gov/mgis/. Accessed on October 30, 2008.

Massachusetts Geographic Information System (MassGIS). 2008b. *Cities and Towns that Include Environmental Justice Communities*. Available [online]: http://www.mass.gov/mgis/ej_cities-towns.pdf. Accessed on October 30, 2008.

Massachusetts Natural Heritage and Endangered Species Program (NHESP). 2009. *Natural Heritage GIS Resources*. Available [online]: http://www.mass.gov/dfwele/dfw/nhesp/gis_resources.htm. Accessed on March 18.

National Park Service (NPS). 2008. *National Register of Historic Places*. Available [online]: http://www.nps.gov/history/nr/research/index.htm. Accessed on November 14, 2008.

Organization for the Assabet River (OAR). 2009a. *Upper Assabet Riverway Plan*. Available [online]: http://www.assabetriver.org/river/technical-info/riverway-plan. Accessed on February 16, 2009.

Organization for the Assabet River (OAR). 2009b. *Assabet Headwaters Current Conditions–2008*. Available [online]: http://www.assabetriver.org/projects . Accessed on February 16, 2009.

Reid, A. 2006. *Visitors to our Vernal Pools*, in *The Westborough News*, March 17, 2006. Available [online]: http://www.westboroughlandtrust.org/nn/nn48.php. Accessed on March 2, 2009.

Town of Westborough. 2003. *Town of Westborough Massachusetts Open Space and Recreation Plan*. Available [online]: http://www.town.westborough.ma.us/Public_Documents/WestboroughMA_BComm/openspacereport/OSRP.html. Accessed on February 16, 2009.

United States Census Bureau. 2008. *American Factfinder*. Available [online]: http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=ChangeGeoContext&geo_id=05000US25027&_geoContext=&_street=&_county=worcester&_cityTown=worcester&_state=04000US25&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=010&_submenuId=factsheet_1&ds_name=ACS_2007_3YR_SAFF&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=. Accessed on October 30 and 31 and November 03, 2008.

United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2003. *SuAsCo Watershed George H. Nichols Multipurpose Dam (A-1) Fish and Wildlife Development and Flood Protection, Westborough, Massachusetts Hydrology and Hydraulic Evaluation for the Existing Structure*. Prepared for the Massachusetts Department of Environmental Management and the SuAsCo Watershed Team. Amherst, Massachusetts. April.

United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2004. *Assessment Report, George H. Nichols Multipurpose Dam, SuAsCo Watershed Project, Westborough, Massachusetts*. Amherst, Massachusetts. September.

United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2008a. *Climate Narrative for Worcester County, Massachusetts*. Available [online]: ftp://ftp.wcc.nrcs.usda.gov/; then go to subdirectories: support/climate/soil-nar/ma/worcester.doc. Accessed on November 13, 2008.

United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2008b. *Farmland Protection Policy Act*. Available [online]: http://www.nrcs.usda.gov/programs/fppa/. Accessed on November 17, 2008

United States Department of Agriculture, Soil Conservation Service, December 1985. *Soil Survey of Worcester County, Massachusetts, Northeastern Part*. U.S. Department of Agriculture, Soil Conservation Service. Available [online]: http://soildatamart.nrcs.usda.gov/Manuscripts/MA613/0/worcester.pdf. Accessed on February 16, 2009.

United States Department of Agriculture, Soil Conservation Service (USDA-SCS). 1958. *Watershed Work Plan for Watershed Protection and Flood Prevention, SuAsCo Watershed, Middlesex and Worcester Counties, Massachusetts*. Prepared by Middlesex Soil Conservation District and Northeastern Worcester County Soil Conservation District with assistance by USDA Soil Conservation Service, USFWS, and SuAsCo Watershed Association. August.

U.S. Environmental Protection Agency (USEPA). 2009. 8-Hour Ozone Nonattainment State/Area/County Report. Available [online]: http://www.epa.gov/oar/oaqps/greenbk/gncs.html#MASSACHUSETTS. Accessed on June 24, 2009.

U.S. Fish and Wildlife Service (FWS). 2009. Correspondence regarding listed species. January 2, 2009.

U.S. Water Resources Council. 1983. *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. Washington, D.C.

Westborough Community Land Trust. 2009. *Headwaters Conservation Area*. Available [online]:http://www.westboroughcharm.org/guide/maps/hca_trail_map.pdf. Accessed on March 2, 2009.

LIST OF PREPARERS

Name and Present Title	Education	Experience (Years)
NRCS		
Carl Gustafson, P.E., State Conservation Engineer	BS, Civil Engineering	37
Laurence Boutiette, Jr., P.E., Civil Engineer	BS, Civil Engineering	39
Rudy Chlanda	BS, Geology	35
Beth Schreier	BS, Environmental Studies	12
Massachusetts Department of Conservation and Recreation		
Michael Misslin, P.E. Deputy Chief Engineer	BS, Civil Engineering	30
Massachusetts Office of Dam Safety		
William Salomaa, P.E. Director Office of Dam Safety	BS, Civil Engineering	20
EA Engineering, Science and Technology		
Jeffrey Elseroad, Project Manager	MSE, Environmental Engineering; BA, Chemistry	36
Samuel Whitin, Assistant Project Manager	BS, Biology	10
Mary Alice Koeneke, Biologist	MS, Biology/Environmental Science; BS, Biology	32
Tracy Layfield, Planner	BS, Biology	25
John O'Neill, Economist	BS, Natural Resource Economics	40
Matthew Richardson, Biologist	MS, Soil & Environmental Science; BS, Environmental Science	4
Allison Rowland	MS, Ecology	5
H&S Environmental		
William Naughton, P.G., V.P. Operations	BS, Geology	23
PARE		
J. Matthew Bellisle, P.E., V.P. and Geotechnical Division Manager	MS, Civil Engineering; BS, Civil Engineering	16
Allen Orsi, P.E., Project Engineer	BS, Civil Engineering	8
AECOM		
Matthew Kennedy, P.E., Department Manager	BS, Civil Engineering	19
Sarah Widing P.E., Project Engineer	MS, Water Resources Engineering; BS, Civil Engineering	5

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APPENDIX A

ECONOMIC AND STRUCTURAL TABLES

Table 1 – Estimated Installation Cost
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts
(Dollars)[1/]

Installation Cost Item	Estimated Cost[2/]		
	PL 83-566 Funds	Other Funds	Total
Structural measures to rehabilitate George H. Nichols Multipurpose Dam	$2,055,700	$844,800	$2,900,500
Total Project	**$2,055,700**	**$844,800**	**$2,900,500**

[1/] Price base: 2009 May 2009

[2/] PL 83-566 Funds include NRCS Engineering and Project Administration ($531,400) , and "Other Funds" include sponsors' Engineering (permitting) ($24,000), neither of which are included when calculating eligible federal cost share. Therefore, federal cost share is based on Total Eligible Project Cost of $2,345,100.

Table 2 – Estimated Cost Distribution – Structural and Nonstructural Measures
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts
(Dollars) [1/]

	Installation Cost – PL 83-566 Funds [2/]				Installation Cost – Other Funds				Total Installation Cost
	Construction	Engineering	Project Administration	Total PL 83-566	Construction	Permitting	Project Administration	Total Other	
Structural measures: George H. Nichols Multipurpose Dam	$1,524,300	$440,400	$91,000	$2,055,700	$765,800	$24,000	$55,000	$844,800	$2,900,500
Nonstructural measures	$0	$0	$0	$0	$0	$0	$0	$0	$0
Grand total	**$1,524,300**	**$440,400**	**$91,000**	**$2,055,700**	**$765,800**	**$24,000**	**$55,000**	**$844,800**	**$2,900,500**

[1/] Price base: 2009 May 2009

[2/] Federal Engineering and Project Administration costs and sponsors' Engineering (permitting) costs ($555,400) are not included when calculating eligible federal cost share. Therefore, federal cost share is based on Total Eligible Project Cost of $2,345,100.

Table 2a – Cost Allocation and Cost-Sharing Summary
Water Resources Project Measures
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts
(Dollars)[1/]

Works of Improvement	Cost allocation[2/]		Cost Sharing			
	Purpose		Public Law 83-566		Other	
	Flood prevention	Recre-ation	Flood prevention	Recre-ation	Flood prevention	Recre-ation
Multiple Purpose Facilities Structure: George H. Nichols Multipurpose Dam						
Construction	$2,290,100	$0	$1,524,300	$0	$765,800	$0
Engineering	$464,400	$0	$440,400	$0	$24,000	$0
Relocation	$0	$0	$0	$0	$0	$0
Real prop. Rights	$0	$0	$0	$0	$0	$0
Acquisition	$0	$0	$0	$0	$0	$0
Legal fees	$0	$0	$0	$0	$0	$0
Easements	$0	$0	$0	$0	$0	$0
Road & utility modification	$0	$0	$0	$0	$0	$0
Project admin.	$146,000	$0	$91,000	$0	$55,000	$0
Subtotal	**$2,900,500**	**$0**	**$2,055,700**	**$0**	**$844,800**	**$0**
Recreation Facilities	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total	**$2,900,500**	**$0**	**$2,055,700**	**$0**	**$844,800**	**$0**

[1/] Price base: 2009 May 2009

[2/] No rehabilitation project funds are allocated for recreation.

