HOLISTIC WATERSHED MANAGEMENT FOR EXISTING AND FUTURE LAND USE DEVELOPMENT ACTIVITIES: OPPORTUNITIES FOR ACTION FOR LOCAL DECISION MAKERS: PHASE 2 – FDC APPLICATION MODELING (FDC 2A PROJECT)

SUPPORT FOR SOUTHEAST NEW ENGLAND PROGRAM (SNEP) COMMUNICATIONS STRATEGY AND TECHNICAL ASSISTANCE

QUALITY ASSURANCE PROJECT PLAN; TASK 1
VERSION 1.1
NOVEMBER 22, 2021

Prepared for:

U.S. EPA Region 1

Prepared by:

Paradigm Environmental

Great Lakes Environmental Center

Blanket Purchase Agreement: BPA-68HE0118A0001-0003
Requisition Number: PR-R1-20-00322
Order: 68HE0121F0052
QA Tracking Number: 21026

This quality assurance project plan (QAPP) is consistent with EPA Requirements for Quality Assurance Project Plans (USEPA QA/R5, 2001, EPA/240/B-01/003); EPA Guidance for Quality Assurance Project Plans for Modeling (USEPA QA/G-5M, 2002, EPA/240/R-02/007) and EPA Guidance for Geospatial Data Quality Assurance Project Plans (USEPA QA/G-5G, 2003, EPA/240/R-3/003). The Great Lakes Environmental Center (GLEC) and its subcontractors will conduct work in conformance with the quality assurance program described in this project QAPP. This QAPP is one of the contractor requirements and is used to communicate to all interested parties the QA/QC procedures that will be followed to ensure that the quality objectives for this project are achieved throughout the project. The QAPP is a commitment by GLEC that must be approved by USEPA Region 1.

APPROVALS

Quality Assurance Project Plan for Phase 2- FDC Application Modeling (FDC 2A Project)

Contract No: BPA-68HE0118A0001-0003
Order Number: 68HE0121F0052
QA Tracking number: 21026

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VERSION HISTORY

The following table outlines the revision history of this QAPP:

Documents	Version No.	Date	Major Revisions
Phase 2 - FDC Application Modeling (FDC 2A Project)	1.0	October 22, 2021	Submitted draft QAPP to EPA Region 1 for review.
Phase 2 - FDC Application Modeling (FDC 2A Project)	1.1	November 22, 2021	Final version with signature page

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
CBI	Confidential Business Information
CD	Conservation Development
CWA	Clean Water Act
DEM	Digital Elevation Model
DQO	Data Quality Objectives
FDC	Flow Duration Curve
GI	Green Infrastructure
GIS	Geographic Information System
GLEC	Great Lakes Environmental Center, Inc.
HRU	Hydrologic Response Unit
HSPF	Hydrological Simulation Program – FORTRAN
IC	Impervious Cover
LiDAR	Light Detecting and Ranging
LSPC	Loading Simulation Program C++
MassGIS	Massachusetts Bureau of Geographic Information Systems
MS4	Municipal Separate Storm Sewer System
NCDC	National Climatic Data Center
nD/rD	New Development and/or Re-Development
NRCS	Natural Resources Conservation Service
PE	Professional Engineer
PM	Program Manager
PWS	Performance Work Statement
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCO	Quality Control Officer
SCM	Stormwater Control Measure
SSURGO	Soil Survey Geographic Database
SUSTAIN	System for Urban Stormwater Treatment and Analysis IntegratioN
TO	Task Order
TOL	Task Order Leader
TOCOR	Task Order Contracting Officer's Representative
TSC	Technical Steering Committee
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

REFERENCE TO EPA QAPP ELEMENTS

To support EPA review of this document, we have developed Table 1 below that cross-references the *Guidance for Quality Assurance Project Plans* sections with the Sections of this QAPP.

EPA QAPP Element	R1 QAPP Section
Group A: Project Management	
A1. Title and Approval Sheet	Cover Page, Page ii
A2. Table of Contents	Page iv
A3. Distribution List	Section A.3
A4. Project/Task Organization	Section A.4
A5. Problem Definition/Background	Section A.5
A6. Project/Task Description and Schedule	Section A.6
A7. Quality Objectives and Criteria for Model Inputs/Outputs	Section A.7
A8. Special Training Requirements/Certification	Section A.8
A9. Documentation and Records	Section A.9
Group B: Measurement and Data Acquisition	
B1. Sampling Process Design	Not applicable
B2. Sampling Methods	Not applicable
B3. Sample Handling and Custody	Not Applicable
B4. Analytical Methods	Not Applicable
B5. Quality Control	Not Applicable
B6. Instrument/Equipment Testing, Inspection, and Maintenance	Not Applicable
B7. Model Calibration	Section B.7
B8. Instrument/Equipment Calibration and Frequency	Not applicable
B9. Data Acquisition (Non-direct Measurements)	Section B.9
B10. Data Management and Hardware/Software Configuration	Section B.10
Group C: Assessment and Oversight	
C1. Assessment and Response Actions	Section C.1
C2. Reports to Management	Section C.2
Group D: Data Validation and Usability	
D1. Departures from Validation Criteria	Section D.1
D2. Validation Methods	Not applicable
D3. Reconciliation with User Requirements	Section D.3

A. PROJECT MANAGEMENT

Certain Project Management elements have been provided in the preface of this document. Those elements include Sections A.1 Title and Approval Sheet (page ii), and A.2 Table of Contents and Document Control Format (page iv). The Project Management Group begins directly with Section A.3 Distribution List.

