QUALITY ASSURANCE PROJECT PLAN

Development of a Watershed Based Plan for Massachusetts

Prepared for:
Massachusetts Department of Environmental Protection
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Project 04-14/319 Development of a Watershed Based Plan for Massachusetts

Prepared for
The Massachusetts Department of Environmental Protection
EPA RFA #

A. Project Management
A.1 Approval Page

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A.4 Project/Task Organization

The following organizational chart identifies the key individuals and the organizations participating in this project. Specific descriptions of the roles and responsibilities for key individuals are also discussed below. The individuals identified are committed to begin and complete this project. No change in key personnel, including the Project Manager, Deputy Project Manager, Task Leaders and/or Technical Review Specialist will be made without the approval of the MassDEP.

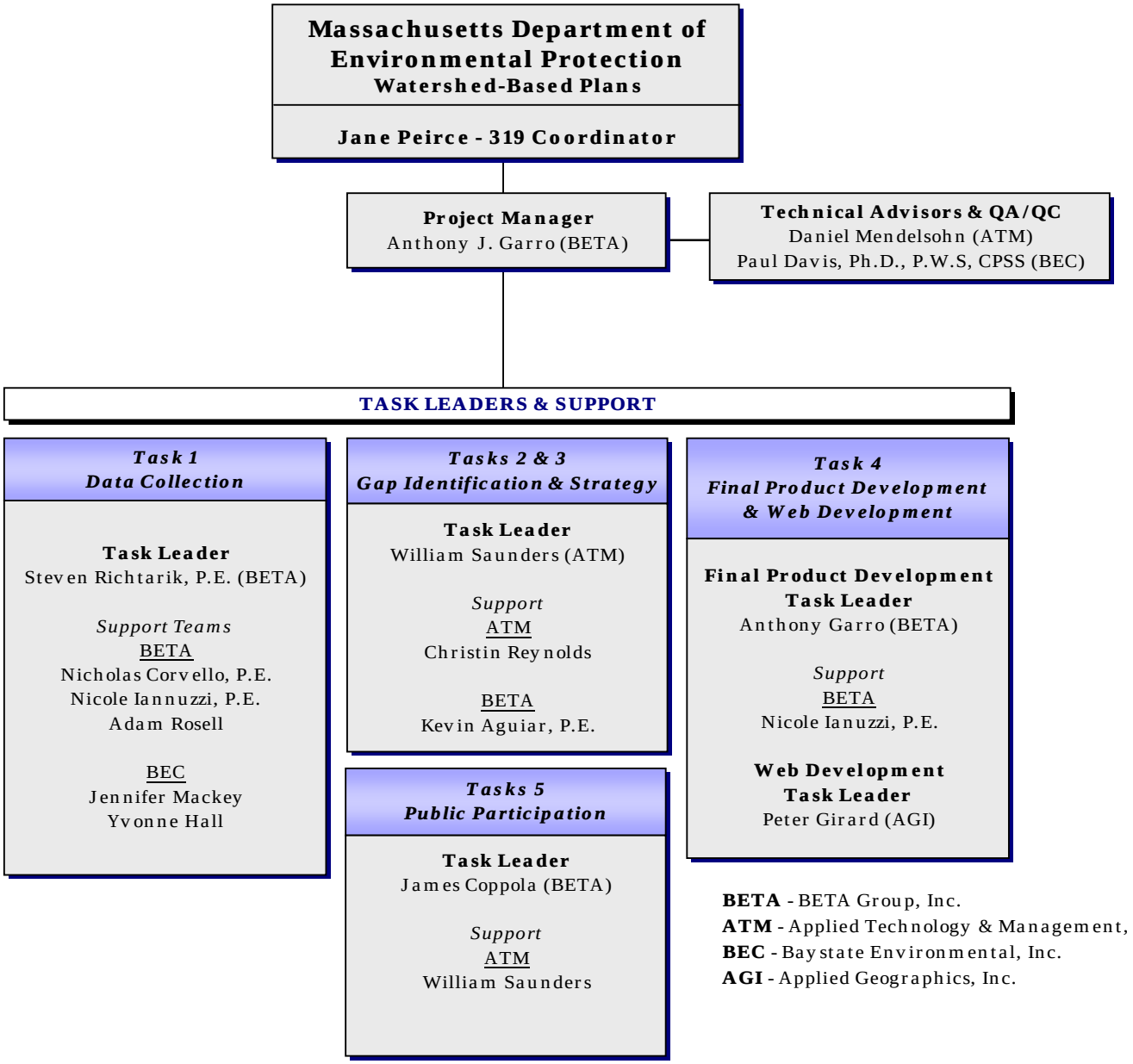


Table 1: Personnel Responsibilities and Qualifications

Project Personnel, Title, Affiliation	Responsibility	Qualifications / Experience
Anthony J. Garro, Project Manager, BETA Group Inc.	The primary point of contact for the project team. He will coordinate the efforts of the entire project team and be responsible for schedules and budgets. Also responsible for the preparation and submission of the QAPP.	More than 15 years experience in watershed and stormwater planning projects. He has also developed numerous databases for state and local agencies *GIS System Development - Stormwater Master Plans* Brookline, North Attleboro, Needham, Natick, Weymouth, Uxbridge and Gloucester, MA
William Saunders, Task Leader Gap Analysis and Modeling, Applied Technology and Management (ATM)	Responsible for the assessment of available data and the preparation and execution of watershed loading models in the nonpoint source pollutant modeling effort and data gap analysis.	• Conducted Watershed Characterization for nutrients, sediment, and bacteria in the Palmer and Ten Mile River watersheds (MA) • Managed Total Maximum Daily Load (TMDL) projects for the State of Texas' lead environmental agency. • Currently leading a TMDL development for e. coli impairments in four agriculture-dominated Indiana watersheds • Directed computer modeling of field-scale BMPs for nonpoint source load reductions in multiple Texas watersheds
Daniel Mendelsohn, Technical Advisor, ATM	Responsible for quality control for all project components with a focus on the modeling effort. He will also provide technical support for the modeling.	More than 20 years experience in numerical model development and application with a focus on environmental hydrodynamics and water quality. Recently completed the development of an integrated, state-of-the-art boundary fitted coastal hydrodynamic and water quality modeling system, including the integration of the USEPA WASP5 kinetic rate equations. • Nitrogen loading, circulation, flushing and water quality analysis for five embayments in Chatham, MA. • Nitrogen loading analysis for buildout evaluation of Fiddlers Cove, Falmouth, MA. • GIS database development, field program, circulation, flushing and water quality analysis of the Parker River - Plum Island Sound system, MA.

Paul Davis, PhD, Technical Advisor, Baystate Environmental Consultants (BEC)	Responsible for quality control for all project components performed by BEC, with a focus on data collection and assessment.	A professional scientist for over 25 years, Dr. Davis has authored over 30 professional research publications in the fields of aquatic science and policy. • Project Manager or principal field scientist on over 300 project requiring environmental impact analysis of lakes, reservoirs, streams, wetlands or groundwater. • Developed watershed assessments and improvement programs for the Connecticut River area • Developed and presented public education programs for water quality improvements to lakes based upon an integrated approach of in-lake and watershed improvements
Steven Richtarik, P.E. - Data Collection Task Leader, BETA Group Inc.	Responsible for data compilation which includes: • reviewing Water Quality Assessment Reports, Watershed Management Plans and other documents for their relevance to this project. • populating the database of water quality impairments. • QA/QC procedures for data collection	Over 23 years experience in the environmental engineering field focusing on watershed analyses and wastewater planning projects. *West Warwick Wastewater Facilities Plan* • Conducted a study of non-point pollutant sources impacting the north and south branches of the Pawtuxet River.
Kevin M. Aguiar, P.E. – Final Product Development Task Leader, BETA Group, Inc.	Responsible for : • preparation of technical memoranda • final product development • task level QA/QC for data collection • assistance with the strategy to assess data gaps	Over his 12 year career, Mr. Aguiar has designed numerous water quality improvement BMP's, developed four Phase II Stormwater plans, and modeled storm drainage systems, while designing drainage master planning and improvement projects. *Stormwater Master Plans and SWMM Modeling* • Quincy, Brookline, North Attleborough, and Needham, MA *Stormwater Improvement Design* • Beaver Brook Daylighting Project - Worcester, MA • Northwest Quincy Drainage Improvements
James C. Coppola – Public Participation Task Leader, BETA Group Inc.	Responsible for the coordinating and implementing the public participation program for this project. Mr. Coppola will be supported by the technical team members in this effort.	More than 30 years of municipal planning and private consulting experience. Mr. Coppola has developed community master plans, Phase II Stormwater plans and compliance guidance documents. Mr. Coppola has made numerous

