ERG

ECHO Quality Assurance

Prepared for:

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February 7, 2019

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1. INTRODUCTION

EPA's Enforcement and Compliance History Online (ECHO) site provides environmental compliance and enforcement data to the public and to government employees. Following ECHO's launch in 2002, demand has increased for access to environmental compliance and enforcement data. In addition, the breadth of information and the types of entities requesting the information have expanded. ECHO users include the general public, regulated entities, non-governmental organizations, press, all levels of government regulators, and academic researchers. ECHO supports the agency's "Improve Transparency" enforcement goal. ECHO was modernized in 2013 and 2014 and now operates more efficiently. In addition to providing enforcement and compliance data to the public, ECHO provides access to data analysis and program management tools. ECHO must continue to grow in utility, improve in performance, operate reliably and efficiently, and stay relevant.

ERG is supporting EPA by conducting the following tasks:

- Providing operation and maintenance support for all interfaces and associated reports, including public ECHO features and restricted ECHO features (ECHO Gov);
- Web designing, developing, and documenting of new ECHO and ECHO Gov web queries and reports; and
- Developing and maintaining ECHO data tables; extraction, transformation, and loading (ETL) flows; and web services.

This document details the quality specifications and verification methods used to assure ECHO's quality and is responsive to all applicable elements of *EPA Requirements for Quality Assurance Project Plans QA/R-5* (EPA, 2001). The organization of this document is as follows:

- Section 2   Project Management
- Section 3   Project Description and Objectives
- Section 4   Quality Criteria, Verification, and Reporting
- Section 5   Software Development and Testing Procedures
- Section 6   References

2.   PROJECT MANAGEMENT

This section addresses project management, including:

- Project organization and responsibilities;
- Special training and certification;
- Project records;
- Assessment of the implementation of the ECHO Quality Assurance Project Plan (QAPP).

2.1   Project Organization and Responsibilities

Project Organization is depicted in Figure 2-1 for staff with program management and technical responsibilities and those with QA/QC roles. It shows the relationship and lines of authority, reporting, and communication among all project participants, including those from EPA.

The ERG Call Order Project Manager (COPM) is the principal contact for the EPA Call Order Contracting Officer's Representative (COR) on project issues, deliverables, and schedule. The ERG COPM will be responsible for:

- Ensuring that the quality of work, schedule, and budget meet the requirements of the ECHO project;
- Providing technical direction to ERG staff and managing the daily activities on the project;
- Maintaining the official, approved QAPP;
- Obtaining appropriate technical review of all deliverables and ensuring deliverables conform to EPA's technical review requirements; and
- Keeping the Project QA Coordinator and the Program Manager advised of any quality problems that arise.

ERG's Project QA Coordinator is responsible for ensuring that the requirements of this QAPP are implemented and documented. The Project QA Coordinator will work with the ERG COPM in developing and executing QA activities throughout the project, including review of this QAPP, data review, software testing, and results reporting. The Project QA Coordinator will also ensure that the ERG COPM is obtaining appropriate technical review of all deliverables.

ERG's development team provides technical support for all programming, web development, and deployment activities. ERG's database analysts provide support for database, ETL, and web service development and maintenance. ERG project staff also support software and data quality testing, documentation, and user support.
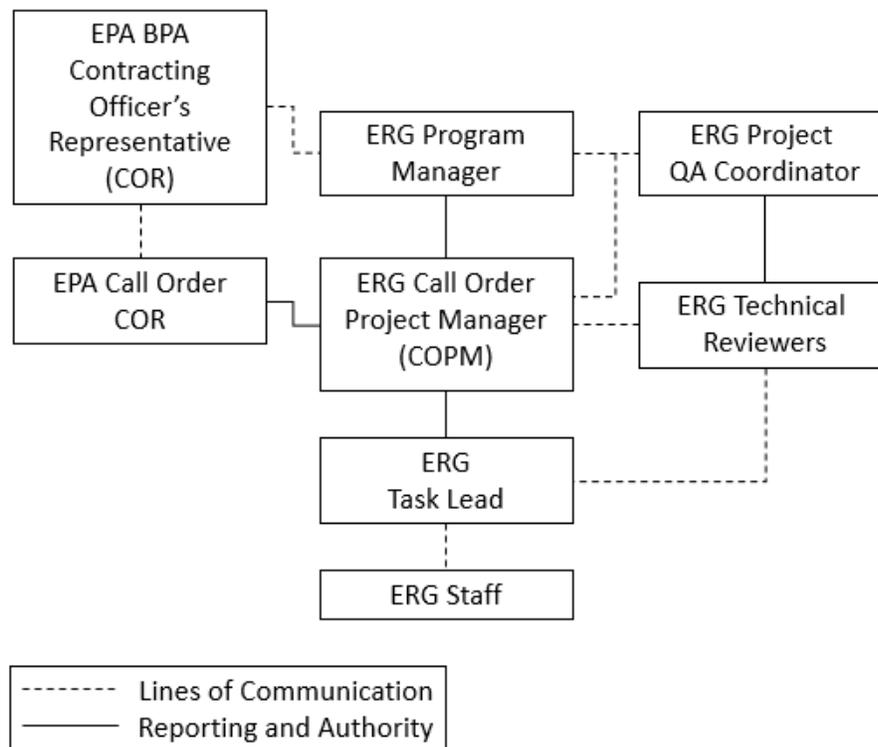
Figure 2-1. Project-Level QA Organization