A.3 Distribution List

This document will be distributed to the staff within the following organizations (Table A-1): U.S. Environmental Protection Agency Region 1 (USEPA), Great Lakes Environmental Center (GLEC), and Paradigm Environmental (Paradigm).

Table A-1. Project Distribution List

Name	Phone & email	Address
U.S. Environmental Protection Agency Region 1 (USEPA)		
Ray Cody Task Order Contractor Officer Representative (TOCOR)	617-918-1366 cody.ray@epa.gov	5 Post Office Square, Suite 100 Boston, MA 02109 Mail Code: OEP 06-1
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A.4 Project/Task Organization

The United States Environmental Protection Agency (USEPA) has retained GLEC to perform hydrological modeling and analysis associated with the Flow Duration Curves (FDC) Phase 2 (FDC2) project. The FDC2 project builds upon the work completed during the FDC Phase 1 (FDC1) project which quantified the impacts of land cover and climate change on FDCs and investigated the ability of distributed Stormwater Control Measures (SCMs) to influence the frequency and distribution of long-term stream flows. The FDC1 results provide the foundation for an analytical framework that includes tools (Opti-Tool) and metrics (i.e., ecosurplus and ecodeficit) to help quantify both the hydrologic impacts of the existing condition and the potential benefits of hydrograph restoration associated with stormwater management activities.

FDC2 will leverage the existing calibrated continuous simulation hydrologic and watershed management models developed during FDC1 for the Wading River portion of the Taunton River watershed. The FDCs will be used to investigate the impacts of next-generation new development and/or redevelopment (nD/rD) practices, or Conservation Development (CD) practices, on watershed hydrology and stream health. FDC2 will demonstrate the efficacy of using FDC-based flow metrics to quantify differences between subwatershed development scenarios, including a pre-development forest condition, the current built state, future development conditions, a scenario that incorporates the State of Massachusetts' stormwater standards, and several potential management scenarios that consider potential climate change and future land development conditions.

FDC2 consists of two task orders. FDC2 Task A focuses on the modeling aspect of the project. FDC Task B focuses on designing site-scale stormwater management approaches to be incorporated into the modeling. Overall, the FDC2 project will provide communicable results that are intended to inform the future of watershed management. Results will assess outcomes for combinations of the following: low, medium, and high development densities, development scenarios guided by status quo policies vs next-generation local bylaws, and a range of future climate conditions.

The following organizational structure will facilitate project performance and adherence to Quality Control (QC) procedures and Quality Assurance (QA) requirements. The project team is composed of individuals from USEPA and the contractor project team. The contractor project team (GLEC Team) includes GLEC as the prime contractor and its subcontractor Paradigm Environmental (Paradigm). Key project roles are filled by the individuals who are leading the various technical phases of the project and the individuals who are ultimately responsible for approving and accepting final products and deliverables. The responsibilities of these persons are described below.

A.4.1 USEPA Region 1

USEPA Region 1 will be responsible for the coordination of QA aspects at the regional level and with local agencies to ensure technical quality throughout the project. USEPA will coordinate with contractors, reviewers, and others to ensure contract objectives are met. USEPA will also be responsible for ensuring that all technical tasks related to the project are fulfilled, and they will be responsible for final project decisions and direction.

Ray Cody will provide overall project/program oversight for this study as the USEPA Region 1 Task Order Contractor Officer Representative (TOCOR). Mark Voorhees (USEPA Region 1) and Ray Cody (TOCOR) will serve as the core Project Team (Project Team) and/or Project Technical Leads (PTL) for this project. The PTL, along with Steven Winnett (Alternate TOCOR), will be responsible for coordinating with contractors, reviewers, and others to ensure technical quality throughout the project so that project objectives are met. Mr. Cody will provide oversight for

project planning and design, data selection, coordination with the TSC and any local agencies, model selection and application, and adherence to overall project objectives. Lilly Simmons, the USEPA Region 1 QA Officer, will be responsible for reviewing and approving the QAPP and ensuring that the QA/QC practices and requirements specific to Region 1 are achieved.

A.4.2 GLEC Team

The key personnel from the GLEC Team assigned to this project and their roles are summarized below. Figure A-1 presents an organizational chart depicting the roles of key staff and the flow of communications across the project team and with EPA.

