124 QA/QC Management Plan

124.1 General

Quality Assurance (QA) and Quality Control (QC) are two processes used by consultant and Department (in-house) designers to ensure that deliverables are complete, orderly, correct, and appropriate for the intended purposes. The quality of the deliverable must meet or exceed industry standards; i.e., "Due Diligence" ("Due or Ordinary Care").

Quality Control (QC) is the process of checking, reviewing, and revising deliverables to comply with Department requirements. Quality Assurance (QA) is enforcing and verifying that quality control procedures have been established and performed.

This chapter describes the Department's QA/QC Management Plan for the development of deliverables. A deliverable is any professional services document (e.g., Plans, Specifications, Reports, Building Information Modeling (BIM) files) where the final version of the product is signed and sealed.

124.2 Quality Control Plan

A Quality Control Plan establishes the review procedures that are to be performed on each deliverable. The Quality Control Plan includes the following elements:

- QA/QC Staffing Plan
- Review procedures for each deliverable type (e.g., reports, plans, BIM files)
- Certificate of Compliance

A project-specific Quality Control Plan is not required for Department (in-house) design projects; however, these projects must follow the procedures outlined in this chapter.

Consultant design projects must either:

(1) Develop a project-specific Quality Control Plan acceptable to the Department. The Quality Control Plan is completed and accepted before any design efforts begin; typically, within 20 days after Notice to Proceed.

(2) Adopt the Quality Control Plan requirements outlined in ***FDM 124*** by submitting a declaration email to the Department PM. Attach the proposed QA/QC Staffing Plan to the declaration email for approval. With this option, the prime consultant is responsible for ensuring that subconsultants also adhere to the procedures outlined in this chapter.

124.2.1 QA/QC Staffing Plan

The QA/QC Staffing Plan contains a list of required deliverables and associated discipline areas. The plan must identify the following staff:

- Engineer of Record (EOR) (professional that will sign and seal the document)
- Lead Technical Professional
- Quality Control (QC) Reviewer
- Quality Assurance (QA) Manager
- BIM Manager

Include the above information for the entire design team; i.e., include information for Geotechnical, Landscaping, Survey and Mapping, Environmental, and Utility staff.

The Lead Technical Professional is the professional responsible for the development of the deliverable, which is often the Engineer of Record.

The QC Reviewer must have equal or higher level of qualification as the Lead Technical Professional and must not be involved in the development of the deliverable.

The QA Manager is responsible for overseeing quality control processes. The QA Manager should be independent and not directly involved with the QC review or production and development of the deliverables and is typically an officer or principal of the design firm for consultant-designed projects. Duties shall include performing reviews of QC processes to maintain compliance and identify improvements while overseeing compliance with the QC Plan.

The BIM Manager is responsible for coordinating and conducting Interdisciplinary Reviews of consolidated BIM content. The BIM Manager should be familiar with developing and delivering BIM content.

Whenever staffing changes are necessary on consultant design projects, provide the Department PM an updated staffing plan for approval prior to making staff changes. Include resumes for the replacement staff and the staff being replaced.

An example of a QA/QC Staffing Plan is shown in ***Table 124.2.1***.

124.2.2 BIM Review Technology

List the software that will be used for conducting BIM Reviews in the Quality Control Plan. When determining the Digital Review Process to be followed, consider the entire project team's needs and capabilities. More than one solution may be necessary to conduct and document a comprehensive BIM Review.

Examples of BIM Review technologies to consider:

- Cloud collaboration technology: Many forward-thinking technologies are available for collaborative BIM Reviews (e.g., iTwin Design Review, BIM 360, Revizto, PlanGrid, etc.).

- Native design software technology: The software used to develop the model is also acceptable for conducting BIM Reviews (e.g., OpenRoads Designer, Civil 3D, etc.).

- Augmented Reality/Virtual Reality/Mixed Reality (AR/VR/MR) technology: May be considered when an immersive experience is warranted when conducting BIM Reviews (e.g., HoloLens, Google Glass, Oculus, etc.).