2.2   Project Records

The ERG COPM is responsible for establishing and ensuring that version control is used for all project deliverables. Under this call order, the version of interim and working deliverables will be identified in the electronic file name using a dating scheme. Historical files will be kept and maintained in the project file on ERG's network. Final versions of documents will be identified in the electronic filename as "FINAL." These procedures apply to project deliverables such as requirements documents, design presentations, planning documents, Word versions of formal test cases, work plans, and technical progress reports. However, the majority of ECHO work products and deliverables are developed using tools that are external to the ERG network, which the EPA Call Order COR and other EPA technical staff can access at any time:

- Programming code: Developers work directly on EPA servers and maintain their code on ECHO development branches. Programming code is version controlled using Bitbucket.
- Help files and site documentation: ECHO documentation is developed, stored, tracked, and maintained in EPA's Drupal environment.
- ETL and web service code: Database developers work directly on EPA's database servers and store code updates in ECHO's Git repository.
- Automated test cases: Test cases are stored in EPA's GitHub repository.
- Design documents: To facilitate coordination among EPA and ERG team members and to maintain version control, design documents are developed using

collaboration tools, such as SharePoint and Confluence. The tools automatically track the revision history of the documents.

At the EPA Call Order COR's request, ERG will provide all electronic project files stored on ERG's network. At the conclusion of the project, ERG will retain a copy of project electronic files in the ERG archive.

2.3   Assessment of QAPP Implementation

ERG will conduct several stages of review during the planning and execution of this project to assess that the procedures outlined in this QAPP are followed. All tasks conducted and products generated receive (1) a conceptual review, (2) a developmental review, and (3) a final product review.

A **conceptual review** is performed during the initial stages of work development and ensures that the final product and associated documentation address the needs set forth by the EPA Call Order COR, the call order, and this QAPP. Conceptual review will be provided by senior analysts knowledgeable about web development, but not directly involved in the call order.

The quality of intermediate deliverables and final products is also evaluated as these work products evolve. This **developmental review** includes, for example, (1) checks on calculations and data quality and (2) reviews of draft deliverables to ensure that the direction of work is consistent with the conceptual review outline. A task lead or team member familiar with the work who did not perform the task will conduct a developmental review.

Final product technical review is conducted on all deliverables prior to delivery to EPA. Technical review is a documented critical review of work that has been performed within the "state of the art." ERG's COPM will conduct this review. In addition, reports and memoranda will be reviewed by a senior-level analyst not directly involved with the project. All deliverables will subsequently be reviewed by the EPA Call Order COR. Reviewer comments in tracked changes are stored on ERG's network in the same directory as the final document with the reviewer's initials in the file name. This provides a review history of the deliverable and documents reviewer comments.

ERG's Project QA Coordinator for this project or her designee will assess the implementation of QA/QC procedures on this project as follows:

- Review the QAPP (this document) for completeness and applicability; and
- Audit project files to ensure and verify the following:
    — That project staff have developed QC procedures and that these procedures are used; and
    — That project staff are documenting their use of these QC procedures by completing checklists, review spreadsheets, workflows, and other project-specific tracking methods.

Any quality deficiencies detected by technical reviewers or the Project QA Coordinator will be communicated, in writing, to the ERG COPM. The ERG COPM is responsible for

ensuring that appropriate corrective action is taken and reported to the Project QA Coordinator. The Project QA Coordinator will notify the ERG Program Manager if, at any time, she considers the project to have quality deficiencies and they are not being remedied in a timely manner. Upon notification, the ERG Program Manager will conduct a project review. If he or she concurs that the work is deficient, he or she may issue a stop work order until the deficiencies are remedied. The ERG COPM will be notified immediately should this occur.

ERG will include any reports of corrective actions in the project QA files. At any time or at the end of the project or call order, the Program Manager or her designee may inspect the project QA files.

2.4   <u>Project Status Reports for Management</u>

Monthly, ERG will electronically submit to the EPA Call Order COR and BPA COR a progress report that documents the costs incurred and work performed during the previous accounting period and work planned for the current accounting period. At the request of the EPA Call Order COR, ERG will provide a description of QA activities conducted for major project deliverables.

3.   PROJECT DESCRIPTION AND OBJECTIVES

This section defines the purpose of the project.

3.1   Problem Definition/Background

EPA's Office of Compliance (OC) created and modernized ECHO to:

- Increase public and government agency access to environmental compliance and enforcement data;
- Support the Agency's "Improve Transparency" Enforcement Goal; and
- Improve operation and maintenance efficiency of the ECHO website.

OC implemented ECHO modernization using a phased approach. The first phase of modernized ECHO primarily replaced existing functionality. Continued development of ECHO will build new tools and improve existing functionality based on user feedback and OC priorities. The overall objectives of the ECHO project include:

- Increase utility of ECHO by adding new data, query tools, and reports, including:
  - Incorporating modern technology and off-the-shelf products to promote cutting-edge data presentations, development and maintenance efficiencies, Web 2.0 concepts (including support for future mobile reports and applications), and ease of navigation;
  - Maximizing data availability, transparency, and usability for each target audience. This means that all presented data will be documented and available for download. Summary or calculated data will have drill downs to see the underlying data in calculations, and new web services will be built and documented to increase data usage;
  - Providing additional search features and data to support stronger inspection and enforcement targeting;
- Maintain and improve performance levels; and
- Ensure site operates reliably and efficiently, including:
  - Maintaining interface with ECHO DataMart at the National Computing Center (NCC));
  - Minimizing operation and maintenance costs by using efficient code and template design, including overall use of style sheets and web application framework; and
  - Implementing security best practices.

3.2   Project Description

ERG supported EPA in modernizing the existing ECHO content and features and provided O&M support for the modernized site. ERG's continued support of ECHO includes adding functionality enhancements and providing O&M support. ERG's support of ECHO involves using several tools which are described in Table 3-1. More information about the tasks that ERG will support is described below.