Mick DeGraeve is the GLEC Program Manager (PM) for this Task Order (TO). He is responsible for directing and coordinating technical work and interaction with the USEPA TOCOR. He will also track the budget, prepare monthly progress reports and invoices, track and ensure adherence to the schedule, and perform any other administrative functions.

Jennifer Hansen is the GLEC QA Officer (QAO) for this project. Ms. Hansen will work with the GLEC PM in cases that the quality of the data is questioned as it relates to the USEPA objectives defined for the work. Ms. Hansen will review the QAPP on behalf of GLEC and will be responsible for maintaining the official QAPP at GLEC.

Khalid Alvi is the Paradigm Project Manager for this Task Order. He is responsible for executing the tasks and other requirements of the contract on time, within budget, and with the QA/QC requirements as defined by the contract and the QAPP. Mr. Alvi will communicate with the GLEC PM and the USEPA TOCOR on technical matters; he will ensure that the quality of work, schedule, and budget meet Task Order requirements; he will provide technical direction to Paradigm staff and will manage the daily activities on the project, and he will obtain appropriate technical review of all deliverables and will ensure deliverables conform to EPA's technical review requirements.

John Craig is the QA Officer for Paradigm. His primary responsibility will be to provide support to the Paradigm PM in preparing and distributing this QAPP, reviewing and internally approving the QAPP, and monitoring QC activities to determine and document conformance.

John Riverson is the modeling QC Officer for Paradigm. He will be responsible for overseeing the data review and modeling activities and be responsible for QA/QC activities. Mr. Riverson will coordinate with the GLEC QAO to resolve any QA-related issues and he will notify the GLEC and Paradigm PMs of particular circumstances that may adversely affect the quality of the products provided by Paradigm. He will conduct the review of technical QA material and data related to the surface water model system design and analytical techniques and he implements, or ensures, implementation of corrective actions needed to resolve non-conformances noted during QA assessments.

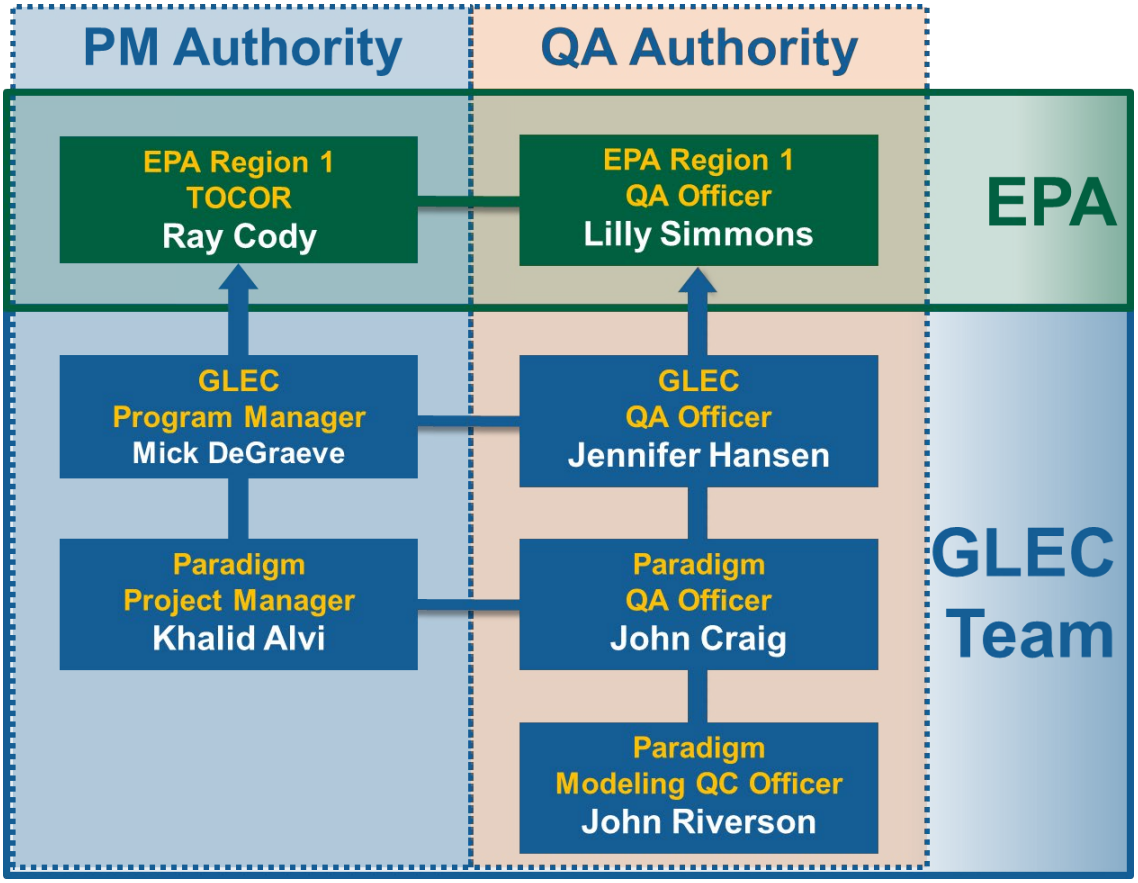

Figure A-1. Organizational diagram for both technical and QA lines of communication.