		public presentations regarding stormwater and watershed issues. These have included presentations before the New England Chapter of the American Public Works Association, Massachusetts Highway Association, Mass Bays Program, RI Public Works Association and Connecticut T2 Center.
Peter Girard – Web Development Task Leader **Applied Geographics Inc.**	Responsible for the development of a web based interface for data components.	More than 20 years experience in geographic information systems and software development with 10 years in web application development Project Experiences • *Massachusetts Technology Collaborative* – Developed a .NET-based connector to ESRI's ArcIMS map server for Mass Means Business, an economic development portal for the Commonwealth of Massachusetts. This connector is the foundation of the DEP watershed mapping web site. • *City of Cambridge, Massachusetts* – Created a general purpose configurable web mapping framework using AJAX (asynchronous JavaScript and XML) methods to enhance application performance. The AJAX technology from this project was redeployed in the DEP web site. • *Rhode Island Economic Development Corporation* – Built a demographics and business analysis web site with special attention on maintaining a consistent look and feel with the Corporation's existing web site.
Nicholas Corvello, P.E. Data Collection **BETA Group Inc.**	Responsible for data compilation which includes: • reviewing Water Quality Assessment Reports, Watershed Management Plans and other documents for their relevance to this project. • developing a user friendly database to compile relevant data for review and analysis. • Assigning impairments to HUC watershed. • database population and reporting	Over 7 years experience in the environmental engineering field focusing on watershed analyses and GIS database development for sewerage and drainage systems.

Nicole Iannuzzi, P.E., Data Collection **BETA Group, Inc.**	Responsible for document review and data compilation • SuAsCo • Parker • Charles • Shawsheen • Hudson • Millers • French • Nashua • Farmington • Connecticut • Housatonic • Merrimack • Deerfield • Blackstone	More than 10-years experience with stormwater planning and design.
Adam Rosell, Data Collection **BETA Group, Inc.**	Responsible for document review and data compilation • Westfield • Quinebaug • Ipswich • Chicopee • Ten Mile • North Coastal	Two years experience watershed hydrology and GIS data development ands analysis
Jennifer Mackey **BEC**	Responsible for document review and data compilation • Boston Harbor • Cape Cod • Buzzards Bay • Narragansett Bay • South Coastal • Islands • Taunton	Extensive research experience in groundwater and surface water quality modeling, as well as geophysical methods. Ms. Mackey has designed stormwater Best Management Practices (BMPs) and has prepared watershed studies focused on improving water quality in downstream receptors for several municipalities in New England. She had a leading role in a recent Stormwater Master Plan Update for the Town of Wellesley, MA. This project included extensive field review and development of a Town-wide hydrologic, hydraulic, and water quality model to represent the Town's open and closed stormwater conveyances. • Leading involvement in Stormwater Master Plan Update – Wellesley, MA • Developed watershed management plans for several New England towns • Developed Stormwater Pollution Prevention Plans for numerous construction projects and industrial facilities • Developed a Stormwater Action Plan, Illicit Discharge Detection Plan, and conducted numerous Phase II activities for Milford, MA • Designed stormwater Best Management Practices in Southwick, MA
Yvonne Hall **BEC**	Responsible for document review and data compilation • Boston Harbor • Cape Cod • South Coastal • Islands	Extensive experience in groundwater and surface water pollution modeling and geophysical sampling methods. She is knowledgeable in

	• Buzzards Bay • Narragansett Bay • Taunton	NPDES stormwater permitting for Phase II communities and industrial activities and is currently involved in the development of a Stormwater Pollution Prevention Plan for the Beverly Airport. • Developing Stormwater Pollution Prevention Plan (SWPPP) and Spill Prevention Control and Countermeasure Plan (SPCC) in Beverly, MA • Conducted NPDES Phase II sampling and activities for the Town of Milford, MA • Developed stormwater/groundwater quality models using MODFLOW
Christin Reynolds **ATM**	Responsible for document review and for collection of modeling input data, comparative observations of water quality and flow information, watershed model setup and execution.	Two years experience with watershed loading and receiving water quality and hydrodynamic models.

A.5 Problem Definition and Background

EPA Guidelines require a watershed-based plan that meets nine elements specified in EPA's October, 2003 Guidelines as a prerequisite for expending 319 implementation funds. The purpose of this project is to develop a Watershed-Based Plan (WBP) for each of the 27 major planning basins in Massachusetts.

On October 23, 2003, EPA issued new guidelines promoting the use of Section 319 funding for developing and implementing Watershed-Based Plans to protect unimpaired waters and restore impaired waters (**Nonpoint Source Program and Grants Guidelines for States and Territories**, available at http://www.epa.gov/owow/nps/cwact.html). Watershed-Based Plans to restore impaired waters are required for all projects implemented with s.319 incremental dollars, and are recommended for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both. The October 23, 2003 Guidance lists nine components required to be included in Watershed-Based Plans to restore waters impaired by nonpoint source pollution.

Massachusetts has historically chosen to apply 319 implementation dollars toward good projects on a statewide basis, rather than focusing funds in one or more targeted basins. This has allowed MassDEP to expend grant dollars on high-priority projects statewide, and to foster a network of effective and reliable grantee partners in all basins. To continue awarding projects on a statewide basis, a statewide Watershed Based Plan is required.

The primary pollutants that are generally associated with nonpoint sources are nitrogen, phosphorus, total suspended solids and fecal coliform bacteria. However, many other secondary pollutants are also associated with nonpoint source pollution. Element A of the Watershed-Based Plan is an "identification of the causes and sources of nonpoint source pollution." This Watershed-Based Plan records all causes of nonpoint source pollution that are listed as impairments in Categories 4 and 5 of the Massachusetts Year 2002 Integrated List of Waters and/or that are reported in Massachusetts Water Quality Assessments for specific basins. Modeled estimates are also provided for the four primary pollutants, to fill data gaps in watersheds where reporting is not complete. This WBP also notes point sources that have been identified in the source documents. Point sources cannot be addressed using nonpoint source funds, and it is important to distinguish where point sources have been reported in nonpoint-source documents in order to clarify project priorities and potential funding sources.

A.6 Project / Task Description

The State of Massachusetts has long been at the forefront of watershed-based planning. Accordingly, an abundance of information has been compiled for watersheds throughout the state. The Massachusetts Watershed-Based Plan will assemble and organize existing information from a basic library of documents for each basin, such as the Massachusetts Year 2002 Integrated List of Waters, Water Quality Assessment Reports, and various state and local watershed planning documents or watershed plans. Each of the referenced plans and documents has undergone public review and comment, and all data that has been used was collected under a MassDEP and EPA approved Quality Assurance Project Plan. Where data gaps exist, modeled estimates are provided to address the gaps. The resulting Watershed-Based Plan is designed to address the nine required elements of a Watershed-Based Plan.

The nine elements are briefly described below.

A. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed.

B. An estimate of the load reductions expected for the proposed management measures.

C. A description of the non-point pollutant source management measures that will need to be implemented to achieve the load reductions estimated under paragraph B and an identification of the critical areas in which those measures will be needed to implement this plan.

D. An estimate of the amounts of technical and financial assistance needed and/or the sources and authorities that will be relied upon, to implement this plan.

E. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the management measures that will be implemented.

F. A schedule for implementing the management measures identified in this plan.

G. A description of interim, measurable milestones for determining whether the management measures or other control actions are being implemented.

H. A set of criteria that can be used to determine whether loading reductions are being achieved and substantial progress is being made toward attaining water quality standards. If not, the criteria for determining whether this watershed-based plan needs to be revised or, if a TMDL has been established, whether the TMDL needs to be revised.

I. A monitoring component to evaluate the effectiveness of the implementation efforts over time.

Project Strategy

The fundamental nature of this project is a data mining and information organizing exercise, based on current documents that have been developed for watershed planning and assessment purposes by MassDEP and other Massachusetts agencies in recent years. The WBP will direct the reader to information about every subwatershed in the state, addressing each of the nine elements. The final product will take advantage of electronic media by presenting a simple map-driven web tool containing hot links to references and source documents.

The first challenge is to define what is meant by “subwatershed.” The information in the WBP should be presented according to the smallest practicable watershed units, in order to provide the best information about the nonpoint source pollution problems and the most feasible, effective recommendations for restoration.

Watershed Delineation

For this project, the major basins have been divided into subwatersheds whose boundaries are defined by USGS 12-digit hydrologic unit codes (HUC). In the absence of a single Massachusetts watershed delineation system, the HUC code convention was selected because of

its general acceptance by EPA and USGS and the trend toward using this convention for many applications. HUC units nest inside one another, with smaller numbers representing larger watersheds. The 27 Massachusetts major planning basins are generally, although not completely, consistent with 8-digit HUC delineations.