Table 3-1. ECHO Development Tools

Tool	Description	QA Purpose
Jira	Software used as part of agile workflow to plan, track, and release ECHO software.	Create, manage, and discuss issues and detailed tasks related to goals and milestones. Allows EPA to communicate potential issues.
Confluence	Content collaboration tool where users can create pages which can be commented on and edited by all members of the team. It is designed to integrate with Jira.	Allows EPA and ERG to collaborate on SOPs and software design documents and technical requirements for each ECHO page, query, and report.
Bitbucket	Web-based version control repository hosting service. It is designed to integrate with Confluence.	Centralized repository for application source code. Allows EPA and ERG to manage and review code changes. Version control.
GitHub	Web-based code repository used to store automated testing code.	Centralized repository for automated testing code. Version control.
Git	Server based, source code version control system located on EPA's development server, vmwhippet.	Centralized repository for ETL scripts. Version control.
Slack	Messaging application interfaced with GitHub.	Allows ERG to communicate in real time and ERG developers to have a centralized platform for code review and to track version control.
SharePoint	Web-based collaborative platform that integrates with Microsoft Office.	Centralized shared platform for tracking, changing, and creating documentation.
Selenium	Automated software testing framework for web applications.	Runs ECHO test cases. Detects functionality issues. Extracts results and maintains a testing log.
Soap UI	Automated web service testing application.	Runs ECHO web service test cases. Detects functionality issues. Extracts results and maintains a testing log.
Drupal	Content management system for EPA.	Built-in revision tracking. Enforcement of roles (editing, publishing).
Sitebeam	EPA's automated website testing software.	Scans site content for broken links, spelling and grammar errors, and accessibility issues.
Zendesk	Cloud-based customer service platform.	Macros for standardizing responses to common questions. Allows messages to be categorized and assigned.
Swagger	Open-source software used to design, build, and document RESTful Web Services.	Builds ECHO API output model for automated testing against Swagger definition for production REST services

Operation and Maintenance Support: ERG will assist EPA in providing on-going operation and maintenance support for all current and future ECHO and ECHO Gov interfaces and associated reports, including the following types of tasks:

- Implement enhancements and revisions to existing interfaces;
- Perform regular testing for functionality, data quality, security, and accessibility;
- Maintain current documentation, edit site content, and load documents onto ECHO; and
- Provide user support.

Web Design, Development, and Documentation: ERG will support EPA in designing, developing, testing, and documenting ECHO and ECHO Gov web queries and reports. This task

includes requirements gathering, design specifications and prototyping, integrated development environment architecture support, programming, testing, documentation, and deployment of new ECHO and ECHO Gov features. This task also includes coordination of development activities with the EPA technical lead and other EPA contractors.

Development of Data Tables, ETL, and Web Services: This task covers DataMart modifications and maintenance tasks needed to support existing ECHO and ECHO Gov tools, including the following types of tasks:

- Physical and logical design of data tables;
- Development and documentation of ETL data flows to extract data from the assigned source databases, transform the data, and load the data tables;
- Support of ECHO mapping capabilities within the database using Oracle Spatial and developing and supporting ArcGIS services;
- Documentation and automation of regular data refreshes;
- Development, deployment, and timely documentation of web services;
- Identification and resolution of performance bottlenecks in ETL and web services; and
- Database tuning to improve performance and efficiency

4.   QUALITY CRITERIA, VERIFICATION, AND REPORTING

This section identifies the quality specifications for ECHO products developed by ERG, including web queries and reports, DataMart ETL flows and web services, ECHO static content, and user support activities; how ERG will verify ECHO products against the specified criteria; and how ERG will communicate quality with the EPA Call Order COR.

4.1   Quality Criteria and Verification

Table 4-1 describes the quality specifications and verification methods for the ECHO web queries and reports, web services, database tables and ETL, static content, and user support processes to ensure ECHO meets the established standards.

Prior to development, ERG will develop software design documents (SDD) and technical requirement reports for each ECHO page, query, and report. This documentation is created and tracked in Confluence, which allows both ERG and EPA to collaborate on tasks and integrate with task tracking on ECHO's Jira board. Testers will refer to this documentation while performing testing to verify that the page implementation matches design and technical requirements.

In addition to ensuring that the ECHO site meets the technical requirements and SDD specifications approved by EPA, ERG will continuously monitor data quality through data review and data verification.

- **Data Review**. According to EPA's Guidance for QAPPs (QA/G-5), data review is "the in-house examination to ensure that the data have been recorded, transmitted, and processed correctly. That includes, for example, checking for data entry, transcription, calculation, and reduction errors… It is a completeness check to determine if there are any deficiencies, such as data missing…" The ECHO DataMart extracts data from established EPA data systems. Therefore, ERG assumes that the data sources are of sufficient quality for the ECHO site and does not perform an upfront data review to verify the quality of the source. If data quality issues, identified through site testing or data verification processes, trace back to errors in the underlying source data, ERG will report these data quality issues to the EPA Call Order COR.

- **Data Verification**. According to EPA's Guidance for QAPPs (QA/G-5), data verification is "the process of evaluating the completeness, correctness, and conformance of a specific data set against the method, procedural or contractual specifications." For this task, data verification means the process by which ERG will determine whether data compiled and summarized are accurate and complete. Table 4-1 describes the procedures that ERG will use to verify the output of ETL data flows, data services, and data presentation in ECHO.