A.5 Problem Definition/Background

Conventional development approaches and existing stormwater management standards (where applicable) do not adequately address the full range of hydrologic, water quality, and aquatic life impacts associated with human development and impervious cover (IC). The weight of evidence is clear that human development and urbanization have had a profound impact on water resources in multiple ways. The paving of vegetated land disrupts the natural hydrologic cycle at a site scale that has ramifications for the larger watershed. Recent research assessing the health and integrity of watersheds indicates that efforts to restore the hydrological and ecological function of our watersheds are not likely to offset the combined impacts of 1) past and future development that expands watershed impervious cover (IC), and 2) changing climate conditions. Watershed management needs to consider the magnitude, frequency, and timing of various flow events–and incorporate new insight on the role of lesser permeability soils (e.g., tills) which indicate such soils provide a primary mechanism for maintaining hydrological balance. As human populations continue to grow, and population centers shift in response to changing natural hazards associated with climate change impacts, appropriate guidance on resource protection is a fundamental need for humans and ecological communities. FDC1 provided the foundation for an analytical framework that includes tools (Opti-Tool) and metrics (i.e., ecosurplus and ecodeficit) to help quantify both the hydrologic impacts of the existing condition and the potential benefits of hydrograph restoration associated with stormwater management activities.

The goal of Phase 2 of this project is to apply the framework and tools developed in Phase 1 to investigate the impacts of next-generation new development and/or redevelopment (nD/rD)

practices, or Conservation Development (CD) practices, on watershed hydrology and stream health. FDC2 will demonstrate the efficacy of using FDC through the modeling of differences between subwatershed development scenarios, including a pre-development forest condition, the current built state, future development conditions, a scenario that incorporates the State of Massachusetts' stormwater standards, and several potential management scenarios that consider potential climate change and future land development conditions.

A.6 Project/Task Description and Schedule

This project is about envisioning a different future for watershed management and communicating the results so that practitioners can appreciate the impact of nD/rD on the future of their watersheds.

The project includes the following specific tasks and deliverables, further detailed in Table A-2:

- Prepare a Work Plan, Budget, and Schedule (Task 0);
- Prepare a Quality Assurance Project Plan (QAPP) (Task 1);
- Participate in a project kick-off meeting and monthly conference calls (Task 2);
- Assist EPA with the formation and management of a TSC comprised of members with expertise in a wide variety of disciplines. Work with EPA to inform and solicit guidance and feedback from TSC members (Task 3);
- Develop future land cover data for Taunton River sub-watershed modeling and hydrologic response unit analyses (Task 4);
- Develop Enhancements to Opti-Tool to allow the simulation of green roofs and temporary runoff storage with IC disconnection (Task 5);
- Conduct modeling and analyses for projected future land development conditions at the sub-watershed and site-development project scales. Coordinate work performed under Task Order A and Task Order B (Task 6);
    - Conduct sub-watershed scale modeling and assess impacts of alternative management approaches using future land use conditions.
    - Develop and simulate site-scale alternative management approaches.
    - Develop and implement rules and assumptions that can be used to translate site-scale results to the sub-watershed scale.
    - Complete final project report and project summary overview.
- Present project results via webinar to SNEP region (Task 7).

This project will rely on a set of analytic tools, including spreadsheet tools, GIS, System for Urban Stormwater Treatment and Analysis IntegratioN (SUSTAIN), and the Opti-Tool. The model development process can be a good platform for gaining valuable information and insight into a natural system. If well-designed, the model development process is an iterative and adaptive cycle that improves understanding of the natural system over time as better information becomes available. Ultimately a model can inform future data acquisition efforts and management decisions by highlighting factors that have the most impact on the behavior of a natural system. A well-designed model development cycle is conceptually circular allowing for feedback loops at key points. This development cycle was largely completed in FDC1, however, this project also includes a considerable modeling effort using the spreadsheet-based Opti-Tool developed by EPA Region 1.

Opti-Tool is a stormwater best management practice optimization tool for use by municipal stormwater managers and consultants. The tool supports the development of technically sound, robust, and optimized cost-effective stormwater management plans, which can demonstrate accountable progress and compliance with stormwater Municipal Separate Storm Sewer System (MS4) permit requirements.