Typical acreages for the 12-digit HUC subwatersheds range between 10,000 acres and 40,000 acres (15 to 62 mi^2). The mean area of the 12-digit HUCs delineated for Massachusetts is approximately 32 mi^2. Two hundred and sixty 12-digit HUC units are found in Massachusetts. Major drainage basins and their corresponding number of sub-watersheds (12-digit HUCs) are identified in Table 2. The 12-digit HUCs are defined in the Watershed Boundary Dataset (WBD) GIS layer, jointly developed by the USGS and the USDA-Natural Resources Conservation Service (NRCS) and distributed via the Geospatial Data Gateway at http://datagateway.nrcs.usda.gov/. This resolution is expected to provide an optimum level of subwatershed characterization in Massachusetts (i.e. enough detail to discern the pollutant loading effects of the predominant land uses and management practices within each subwatershed without duplicating the effort for adjacent tributary drainage areas).

Source Documents

Having established a convention for watershed delineation, the next challenge is in determining what resources to use as sources for addressing the A through I elements of the Watershed-Based Plan.

In general, to develop Watershed-Based Plans consistent with the USEPA requirements previously identified, the following source documents will be reviewed for each of the 27 basins:

1. MassDEP Water Quality Assessments
2. Massachusetts Nonpoint Source Management Plan and Action Strategies
3. Final Massachusetts Year 2002 Integrated List of Waters
4. EOEA Watershed Action Plans
5. Existing Watershed-Based Plans
6. TMDL Reports

Other reports and documents such as final reports from grant-funded projects, and studies produced by other agencies (e.g., DCR, DFA, EOEA, DMF, CZM, EPA), where available, may be considered for inclusion as supplemental information. Supplemental information will only be used 1) when it satisfies a data gap not addressed in the basic library of source documents and 2) where the data or modeling is supported by a MassDEP and EPA approved Quality Assurance Project Plan. MassDEP will make the final determination about whether to include supplemental information. Detailed discussion about the source and supplemental documents used for each major planning basin is provided in the Technical Memorandum developed for each basin.

Table 2: Massachusetts Major Planning Basins

MA Basin ID	Major Basin Name	Number of 12-digit HUCS
1	HUDSON	9
2	HOUSATONIC	15
3	DEERFIELD	12
4	WESTFIELD	12
5	FARMINGTON	8
6	CONNECTICUT	21
7	MILLERS	10
8	CHICOPEE	22
9	QUINEBAUG	10
10	FRENCH	4
11	NASHUA	12
12	BLACKSTONE	12
13	MERRIMACK	11
14	SuAsCo (Concord)	10
15	SHAWSHEEN	3
16	PARKER	2
17	IPSWICH	5
18	NORTH COASTAL	6
19	BOSTON HARBOR	22
20	CHARLES	8
21	SOUTH COASTAL	7
22	CAPE COD	7
23	ISLANDS	4
24	BUZZARDS BAY	11
25	TAUNTON	12
26	NARRAGANSETT BAY	4
27	TEN MILE	1
	Total	260

Assembling the information

The source documents will be assembled and reviewed. For each 12-digit HUC unit, information addressing each of the nine elements will be pinpointed and the location of the information will be cited according to source document and location within that document. Where the information is not presented consistent with HUC delineations – for example, in the 2002 Integrated List, which is organized by reach – the source information will be reorganized according to the HUC convention. Reaches will be assigned to HUCs, which may result in extrapolating reach-specific information across an entire HUC watershed. Criteria for decision-making in these circumstances are further described in section B-2.

Data Gaps

Data gaps will be found as materials are assembled and analyzed. Data gaps for this project are most commonly associated with meeting Elements A and B, related to the causes and sources of pollutants and the load reductions needed to meet project goals. This is because not all

waterbodies in the state have been assessed for all nonpoint source pollutants. Rather than leave gaps in the WBP, modeled estimates of pollutant load reductions that are needed to meet HUC-wide water quality objectives for four primary NPS pollutants (phosphorus, nitrogen, fecal coliform, and TSS) are also provided. The modeled estimates are derived through the Watershed Management Model, which is calibrated using validated data whenever it is available to ensure that modeled results are as accurate as possible. Following the modeling exercise, where data gaps still remain, no nonpoint source pollution problem is either identified or predicted. Section B1 and the Technical Memorandum for each basin describe the modeling effort and conclusions in further detail.

Final Product Format

While the fundamental purpose of the WBP is to support effective implementation projects, the information contained in the Plan will be useful for a wide audience. To maximize the availability of the information, the WBP will be primarily presented as a web-based product in simple map-driven format that also provides increasing levels of detail through links to supporting documents and resources. The WBP web site will be accessible at the MassDEP Nonpoint Source web page (http://www.mass.gov/dep/water/resources/nonpoint.htm), for use by potential grantees, watershed groups, and agencies who are seeking information and resources available to support monitoring and project development in their target areas. These users will be interested in reviewing the technical memoranda and source documents associated with the WBP, which will be available as links to the WBP pages once a watershed is selected. The main WBP page will also be available from the "My Community" site found on MassDEP's main web page (http://www.mass.gov/dep). This link will offer the information to a broader general audience who may be more interested in a "snapshot" of the nonpoint source pollution problems in their community, without delving into the detail provided through the links.

A.7 Critical Objectives and Criteria

The approach used here is appropriate for the development of a statewide Watershed-Based Plan that will fully support implementation projects that will result in attaining water quality objectives and the restoration of designated uses to the greatest extent possible. By relying on existing documents containing current information that has been publicly reviewed, the framework of the WBP is robust, well-supported, and populated by reliable and comprehensive information for each element of the WBP. Employing a sophisticated model to generate estimates of pollutant loads of the four primary pollutants further strengthens the core Elements A and B of the WBP (Element A, identification of causes and sources, and Element B, estimate of load reductions needed) by providing additional, credible information about likely causes and sources of NPS in each HUC 12 watershed.

The steady-state Watershed Management Model (WMM), version 4.20, developed by Camp, Dresser, and McKee and applied for watersheds in such diverse U.S. climates as Michigan (Rouge River), New Hampshire (Merrimack River), and Florida (many TMDL watersheds), was chosen as the model to be used for the Massachusetts WBPs. The WMM is a database model that simulates the generation and fate of pollutant loads from a number of various sources within each simulated watershed. The model is executed from a Microsoft Windows interface that interacts with a set of Microsoft Access database files, which are built by the user as part of model setup. The WMM partitions pollutant loads from a few different source categories, such as rainfall runoff, point source contributions, and combined sewer overflows (CSOs). For WBP

loading estimates, CSOs are not explicitly simulated. Rather, the annual average loading contributions from CSOs are assumed to be integrated with rainfall runoff loads.

The WMM has a history of successful application for total nutrients (nitrogen and phosphorus) in Florida and, through its use of watershed-specific delivery ratios, is specifically designed to provide nonpoint source estimates of total suspended solids (TSS). WMM is also capable of simulating pathogens, such as fecal coliform. Since these are the specific parameters of interest for the WBP project, the WMM is an appropriate model to provide annual average nonpoint source loading estimates prior to the availability of the more complex AVGWLF model. Each of the 27 basins in Massachusetts is modeled with a unique WMM application, further described in the Technical Memorandum for each basin.

No strategy is without limitations. In this case, the challenge of developing a statewide plan with adequate detail at the subwatershed level forces some decisions and extrapolations that will likely necessitate further information gathering to support specific projects or proposals. In particular, the reorganization of information into 12-digit HUC units has the effect of extrapolating specific reach and waterbody information across the entire HUC 12 watershed. For Element A, this means that one stream segment labeled as impaired by bacteria will cause the entire HUC watershed to show as having that impairment. For Element B, the sources of NPS are associated with land use percentages in the HUC unit, but the information is not sufficiently site-specific to support identification of BMPs beyond the general category level. For this reason, the WBP will always be refined and enhanced by projects and proposals that investigate site-specific problems and propose management practices that are truly "best."

At a more detailed level, the Technical Memorandum for each watershed also describes any watershed-specific limitations and assumptions related to the reliability of the modeled estimates and other element-specific information provided for each basin. Technical memoranda are provided as linked documents on the WBP website.

A8. Special Training/Certification

The team members bring a variety of skills and abilities to this project. The primary contractor, BETA Group, was selected through a competitive process that included evaluation of the team qualifications. Subcontractors with demonstrated ability in modeling (ATM) and WWW-based Applications (Applied Geographics) are used to supplement the strengths of the BETA Group team. Table 1 on page 6, "Personnel Responsibilities and Qualifications," identifies the experience and qualifications of the various team members.