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Web Queries and Reports		
Completeness	Includes all appropriate search options, data fields and records specified in the technical requirements.	Compare the page, query, and report elements to the list of elements specified in the software design document (SDD) stored in Confluence. Verify that all elements are displayed on the page as specified in the SDD.
Functionality	Queries execute and pages load without error. Behavior of user interface objects matches design specifications.	Click all links, buttons, and other user interface controls. Verify behavior matches SDD specifications.
Accuracy	Search results reflect the underlying web services, apply appropriate logic for selecting/interpreting service output, and display service output in appropriate fields/columns. All search criteria are captured in the web query's service call.	Compare values displayed in ECHO reports to results found by calling the web service directly. Confirm search criteria are displayed correctly on results pages. For reports that use visual data displays, review the underlying data services to ensure that the visual display is correctly capturing and interpreting the data.
Format	Output format is appropriate for data type.	Verify that the output format matches the SDD specifications. Check high- and low-end numeric values for appropriate number of digits/decimals.
Speed	ECHO queries perform at the same level or faster than historic tests.	Record the times required to return results for select test case using the production ECHO website. Run queries multiple times to obtain an average query return time for each of the test cases. Record and compare the times required to run the same test cases in the revised website.
Security	Information displayed on page matches the user role and permissions. Code complies with NCC security standards.	Use test user accounts to check user authorization and authentication on the site for public, government-only, EPA-only, and Enforcement Sensitive user types. Test the ECHO login, site display, and secondary menus against the SDD specifications for the different levels of access to ensure that the proper page elements and features are displaying for each user type. Submit all code to NCC security review prior to production deployments. Respond to issues, as needed.
Accessibility	All pages, queries, and reports meet Section 508 Accessibility requirements.	Complete the Accessibility checklist[1] for each ECHO page, query, and report. ERG accessibility experts will periodically conduct an external accessibility review of new designs and features.

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[1] http://www2.epa.gov/sites/production/files/2013-09/documents/eit-procurement-checklist.pdf

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Browser Compatibility	All pages, queries, and reports function consistently in target browsers.	Test the ECHO site in Internet Explorer 9, 10 and 11, Chrome, and Firefox. Address browser incompatibility issues according to priorities set by the EPA Call Order COR. Test the ECHO site on desktop computers, and emulators representing laptops, tablets, and smart phones.
Web Services/Site Data Quality		
Completeness	Service includes all input parameters for all search options and output tags for all results.	Perform direct service calls using the list of parameters and expected inputs from the SDD. Verify output tags match the SDD list.
Accuracy	Services correctly applies data transformations and calculations. Service correctly applies query criteria.	Verify that summary information and statistics accurately reflect the underlying detailed data. Service output contains data for all expected elements based on query criteria (e.g., service has RCRA IDs for all facilities if query specified "facility must have RCRA ID").
Format	Output format is appropriate for data type.	Verify that the output format matches the SDD specifications.
Reasonableness	Number of records returned by query matches expectations established by legacy ECHO results and historic tests. Maximum and minimum values fall within the range of reasonable results.	Compare search and query results to documented expected results from the legacy site and results of previous test cases. Test search results and reports against expectations established by team members familiar with the underlying data and subject matter (e.g., industries or states expected to return a large number of results). These expected results are documented in the formal test cases.
Comparability	Search results from one query (e.g., All Data Search) are consistent with results generated from other queries in ECHO (e.g., Summary information on a Detailed Facility Report). Trends reports show reasonable year-to-year variability.	Compare results for different reports in ECHO. For example, verify that compliance status information on the facility search results is consistent with the Detailed Facility Report. Compare ECHO results to other web applications for consistency, such as Envirofacts, TRI, and the DMR Pollutant Loading Tool.
Speed	ECHO services perform at the same level or faster than historic tests.	Record the times required to return results for select test case using the production ECHO web services. Run queries multiple times to obtain an average query return time for each of the test cases. Record and compare the times required to run the same test cases in the revised web services.

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Application Source Code		
Readability	Adheres to internal coding standards, which are available to all developers from ECHO Confluence wiki.	Production ready code changes are reviewed by lead developer for adherence to the code quality standard. Standards are revised and expanded when appropriate.
Security	Custom application code is written to mitigate potential security issues, such as Cross-Site Scripting (XSS) and Cross-Site Request Forgery (CSRF). Modifications and additions to custom application code do not negatively impact the overall security of the ECHO system.	Production ready code changes are reviewed by lead developer for adherence to security standards.
Speed	Custom application code is written to optimize page load time and appropriately balance new features. Modifications and additions to custom application code do not negatively impact the overall performance of the ECHO system.	Record the times required to return results for select test case using the production ECHO web services. Run queries multiple times to obtain an average query return time for each of the test cases. Record and compare the times required to run the same test cases in the revised web services.
Data Tables and ETL		
Completeness	Scope of data in final tables (e.g., geographic coverage, reporting programs, pollutant coverage, industry coverage, facility counts) matches scope of source data, except for intentional exclusions.	Review statistics of final output tables, such as total number of records, records by state, SIC/NAICS code, reporting program, or pollutant as appropriate for the data set. Compare to statistics for source data tables. After any modification to the ETL code, review output table statistics to the previous output to ensure consistency.
Functionality	All scripts, procedures, and views compile and execute without error.	Perform unit testing on scripts and procedures to ensure they complete without error. Compile all invalid objects and address errors.
Accuracy	Data transformations and calculations have been correctly applied (e.g., aggregated values can be verified against the raw data). Data outliers can be verified in source data.	For data outliers, review underlying data and verify calculations and transformations by hand. Ensure accuracy of source data by comparing outliers to the source database or website.
Integrity	All data table records are unique and relate appropriately to other data tables.	Database schemas include appropriate constraints (e.g., primary keys, foreign keys).