The Opti-Tool provides the ability to evaluate options for determining the best mix of structural best management practices (BMPs) to achieve quantitative water resource goals specific to New England, EPA Region 1 states. The tool incorporates long-term Hydrologic Response Unit (HRU) runoff and pollutant load time-series for regional climate conditions that are calibrated to regionally representative stormwater data and annual average load export rates from nine (9) major land uses. Opti-Tool also incorporates regionally representative BMP cost functions and regionally calibrated BMP performance parameters for pollutants including total phosphorus (TP) and total nitrogen (TN), to calculate long-term cumulative load reductions for a variety of structural controls (USEPA 2016).

Opti-Tool was updated during FDC1 to include groundwater components comparable to those found in the EPA SUSTAIN model. Water can now infiltrate to 'active groundwater storage' and move laterally and contribute to baseflow, percolate to the deeper groundwater or leave the groundwater through plant uptake. Opti-Tool will be further refined in this project to allow the simulation and cost-benefit analysis of green roof technologies and temporary runoff storage (e.g., cistern).

A.6.1 Electronic Data and Administrative Record

Our team will maintain an ongoing, updated inventory of all data compiled (and how/if it is being used), all studies reviewed, all GIS data collected, all derived GIS products, all model input and output files (including calibration and validation calculations), all draft and final products (electronic and hard copies), and project communications. All materials will be delivered to USEPA at the project close per the schedule in Table A-2.

A.6.2 Schedule

Table A-2. Project Schedule.

Project Elements/Sub-Tasks	Deliverables
Task 0: Work Plan, Budget, and Schedule	
Draft work plan, budget, and schedule	10/22/2021
Final work plan, budget, and schedule	11/19/2021
Task 1: Prepare Quality Assurance Project Plan	
Prepare draft QAPP	10/22/2021
Final QAPP	12/31/2021*
Task 2: Project Management and Administration	
Kickoff meeting and summary	10/28/2021*
Monthly progress calls and summaries	Monthly
Task 3: Technical Steering Committee Meetings	
TSC Meeting 1: Completion of draft work plan	11/11/2021*
TSC Meeting 2: Completion of draft project report	9/15/2022*
Task 4: Develop Future Land Cover Data for Taunton River Sub-Watershed Modeling and Hydrologic Response Unit Analyses	
Draft technical memo	12/17/2021
Final technical memo	12/31/2021
Task 5: Opti-Tool Enhancements: Green Roofs and Temporary Runoff Storage with IC Disconnection	
Draft technical memo	12/17/2021
Final technical memo	12/31/2021
Task 6: Modeling Analyses for Projected Future Land Development Conditions at Sub-watershed and Site-Development Project Scales	
Draft project report and project summary overview	8/26/2022
Final project report	9/30/2022
Task 7. Project Webinar to SNEP Region	
Draft presentation slides	9/23/2022
Webinar presentation	9/30/2022*

*=tentative, to be finalized in consultation with EPA

As needed, 1 call each month

A.7 Quality Objectives and Criteria for Measuring Data

This QAPP is intended to ensure that any collected information is of the quality necessary to support USEPA in the tasks described above. This support may include a review of existing data; collection and review of additional data; performing data analyses in spreadsheets, databases, and models; and project deliverable review. The data quality criteria and/or quality control for each of these activities are outlined in the following subsections. While datasets may be added during the project, Table B-1 provides a list of starting datasets that will be used in this project:

A.7.1 Data Compilation and Information Collection

In support of this project, the GLEC team will review existing data and collect/review new data (e.g., readily available GIS datasets, climate datasets, etc.). We will review local and regional governmental and non-governmental sources for available land use, flow gauging, and hydrologic data. GLEC will not perform sampling as part of this Task Order. Factors that the GLEC Team will

consider in reviewing gathered information for use in the calibration and development of the models are described in Table A-3.

Table A-3. Factors considered when reviewing gathered information for model development

Quality Criterion	Description/Definition
Accuracy	All (100 percent) data will be proofread to ensure accurate data entry into any data tables, spreadsheets, or databases.
Completeness	All data collected or received into any data tables, spreadsheets, or databases will be checked to ensure the presentation of results is complete.
Comparability	Data from different locations or within a single field site will be compared by checking methods used to collect the data and that the units of reporting are standardized.
Relevance	Data sources specific to the topic being investigated will be considered for use. Sources that most closely represent the topic/data of interest are the most relevant.
Reliability	The information/data source is reliable. For example, this criterion includes at least one of the following acceptance specifications: • The information or data is from a peer-reviewed, government, or industry-specific source. • The source is published. • The author is engaged in a relevant field such that competent knowledge is expected (i.e., the author writes for an industry trade association publication versus a general newspaper). • The information was presented at a technical conference where it is subject to review by other industry experts. • The documented quality assurance program for various information will be reviewed to assess the data's precision and accuracy. Data limitations that are identified in the quality assurance program will be included in model reporting to properly present results in the context of the uncertainty associated with the input data.
Representativeness/Content	The information/data source is represented in its content. Examples of source content can include the extent of data (e.g., what geographical area does it cover, over what period) and level of documentation describing the generation of the data.