Table 124.2.1 Example QA/QC Staffing Plan

Element/Task	Deliverable	Lead Technical Professional	QC Reviewer
General (PM: Luke S. Walker, PE) (QA Mgr.: Dew Wright, PE) (BIM Mgr.: Tye Down, PE)			
Project Schedule	Schedule	Luke S. Walker, PE	Dep Abillaba, PE
Quality Assurance	Quality Control Plan	Luke S. Walker, PE	Dep Abillaba, PE
Roadway (Rdwy EOR: Luke S. Walker, PE) (Drg EOR: Flow Fast, PE) (TTCP EOR: Lan Solo, PE)			
Variations/Exceptions	Sidewalk Variation	Luke S. Walker, PE	Dep Abillaba, PE
Typical Section	Typical Section Package	Luke S. Walker, PE	Dep Abillaba, PE
Pavement Design	Pavement Design Package	Luke S. Walker, PE	Dep Abillaba, PE
Project Control	Roadway Plans	Chad Bane, PE	Anna King, PSM
Roadway Design	Roadway Plans	Chad Bane, PE	Dep Abillaba, PE
	BIM files	Mora d' Minbas, E.I.	Sabrina Ren, PE
Temp Traffic Control	Roadway Plans	Lan Solo, PE	Luke S. Walker, PE
Drainage Design	Roadway Plans	Flow Fast, PE	Dep Abillaba, PE
Quantity Computations	QTDSRD files	Mora d' Minbas, E.I.	Sabrina Ren, PE
	EQ Report / AASHTOWare	Luke S. Walker, PE	Dep Abillaba, PE
Specifications, TSP	Specifications Package	Luke S. Walker, PE	Dep Abillaba, PE
Signing & Pavement Marking (EOR: Tara Full, PE)			
Signing Design	S&PM Plans	Tara Full, PE	Luke S. Walker, PE
Pavt Marking Design	S&PM Plans	Tara Full, PE	Luke S. Walker, PE
Quantity Computations	EQ Report	Chad Bane, PE	Luke S. Walker, PE
Survey and Mapping (SOR: Anna King, PSM)			
Design Survey	Survey Files	Anna King, PSM	Bob Afett, PSM
Terr Mobile LiDAR	SURVRD01.dgn file	Anna King, PSM	Bob Afett, PSM

124.3 QC Review Procedures for Plans and Documents

This check and back check review process is performed by the applicable design group (in-house design units or consultants) before the deliverable is submitted for the Department's ERC Review. The Quality Control Review may be conducted on either a printed paper copy or a PDF of the deliverable.

A formal and documented Quality Control Review is to be performed on all draft and final Reports, Documents and Plans where the final deliverable is signed and sealed. The project schedule must allocate time to complete this review prior to the submittal date; typically, one to three weeks (depending upon complexity of the deliverable).

The plan set or document that has completed the Quality Control Review is referred to as the "QC Document". Documents that contain multidisciplinary information must show documentation of all applicable discipline reviews. For a paper review, scan the QC Document to PDF.

For consultant design projects, the QC Document must be included with the submittal of any deliverable in which the final PDF document is to be signed and sealed; e.g., Typical Section Package, Pavement Design Package, Specifications Package, Plans (all phase submittals), Lighting Justification Report.

For all projects, the Department PM must place the QC Document in the project file.

124.3.1 5-Step Review Process

The 5-step review described in this section pertains to a review of a paper print of the QC Document. It is expected that minor differences to the 5-step review process described will occur based on office or business adopted practices; however, each of the five steps must be carried out.

A color scheme other than the one described in this section may be used. Specify the colors used within the QC stamp.

Step 1 – Origination

The Lead Technical Professional assembles the review document and applies a QC Stamp to the cover of a bound set of documents or to individual sheets, if unbound. The QC Stamp may be digitally generated. An example of a QC Stamp is shown in ***Figure 124.3.1***.

The Lead Technical Professional enters a description for the QC Document in the block provided (e.g., Phase II Plans, Draft Typical Section Package). By initialing and dating the Origination block, the Lead Technical Professional affirms that the documents are ready for checking.

Figure 124.3.1 Example QC Stamp

QC Stamp Submittal:		
Step	By	Date
Origination		
Checked Correct - Yellow Highlight Change - Red Comments		
Concurrence Agree - Green Check No change - Green 'X'		
Changes Made Green Highlight		
Changes Verified Blue Check		

Step 2 – Checking

The QC Reviewer checks the QC Document:

- Yellow highlight is used to identify the elements of the document that are deemed to be acceptable. Items not checked are not to be highlighted.
- Red mark is used to identify the elements of the document that are deemed to be in error or in question (i.e., provide comments).