Table 4-1. Quality Specifications and Verification Methods for ECHO

Quality Criterion	Specification	Verification Method
Speed	Large database tables are structured appropriately to optimize performance.	Review data tables to ensure indexes are applied to columns appropriately and are using the appropriate type of index (e.g., bitmap indexes are applied to low-cardinality columns). Ensure table statistics are analyzed and up to date.
	Modifications and additions to ETL process do not negatively impact the overall performance of the ECHO refresh.	Run time trials prior to integrating new ETL with ECHO refresh. Output timestamps to monitor how long database takes to complete each processing step. Review output to identify process bottlenecks.
Static Pages and Site Documentation		
Currency	Help content reflects most recent updates to web queries, reports, and web services.	Content editors use Jira to monitor developer tasks for updates that affect help content.
Format	Content follows EPA web styles. HTML formatting and commands follow ECHO guidance.	Content editors audit recently edited content for web style standards. Content editors periodically run module that scans for redundant HTML.
Functionality	Links to other pages and documents function properly.	Content editors test links after publishing content. Content editors review EPA's Sitebeam reports for broken links and missing files.
Accuracy	Content accurately describes ECHO data sources and query logic. Site does not contain typos or spelling errors.	Content is reviewed by another ERG team member before being published in Drupal. Content editors review Sitebeam reports for spelling errors.
Accessibility	All content meets Section 508 Accessibility requirements.	ERG will complete the Accessibility checklist provided in the Technical requirement report for each ECHO page. ERG will review the Sitebeam report for accessibility recommendations. In addition, ERG will periodically conduct an external accessibility review of static content and documentation.
User Support		
Timeliness	Respond to all inquiries within 48 hours.	Team members check timestamp within help system interface to ensure all tickets are acknowledged or closed within the specified time period.
Accuracy	Responses are accurate based on current knowledge and available documentation, provide appropriate level of detail, and have a formal, but friendly tone.	Responses to frequently asked questions use standard, EPA-approved language. Non-standard responses receive review by another ERG team member. Advanced technical questions are elevated to the EPA Call Order COR.

4.2   <u>Quality Reporting</u>

ERG uses Jira, a web-based agile task management tool, to create, manage, and communicate tasks across the ERG and EPA ECHO teams. ERG and EPA use an agile development process adapted for the ECHO project workflow. Agile software development allows evolving requirements and solutions which progress iteratively through software development activities. These activities are implemented in short incremental phases, called "sprints," which are tracked in Jira. ECHO sprints are typically two weeks long.

All teams members may create Jira "issues", which are incremental, actionable tasks such as new features, enhancements to existing functionality, bugs identified during testing, or design and documentation tasks. The EPA Call Order COR is responsible for creating sprints and assigning issues to a sprint. Issues that are not assigned to a sprint are placed in the "backlog", where ECHO team members can refer to for future planning purposes.

Once issues are assigned to a sprint, the ERG team meets and distributes them across individuals based on technical proficiency and task responsibility. The individual assigned to a task assigns story points to reflect the amount of work each task represents. Story points allow ERG and EPA to assess and discuss the level of effort for a task and, as appropriate, refine the task or redistribute work as needed to ensure the development priorities can be met.

Once a sprint begins, the individual assigned to an issue (typically software developers and testers) are responsible for moving these issues on the Jira "sprint board" to reflect real-time status. Figure 4-1 and Figure 4-2 illustrate how ERG uses the Jira board to organize and track the workflow. Developers move issues into "Ready for Testing" once they have completed the requirements. Testers verify the updates and identify any issues that impact the user interface or web services based on the requirements. If any issues are identified during testing, testers document the issue, providing test steps and examples and moving the issue back to the "To Do" status. Developers are responsible for addressing any issues and retesting before indicating the issue is again "Ready for Testing." Each issue will follow this process until it is successfully tested in all three development environments: development, staging, and production (ECHO development environments are described in Section 5.1).

Prior to deployment, ERG testers communicate any remaining critical issues to the EPA Call Order COR via email or during weekly status meetings. The EPA Call Order COR determines whether the website is of adequate quality for deployment. After the website is approved for deployment, ERG drafts the list of known issues in Drupal for posting on the public ECHO website. The EPA Call Order COR prioritizes the outstanding issues for future development sprints or the backlog. Once updates are deployed and the issues are verified on the production environment, ERG ends the sprint.

Documentation of the manual testing and status of each issue is maintained in EPA's ECHO Jira instance. ERG maintains a history of automated test cases performed and their results (as described in Section 5.3.5) for each ECHO code deployment on ERG's network or EPA's GitHub repository. ERG developed Jira SOPs, which document the workflow, roles, and expectations for ECHO team members. The Jira SOPs are maintained in ECHO's Confluence

space and will be periodically reviewed and updated, as appropriate, to reflect changes to the workflow.

Figure 4-1. Example ECHO Sprint Board in Jira

```
Backlog
  ↓
EPA Call Order
COR assigns
issues to sprints
  ↓
ERG starts sprint.
All assigned issues
automatically
placed in "To Do"
```

ERG completes sprint. "Done" issues are archived. Open issues move to backlog or another sprint

Developer transitions issue to "In Progress"

Tester transitions issue to "Done"

Developer transitions issue to "Ready for Testing"

pass

fail

Tester reviews functionality in production environment

Tester reviews functionality in development environment

fail

pass

Tester transitions issue to "Confirmed on Staging"

Tester transitions issue to "Confirmed on Development"

fail

pass

Tester reviews functionality in staging environment

Figure 4-2. Jira Issue Management Process for ECHO Development Sprints

5.   **SOFTWARE DEVELOPMENT AND TESTING PROCEDURES**

This section describes the ECHO development workflow and testing and maintenance procedures.