A.7.2 Opti-Tool and Other Analytical Tools

All Opti-Tool and other analytical spreadsheets will undergo review by technical/project staff other than the original spreadsheet developer. The responsibilities of the technical reviewer are to verify that the technical approach and procedures used in the spreadsheet are reasonable and logical, verify that the spreadsheet documentation is complete and clear, and verify that calculations and results are accurate by manually verifying equation cells. Project staff will document the technical review of spreadsheets. The technical reviewer will provide a written summary of the data checked, errors or problems found, and recommendations for revisions. This summary may be provided separately or included in a QA worksheet in the spreadsheet workbook. Additional discussion of model calibration and proposed Data Quality Objectives (DQOs) specific to Opti-Tool inputs and outputs are presented in Section B.7.

A.7.3 Deliverable Review

The GLEC Team has an established internal QC review procedure for all deliverables (memoranda, spreadsheets, etc.). Table A-4 shows the levels of review that the GLEC Team requires for various

types of deliverables. At the direction of the USEPA TOCOR, GLEC will deviate from these levels of review to accommodate situations where there is limited time and/or budget.

Table A-4. Summary of required review levels by type of deliverable

Work Product	Degree of QC Reviewer Involvement			
	Team Member / Technical Reviewer	Project / Modeling QA Manager	Technical Editor	Senior Manager
Internal project documentation, including modeling and GIS products	●	--	--	●
Methodology development	●	--	●	●
Papers, reports, technical memos, and all project deliverables	●	●	●	●
QA Project Plan (QAPP)	●	●	--	●

The GLEC Team conducts technical tasks and prepares deliverables using in-progress/interim deliverable reviews and final product reviews. The quality of intermediate products and draft deliverables are evaluated as these work products evolve. Progress reviews include a check on calculations and data and reviews of draft documents. Draft and final deliverables are reviewed by an independent senior manager and a technical editor before delivery to USEPA.

A.8 Special Training Requirements/Certifications

Work processes performed under this TO may require experience, advanced training, or academic degrees in such topics as environmental science, computer science, data management, GIS, statistics, engineering and SCM principles, and watershed management. The requirements will vary depending on the portion of the project that a staff member is assigned. All staff proposed to work on this project are trained and have a professional proficiency with the following skills that will be utilized in this project:

- Database management, basic database skills using such packages as Microsoft Excel or Microsoft Access and basic GIS skills;
- Experience in developing and reviewing datasets for model development;
- Experience with application and development of the HSPF/LSPC, SUSTAIN, and Opti-Tool models;
- High-level geospatial analysis using a variety of GIS software; and
- Strong science background and knowledge of major USEPA programs, including the Clean Water Act (CWA), and other major natural resource and water quality laws.

The GLEC Team PMs will be responsible for ensuring the qualifications of their respective staff. All staff participating in this project will be qualified and have previous experience with the skills required for the assigned task. The GLEC Team does not expect to collect or review any confidential business information (CBI) under this Task Order; however, all project staff will strictly adhere to all USEPA procedures when handling industry information and will coordinate with the USEPA TOCOR to ensure that CBI is not used or disclosed.

A.9 Documents and Records

Thorough documentation of all project activities will be a priority for the GLEC Team. We understand the need for document control for review, version control, and the development of an accurate electronic library and administrative record. Our team retains and stores all project documents and communications, including modeling input and output files that will be necessary for the review of the study results.

Data and assumptions used to develop project models will be recorded and documented in the draft and final reports and memos as well as internal approach and preliminary results documents. We will document and save the results of technical reviews, model tests, assessments of output data and audits, actual input and databases used, and our responses to comments in model development.

The GLEC Team will deliver the project files that will contain copies of project documents and data, including model input and output datasets. The GLEC Team will deliver those files to USEPA at the end of the project as part of the final deliverables outlined in the Performance Work Statement (PWS). The GLEC Team will maintain files, as appropriate, as repositories for information and data used in models and for the preparation of any reports and documents during the project. GLEC will distribute the approved QAPP and any updates to the approved QAPP to project staff on the distribution list (Section A.3).

It is expected that most project information will be stored as electronic files, although there may be cases where data is stored as a hard copy. An example is a previous study that only exists as a hard copy and whose conversion to a digital version is overly cumbersome. The following outlines the kinds of information and data that will be included in the hard copy or electronic project files in the administrative record:

- Reports and documents prepared, including the draft and approved QAPP;
- Electronic copies of model input/output;
- Electronic data files, including physical measurements, land use data, and any watershed data;
- Electronic copies of all GIS data, including derived products (some of this will likely be delivered via external hard drive or other electronic media based on the size of the files);
- Maps, photographs, and drawings (if applicable);
- Results of internal technical reviews, model tests, data quality assessments of output data, and audits;
- Studies, reports, documents, and newspaper articles about the project (hard copy and electronic—hard copy documents may be scanned depending on size); and
- Contract and project information.