Black pen (or similar) is used to perform interim manual calculations or make notes for reference on the document.

By initialing and dating the Checked block, the QC Reviewer affirms the completion of the checking process.

Step 3 – Concurrence

The Lead Technical Professional indicates agreement with the suggested change by placing a green check mark by the QC comment. This affirms that this change is to be made. The Lead Professional indicates disagreement with the suggested change by placing a green "X" mark over the QC comment. This affirms that this change is not to be made. This is done only after the Lead Professional has discussed the comment with the QC Reviewer and they reach this conclusion together. Clarification of comment resolution may be provided near the QC comment using blue ink.

By initialing and dating the Concurrence block, the Lead Professional affirms completion of this Concurrence step.

Step 4 – Changes Made

The Lead Professional makes the agreed-upon changes and uses green highlight to identify that the change has been made.

By initialing and dating the Changes Made block, the Lead Professional affirms that all agreed-upon changes have been made.

Step 5 – Changes Verified

The QC Reviewer verifies that comments have been appropriately interpreted and addressed by placing a blue check by the QC comment. The QC Reviewer will coordinate any unresolved issues with the Lead Professional for final resolution, and Step 4 will be repeated when necessary.

By initialing and dating the Changes Verified block, the QC Reviewer affirms that all agreed-upon changes have been verified.

124.3.2 Electronic Review Process

When conducting a Quality Control Review within a PDF document, use an electronic comment review, resolution, and documentation process mimicking the 5-Step Review Process. Place the QC Stamp only on the first sheet of the QC Document. **Bluebeam©** offers a collaborative approach to performing digital QC reviews and is recommended for multidiscipline reviews; other software applications may be used that provide similar workflow.

124.4 QC Review Procedures for BIM Files

A formal Quality Control Review, as outlined in this chapter, must be conducted on project BIM files that are signed and sealed. It is recommended that other CADD files provided to the Department follow these requirements as well.

Conduct and document BIM Reviews using a digital review process. For more information regarding BIM development and BIM.zip deliverable expectations, refer to the ***FDOT CADD Manual***; ***Sections 5.16 Modeling Standards*** and ***8.4.7 BIM ZIP File***.

QC comments made during the phase submittal BIM Reviews must be documented in a QC Summary Report and submitted with each phase submittal. Spreadsheet tables are an acceptable format.

The Department categorizes BIM Reviews as:

- Developmental Reviews.
- Design Analysis Reviews.
- Interdisciplinary Reviews.

124.4.1 Developmental Reviews

Developmental Reviews are typically conducted by the QC Reviewer for each discipline, and have three focus areas:

(1) Conformance: BIM adheres to CADD standards.

(2) Completeness: BIM meets the project scoped expectations.

(3) Consistency: BIM files are accurate relative to each other.

124.4.1.1 Conformance

Development Reviews are conducted to check the BIM for conformance, verifying that the BIM elements adhere to the standards defined in the FDOT CADD Manual.

Checking conformance at developmental milestones minimizes the impact of deficiencies (i.e., when the roadway geometries are initially created, when the drainage network is initially developed).

Example of Conformance checks include the following:

- Do the files adhere to CADD standard compliance using the QC Project Inspector and Project Validator tools?
- Are the files based on the correct seed files?
- Are the files and folders named properly?
- Are elements assigned the correct level/layer, color, line-style, and weight?
- Are elements assigned the correct feature definitions/styles, material types and data attributions?
- Do the files have the correct geographic coordinate system defined?
- Is the corridor frequency interval appropriate to account for context classification, tangent/curves, intersections, and critical station expectations?

124.4.1.2 Completeness

Development Reviews are conducted to check the BIM for completeness, verifying that all required existing and proposed elements are developed to the minimum Level of Development (LOD). The Completeness check is conducted prior to each phased delivery. The Completeness check conducted on completed files should verify that "work" elements (aka., scratch elements) have been removed from the BIM files.

Level of Development (LOD) is the degree to which the elements contained in the BIM file are detailed. See FDOT CADD Manual; **Section 5.16.6** for LOD definitions.

124.4.1.3 Consistency

Development Reviews are conducted to check the BIM for consistency, verifying that the project elements are consistent across the various types of data formats (e.g., dwg/dgn, xml, i-model). Disparities between equivalent data indicates that one of the files is inaccurate.