Consistency of effort across all tasks and throughout all watersheds is critically important to the integrity of the finished WBP. Team members who are carrying out the data gathering task are trained and overseen by the BETA Group Project Manager.

A.9 Documents and Records

Documents that will be reviewed by the data collection team are provided by MassDEP and summarized in each technical Memorandum for the basin In general, source documents include

1. MassDEP Water Quality Assessments
2. Massachusetts Nonpoint Source Management Plan and Action Strategies
3. Final Massachusetts Year 2002 Integrated List of Waters

4. EOEA Watershed Action Plans
5. Existing Watershed-Based Plans
6. TMDL Reports

Not all documents are available in final form for every basin. Some are older than others, but no source documents are older than five years. For data contained in a source document to be considered viable, it must be supported by a MassDEP and EPA approved Quality Assurance Project Plan. All source documents are available in electronic versions that can be linked to the final WBP for the basin.

For each major basin, printed copies of the documents will be assembled into one binder so that the raw data is easily accessed, catalogued and referenced. Duplicate sets of binders will be maintained by staff who will be responsible for the data collection/review task at BETA and at Baystate Environmental Consultants. Electronic copies of the paper documents will be made where needed and all documents will be stored on BETA's main file server.

To ensure that data generated from the review of the documents is preserved and can be easily retrieved and reviewed, hand written worksheets will be stored in the binder containing the watershed reports and a scanned copy (portable document format, pdf) will be maintained on BETA's main file server. The file server is backed up on tape on a daily basis and a second copy of the tape is also stored offsite.

Information that is logged into the database (Microsoft Access) will also be stored on BETA's main file server and backed up according to the protocol previously described.

In addition, background notes and results that are not incorporated into the final WBP will nevertheless be retained in binders, organized per basin. The detailed notes and calculations and resulting estimates from the modeling exercise will be retained for MassDEP water quality monitoring and planning purposes. Record keeping will facilitate updating and revisiting the plan as necessary in the future.

B. Data Generation and Acquisition

B.1 Non-direct Measurements: Modeling

WMM Model Data Acquisition

Modeling is used to augment Elements A and B (i.e., identification of causes/ sources of NPS and an estimate of load reduction needed to meet program goals). The four primary NPS pollutants (phosphorus, nitrogen, total suspended solids, fecal coliform) are modeled for all 12-digit HUC units, incorporating validated data whenever it is available. The WMM estimates annual pollutant loadings within each simulated watershed based on rainfall, overall pervious and impervious runoff coefficients within each watershed, land use-based pollutant event mean concentrations (EMCs), percent imperviousness for each land use category, and watershed-specific delivery ratios that are specified for the suspended fraction of each estimated pollutant. A general description of the modeling approach is provided in this section. Basin-specific maps and information related to data acquisition, model configuration, and interpretation of results is

provided in each basin-specific Technical Memorandum, accessible from the WBP web site, http://host.appgeo.com/MADEPWatershed/.

Precipitation: Annual depth of rainfall (inches) is determined for each basin from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) dataset, provided by the Oregon State University Spatial Climate Analysis Service at http://www.ocs.orst.edu/prism/. PRISM is an analytical model that integrates precipitation data measured at over 700 National Weather Service and cooperator stations with selected State network stations. Spatial regression interpolations are performed between the stations to establish monthly and annual precipitation values for each individual grid cell (approximate area 4 square miles) over the conterminous (lower 48) United States.

For Massachusetts, a 5-year annual average precipitation layer is created by averaging the individual annual precipitation grids from the years between 2000 and 2004. Then, for each basin, the 5-year precipitation layer is clipped with the boundary of the basin. Finally, a spatial average of the grid cell values within the clipped area is calculated for the basin, yielding a single 5-year average precipitation value for the basin.

Land Use: The WMM uses land use-based EMCs as the basis for determination of NPS sources and pollutant loads to address Elements A and B. Therefore, a fine-scale land use layer is required for each WMM application. To meet this requirement, the January 2002 Massachusetts statewide 1:25,000 scale land use layer was acquired from the MassGIS website at http://www.mass.gov/mgis/ftplus.htm. In order to facilitate the use of this land use information within the WMM, the 37 land use categories in the layer were mapped to the following 14 encompassing categories:

Agricultural/Pasture	Industrial
Forest/Rural Open	Highways (Transportation)
Urban Open	Water/Wetlands
Low Density Residential	Cranberry Bogs
Medium Density Residential	Mining
High Density Residential	Waste Disposal
Commercial	Water-Based Recreation

Once the land use categories have been remapped to these 14 categories, the land use layer is clipped with the boundary of the basin under simulation and the resultant layer is intersected with the layer 12-digit HUC watershed layer for the basin and the total acreage of each land use category that occurs within each individual watershed is calculated and entered into the WMM.

Percent Imperviousness: Percent imperviousness values for each of the 14 land use categories are also entered into the WMM. The values used for the Massachusetts WBP applications were extracted from the Southeast Michigan Council of Governments (SEMCOG) Pilot Study for Davis Creek (Perry and Hamann, 1998). The percent imperviousness values from this study are generally higher than the default WMM values. One exception to the use of the SEMCOG values is for the water/wetland category. The SEMCOG study assigned a value of 0% imperviousness to this category. This is

counterintuitive, since water is an incompressible fluid. Accordingly, a percent imperviousness value of 90% was assigned to water/wetlands and was also extended to the cranberry bog category. Additionally, the SEMCOG percent imperviousness value for urban open (10.9%) was extended to the waste disposal and water-based recreation categories.

Base Flow: An annual base flow volume and base flow water quality for the parameters under simulation may be entered into the WMM for each basin under simulation. Base flow volume is entered as a depth of flow (in/year), which is then applied to each watershed within the basin. Since WMM only allows for specification of a single base flow value, and does not account for watershed variations in base flow contribution, this feature of the model is sometimes omitted, with all pollutant loadings treated as coming from runoff point sources, or upstream flows. For the Massachusetts WBP applications, base flow volume and base flow water quality is explicitly specified. Depth of base flow is initially calculated using the USGS PART (stream flow partitioning) algorithm, which extracts the base flow component of an observed flow record. The PART algorithm is applied to a representative gauge in the basin, typically close to the basin outlet. The mean base flow is then divided by the contributing drainage area at the gauge to determine a mean depth of flow.

Base flow water quality (i.e. background concentrations) is estimated using the means of dry weather flow observations of the simulated parameters for a sampling location coincident with the gauge for which the base flow was determined.

Event Mean Concentrations: Event Mean Concentrations (EMCs) are the typical pollutant concentrations associated with each land use category. The WMM estimates pollutant loading from individual land use categories within each watershed by taking the product of the depth of runoff, the acreage of the individual land use category, and the pollutant EMC. EMCs for each land use/pollutant combination (and associated coefficients of variation (CVs)) are specified by the WMM user. The CV for each EMC is defined as the standard deviation of the EMC value divided by the mean of the observed concentrations from which the EMC was established. For the Massachusetts WBP applications of the WMM, EMCs are established from multiple sources, including:

(a) the default values specified in the WMM manual (November 1998)
(b) the US Army Corps of Engineers' Merrimack River Watershed Assessment Study Screening Level Model report (March 2004)
(c) the New Bedford Regional Airport DEIS/DEIR Technical Memorandum 1.8: Water Quality (January 2005)
(d) Environmental Research and Design's report on Stormwater Loading Rate Parameters for Central and South Florida (1994)
(e) the Los Angeles County Department of Public Works 1994-2000 Integrated Receiving Water Impacts Report (July 2000).

When available, locally or regionally established EMCs were given preference over those identified in the WMM manual or those identified in reports from other regions. Table 3 shows the EMCs assigned for each land use/pollutant combination in the Massachusetts WBP applications of the WMM.