The GLEC Team will also prepare monthly progress reports that will address task and subtask milestones, deliverables, adherence to schedule, and financial progression at the end of each full month while the TO for this project is open.

The modeling software to be used on this project consists primarily of the USEPA developed Opti-Tool. The code and executables to be used are publicly available from USEPA. Any other post-

processed model outputs (primarily Microsoft Excel-based) will be included with final electronic deliverables.

B. MEASUREMENT AND DATA ACQUISITION

Only sections B.9, and B.10 are included with this QAPP. The remaining sections are not relevant to this QAPP.

B.1 Sampling Process Design (Experimental Design)

This section does not apply to this QAPP.

B.2 Sampling Methods

This section does not apply to this QAPP.

B.3 Sample Handling and Custody

This section does not apply to this QAPP.

B.4 Analytical Methods

This section does not apply to this QAPP.

B.5 Quality Control

This section does not apply to this QAPP.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

This section does not apply to this QAPP.

B.7 Calibration

Model calibration occurred during FDC1. This section does not apply to this QAPP.

B.8 Instrument/Equipment Calibration and Frequency

This section does not apply to this QAPP.

B.9 Data Acquisition (Non-Direct Measurements)

Non-direct measurements (i.e., secondary data) are data that were previously collected under a different effort outside this Task Order. Non-direct data can come from numerous sources, but the non-direct data most likely to be used for this project will originate from the previously completed FDC1 in the form of model output timeseries. Additionally, non-project-generated data may be obtained from published or unpublished sources. The published data are likely to have had some form of peer review. These data are generally examined by modelers as part of a data quality assessment. Databases that have not been published are also examined in light of a data quality assessment. The GLEC Team will confirm that data provided by USEPA or other sources meets precision objectives established by those entities. A preliminary list of secondary datasets identified through a review of the PWS, and development of the Work Plan are presented in Table B-1.

Table B-1. Inventory of non-direct measurement datasets to be collected under this Task Order

Source	Dataset	Purpose
New England Landscape Futures Project	Land-Cover Change Scenarios for Massachusetts 2010-2060	Provide datasets for future land use.

The quality of data used for this project is addressed, in part, by the training and experience of project staff (as described in Section A.8) and the documentation of project activities (as described in Section A.9). This QAPP and other supporting materials will be distributed to all personnel involved in this project. Mr. Craig (Paradigm QA Manager) and Mr. Riverson (Paradigm Modeling QC Officer) will ensure that all tasks described in the Task Order are carried out following this QAPP.

GLEC Team personnel performance will be reviewed throughout each of the project phases to ensure adherence to project protocols. QC is defined as the process by which QA is implemented in the project. GLEC Team personnel will conform to the following guidelines:

- All activities that include data interpretation and computation are subject to audit, peer review, or both. GLEC Team personnel will maintain careful written and electronic records.
- A written record of where the data used in the project analyses were obtained will be kept, and any information on data quality will be documented for inclusion in the final report. A written record of where this information is located on a computer or backup media will be maintained in the project files.
- GLEC Team personnel will evaluate the quality of all existing data. When existing data are published with an accompanying report, document, or other metadata describing data quality, data quality will be inferred from statements made in the accompanying documentation. It is not expected that data with only inferred quality will impact the goals of the project, such data will be used primarily as supporting information. If the quality of a data source cannot be determined at all, it will not be used. Additionally, existing data values incorporated into the Opti-Tool model or report will be verified against the source data (i.e., transcription checks).
- Non-modeling data (e.g., watershed characterization and data assessment) will be checked through technical reviews. As an example, a table presenting future land use/land cover areas and percentages will be checked by ensuring that the individual areas equal the known total watershed area.

B.10 Data Management and Hardware/Software Configuration

Secondary data collected as part of this TO will be maintained as hardcopy only, both hardcopy and electronic, or electronic only, depending on their nature. In some cases, hardcopy reports will be scanned and/or digitized if they are not too large or in a condition that precludes easy scanning or digitization. If scanned, the document will be included in the electronic repository. Our team routinely deals with large amounts of data from diverse sources and in multiple formats. We are experienced at managing and storing information in an orderly fashion to avoid the production of

conflicting or duplicate data and to allow for the efficient transfer of project files and administrative records in a timely and accurate manner. The GLEC Team will perform general quality checks on the transfer of data from any source database to another database, spreadsheet, or document. Other activities related to model development, such as verifying continuity of boundary conditions and observed data during calibration, will be performed per direction from the project QC Officer.

The Opti-Tool modeling software will be the primary model used for this project, and the code, executables, and project documentation are all readily and publicly available from USEPA.