Table 3 – Structural Data – Dams with Planned Storage Capacity
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts

Item	Unit	Nichols Dam
Class of structure		C
Seismic zone		2
Total drainage area	mi^2	6.95
Runoff curve number (1-day) (AMC II)		74 existing development 78 future build-out
Time of concentration (T_c)	hr	5.3
Elevation top of dam	ft	318.5
Elevation crest of auxiliary spillway	ft	313.0
Elevation crest principal spillway	ft	310.0
Elevation sediment pool	ft	302.0
Maximum height of dam	ft	20
Volume of fill (rehabilitation)	yd^3	0[1/]
Total capacity (auxiliary spillway crest)	ac-ft	2,900
Sediment pool	ac-ft	44
Aerated sediment	ac-ft	0
Recreation	ac-ft	1,580
Flood	ac-ft	1,276
Between high and low stage	ac-ft	635
Surface area		
Sediment pool	acre	35
Recreation pool	acre	380
Floodwater retarding pool	acre	490
Principal spillway		
Rainfall volume (1-day)	in	6.6
Rainfall volume (10-day)	in	13.0
Runoff volume (10-day)	in	7.4
Type (standard drop inlet)		reinforced concrete
Diameter	in	48
Capacity of low stage (max.)	ft^3/s	211
Capacity of high stage (max.)	ft^3/s	1,350
Auxiliary spillway		
Type		armored with articulated concrete blocks covered by sacrificial soil/grass layer
Bottom width	ft	350
Exit slope	%	3.5
Frequency of operation[2/]	% chance	less than 1
Auxiliary spillway hydrograph[3/]		
Rainfall volume	in	10.00
Runoff volume	in	7.3

Item	Unit	Nichols Dam
Storm duration	hr	6
Velocity of flow (V_e)	ft/s	6.4
Maximum reservoir water surface elevation	ft	314.9
Freeboard hydrograph[3/]		
Rainfall volume	in	31.5
Runoff volume	in	28.4
Storm duration	hr	6
Maximum reservoir water surface elevation	ft	318.5
Storage capacity equivalents		
Sediment volume	in	0.1
Floodwater retarding volume	in	3.4
Recreation volume	in	4.3

May 2009

[1/] Approximately 1,625 cubic yards of fill will be removed from the existing dam for widening the auxiliary spillway; original volume of fill was 53,000 cubic yards.

[2/] The auxiliary spillway will not spill during the 24-hour, 100-year return period, SCS type III storm event assuming the water surface of the reservoir begins at the normal pool elevation.

[3/] SDH is based on the 6-hr storm; the FBH is based on the most critical condition from the 6-hr and 24-hr storms.

Table 4 – Estimated Average Annual NED Costs
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts
(Dollars)[1/]

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost [2/]	Operation, Maintenance and Replacement Cost	
George H. Nichols Multipurpose Dam	$143,200	$15,700	$158,900
Grand Total	**$143,200**	**$15,700**	**$158,900**

[1/] Price base 2009 May 2009
[2/] Amortized over 61 years at 4.625%

Table 5 – Estimated Average Annual Flood Damage Reduction Benefits
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts
(Dollars)[1/]

Item	Estimated Average Annual Damage		Damage Reduction Benefit[3/]
	Without Project[2/]	With Project[2/]	
Floodwater			
Crop and Pasture	$0	$0	$0
Other Agricultural	$0	$0	$0
Nonagricultural (Road and Bridge)	$3,000	$3,000	$0
Nonagricultural (Urban)	$306,600	$306,600	$0
Subtotal	$309,600	$309,600	$0
Sediment			
Overbank Deposition	$0	$0	$0
Erosion			
Floodplain Scour	$0	$0	$0
Grand Total	**$309,600**	**$309,600**	**$0**

[1/] Price Base: 2009 May 2009
[2/] Original downstream damages updated using applicable indices and updated data.
[3/] Damage reduction benefits resulting from the recommended plan equal zero as compared to the No Action (future without project) Alternative because they are the same in scope, cost, and effects, and therefore yield equivalent benefits. Positive benefits will accrue as a result of this project as compared to existing conditions, but no attempt was made to compute an estimate of the difference between the future with project and existing conditions because the existing conditions are not the most likely future conditions. The added details would not alter the recommended alternative and, therefore, would not justify the added planning costs. Sections 1.7.2(a)(4)(ii) and 2.1.1(b)(2) of the P&G allow for the abbreviated procedures.

Table 6 – Comparison of NED Benefits and Costs
George H. Nichols Multipurpose Dam
SuAsCo Watershed, Massachusetts
(Dollars)[1/]

Evaluation Unit	Benefits			Average Annual Costs[3/]	Benefit/Cost Ratio
	Average Annual Benefits		Average Annual Benefits		
	Agriculture-related[2/]	Nonagricultural[3/]			
George H. Nichols Multipurpose Dam	$0	$158,900	$158,900	$158,900	1.0:1.0
Total	**$0**	**$158,900**	**$158,900**	**$158,900**	**1.0:1.0**

[1/] Price Base: 2009 May 2009
[2/] From Table 5
[3/] From Table 4. The costs and the benefits for the future with project plan are the same as those for the future without project plan. To maintain consistency with the display in Table 4, the costs associated with the No Action Alternative (Future Without Project) are tracked as a benefit of the preferred alternative. Per sections 1.7.2(a)(4)(ii) and 2.1.1(b)(2) of the P&G allowing for abbreviated procedures, damage reduction benefits have not been estimated because they are the same for both alternatives, and no net change in benefits occurs when comparing the two candidate plans to each other. The federally assisted alternative is displayed within a zero-based accounting context that credits local costs avoided as "other" benefits consistent with P&G 1.7.2(b)(3). Net benefits are zero because the total project cost is equal to the claimed benefits and the resulting B/C ratio is 1.0:1.0.

APPENDIX B

SUPPORT MAPS

NRCS

NICHOLS DAM
WESTBOROUGH, MA

Figure 1.
Vicinity Map

PROJECT MGR:	DESIGNED BY:	CREATED BY:	CHECKED BY:	SCALE:	DATE:	PROJECT NO:	FILE:
JE	MR	MR	SW	AS SHOWN	MAY 2009	62028.23	SITE_LOCUS.MXD

H&S ENVIRONMENTAL

PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 103
FOXBORO, MA 02035
508-543-1755

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

GEORGE H. NICHOLS DAM

MA 01000 / 3-14-328-9

NRCS NATURAL RESOURCES CONSERVATION SERVICE

WESTBOROUGH, MASSACHUSETTS

Figure 2. Project Schematic

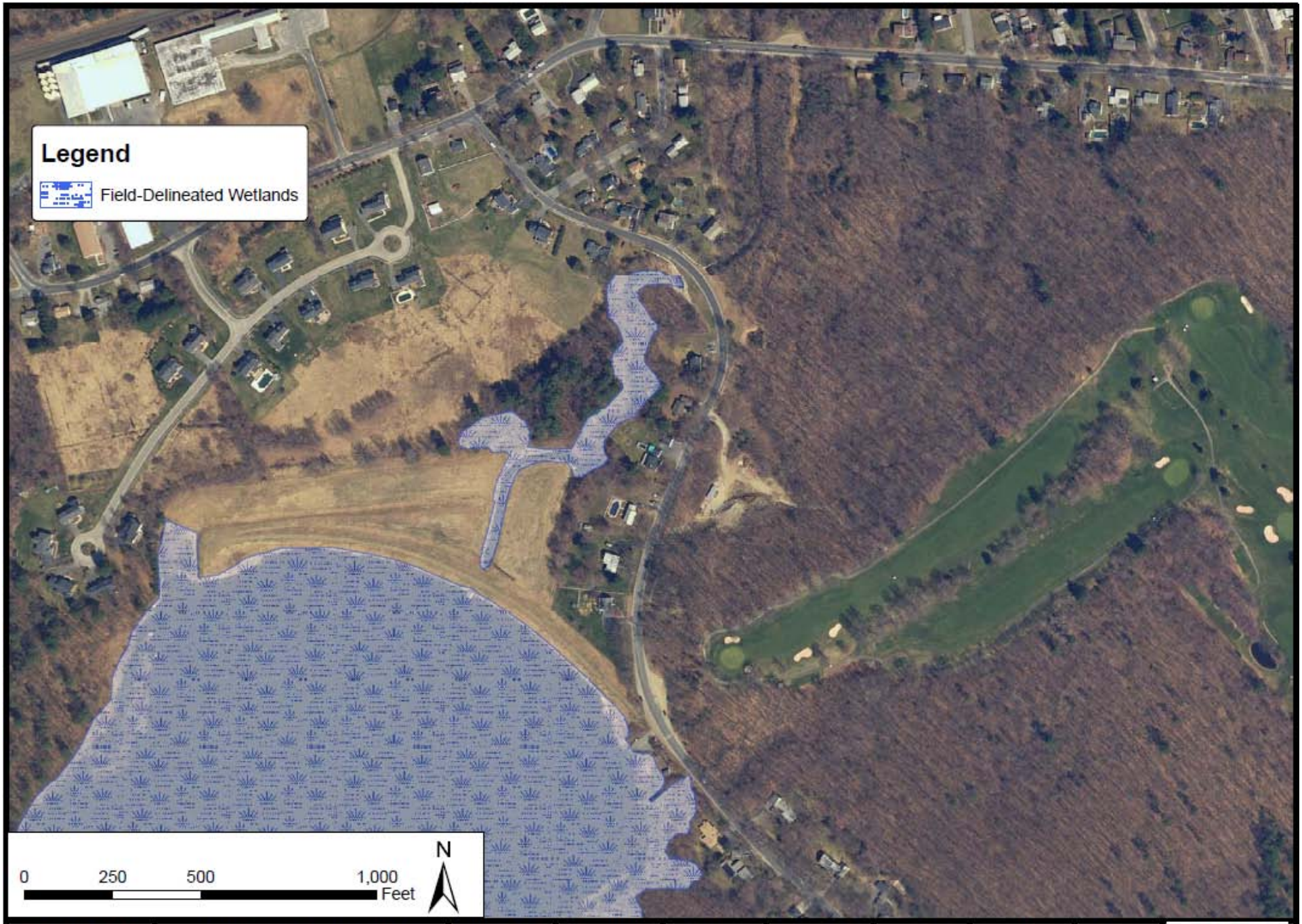
REVISIONS:		