Table 3 - Initial Event Mean Concentration (EMC) Values Assigned

Land Use Category	Pollutant Parameter			
	TSS (mg/L)	TN (mg/L)	TP (mg/L)	F-Coli (#/100mL)
Agriculture/Pasture	**145**	**5.98**	**0.37**	**5,000**
Commercial	**44**	**1.85**	**0.15**	**9,306**
Cranberry Bog	**145**	**5.98**	**0.37**	**5,000**
Forest/Rural Open	**51**	**1.74**	**0.11**	**300**
High Density Residential	**102**	**3.81**	**0.64**	**16,901**
Highways	**141**	**2.65**	**0.43**	**600**
Industrial	**42**	**4.01**	**0.11**	**1,467**
Low Density Residential	**34**	**3.18**	**0.27**	**2,950**
Medium Density Residential	**49**	**3.5**	**0.41**	**12,360**
Mining	**94**	**1.18**	**0.15**	**300**
Urban Open	**51**	**1.74**	**0.11**	**5,000**
Waste Disposal	**75**	**1.74**	**0.11**	**7,500**
Water Based Rec	**51**	**1.74**	**0.11**	**5,000**
Water/Wetland	**6**	**1.38**	**0.08**	**300**

Suspended Fractions: The percent of each pollutant from each land use category that is suspended in the particulate form is also entered by the WMM user. The pollutant percentage in the dissolved form is assumed to be completely transported to the watershed outlet point. Suspended fractions are treated differently and are attenuated within each watershed, based on watershed specific delivery ratios (see below) and the suspended fraction of the pollutant specified. For the Massachusetts WBP applications, the suspended fractions specified are varied to calibrate modeled output with field observations. Fractions used in the model are 100% for TSS, 80 - 100% for TP, 80 – 100% for fecal coliform and 20 – 80% for TN. These fractions were specified for all land use categories.

Septic Systems: Nutrient loadings from failing septic systems can also be simulated with the WMM. These loadings are estimated from the following information specified by the user: (a) percentage of each residential land use category serviced by septic systems, (b) typical septic system failure rate, and (c) a set of high, medium, and low concentration multipliers specified for each residential land use. Percentages of high, medium, and low intensity residential land uses serviced by septic systems are averaged from the respective urban, main stem, and tributary values presented in the US Army Corps of Engineers' Merrimack River Watershed Assessment Study Screening Level Model report (March 2004). The WMM default value of 11% is used for the typical septic system failure rate and the WMM default multipliers are also employed for TN and TP.

Point Source Loads: The WMM allows users to specify point source loads that enter the system directly through NPDES discharges. For the Massachusetts WBP applications, the point sources in each basin are identified using a GIS point layer of all NPDES discharge locations (acquired through the MassDEP Central Regional Office GIS coordinator). For each simulated basin, the NPDES layer is clipped with the USGS 12-digit HUC layer to ascertain which watershed contains each point source. The USEPA's Permit Compliance System (PCS) database, accessible through the Envirofacts website at http://www.epa.gov/enviro/index.html, is then used to extract the most recent data monitoring

reports (DMRs) for each point source in the basin. If available, a minimum of 5 years worth of DMR data is desired for each point source. Once this data is acquired, average discharge flows and average concentrations for TN, TP, TSS, and fecal coliform are calculated for each point source that discharges those parameters. Individual point source loads are then calculated for each point source and summed within each watershed to establish a total point source load for the watershed. The total point source load is then divided by the total point source flow to establish flow-weighted TN, TP, TSS, and fecal coliform concentrations for each watershed.

For basins that receive upstream inflows from other states or other Massachusetts basins (e.g. Connecticut River basin, Merrimack River basin), the upstream pollutant loads, which are calculated from measured flow and concentration information at the closest monitoring location (Massachusetts or upstream state), are also entered into the WMM as a point source load in the receiving watershed. The WMM does not have a provision for entering these upstream loads separately, so they are combined with the NPDES discharges in the receiving watershed, so that all sources other than rainfall runoff and groundwater base flow sources are accounted for at the outlet point of the watershed.

Basin Runoff Coefficients and Gauged Flow Data: Runoff coefficients for the pervious and impervious areas throughout a basin are specified by the user and are used as calibration parameters to match WMM simulated flows to average annual flows at various gauged locations throughout the basin. WMM manual guidance for these parameters identifies that pervious runoff coefficients should typically be between 0.05 and 0.3, while the impervious runoff coefficients should be between 0.85 and 1.00. The simulated flows are compared with average flows at the active USGS gauges within each basin that have reported values for the most recent 5 years. This gauge flow information is acquired from the USGS National Water Information System Website (NWISWeb) at http://waterdata.usgs.gov/ma/nwis/. For basins that cross state boundaries, USGS gauge data may also be acquired from the NWISWeb site for the adjacent state.

As the pervious and impervious runoff coefficients are adjusted for each basin, the simulated flows are compared with the average annual observed flows for each gauge location. Positive or negative percent differences between simulated and observed are determined for each gauge. A satisfactory hydrologic calibration is established when the sum of these percent differences is close to zero.

The Technical Memorandum for each basin discusses unique basin characteristics and provides details about how the modeling was conducted with respect to individual basin features.

B.2 Secondary Data Management

This section discusses the methods and the reasoning that will be used to review, evaluate and report data that has been assembled in previously prepared documents. The core of the WBP is the information provided to satisfy Elements A and B (i.e., identification of causes/ sources of NPS and an estimate of load reduction needed to meet program goals). Collection and management of secondary data to address Elements A and B is emphasized, followed by an overview of information collected to satisfy the remaining elements.

Element A: Data Categories and Causes

Related to the reporting of causes to satisfy Element A, the WBP categorizes four types of causes of NPS, denoted by the letters I, R, M, and P.

- **I**: The term "impairment" has regulatory meaning. The letter I denotes a cause that is documented as an impairment in Category 4 or 5 of the Massachusetts Year 2002 Integrated List of Waters.
- **R**: Water Quality Assessment Reports include impairments, but may also report causes that are suspected or that are otherwise not included on the Integrated List. Water Quality Assessments also report resources that fail to meet their designated uses. R denotes a nonpoint source water quality problem that is reported in the most recent Water Quality Assessment Report for the basin, but not in Category 4 or 5 of the Massachusetts Year 2002 Integrated List of Waters.
- **M**: Modeling has been used to supplement the Element A information provided for the four primary NPS pollutants: nitrogen, phosphorus, fecal coliform bacteria, and total suspended solids. A letter M denotes a cause that is reported based on a modeled prediction that the pollutant is likely to exist in the HUC watershed.
- **P**: Water Quality Assessment Reports and other source documents sometimes specify that a cause is from a point source, not a nonpoint source. The letter P denotes a suspected or actual point source that has been identified in one or more source documents (i.e. Category 4 or 5 of the Massachusetts Year 2002 Integrated List of Waters, Water Quality Assessment Report, etc.) . Point sources cannot be addressed with nonpoint source funds or resources. The information is provided in the WBP as a way to clearly segregate point sources from eligible nonpoint source work.

Extrapolating River Segment Data to the HUC12 Level

As part of the initial screening of the source documents, each individual river segment is assigned to the HUC12 subwatershed(s) within which it is spatially located. This is completed by comparing the location of the river segment, which can be definitively located in each Water Quality Assessment Report on the map on the first page of the given river segment, to the previously described GIS-generated watershed map with the HUC12 overlay, provided by USGS. For river segments spanning multiple HUCs, the river segment (and subsequent data) is assigned to all HUCs in which the river segment is located. Based on this screening, each river segment will have at least one HUC to which it is assigned. This occasionally results in river segments being assigned to multiple HUCs.

Impairments

The term "impairment" is limited to causes that are listed in Category 4 or 5 of the Massachusetts Year 2002 Integrated List of Waters. Impairments are known causes, supported by validated data, and are therefore recognized to be definitive information to fulfill Element A of the WBP. Reviewers analyze Categories 4 and 5 of the Integrated List and record all occurrences of impairments, assigning them to their appropriate HUC12 watershed unit(s) as category "I" causes.

As described above, because the impairment analysis is conducted at the river segment level and the data is reported at the HUC12 level, the river segment data, or the "raw data", must be extrapolated to the HUC 12 level for reporting purposes. Using this approach, if a given river segment is impaired by elevated levels of fecal coliform bacteria, the WBP will report that the entire HUC12 in which the river segment is located is impaired by elevated levels of fecal

coliform bacteria. One instance of an impaired reach within a 12-digit HUC unit is sufficient to note the impairment; additional occurrences do not change the reporting.

Water Quality Assessment Reports

Water Quality Assessment Reports are published for each basin by the MassDEP Division of Watershed Management. Water Quality Assessment Reports incorporate impairment information and generally evaluate the status of water quality in the watershed, reporting at the river segment level. For each river segment, the level of support for 5 specific designated use categories is reported. The five designated use categories are Aquatic Life, Fish Consumption, Primary Contact, Secondary Contact, and Aesthetics. The support status for each of these use categories, if assessed, is identified as one of three designations: Support, Partial Support, or Non-Support/Impaired. "Support" means that the river segment is safe for the particular designated use. "Partial Support" means that portions of the river segment are unsafe for the designated use, while other portions of the segment can support that same activity or use. "Non-Support" or "Impaired" means that the entire river segment is not safe for the particular designated use.