Example of Consistency checks include the following:

- Is the alignment data provided in xml format consistent with the 2D planimetric design in pdf format?
- Are 3D proposed breaklines in dwg/dgn format consistent with the 2D planimetric design in pdf format?
- Are 3D proposed breaklines in dwg/dgn format consistent with the 3D final graded surface provided in xml format?

- Are summary of quantity design files (QTDSRD file) consistent with 2D representation of the planimetric design in pdf format?

124.4.2 Design Analysis Reviews

Design Analysis Reviews are conducted to check that the BIM adheres to design criteria, is void of design flaws, and complies with Department requirements. These reviews are conducted by the discipline QC Reviewers prior to each phase delivery.

Many design flaws are identified in the review of the plans, however, reviews within the BIM further enhance the reviewer's ability to identify unsuitable conditions, such as:

- Trapped stormwater runoff
- Vertical or horizontal clearance issues
- Undesirable intersection, side road or driveway geometrics or profiles
- Constructability issues associated with deep excavations
- Adherence to ADA requirements

The Design Analysis Review should also include checks to ensure that the BIM reflects the data contained in project reports (e.g., Typical Section Package, Pavement Design Package, No Passing Zone Study, Drainage Report, Bridge Hydraulics Report, Geotechnical Report).

124.4.3 Interdisciplinary Reviews

Interdisciplinary Reviews are conducted to check the interaction between the BIM content developed by each discipline. These reviews are typically coordinated by the BIM Manager prior to each phase submittal.

The primary purpose of the Interdisciplinary Reviews is to identify conflicts or inconsistences between the various discipline designs, such as:

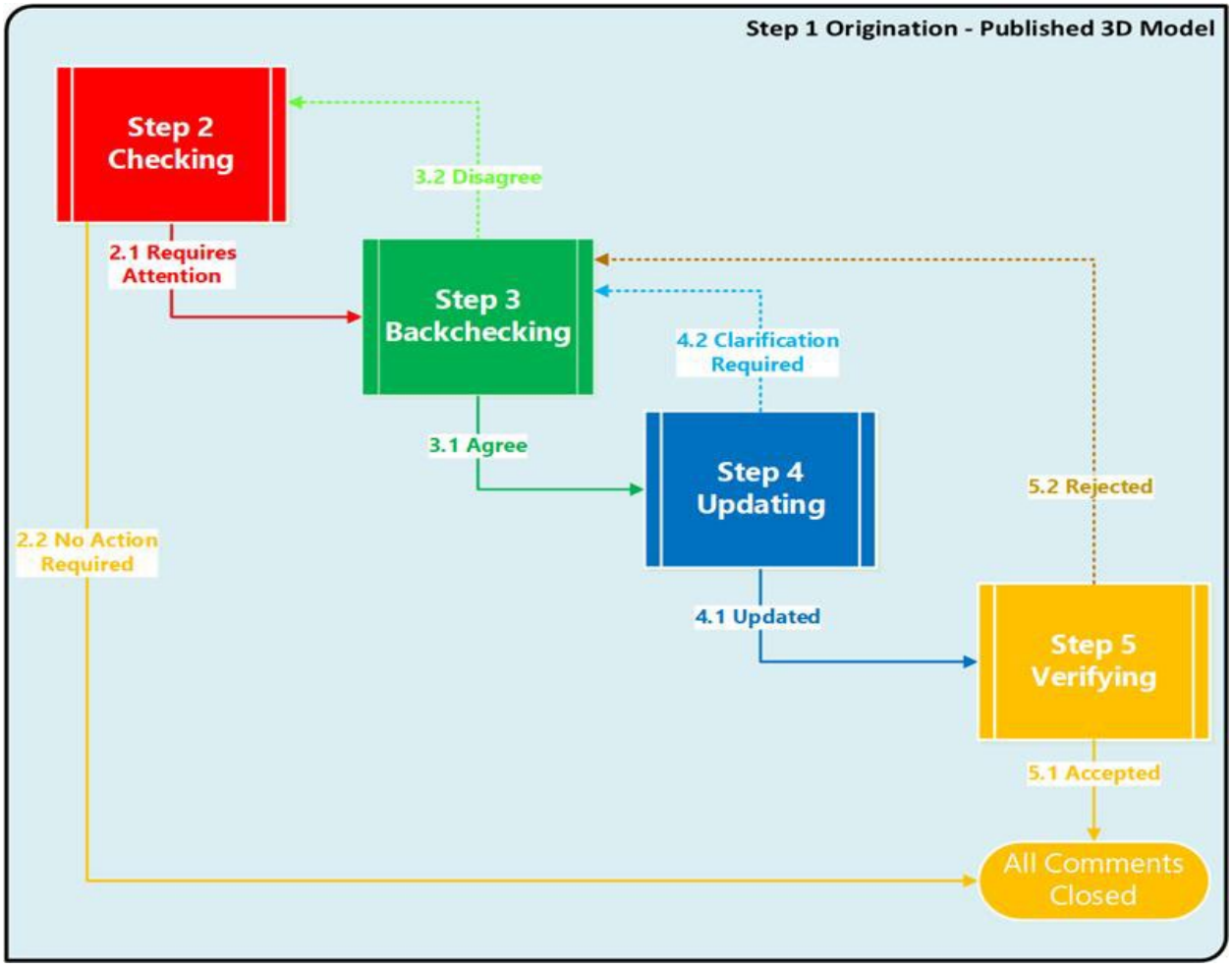
- Are drainage inlet elevations set properly relative to curbs, ditches, and ponds?
- Are clearing and grubbing limits appropriate for all disciplines?
- Are multiple elements occupying the same physical space?
- Are high mast lighting, mast arm, and overhead sign locations clear from obstructions and standing water (final and TTC phases).
- Are minimum pipe cover expectations met?