PROJECT NO.:	08147.01
DATE:	APRIL 2009
SCALE:	1" = 100
DESIGNED BY:	
CHECKED BY:	JMB
DRAWN BY:	GLB
APPROVED BY:	

SITE LAYOUT

FIGURE NO.: 2

SHEET NO. 1 OF 1



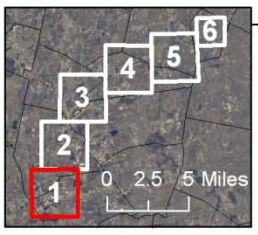
NRCS	FIELD-DELINEATED WETLANDS NICHOLS DAM WESTBOROUGH, MA	PROJECT MGR:	DESIGNED BY:	CREATED BY:	CHECKED BY:	SCALE:	DATE:	PROJECT NO:	Figure 3 Delineated Wetlands
		JE	MR	MR	SW	AS SHOWN	MAY 2009	62028.23	

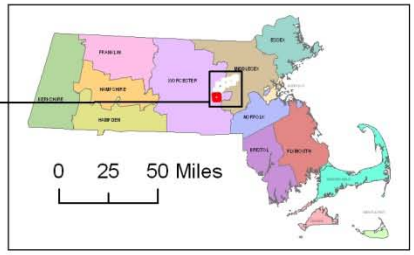
Figure 4. George H. Nichols Dam floodplain areas and 2005 aerial imagery - Map 1

Limited Access Highway
Multi-lane Hwy, not limited access
Other Numbered Highway
Major Road, Collector
Railroad
MA Towns
Breach inundation boundary
FEMA 100-year floodplain

N
W
E
S

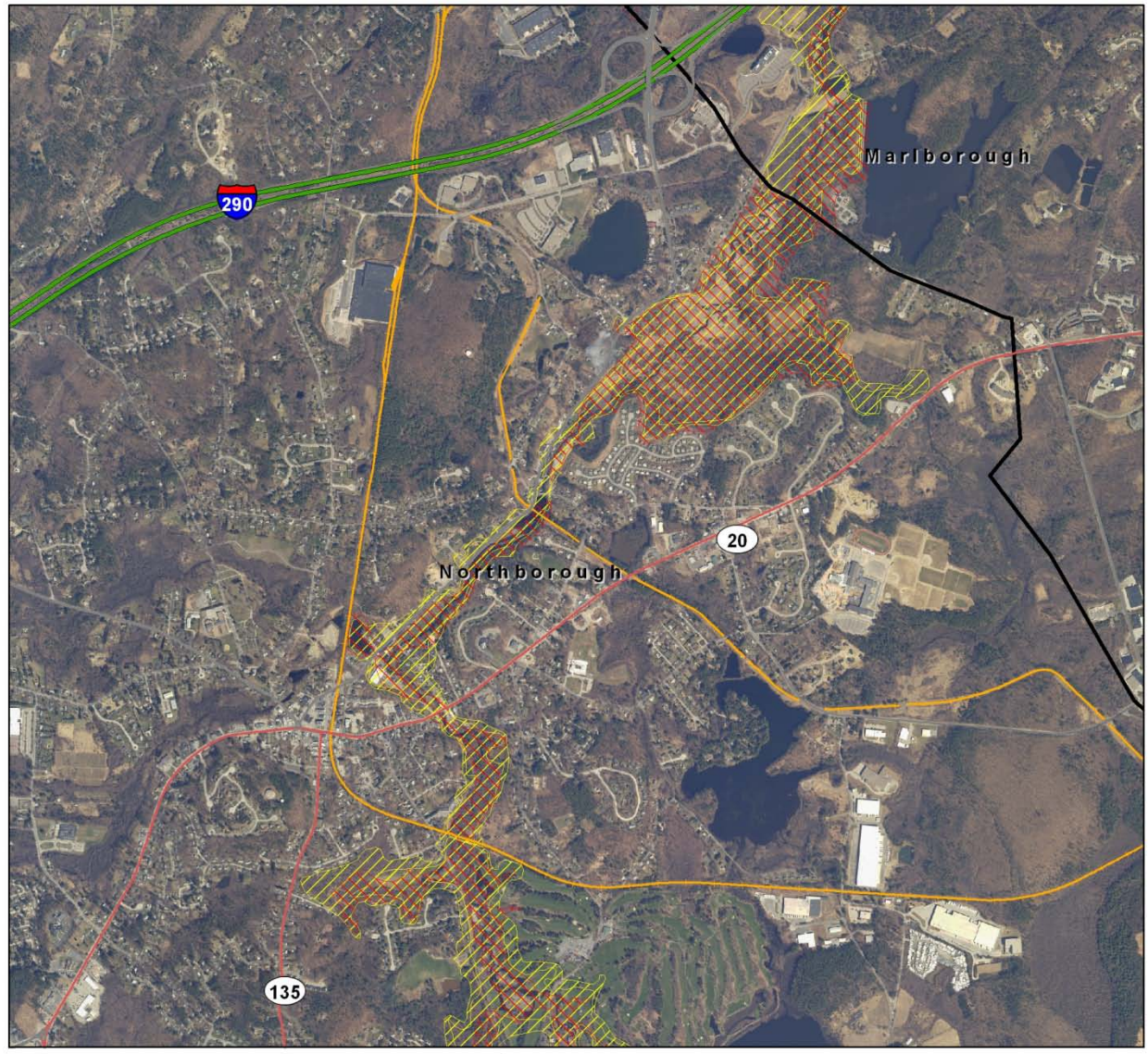
0 0.25 0.5 1 Miles





USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Figure 5. George H. Nichols Dam floodplain areas and 2005 aerial imagery - Map 2



Limited Access Highway
Multi-lane Hwy, not limited access
Other Numbered Highway
Major Road, Collector
Railroad
MA Towns
Breach inundation boundary
FEMA 100-year floodplain