At the end of each river segment's section in the document, the support status of the designated uses is summarized in what is called a "Use Summary Table". Along with the support status, the Use Summary Table lists the known and suspected causes for the designated use being classified as less than "Support" and the known and suspected sources of the causes. Below is an example Use Summary Table for a river segment in the Nashua watershed.

North Nashua River (MA81-01) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		SUPPORT – 0.2 upper miles PARTIAL SUPPORT – 1.0 lower miles	unknown	chronic effluent toxicity	municipal point source	
Fish Consumption		NOT ASSESSED				
Primary Contact		NON-SUPPORT	pathogens		urban runoff, CSO	
Secondary Contact		NON-SUPPORT	pathogens		urban runoff, CSO	
Aesthetics		SUPPORT				

Reporting Water Quality Assessment Results at the River Segment Level

Designated uses are not specified in the WBP. However, causes impacting the intended use of a water body are reported with either an R or P designation:

- Support and Not Assessed designations are not reported in the WBP.
- Non-support designations are reported as R when the cause is a known or suspected nonpoint source.
- If the cause is solely a point source, it is reported as P.
- If the cause is a combination of point and nonpoint source, it is reported as R.
- If the cause is also listed on the Integrated List of Waters, it is reported as I.

The segment above shows two occurrences of pathogens from combined point and nonpoint sources. This water quality problem is also shown in Category 5 of the Integrated List for this segment. Therefore, the report for this segment, and this HUC, will record pathogens as a category I impairment for the nonpoint source. A flow chart summarizing the data review and reporting process is presented in Figure 1.

Results of the HUC worksheet are consolidated into one report for the HUC on the same worksheet. In summarizing the information, one instance of a cause in a reach is sufficient to list the cause for the entire HUC. The general listing hierarchy is, from highest to lowest, I, R, M, and P. Thus, if a cause is listed in a HUC three times, once each as I, R, and M, the cause will be reported for the HUC at the highest level, I. However, since the WBP is intended to address nonpoint pollution sources only, any cause that is derived from a solely from a documented point will be classified as P.

For several pollutants, the Integrated List of Waters assigns them to a broad categorization, where the Water Quality Assessment Reports (WQAR), TMDLs and other documents refers to the specific pollutant. Examples of these are listed below:

	Cause
Integrated List	**WQAR, TMDL, etc.**
Nutrients	Nitrogen
	Phosphorus
Metals	Mercury
	Lead
Priority Organics	PCBs

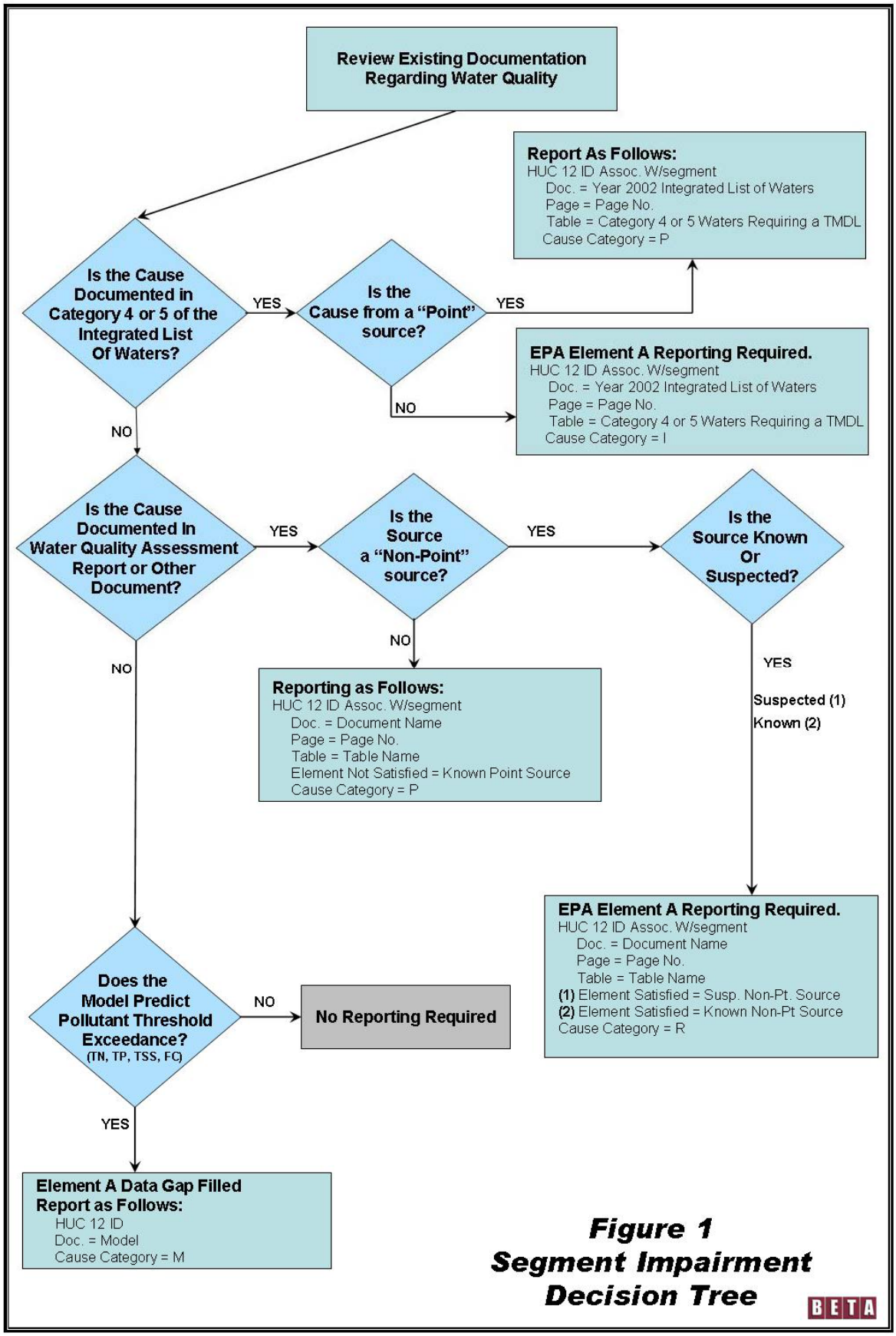
In these cases, reporting is done for both cause identified in the Integrated List as either an I or P, and for the specific pollutant identified in the WQAR, TMDL, etc. as either an R or P. Causes are reported exactly as listed. In some cases, modeled results will support, but not duplicate, impairment listings. Since total nitrogen and total phosphorus loadings are being modeled in each HUC, predicted water quality impacts may also result. The M classification will only apply to nitrogen and phosphorus (not nutrients) and will be used if there is there is no supporting documentation of the cause but the model predicts a potential water quality impact.

Modeling

The modeling effort is described under Section B1, and a detailed Technical Memorandum is provided for each basin describing the specific approach that is used to estimate category M causes for the basin. The model provides a range of likely pollutant concentrations for each HUC unit which are compared to threshold values: 12 mg/L for TSS, 2.0 mg/L for TN, 0.075 mg/L for TP, and 200 colonies/100 mL for fecal coliform. Where the predicted concentrations for the HUC exceed these thresholds, a category M cause is noted. Modeled estimates not are intended as definitive identification of a cause; rather, category M causes are predictions that should be used to support data gathering and proactive implementation work in the watershed.

Element A: Sources

The second component of Element A is identification of the sources of the NPS. Because nonpoint source pollution is directly related to land use, the WBP specifies land use as the NPS source and accordingly provides land use information in percentages for each HUC unit. Land


Review Existing Documentation Regarding Water Quality
Report As Follows:
HUC 12 ID Assoc. W/segment
Doc. = Year 2002 Integrated List of Waters
Page = Page No.
Table = Category 4 or 5 Waters Requiring a TMDL
Cause Category = P
Is the Cause Documented in Category 4 or 5 of the Integrated List Of Waters?
YES
Is the Cause from a "Point" source?
YES
NO
EPA Element A Reporting Required.
HUC 12 ID Assoc. W/segment
Doc. = Year 2002 Integrated List of Waters
Page = Page No.
Table = Category 4 or 5 Waters Requiring a TMDL
Cause Category = I
NO
Is the Cause Documented In Water Quality Assessment Report or Other Document?
YES
Is the Source a "Non-Point" source?
YES
Is the Source Known Or Suspected?
NO
YES
Suspected (1)
Known (2)
NO
Reporting as Follows:
HUC 12 ID Assoc. W/segment
Doc. = Document Name
Page = Page No.
Table = Table Name
Element Not Satisfied = Known Point Source
Cause Category = P
EPA Element A Reporting Required.
HUC 12 ID Assoc. W/segment
Doc. = Document Name
Page = Page No.
Table = Table Name
(1) Element Satisfied = Susp. Non-Pt. Source
(2) Element Satisfied = Known Non-Pt Source
Cause Category = R
Does the Model Predict Pollutant Threshold Exceedance? (TN, TP, TSS, FC)
NO
No Reporting Required
YES
Element A Data Gap Filled Report as Follows:
HUC 12 ID
Doc. = Model
Cause Category = M
Figure 1
Segment Impairment Decision Tree
BETA

use categories are carefully derived for each 12 digit HUC unit as a component of the modeling effort, and the information is carried through to address this source for Element A. The Water Quality Assessment Reports may also include information about the source of a pollutant, but this is most often where the source is a point source. The Technical Memorandum for each basin contains a detailed description of data sources, land use categories and percentage composition for each land use category.