5.1   Unit Testing

Individual developers will conduct unit testing as they code individual functions or blocks of code. Unit tests are written using Jest JavaScript testing framework and PHPUnit PHP testing framework. Although the developers do not generate a unit testing report and documentation, they are required to confirm the following before releasing materials for integration testing:

- Functional requirements are completely fulfilled for the pages in question;
- Functionality of new functions and methods is documented; and
- New code does not break any existing unit tests.

Unit Test SOPs are documented in Confluence and ERG developers are responsible for following and maintaining the standards. Developers use Confluence and Jira to track and complete specific unit test development tasks for ECHO. Formal unit tests were not developed during past work assignments, where ERG developers focused on updating and converting code for known functionality to modernize the ECHO website. As a result, ERG maintains a backlog of unit tests for JavaScript files and React components without unit tests. As directed or as appropriate, developers work on the tasks, and document their progress by tracking each task as an issue in Jira under the active sprint.

For new development, developers will write unit tests as they write code, and unit testing will be completed as part of the corresponding Jira task.

5.2   Integration Testing

The lead programmer (or designee) will conduct system testing by examining integrated units and modules, grouped as appropriate. During integration testing, the lead programmer will ensure that the new code addition does not impact the stable code base and that all parts of the integrated code function properly. ERG manages this process in Bitbucket by reviewing pull requests and in Slack by tracking commit notifications. If the pull request is approved, the lead programmer will merge code into the deployment branch. If the pull request is not approved, the developer who made the pull request is notified of any bugs identified during testing and will revise and retest the code. The lead programmer will also review code to ensure that it meets design specifications, as described in the SDD and/or technical requirements report. These documents will be drafted by ERG and reviewed and approved by EPA prior to development of a particular feature.

5.3   System Testing

An ERG testing team will conduct system testing to verify that the code functions as expected. The ERG testing team will perform test cases to evaluate the website code against the quality criteria described in Section 4. ERG testers will communicate any issues to the ERG

programming team to identify and correct the source of the error. ERG will retest code following revisions. ERG testers will also test searches and reports on ECHO's production site for each production release and will communicate any issues to the EPA Call Order COR through the ECHO Jira board. Individual test cases will specify:

- Scenarios users are expected to execute;
- Values that should work in each scenario;
- Values that should return errors;
- The appropriate error messages according to the type of value;
- Output to be checked against expected values;
- Levels of access to be tested; and
- Any other relevant functional or technical specifications.

5.4 **User Acceptance Testing**

The ERG COPM coordinates with the EPA Call Order COR to determine when the website is of adequate quality for user acceptance testing (UAT). The EPA Call Order COR coordinates UAT, collects comments, and prioritizes comments to be addressed in future development cycles. UAT comments will be documented in Confluence and the EPA Call Order COR will create Jira tickets for comments that will be addressed in future development cycles.

5.5 **Automated Regression Testing**

ERG testers will maintain automated test cases and conduct an automated testing procedure on a regular basis to verify the ECHO front end interface as well as web services. Automated test cases are maintained on EPA GitHub repositories to assure version control. The latest available results of automated front end and web service testing are documented on ERG's local network.

Front end test cases will test ECHO features by automatically running test steps in the web browser. Front end test cases are developed using the Geb Selenium browser automation framework. Front end test cases produce an HTML report containing test results, including any errors that occurred. The latest test report will be maintained in the GitHub repository as documentation. Testers will review the HTML logs for errors, manually investigate and confirm the errors, and report error details to the EPA Call Order COR. A summary of front end tests is documented in the ECHO Confluence space. (See Appendix A for a formal front end test case example documented in plain language).

ERG conducts front end automated testing on the staging environment prior to requesting NCC code reviews on ECHO or ECHO Lab (typically every two weeks). ERG will also conduct front end automated testing on echo.epa.gov after each software release, and within the ECHO Lab environment after significant code merges.

Web service test cases will verify all ECHO web services for data quality. Web service test cases are developed based on ERG's formal ECHO test cases, informal ECHO testing knowledge, and Jira tickets that describe ECHO DataMart data quality issues. ERG will continue to create new and maintain web service test cases using the SoapUI automated testing software. The web service test cases produce testing result files that describe data quality issues. Testers

will manually review the results, investigate any data quality errors, and report issues to the EPA Call Order COR. Documentation describing web service test cases is maintained on ERG's local network and in the ECHO Confluence space.

ERG conducts web service automated test cases on a weekly basis, consistent with the ECHO DataMart weekly refresh schedule.

ERG also uses Swagger software to test ECHO production web services daily by using forms of the JSON schema to model the output produced by ECHO. The JSON schema that describes each service endpoint is tested against the current ECHO API output to verify if it matches. ERG reviews the results of the tests and discusses any detected failures with the ECHO team and EPA to either investigate potential service outages (services that do not respond during testing) or to make updates to Swagger documentation (typically to add search parameters).

5.6 Source Code Review and Documentation

ERG developers include 'developer comments' in the source code. Source code also adheres to internal coding standards to ensure code is reasonably self-documenting and readable. Comments enable future developers to understand the purpose and flow of each module. The ERG lead developer (or designee) reviews all changes to source code to ensure that the ERG programming team follows all coding standards and provided the appropriate level of detail in the documentation embedded in the source code.

5.7 ECHO Static Content

New and updated content will be drafted in the Drupal web content management system and reviewed by the EPA Call Order COR prior to publication. Revisions are automatically saved in Drupal to facilitate comparison of previously published content.