N
W
E
S

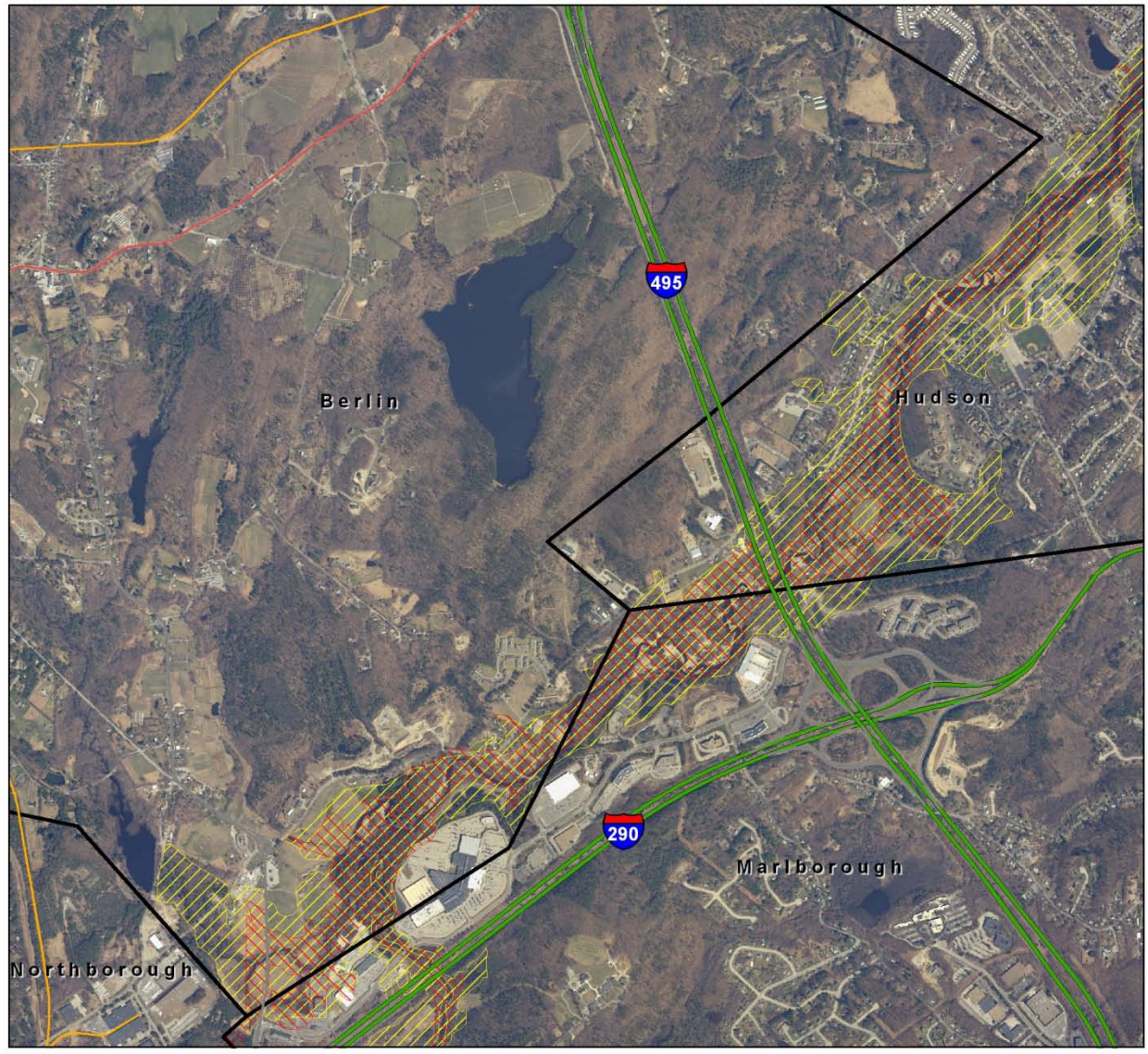
0 0.25 0.5 1 Miles

1 2 3 4 5 6
0 2.5 5 Miles

0 25 50 Miles

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Figure 6. George H. Nichols Dam floodplain areas and 2005 aerial imagery - Map 3



Limited Access Highway
Multi-lane Hwy, not limited access
Other Numbered Highway
Major Road, Collector
Railroad
MA Towns
Breach inundation boundary
FEMA 100-year floodplain

N
W
E
S

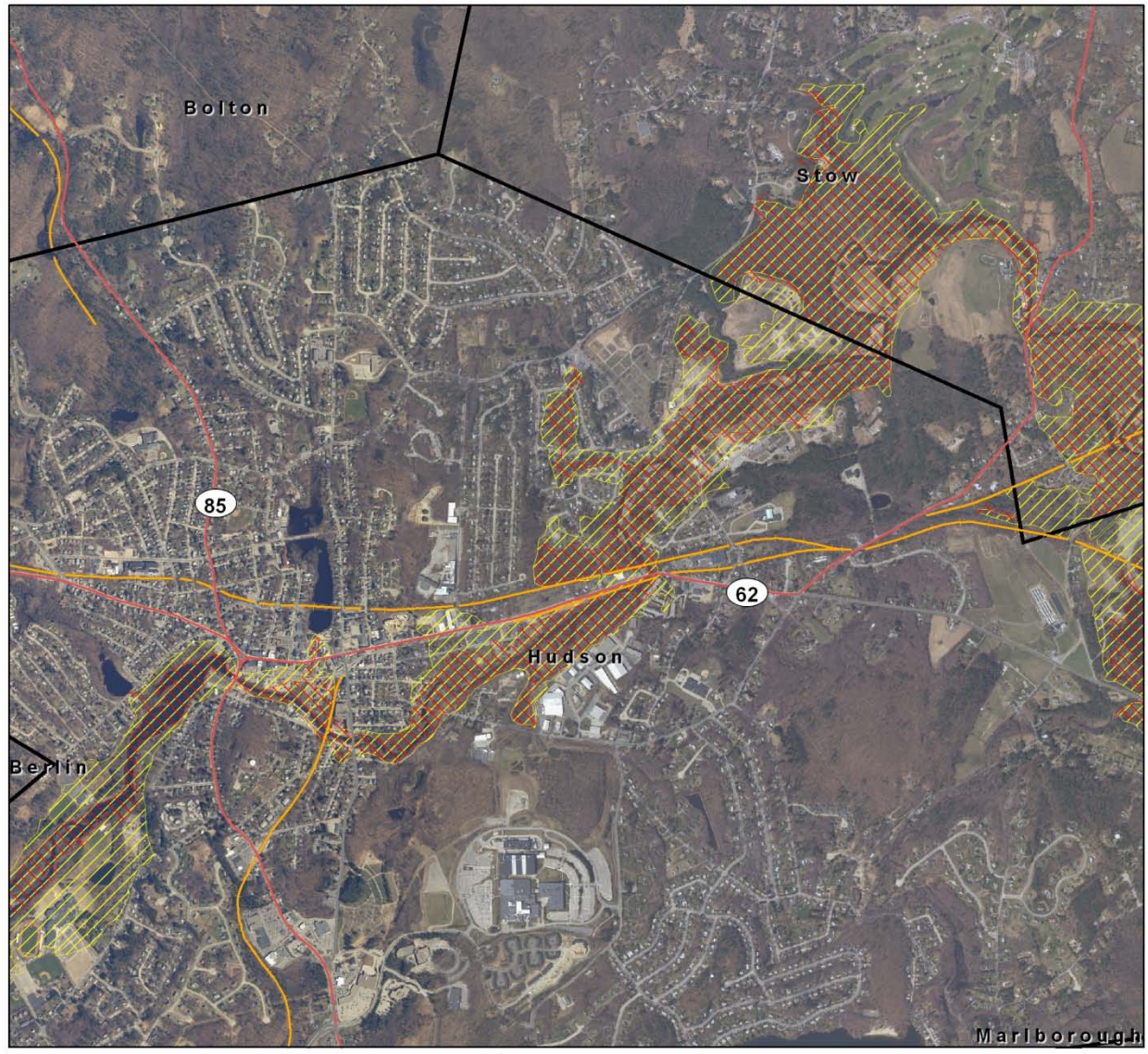
0 0.25 0.5 1 Miles

1 2 3 4 5 6
0 2.5 5 Miles

0 25 50 Miles

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

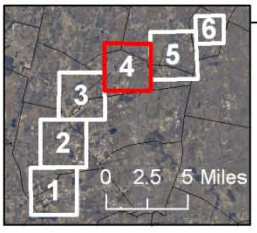
Figure 7. George H. Nichols Dam floodplain areas and 2005 aerial imagery - Map 4

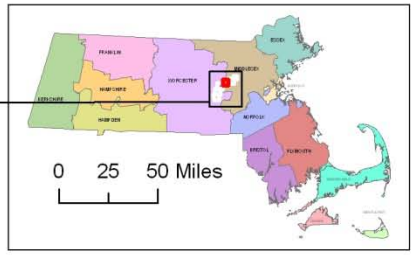


Limited Access Highway
Multi-lane Hwy, not limited access
Other Numbered Highway
Major Road, Collector
Railroad
MA Towns
Breach inundation boundary
FEMA 100-year floodplain