The nature of the GLEC Team's work requires that we possess and maintain a variety of state-of-the-art computer resources. All of our team's computer resources are covered by on-site maintenance agreements. We also possess computer redundancy to ensure resources are always available. If a problem with a computer or server occurs, our computer specialists diagnose the problem and correct it. Routine maintenance of computers and servers is performed by in-house computer specialists. All computers are connected to a surge suppressor to protect them from damaging voltage spikes. The GLEC project files are stored on the company network server which is backed up nightly. Screening for viruses on electronic files loaded on computers or the network is standard company practice, and every machine has the latest updated antivirus installed. Regular maintenance, and updates if necessary, of software, are performed to keep up with changes in computer storage, media, and software.

C. ASSESSMENT AND OVERSIGHT

The QA program for this TO provides a framework to oversee the quality of work being released to clients. It consists of QC reviews, QA audits, and technical reviews. QC is the process of checking specific work products completed for a task. QA audits provide a method for checking that work performed follows established procedures. Audits help to standardize the product that is provided to the client. Finally, technical reviews ensure the accuracy of reports that are published for or delivered to the client.

C.1 Assessment and Response Actions

The GLEC Team will use secondary data discussed in Section B.9 for the development of model inputs. The Paradigm Modeling Quality Control Officer (QCO), Mr. Riverson, will examine the representativeness and comparability of project-generated input and output data.

The QA program under which this TO will operate includes surveillance, with independent checks of the data obtained from sampling, analysis, and data-gathering activities. The essential steps in the QA program are as follows:

- Identify and define the problem;
- Assign responsibility for investigating the problem;
- Investigate and determine the cause of the problem;
- Assign and accept responsibility for implementing appropriate corrective action;
- Establish the effectiveness of and implement the corrective action; and
- Verify that the corrective action has eliminated the problem.

If problems arise in the process of completing the aforementioned activities, the GLEC PM will determine the appropriate long-term or short-term action to be taken. Steps to address the problem

could include investigation and determining the cause of the problem, implementing corrective action, and following up with team members to ensure that the appropriate corrective action has been taken and that the problem has been resolved. If these steps do not adequately address the problem, the GLEC QAO will be responsible for corrective action and will inform the GLEC PM as appropriate.

GLEC will prepare monthly progress reports and provide them to the TOCOR. These progress reports will describe the status of the project and work completed, including any identified problems with remedies, as well as anticipated work to be completed during the next reporting period.

C.2 Reports to Management

Individual assignment status will be reported monthly to the PM by each staff member. These reports will be submitted at the beginning of the month and will cover the previous month's activities. The PM will compile inputs from all project staff and create a monthly report for their task order that will be reviewed by the GLEC PM. The monthly report will be edited and formatted by the document preparation staff before submission to the TOCOR. All QC documentation forms will be signed by the Project Manager. This will ensure that the Project Manager is kept informed about QA/QC problems that may exist within the project.

D. DATA VALIDATION AND USABILITY

D.1 Departures from Validation Criteria

Data review is an internal check performed to ensure that data have been recorded, calculated, and transmitted correctly by checking original records, transcription, and calculations for errors (USPEA 2002). The GLEC Team will perform a proof-read level check (i.e., 100% check) for all data transcribed from existing data sheets, field notebooks, literature sources, and other data sources to work assignment products (e.g., spreadsheets models, databases, reports). QC reviews will be an ongoing effort during the project execution and will be documented in the monthly progress reports. The GLEC Team Program Manager and Project Manager will be responsible for the review of data.

Data verification is the process of evaluating the completeness, correctness, and conformance/ compliance of a specific data set against the method, procedural, or contractual requirements (USPEA 2002). The GLEC Team will compare the data to the data quality criteria presented in Table A-3 and identify any data that do not meet the requirements. The GLEC team Project Manager, or his designee, will be responsible for data verification.

D.2 Validation Methods

Data validation is an analyte and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. No data validation will be performed because no sample data will be collected as part of the work assignment.

D.3 Reconciliation with User Requirements

All data quality indicators will be calculated after the data analysis phase. Measurement quality requirements will be met and compared with the DQOs to confirm that the correct type, quality, and quantity of data are being used for the analyses. The Paradigm QCO (Mr. Riverson) will perform

internal reviews to assess departures from assumptions established in the planning phase of the modeling process. If requested by the USEPA TOCOR and funding is available, the GLEC Team will perform a post-audit for the project. A post-audit is an evaluation of the correctness of the initial model predictions conducted several years after the original modeling study is completed. If the models' predictions are deemed to be representative of the natural system, the model can be considered valid for making management decisions at the specific site and the actual stresses. A post-audit requires new field observations for the predicted variables, which are to be collected at a time after the system has had a chance to adjust to the management changes. Uncertainties and limitations in the use of such data and interpretation of results will be provided to USEPA.

E. REFERENCES

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