Element B
Element B requires an estimate of the load reductions that should be achieved by the management measures to be prescribed in Element C. Where a TMDL has been written, a precise calculation of load allocations and required reductions is provided in the TMDL analysis. Links to available TMDLs are found in the WBP. In the absence of a TMDL, the desired load reductions are those required to meet water quality standards or restore beneficial uses. This amount can be roughly quantified for the HUC-wide primary pollutants based on the modeled estimates, although factors such as point sources, upstream contributions, seasonal considerations, and other variables can interfere with the accuracy of this effort. Each Technical Memorandum discusses unique circumstances and considerations that will affect Element B outcomes.

Element C
This element describes the management measures that will be employed to achieve the load reductions that will meet water quality standards and attain beneficial uses. Management measures must be appropriate for the causes and sources being addressed, which are in turn directly related to land use. Best Management Practices and effective nonpoint source pollution strategies are therefore engendered by the land use in the surrounding watershed. Detailed information about land uses is a basic component of the WBP that informs the model and helps determine the source of the pollutants. The same land use information is then used to determine what type of Best Management Practice is appropriate for the watershed. The WBP links to the 2005 Clean Water Toolkit, aka the Massachusetts Nonpoint Source Pollution Management Manual, (http://www.mass.gov/dep/water/resources/nonpoint.htm), which is organized along the lines of land use category and pollutant problems in order to direct selection of appropriate management practices. Further detail about watershed specifics is found in each Technical Memorandum.

Elements D through I
Remaining elements of the WBP are found within the source documents and are specifically outlined in each Technical Memorandum. Information addressing these elements may be less specific than what is provided in the WBP for the core elements A, B, and C. Individual projects that are selected for implementation always provide additional detail with regard to timetables, resources required, site-specific BMP designs, outreach and education, and metrics that is specific and timely; thus completing and/or enhancing the WBP for the watershed and strengthening the basis for funding the project.

B3. Sample Handling and Custody
N/A for this project.

B4. Analytical Methods

N/A for this project

B5. Quality Control

The QA/QC process establishes a methodology for promoting quality assurance and quality control of all technical documents and data produced. QA/QC procedures are designed to encourage the professional quality, technical accuracy, timely completion and coordination of all deliverables. These procedures involve inspection and checking of work products and are designed to ensure that technical documents are complete and accurate.

Although QA/QC is the responsibility of all employees involved in the project, on projects such as this the Project Manager with assistance from the Project Technical Advisors and Task Leaders will be responsible for formulating and implementing the procedures. The QA/QC Plan includes a 3-level data verification procedure. This procedure is presented in graphic form in Figure 2. Please note that based on available information, the QA/QC procedure may differ from basin to basin.

In addition to discussing routine QA/QC procedures that are undertaken, individual Technical Memoranda for each basin will describe any specific QA/QC measures outside the realm of the flow chart. This will include the information that will be evaluated on a case by case basis. Examples might include where a HUC contains multiple occurrences of the same impairment, or where no causes or sources are identified or other elements are not met.

At Level 1, the Data Collection Task Leader will review 10 percent of the entries made on the Data Compliation Worksheet. Under the Modeling effort, the Level 1 review will consist of hand calculations to verify approximately 1 percent of the model results.

Level 2 review under the Data Collection Task will review a minimum of 20 percent of the impairments/causes identified for as representative of a given HUC. Since the modeling task is highly technical, the most of the QA/QC work related to data and output verification will be performed under Level 1. Level 2 QA/QC will consist of a review of the assumptions and the watershed characteristics that were used as model inputs.

Level 3 QA/QC will consist of a review of the technical memoranda and the data entered into the watershed impairment/cause database that will form the basis of the web application. Once the data is approved at Level 3, it will be delivered to the MassDEP for review and comment. Comments received from MassDEP will be addressed accordingly and a revised data set will be submitted to AGI for upload to the Web application. Once the information is posted on the Web, it is the role of MassDEP and the Project Team to utilize the system and identify errors and omissions.

B6. Instrument/Equipment Testing, Inspection, and Maintenance

N/A for this project

B7. Instrument/Equipment Calibration and Frequency

N/A for this project

B8. Inspection/Acceptance of Deliverables

The MassDEP Project Manager reviews all deliverables for quality and consistency with project goals and contract requirements. The MassDEP Project Officer reviews and approves invoices from the contractor contingent upon receipt of acceptable deliverables. Other reviewers including the MassDEP Quality Assurance Contact, the EPA Project Officer, the EPA Quality Assurance contact, outside stakeholders and other agency personnel may also review and spot-check project materials. Feedback from other reviewers will be received and reviewed by the MassDEP Project Officer and forwarded to the Project Manager for appropriate action.

B9. Non-Direct Measurements

Source documents used in the preparation of the WBP have been described elsewhere in this document (Section A.6) and are specifically named and referenced in each Technical Memorandum. Water quality data used to support and calibrate modeling must be from a source that is supported by a MassDEP- and EPA-approved Quality Assurance Project Plan.

B10. Data Management

The primary function of the database is to store the data identified during the review of the documents. The database architecture is structured such that the unique identifier of a record is a function of the HUC12 identifier and a cause identifier. This means that each HUC can have multiple causes, and each cause can occur in many different HUCs. However, a cause can only be identified once for each individual HUC.

An electronic database was developed in MS Access for the purpose of entering, analyzing, and retaining information used to develop the WBP.

The data is stored in a series of tables and queries to facilitate report preparation and transfer to the web application. Two primary tables, “Main Table” and “THUCBase” store the majority of the data that is presented in the Technical Memoranda and on the web site. A data transfer protocol has been established that involves uploading the WBP database to BETA’s FTP site. The developer of the web site (AGI) then downloads the database to their site for migration to ArcIMS, which is the software used for the WBP web site. Data is transferred as required during the project development process.

For each major basin, printed copies of the documents will be assembled into one binder so that the raw data is easily accessed, catalogued and referenced. Duplicate sets of binders will be maintained by staff who will be responsible for the data collection/review task at BETA and at Baystate Environmental Consultants. Electronic copies of the paper documents will be made where needed and all documents will be stored on BETA’s main file server.

To ensure that data generated from the review of the documents is preserved and can be easily retrieved and reviewed, hand written worksheets will be stored in the binder containing the watershed reports and a scanned copy (portable document format, pdf) will be maintained on BETA’s main file server. The file server is backed up on tape on a daily basis with a second copy of the tape is also stored offsite.

Information that is logged into the database (Microsoft Access) will also be stored on BETA’s main file server and back-up according to the protocol previously described.