N
W
E
S

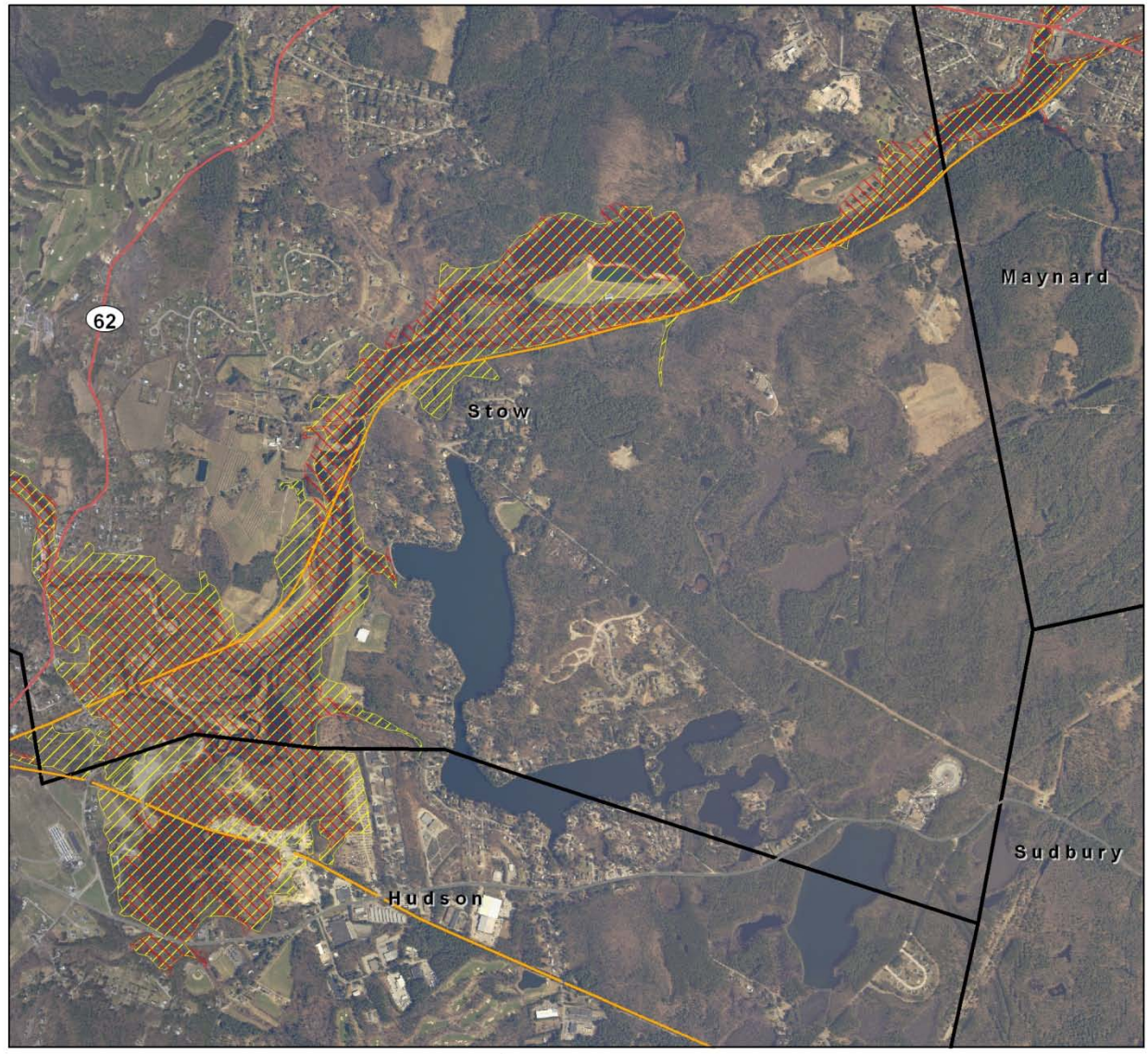
0 0.25 0.5 1 Miles





USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

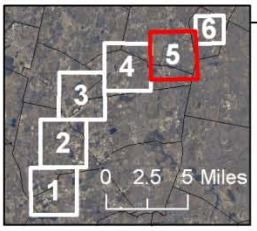
Figure 8. George H. Nichols Dam floodplain areas and 2005 aerial imagery - Map 5

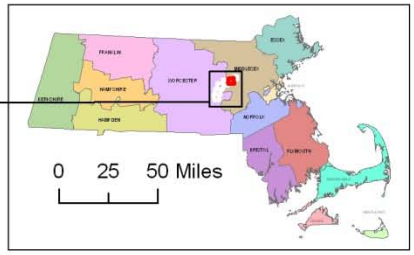


Limited Access Highway
Multi-lane Hwy, not limited access
Other Numbered Highway
Major Road, Collector
Railroad
MA Towns
Breach inundation boundary
FEMA 100-year floodplain

N
W
E
S

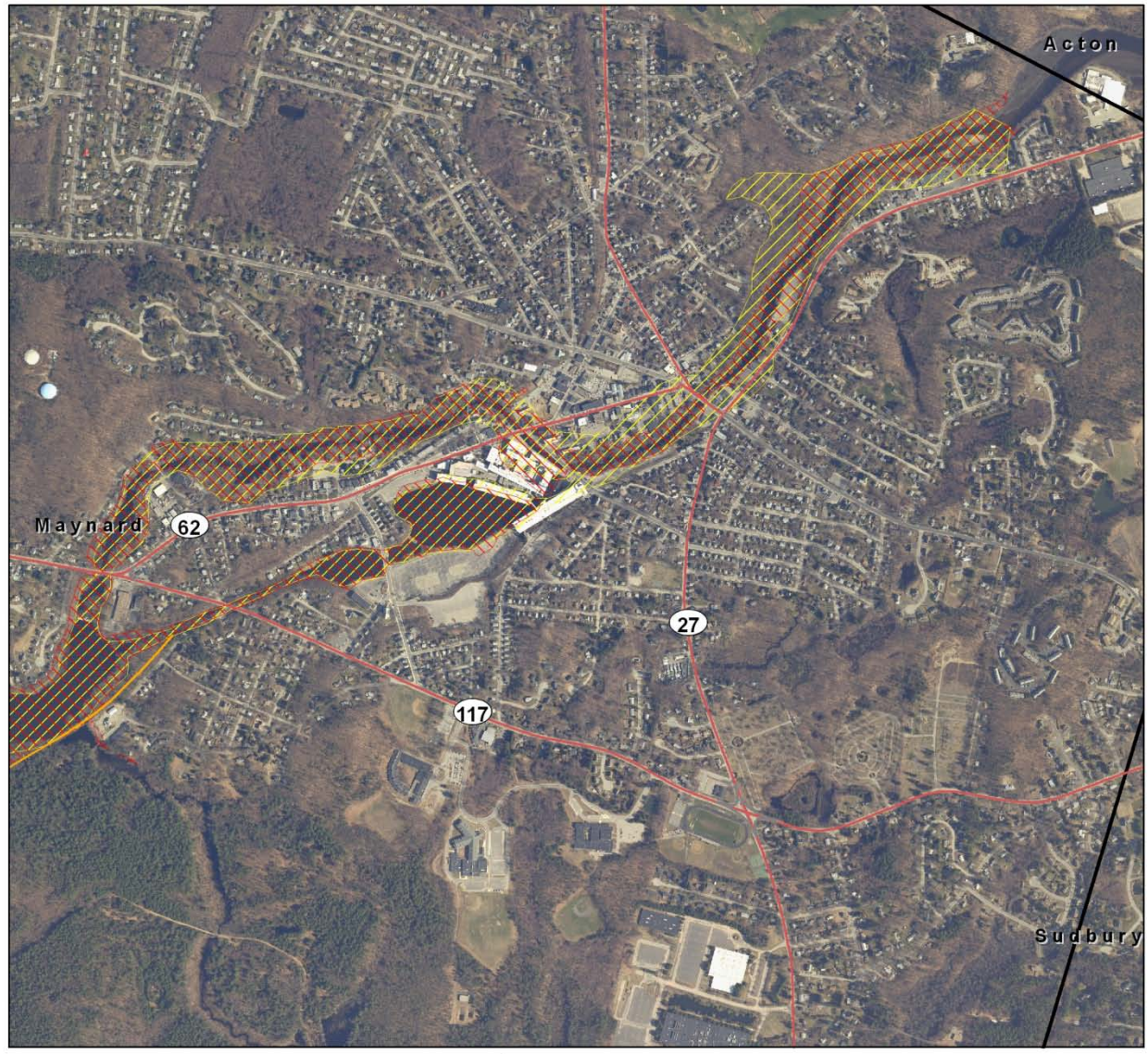
0 0.25 0.5 1 Miles

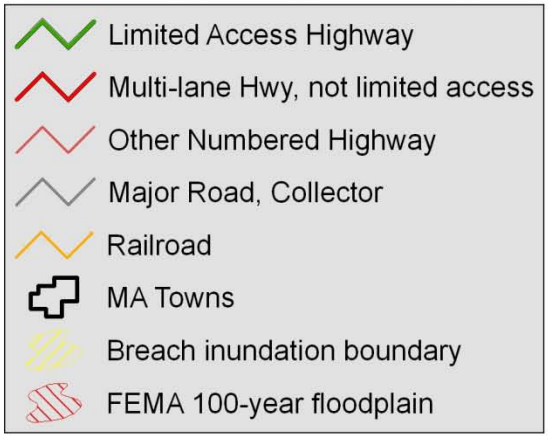




USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Figure 9. George H. Nichols Dam floodplain areas and 2005 aerial imagery - Map 6