ERG team members will regularly review existing ECHO help pages and other documentation to ensure that help content is consistent with new development during each code release. ERG drafts and publishes minor updates accompanying code releases in Drupal (e.g., adding or modifying search results column descriptions). Content with substantial revisions is drafted for review by an ERG Editor, and as appropriate, the EPA Call Order COR.

Content created in ECHO follows EPA web styles. Since ECHO maintains a separate instance of Drupal from the EPA WebCMS, ERG developed a guidance page for creating ECHO content to clarify site-specific standards, such as content organization and restrictions. ERG will periodically review pages to make sure content, formatting, and organization are consistent with EPA web style and ECHO guidance. The location of a new page within the site organization will be approved by the EPA Call Order COR before the content is drafted in Drupal.

Site content is written by default in Filtered HTML text format, which restricts the types of formatting and commands that can be used in HTML. However, the text format may be upgraded to Advanced HTML to allow enhanced formatting and functionality. ERG developed a function to scan the Drupal database for unnecessary or redundant HTML. ERG periodically runs the report and assess whether specific pages formatted in Advanced HTML can be downgraded to Filtered HTML, where appropriate, and remove redundant code.

EPA maintains a subscription to Sitebeam, a software tool for automated website testing. Sitebeam provides a suite of metrics that scan and provide feedback on usability and accessibility features on web pages, including spelling and grammar, broken links, speed, accessibility standards compliance, and search engine results. ERG reviews the reports each month to identify and correct updated or broken links, missing files, and spelling errors that may exist in ECHO. ERG also periodically reviews other content and accessibility summaries and recommendations from the Sitebeam reports.

5.8 **ECHO User Support**

ERG manages ECHO's technical user support services. Most support requests are received through the Contact Us page in ECHO[2], with additional requests forwarded from the EPA Call Order COR. All messages sent through the ECHO Contact Us page are routed to Zendesk customer service software. ERG responds to messages using Zendesk, and occasionally via phone, upon request. ERG developed SOPs that are shared with all EPA and ERG team members on an ECHO Confluence page. ERG will update the SOPs in Confluence as needed.

ERG Support team members use macros within Zendesk to maintain and retrieve responses to common questions. This feature enables ERG to quickly and easily write responses with standard, EPA Call Order COR-approved language (e.g., login issues, historical data requests, error reporting). Each non-standard response is reviewed by a second team member for accuracy, clarity, and tone. Questions that cannot be answered by an ERG team member are elevated to the EPA Call Order COR or specific EPA staff, as outlined in the ECHO Support SOPs.

ERG monitors Zendesk several times a day. ERG staff strive to respond to all messages within 48 hours. Urgent messages, such as registration or site access issues and potential bugs, are addressed as soon as possible (usually within 2 hours of receipt). If a particular response or resolution will require additional time (e.g., to request input from an EPA subject matter expert), ERG will provide acknowledgement to the commenter that the inquiry is in-progress.

Zendesk retains all messages and responses together as tickets. Zendesk allows tickets to be quickly retrieved by organizing tickets by ECHO user name, category (customized by ECHO topics), and other metadata. The categories used to flag tickets by topic are described in the ECHO Support SOPs. The complete message history enables ECHO help desk staff to better respond to individual users and streamlines recordkeeping. ERG will discuss feedback received through the helpline and support requests forwarded by EPA with the EPA Call Order COR during weekly status meetings. ERG reports the number of tickets received each month to the EPA Call Order COR.

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[2] https://echo.epa.gov/contact

## 6.	REFERENCES

EPA, 2001. U.S. Environmental Protection Agency. *EPA Requirements for Quality Assurance Project Plans QA/R-5*. EPA/240/B-01/003. Office of Environmental Information. March 2001.

EPA, 2002. U.S. Environmental Protection Agency. *Guidance for Quality Assurance Project Plans QA/G-5*. EPA/240/R-02/009. Office of Environmental Information. March 2001.

EPA, 2002. U.S. Environmental Protection Agency. *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency.* EPA/260R-02-008. October 2002.

EPA, 2003. U.S. Environmental Protection Agency. *A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information*, EPA 100/B-03/001. June 2003.

OMB, 2002. U.S. Office of Management and Budget. *Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies* (67 FR 8452).

Appendix A: FORMAL TEST CASE EXAMPLE

Test Name: Effluent Charts – Chart High-Level Display and Functionality	
Test Case ID: TC-6C	
Tester:	**Date of Test:**
Testing Phase:	**Priority:**
Objective: Verify that charts are correctly hiding and displaying the data series and limit lines using the dual-purpose legend, charts are correctly zooming to the desired date range, and data points and limit lines are displaying values after mouse over, and other high-level features.	
Test Conditions/Requirements: Access to https://echostage.epa.gov.	
Browser:	