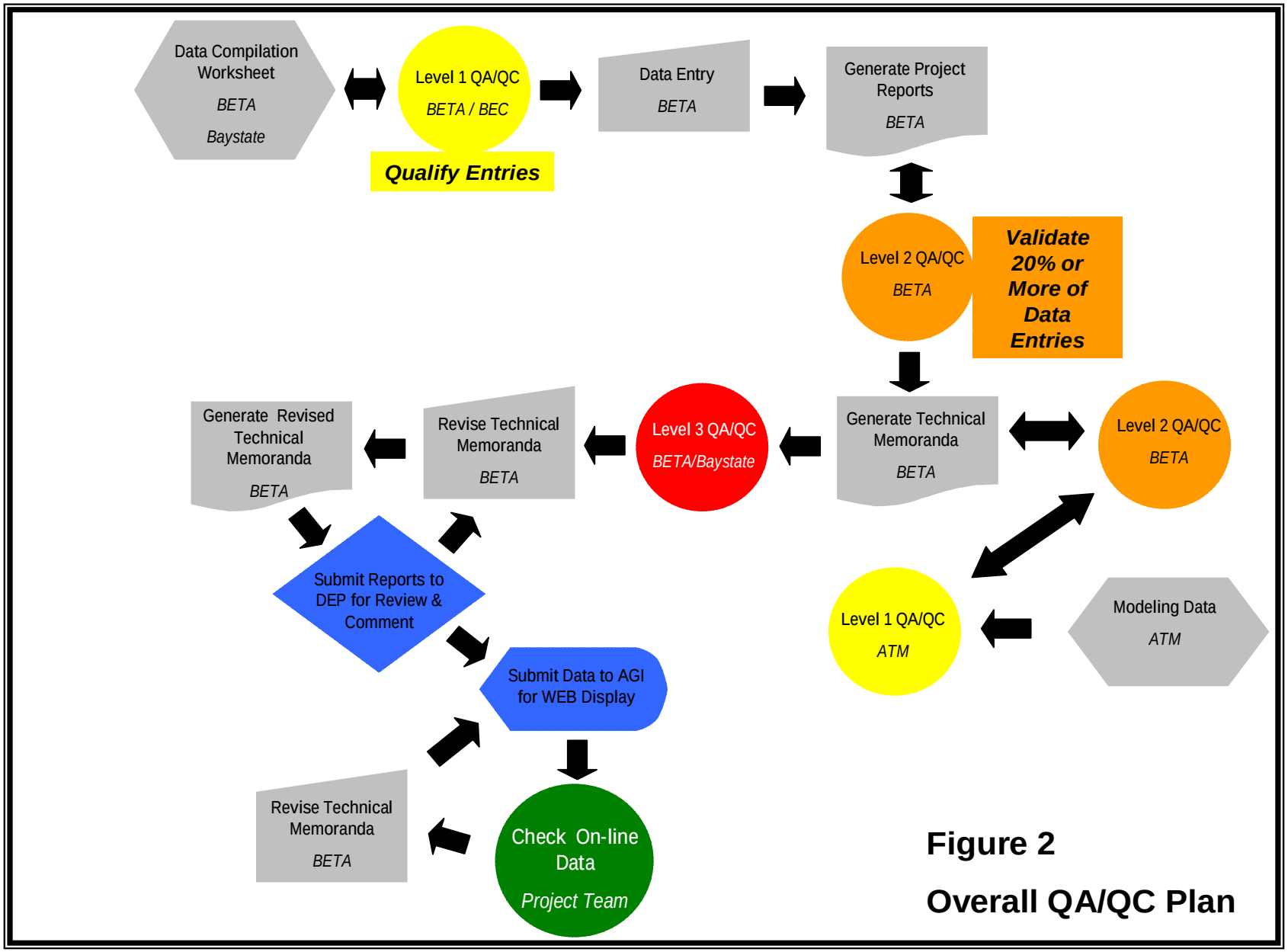


Figure 2

Overall QA/QC Plan

In addition, background notes and results that are not incorporated into the final WBP will nevertheless be retained in binders, organized per basin. The detailed notes and calculations and resulting estimates from the modeling exercise will be retained for MassDEP water quality monitoring and planning purposes. Record keeping will facilitate updating and revisiting the plan as necessary in the future. A complete set of paper reports and electronic backup will be included as final project deliverables.

C. Assessment and Oversight

C.1 Assessments and Response Actions

Overview

The members of the Project Team have clearly defined roles, described in section A4. Teams report directly to the project manager for each phase of the project. The project manager will have primary authority for scheduling and budget, as well as the quality of the work performed in all phases of the project. The designated Project Manager will be with this project from its beginning to its successful completion.

This project requires a hands-on technical and management approach. The Project Manager will prepare and enact a project strategy and will be involved in the day-to-day aspects of the project. The Project Manager maintains regular contact with MassDEP and is responsible for follow-up to comments and feedback provided by the MassDEP Project Manager.

Project Review Meetings

Project review meetings with project team members (ATM, Baystate, and AGI) are held on a monthly basis. Meetings are convened and led by the Project Manager. The purpose of these meetings is to review technical memoranda, review project schedules, receive input and incorporate project staff into the decision making process. This is also the primary mechanism for obtaining team feedback with respect to task methodologies and deliverables, and for communicating and addressing feedback received from external reviewers and agency staff.

Project Administration & QA/QC

The Project Manager will be responsible for monitoring and controlling in-house personnel and subconsultants. He will insure that adequate staff is assigned to perform the project in accordance with the schedule.

BETA's in-house QA/QC establishes a methodology for promoting quality assurance and quality control of all technical documents and data produced by BETA Group, Inc. QA/QC procedures are designed to encourage the professional quality, technical accuracy, timely completion and coordination of all deliverables. These procedures involve inspection and checking of work products and are designed to ensure that technical documents are complete and accurate. These procedures are illustrated in the flow chart in Figure 2.

QA/QC procedures may differ from basin to basin, and specific QA/QC measures outside the realm of the flow chart will be described in the individual basin Technical Memoranda.

The Project Manager reviews the reports prepared for "Level 2 QA/QC" and assigns a validation directive to be accomplished at Level 3 as shown in the flow chart. Once the data is approved at Level 3, it will be delivered to the MassDEP for review and comment. Comments received from MassDEP will be addressed by the Project Manager and a revised data set will be submitted to AGI for upload to the Web application. Once the information is posted on the Web, it is the role of MassDEP and the Project Team to utilize the system and identify errors and omissions.

Document Review

BETA Group, Inc.'s document review team will be responsible for the review of 20 watersheds, while the BEC document review team will be responsible for 7 watersheds. The methodology employed by each team will be identical and will follow the procedures outlined in Section B.2. Entries made into the electronic database will only be made by the Task Leader. Until the project is completed, access to the database will be restricted to the Data Collection Task Leader and the Project Manager.

Data review will be performed in several distinct steps:

- Once a watershed is assigned by the MassDEP for review and documents are made available, the Project Manager will assign the watershed to one of the data collection support personnel. This person will be responsible for the review of all available documents and will flag all identified causes within each watershed on a handwritten worksheet.

- Once the causes are identified, the worksheet will be forwarded to another member of the data collection support team who will assign each cause to a specific HUC12.

- The worksheet for the watershed is then forwarded to the Task Leader who will review it for completeness and spot check approximately 20 percent of the entries for accuracy. Once the accuracy is verified, the data will be input into the database by the Task Leader. A report will then be generated for the watershed.

- The Task Leader will then forward reports and worksheets that were develop by BETA's team to BEC's team for a quality review and vice versa. The reviewing team will validate approximately 15 percent of the entries selected randomly for each HUC. If an error is noted then all data entries for that particular HUC will be reviewed.

- The results of the review will be forwarded to the Task Leader so the database can be revised, if necessary.

C.2 Reports to Management

The Project Manager maintains close communication with the MassDEP Project Officer. Monthly invoices are checked and approved by the MassDEP Project Officer to ensure that the pace of the work is consistent with the rate of compensation. Invoices are processed by

the MassDEP Contracts Manager, who reviews the expenses to make sure they are within the approved project budget.

A web based GIS application will be developed to provide access to the data compiled as part of this project. The web application will be developed by AGI and includes hosting the site for a period of 12 months upon completion of the project. Once the web site is operational, the Project Team will work with MassDEP to establish a protocol for transferring the site to the MassDEP or other state entity.

D. Project Review and Evaluation

D.1 Data Review and Verification

All acquired data will be reviewed and verified for conformance to project requirements, and validated against the data quality objectives which are identified Section A.7. Only those data which are supported by appropriate quality control data and meet the data quality objectives defined for this project will be considered acceptable for use. These objectives require the best available quality control standards of the source agency and the MassDEP.

D.2 Data Evaluation of Load Reduction Estimates

Load reduction estimates to be realized (element C) are based on a presumption that best management practices can attain water quality standards and restore beneficial uses in nonpoint source impaired waters. The WBP relies on modeled estimates of the primary pollutants to predict the severity or predicted severity of the impairments. A detailed account of the modeling exercise, data inputs, conclusions, and exceptions is provided in each Technical Memorandum.

D.3 Evaluation of Project Success

The success of this project will be assessed in two ways: the results from the calibration and verification process and the ability of the MassDEP to utilize this tool to guide future NPS projects. All input data for the model will undergo a review to ensure the quality of the data, as outlined in Section B1.

Upon completion of the Watershed Based Plan, the BETA Team will prepare for and attend public meetings to review and discuss the plan. Public notification of the Watershed Based Plan will be issued through the Environmental Monitor, as well as by direct mailings or other means typically used to notify the public. It is envisioned that dissemination of the work products developed as part of this project will be completed on a regional basis. This could include utilizing Watershed Leaders, Regional Planning Agencies and other related organizations located throughout the Commonwealth to assist with this effort. Obtaining acceptance of the project from these entities will also provide a measure of project success.

Web technology will also serve as a valuable outreach mechanism for informing watershed groups, municipalities and the general public. A summary report of the public meetings, including comments and responses from the public, will be provided to MassDEP.