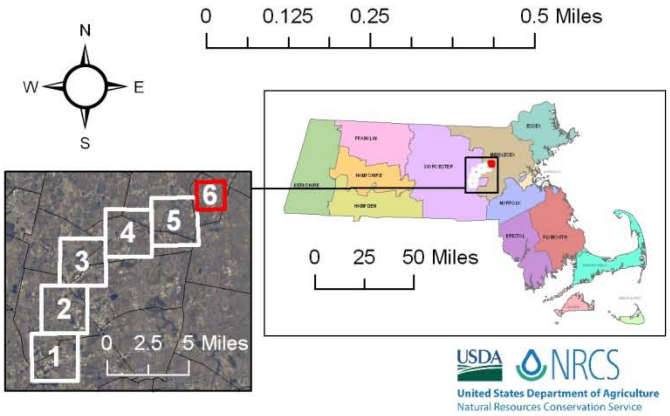


Figure 10

Nichols Site (A-1)
Current Land Use

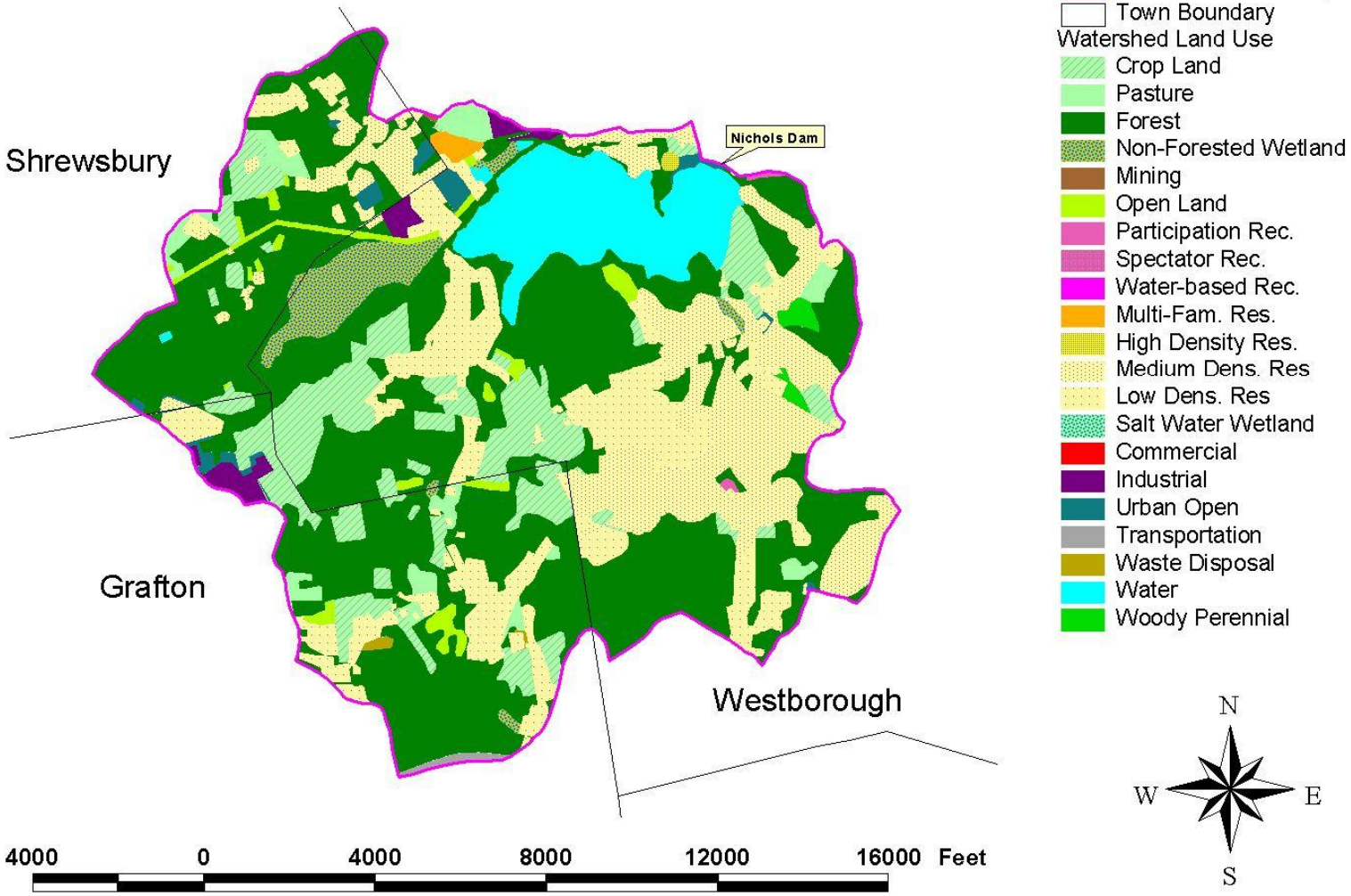
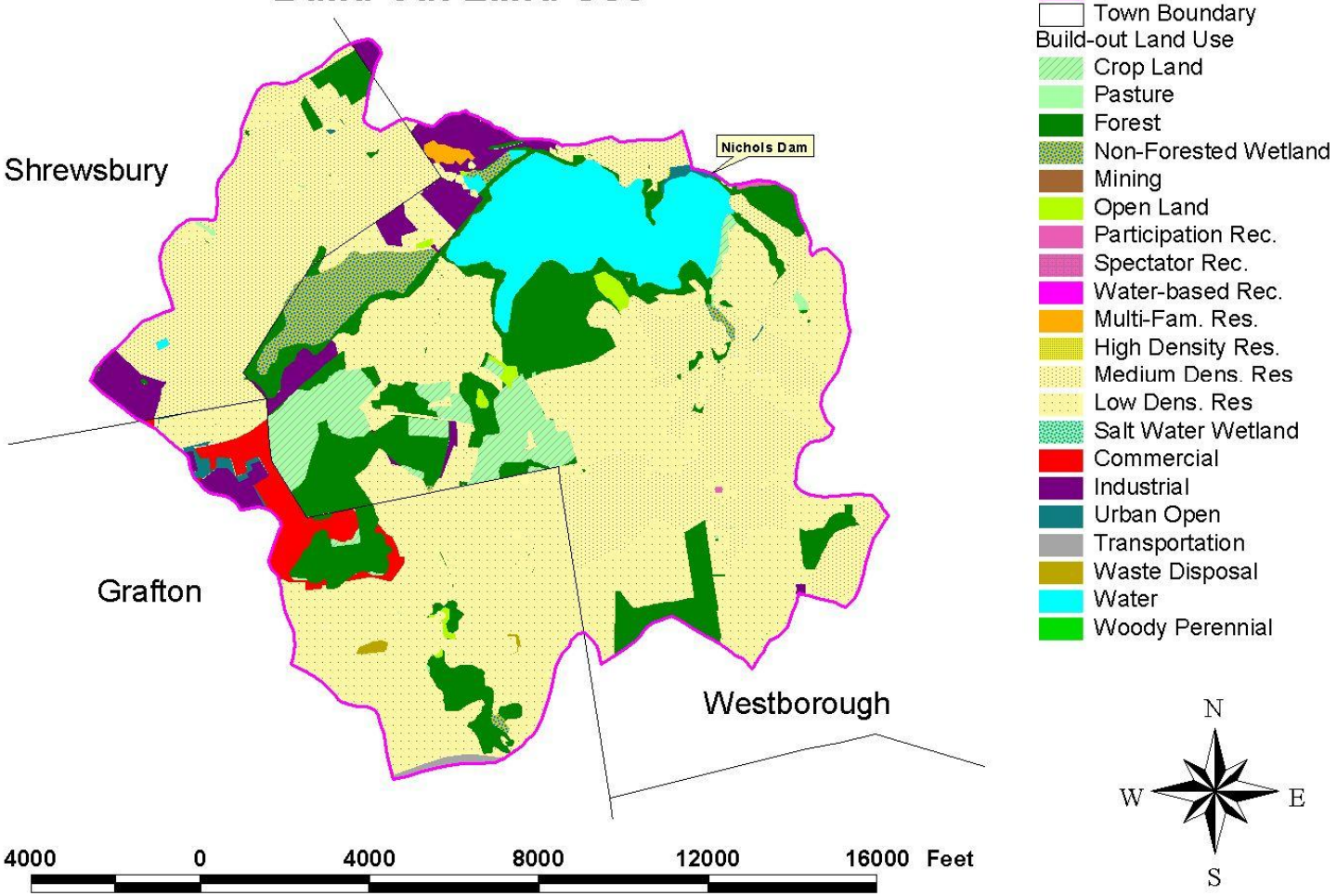


Figure 11

Nichols Site (A-1)
Build-out Land Use



APPENDIX C

INVESTIGATION AND ANALYSIS REPORT

Environmental: Initial assessment of potential environmental impacts was based on review of natural resources information in MassGIS and endangered species databases available online through the U.S. Fish and Wildlife Service and Massachusetts Natural Heritage and Endangered Species Program. Sensitive features in the project area were identified as the Assabet River, the pool behind the Nichols Dam, and wetlands around the pool and in the Assabet River floodplain. There are no federally protected or state-listed threatened or endangered species in the project area.

A field survey was conducted by EA Engineering, Science, and Technology to delineate wetlands along the upstream and downstream sides of the dam in the potential construction area. Based on this survey and the conceptual project design, construction for dam rehabilitation would occur within the existing area disturbed for construction of the dam and maintained as mowed grass, and there would be no impacts to sensitive resources.