Step #	Description	Expected Results	Actual Results	Pass/ Fail
1	Navigate to http://echostage.epa.gov/effluent-charts #MD0063282	Displays the Effluent Charts page for Hearne-Meadows, LLC.		
2	Click the cell in the summary grid for BOD, 5-day, 20 deg. C, Outfall 001.	Two charts are displayed below the summary grid, one Concentration chart and one Quantity Chart. A header above both charts displays BOD, 5-day, 20 deg. C. Each chart has 4 labels above the chart area: Parameter, Discharge Point, Monitoring Location, and Sampling Period. The x-axis displays dates for a 3-year period. The y-axis displays the units for measurements. A legend is displayed below each chart. Two limit lines and two data series are displayed for each chart. Certain data points are red indicating a violation. Circular data points are shown above the chart areas indicating reporting/monitoring violations.		
3	Click the MX MO AV LIMIT label in the legend below the quantity chart.	The MX MO AV LIMIT line no longer displays on the chart area.		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
4	Click the MX WK AV LIMIT label in the legend below the quantity chart.	The MX WK AV LIMIT line no longer displays on the chart area. All that remains on the chart area are triangular data points.		
5	Click the MX MO AV label in the legend below the quantity chart.	The MX MO AV data series no long displays on the chart area. Only one data series remains on the chart.		
6	Click on the concentration chart area at Jan 13 and drag the cursor to the right to May 13.	The chart area zooms into the selected date range (Jan 13 – May 13). A Reset Zoom button appears on the chart area. 6 data points are displayed.		
7	Hover mouse over the far-right data point.	A text box appears above the data point: "April 30, 2013. MX WK AV: 20.3"		
8	Click Reset Zoom.	The chart area reverts back to displaying the 3-year date range.		
9	Click the MX WK AV LIMIT label in the legend.	The limit line appears on the chart area.		
10	Hover mouse over the limit line over Jan '12.	A text box appears above the data point: "Dec 31, 2011. MX WK AV LIMIT: 45"		
11	Click the Chart Legend link in the chart header.	An image of the detailed legend is displayed in an overlay window.		
12	Click the Help link in the chart header.	A new tab opens with the Effluent Charts help page.		
13	Click the Download Data button in the chart header.	A download prompt appears and all data from the BOD Quantity and Concentration charts are downloaded in a CSV file.		

Test Name:	Effluent Charts – Chart Data Display and Quality	
Test Case ID: TC-6D		
Tester:	**Date of Test:**	
Testing Phase:	**Priority:**	
Objective: Verify that individual charts are correctly displaying data points, including violation indicators and measurement indicators. Verify that chart data points match data in the web service.		
Test Conditions/Requirements: Access to https://echostage.epa.gov.		
Browser:		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
1	Navigate to https://echostage.epa.gov/effluent-charts#GU0020222	Displays the Effluent Charts page for AGAT STP.		
2	Change the start date to 10/1/2011 and the end date to 1/1/2014.	The summary grid is updated to reflect the selected date range.		
3	Click the cell in the summary grid for Copper, total recoverable, Outfall 001.	Concentration and Quantity charts display below the summary grid for Copper, Outfall 001. The Concentration chart displays mg/L units on the y-axis, and the Quantity chart displays lb/d units on the y-axis. The Avg limit line is dashes and the Max limit line is solid.		
4	From the concentration chart, click the legend labels to hide MO AVG LIMIT, DAILY MX LIMIT, and DAILY MX data points from the chart area.	Only MO AVG data points remain on the chart.		
5	Examine the MO AVG data point shapes/colors using the legend link above each chart.	All average measurements (e.g., MO AVG) should be diamond shaped. The following points are displayed: 1 yellow unfilled at 11/11. 5 purple filled from 1/13 to 5/13. 2 green filled at 8/11 and 12/11. 5 red filled from 7/13 to 12/13. The remaining points are red unfilled. There are 10 blue or green circles on the late/missing reports timeline.		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
6	Click the Show/Hide Table button above the chart.	A data table is displayed containing data from the chart.		
7	Confirm that the MO AVG violation indicators in the chart match the table data.	The color of the data point matches the Violation Severity column (SNC: Red, RNC: Yellow, Effluent: Purple). If the RNC Resolution Code column is 1, A, or null, the data point should be filled. If the RNC Resolution Code is anything else, the data point should be unfilled.		
8	Navigate to http://ofmpub.epa.gov/echo/eff_rest_ services3.get_effluent_chart?&p_id= GU0020222&parameter_code=0111 9&outfall=001&start_date=12/31/20 12&end_date=02/28/2013	Displays the raw service data for the Copper, Outfall 001 charts from the previous steps. The date range is set in the URL to only show data from 12/31/2012 to 02/28/2013.		
9	Compare the three MO AVG data points (12/31/2012, 1/31/2013, 2/28/2013) on the chart with the service data	The ViolationCode service parameter should contain an "E90" value for all three points. Under the E90 service data, the RNCResolutionCode parameter value should be "2" for 12/31/12, and null for 1/31/13 and 2/28/13, and the ViolationSeverity value should be "SNC" for 12/31/12, and "Effluent" for 1/31/13 and 2/28/13. There should be a second ViolationCode parameter for 1/31/13, populated with "D90". The DMRValueNmbr parameter matches the value in the chart for each data point, and the LimitValueNmbr parameter matches the MO AVG limit value in the chart.		
10	Navigate to https://echostage.epa.gov/effluent-charts# PA0023264	Displays the Effluent Charts page for Twin Boroughs Sanitary Auth.		
11	Click the cell in the summary grid for Phosphorous, Total, Outfall 001.	Two quantity charts display. One for Monitoring Location: Effluent Net, and one for Monitoring Location: Effluent Gross. Both charts display two Total data series. Both series' data points are green diamonds. Both charts display "Quantity (lb)" on the y-axis.		

Step #	Description	Expected Results	Actual Results	Pass/ Fail
12	Click the cell in the summary grid for pH, Outfall 001.	One concentration chart displays with one Min data series and on Max. The Min data points are orange downward-pointing triangles and the Min limit line is solid. The chart displays "Concentration (SU)" on the y-axis.		
13	Navigate to https://echostage.epa.gov/effluent-charts#GU0020222	Displays the Effluent Charts page for AGAT STP.		
14	Click the All Pollutants-All Outfalls cell in the summary grid	All available charts are displayed that have limit data, effluent data, or violation data. Charts that do not have any limit data, effluent data, or violation data are not displayed, and there are no empty chart headers displayed for these charts.		