Water quality of the Nichols pool and the Assabet River may be affected by temporary construction-related disturbance resulting in erosion and sedimentation. Compliance with state laws, application of best management practices (BMPs) for erosion and sediment control, and revegetation of the disturbed area would minimize impacts. Construction activity would also result in minor impacts affecting the aesthetics of the area as vegetation is removed and equipment is in place and active. At the completion of construction, equipment would be removed and the disturbed area would be revegetated.

A walking survey of the upper inlet areas to the Nichols pool confirmed that there is minimal sediment accumulation from the past 39 years. No sediment removal has occurred in that period.

There are no historic sites on the dam property, and no archeological sites would be affected by construction, which would be limited to the existing disturbed area. The Massachusetts SHPO concurred with a determination of no effect on historic resources on July 17, 2009. A response was not received from the THPO.

The following table displays the effects of the recommended plan on particular types of resources that are recognized by certain federal policies.

Effects of the Recommended Plan on Resources of National Recognition		
Types of Resources	**Principal Sources of National Recognition**	**Measurement of Effects**
Air quality	Clean Air Act, as amended (42 USC 7401 et seq.)	No long-term effect; temporary emissions during construction
Areas of particular concern within the coastal zone	Coastal Zone Management Act of 1972, as amended (16 USC 1451 et. seq.)	Not applicable--project area not in coastal zone.

Effects of the Recommended Plan on Resources of National Recognition		
Types of Resources	**Principal Sources of National Recognition**	**Measurement of Effects**
Endangered and threatened species critical habitat	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)	No effect—no federally protected species in project area
Fish and wildlife habitat	Fish and Wildlife Coordination Act (16 USC Sec. 661 et seq.)	Potential for loss of up to 0.8 acre of wildlife habitat.
Floodplains	Executive Order 11988, Flood Plain Management	No long-term effect; temporary construction in floodplain.
Historical and cultural properties	National Historic Preservation Act of 1966, as amended (16 USC Sec. 470 et seq.)	No effect—no historic resources present in project area
Prime and unique farmland	Council on Environmental Quality Memorandum of August 1, 1980: Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act, Farmland Protection Policy Act of 1981.	No effect—construction only within existing dam mowed area
Water quality	Clean Water Act of 1977 (33 USC 1251 et seq.)	No long-term effect; temporary impact during construction mitigated by erosion and sediment control BMPs
Wetlands	Executive Order 11990, Protection of Wetlands; Clean Water Act of 1977 (33 USC 1251 et seq.) Food Security Act of 1985	No permanent impact to wetlands; potential temporary impact to wetlands adjacent to construction area (less than 1 acre) – wetlands to be avoided if possible and restored with native vegetation if affected by construction
Wild and scenic rivers	Wild and Scenic Rivers Act, as amended (16 USC 1271 et seq.)	Not present in project area

Sedimentation: During a field inspection of the pool area by Rudy Chlanda, the NRCS geologist, it was noted that minimal sediment has been delivered to the sediment pool. The soils and geology in the drainage area are mostly outwash with low clay/silt percentage. Due to hummocky glacial topography, much of the sediment would not be transported to stream channels. Approximately 123 acres of wetlands adjacent to the stream capture much of the sediment. The streams are low gradient. The stream buffers developed to satisfy the Massachusetts Wetlands Protection Act do an excellent job of reducing sedimentation. The railroad along the western portion of the watershed reduces sediment delivery to the pool.

Since surveying the pool would amount to several weeks of surveying and staff time, it was decided to revisit the original sedimentation estimate in the 1958 Plan. Three estimates were prepared by Mr. Chlanda, using NRCS form 309 based on three scenarios:

1. A revision of the original 1954 estimate, which was based on the probable soil loss formula. It is likely that this outdated methodology overestimated the sediment. Forty years was used to estimate sediment accumulation from dam construction to dam rehabilitation. The revised calculation also used the revised estimate of watershed size, 4,447 acres, which is lower than the original estimate of 4,589 acres.
2. A second estimate uses the most recent (1999) land use acreages developed by ENSR from the dam assessment.
3. A third estimate, based on build-out of the watershed through its extended service life of 60 years, was developed using 20 years at present land use and 40 years at future build-out land use.

Values Used for Soil Loss
The values used for soil loss came from NRCS references, a reference from NRCS District Conservationist (D. Lenthall), NRI data for Cultivated Land, NRI data and observation for Pasture/Range, Woodland, Meadow, and from observation and web references for Urban Lands, with judgment applied based on the percentage of impervious surfaces.

The delivery ratio of 22 percent was taken from NEH-3, with no adjustments. The original plan's estimate of 33 percent was felt to be excessive for the watershed's characteristics. Average values for annual sediment deposition were checked against New England sites from the RESSED database. Values range from 0.04 acre feet/mile² in Connecticut to 0.15 acre feet/mile² in Maine. Nichols average annual deposition is 0.06 acre feet/mile², which compares favorably with similarly situated reservoirs in New England.

The estimated sediment volume for the first 40 years of the dam is 17.1 acre-feet. The estimated sediment volume for the remaining 60 years of project life is 25.5 acre-feet. The total of 42.6 acre-feet is still 1.4 acre-feet less than the sediment volume (44 acre-feet) predicted for design. Nichols Dam has more than ample sediment storage available for its predicted service life and beyond.

Breach Analysis: A breach analysis was conducted by GZA Geo Environmental (GZA) to estimate the inundation areas and corresponding time to flood downstream as a result of failure of the Nichols Dam (GZA 2008). A National Weather Service computer model (DAMBRK, Version 3.0) was used to predict the hypothetical dam break wave formation at Nichols Dam and its downstream progression along the Assabet River. The model used input from riverine geometry in the form of cross sections to simulate the response of a flood wave traveling downstream and produced data on peak flow, maximum water surface elevations, arrival time of the leading edge, and maximum flood stage to identify key damage centers and other areas inundated by the flood wave. The model also computed the outflow from the breached dam in conjunction with breach characteristics (size and shape of the breach opening over time, including spillway characteristics) and estimated the time and extent of flooding downstream.

Because the impoundment behind the Nichols Dam impounds water at all times, GZA analyzed the effects of a fair weather dam break and a wet weather dam break. The fair weather dam failure scenario is not discussed in this report because dam failure is only probable under extreme wet weather conditions. The spillway design flood (SDF) for the dam based on its current size (Large) and hazard (High) classifications is the ½ probable maximum flood (PMF). The wet weather scenario used an SDF outflow of 3,800 cfs and a peak SDF reservoir elevation of 1.4 feet below the top of the dam at the time of the dam failure.

GZA used information gathered from MassGIS topographic data for its detailed river model for the areas downstream of the dam. Cross section locations were selected to approximate natural and man-made changes in the geometry of the downstream river valley and were spaced closer together in portions of the valley where changes in bed slope and flow regime occurred and where side slopes alternated from narrow and constricted to wide floodplains. Manning's "n" roughness coefficients necessary for modeling were 0.04 for the channel areas, and 0.08 for the overbank areas, which are consistent with the range of values used in the Federal Emergency Management Agency (FEMA) Flood Insurance Study for the Town of Westborough and the downstream communities.

GZA calibrated the riverine portion of the Nichols Dam DAMBRK model to the published FEMA 100-year flood. Water surface elevations and discharges for the 100-year flood were obtained from the FEMA study for the Towns of Westborough, Northborough, Berlin, Stow, Hudson, and Maynard, and the City of Marlborough. Water depths were calibrated to the 100-year flood by adjusting Manning's "n" coefficient values, streambed invert elevations, and cross section geometries. Hypothetical dam breach parameters were estimated in accordance with the recommended range of values in Federal Energy Regulatory Commission guidelines. The maximum average breach width selections were based on U.S. Army Corps of Engineers guidelines with the hypothetical failure occurring at the deepest section. The average breach width chosen for the Nichols Dam was a typical value for earthen dams (3 times the hydraulic height) and a corresponding time to failure of approximately 0.5 hours. The average breach width was estimated to be 54 feet.

The downstream limit of the model was the Assabet River approximately 24 miles downstream of the dam and was based on prior analysis which determined that the flood wave is not expected to propagate beyond that point. Two other downstream dams on the Assabet River, Tyler Dam and Washington Street Dam, were included in the model.

GZA's wet weather scenario modeling determined that the maximum discharge through the Nichols Dam breach opening is approximately 15,000 cfs and occurs 0.5 hours from the beginning of the simulation. The peak dam flow is expected to be an order of magnitude greater than the FEMA 500-year flood. The arrival time of the leading edge at the downstream corporate limit of the Town of Maynard, 24 miles down the Assabet River from the Nichols Dam, was approximately 11 hours. Peak flood depth over initial conditions ranges from approximately 4 feet downstream of the Nichols Dam to about 2 feet downstream of the Tyler Dam. Peak flood depth over initial conditions increases to approximately 3 feet just downstream of the Washington Street Dam and dissipates to approximately 1.5 feet at the downstream

corporate limit of the Town of Maynard. Inundation maps presenting the results of the DAMBRK modeling are located in Appendix B, Figures 4-9.

Results from the dam breach analysis were used to update the EAP for the Nichols Dam. The EAP provides appropriate actions in the case of dam failure and is updated annually by DCR.

Hydrology: NRCS prepared an assessment report on the George H. Nichols Multipurpose Dam in 2004 based on a comprehensive study in 2003 of the hydrologic conditions of the dam for existing and future watershed build-out conditions. The study evaluated the hydrological parameters of the Assabet River watershed using NRCS and TR-60 methods, with NRCS runoff curve numbers for existing and future build-out conditions of 74 and 78, respectively, and a time of concentration of approximately 5.3 hours.

Using the SITES model the Nichols Dam was evaluated against TR-60 criteria and was determined to be a Class C structure in accordance with federal standards. The Principal Spillway Storm was the 100-year frequency with 1-day and 10-day storm durations. The Auxiliary Spillway Design Storm used a precipitation amount greater than the 100-year event and less than the Probable Maximum Precipitation (PMP) and a 6-hour design storm for developing the Auxiliary Spillway Hydrograph. The 2004 Dam Assessment Report indicated that the George H. Nichols Multipurpose Dam does not meet TR-60 design criteria for the freeboard and auxiliary spillway design under existing or future build-out conditions. In general, the spillway is undersized.

The SITES model results indicated that under both the existing and future watershed build-out conditions, the exit velocity in the existing auxiliary spillway would cause the vegetative cover to fail, concentrated flow to develop, and the spillway to breach during both the SDH and FBH design storms.

Engineering: NRCS contracted H&S Environmental to complete phase I and phase II engineering studies of the Nichols Dam in 2008-2009. Several alternatives were screened out from further analysis because of cost, constructability, or environmental impacts:

- Breach dam
- Purchase/relocate flooded properties
- Install downstream floodwalls
- Increase height of dam
- Increase width of existing auxiliary spillway

Structural alternatives evaluated in detail were:

- Armor dam embankment and auxiliary spillway
- Increase width of existing auxiliary spillway and armor spillway

The project team performed a spillway integrity analysis to determine whether the existing auxiliary spillway would withstand the exit velocities estimated for the SDH and FBH design storms for the future watershed build-out condition. The project team used the SITES IDE

model version 2005.1.3 to evaluate the stability of the auxiliary spillway. The project team developed a soil profile of the auxiliary spillway using information from the soil boring descriptions and Unified Soil Classification System designations described in the as-built plans for Nichols Dam. The SITES model indicated that the width of the auxiliary spillway could be increased to prevent overtopping of the dam during the FBH, but the exit velocity in the auxiliary spillway would cause the vegetative cover to fail, concentrated flow to develop, and the spillway to breach during both the SDH and the FBH design storms. An armoring system of articulated concrete blocks was recommended to provide scour protection to the spillway.

Socioeconomic Conditions: Sources for the data included in the social and economic conditions section of this supplement include the U.S. Census Bureau, Department of Commerce, 2000 Census, and interviews conducted with local contacts.

Economic Analysis: The NRCS National Watershed Manual was used as a reference for the economic analysis along with two economic analysis guidance documents: *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), U.S. Water Resources Council, March, 1983, and the *Economics Handbook, Part II for Water Resources*, NRCS, July, 1998. These guidance documents were used to evaluate potential flood damages, and estimate recreational use, project benefits and associated costs. P&G was developed to define a consistent set of project formulation and evaluation instructions for all federal agencies that carry out water and related land resource implementation studies. The basic objective of P&G is to determine whether or not benefits from proposed actions exceed project costs. P&G also requires that the "National Economic Development" or NED Alternative, which maximizes monetary net benefits, be selected for implementation unless there is an overriding reason for selecting another alternative based on federal, state, local, or international concerns related to the social and environmental accounts. The allowance for exceptions to the NED plan recognizes the fact that not all project considerations or benefits can be quantified and monetized when it comes to some ecological system and social effects.

Per sections 1.7.2(a)(4)(ii) and 2.1.1(b)(2) of the P&G allowing for abbreviated procedures, damage reduction benefits have not been estimated because they are the same for both alternatives, and no net change in benefits occurs when comparing the two candidate plans to each other. The federally assisted alternative (Alternative 2) is displayed within a zero-based accounting context that credits local costs avoided (Adverse, annual) as beneficial costs (Beneficial, annual) consistent with P&G 1.7.2(b)(3). Net benefits are zero because the total project cost is equal to the claimed benefits and the resulting B/C ratio is 1.0:1.0.

Positive benefits would accrue as a result of this project as compared to existing conditions, but no attempt was made to compute an estimate of the difference between the future with project and existing conditions because the existing conditions are not the most likely future conditions. The added details would not alter the recommended alternative and, therefore, would not justify the added planning costs. Project flood-prevention benefit estimates were updated to 2009 dollars from the 1958 watershed plan. The Consumer Price Index was used for updating reduction benefits for roads and bridges. Original downstream damage reduction benefits for residential and commercial properties were updated using the average increase in tax receipts. Values for selected commercial properties that constitute a major portion of the benefit

calculations were updated to reflect current market values. These benefit estimates were not used to compare alternatives, because both alternatives provide the same benefit, but they show the ongoing value to the Commonwealth of Massachusetts and the local towns of the flood prevention provided by the George H. Nichols Dam.

All costs of installation and operation and maintenance were based on 2009 prices. One year was assumed for development, review, and approval of the final design and installation of the proposed rehabilitation project. Structural measures were assumed to have a 60-year useful life. Thus, a 61-year period of analysis was used along with the mandated 4.625 percent discount rate for all federal water resource projects for FY09 to discount and amortize the anticipated streams of costs and benefits.

References not listed in main report reference list:

Federal Emergency Management Agency (FEMA), Flood Insurance Study Town of Berlin, MA, Worcester County – Community Number 250294, December1979.

Federal Emergency Management Agency (FEMA), Flood Insurance Study Town of Hudson, MA, Worcester County, June 1979.

Federal Emergency Management Agency (FEMA), Flood Insurance Study City of Marlborough, MA, Worcester County – Community Number 250203, July 6, 1981.

Federal Emergency Management Agency (FEMA), Flood Insurance Study Town of Maynard, MA, Worcester County, December 1978.

Federal Emergency Management Agency (FEMA), Flood Insurance Study Town of Northborough, MA, Worcester County, May 1979.

Federal Emergency Management Agency (FEMA), Flood Insurance Study Town of Stow, MA, Worcester County, February 1979.

Federal Emergency Management Agency (FEMA), Flood Insurance Study Town of Westborough, MA, Worcester County, November 1979.

APPENDIX D

CONSULTATION AND PUBLIC SCOPING PROCESS

Stakeholder agencies that were contacted concerning the proposed project are:

- Worcester County Conservation District
- Massachusetts Department of Conservation and Recreation
- Massachusetts Department of Fish & Game, Division of Fisheries and Wildlife
- Massachusetts Department of Fish & Game, Riverways Program
- Massachusetts Department of Environmental Protection
- Town of Westborough (Selectmen, Conservation Commission, Planning Board, Engineering Department)
- Organization for the Assabet River
- Massachusetts Executive Office of Energy and Environmental Affairs
- Massachusetts Executive Office of Energy and Environmental Affairs, MEPA
- EPA Region 1,Regulatory
- USACE, Regulatory Division
- Massachusetts Office of Dam Safety

Consultations with the Massachusetts SHPO and the THPO of the Wampanoag Tribe of Gay Head (Aquinnah) were conducted to determine the presence of any cultural or historic resources within the proposed project area. The SHPO concurred with the NRCS determination that no historic properties would be affected by the proposed project on July 17, 2009. A response was not received from the THPO.

Consultation with FWS for threatened or endangered species was not required, because it was determined from the FWS web site that no federally listed species are known from the area. It was also determined from MassGIS that no habitat for a state-protected species lies in the project area.

Public scoping also included a public meeting held in Westborough on February 19, 2009, to explain the Watershed Rehabilitation Program and to obtain comments on resource problems, issues, and concerns of local residents associated with the Nichols Dam project area. NRCS distributed a press release on February 4, 2009, that resulted in articles about the meeting in the Westborough News on February 6, 2009, and the MetroWest Daily News on February 16, 2009.

Potential alternative solutions to bring the Nichols Dam into compliance with current dam safety criteria were presented at the public meeting. A fact sheet summarizing the planned rehabilitation projects at six dams in the SuAsCo watershed was distributed at the meeting. One member of the public, the chairman of the Westborough Community Land Trust, attended the meeting. He expressed willingness to work with NRCS on notifying the public through the Trust's web site of the construction period and temporary effects on access to the trail. No verbal or written comments have been received in the intervening time to the publishing of this Plan.