- Does landscaping provide required sight distance for sideroads and driveways?
- Does the roadway pavement cross slope match the bridge deck cross slope?

124.4.4 Digital Review Process

This section describes a Digital Review Process used to conduct reviews of the BIM content. This process follows the basic QC steps shown in ***Figure 124.4.1***. It is expected the process used by the designer will have minor differences from the Digital Review Process described here; however, each of the steps (Origination, Checking, Backchecking, Updating and Verifying) must be carried out.

Figure 124.4.1 QC Review Steps



To manage the Digital Reviews expected during design development, develop a BIM Review Log. The review log should be submitted with each phase submittal of the BIM files. An example of a BIM Review Log is shown in ***Table 124.4.1***.

Table 124.4.1 Example BIM Review Log

Review Description	Reviewer	Developmental Review			Design Analysis Review	Inter-disciplinary Review
		Conform.	Complete.	Consist.		
Initial Geometrics	Sabrina Ren, PE	12/10/2020			12/12/2020	
Existing Utilities	Sabrina Ren, PE	2/14/2021			2/15/2020	
Phase I BIM	Tye Down, PE	3/25/2021	3/27/2021	3/28/2021	3/28/2021	3/29/2021
Initial Drainage	Dep Abillaba, PE	4/20/2021			4/21/2021	
Final Geometrics	Sabrina Ren, PE	4/26/2021			4/28/2021	
Phase II BIM	Tye Down, PE	8/9/2021	8/10/2021	8/12/2021	8/13/2021	8/15/2021
QTDSRD files	Sabrina Ren, PE					
Final Drainage	Dep Abillaba, PE					
Phase III BIM	Tye Down, PE					
Phase IV BIM	Tye Down, PE					
Final BIM	Tye Down, PE					

Use a status scheme common to many review applications to track each comment through the review process. A status scheme other than the one described in this section may be used; however, it must mimic the intent of the Digital Review Process.

QC Summary Report should include the following information for each comment:

- Unique ID Number
- Name and Role of Originator
- Name and Role of Reviewer
- Date and Review Type (Developmental, Design Analysis, or Interdisciplinary)
- Comment Status
- Comment Response
- Communication Log (e.g., discussion, decisions, directions)

Step 1 – Origination

Each BIM review conducted, as documented by the BIM Review Log, begins with the Originator notifying the Reviewer that the BIM is locked down and ready for review. The BIM Manager often assists with the coordination of this step.

Step 2 – Checking

The Reviewer will check the BIM and create comments with the comment status of:

(a) "Requires Attention" (associated color is red) – Indicates that the QC Comment is ready for backchecking.

(b) "No Action Required" (associated color is yellow) – Indicates that the QC Comment is an informational note in the model that does not require further action.

When the review is completed, the Reviewer should request necessary clarification and discuss the QC Comments with the Originator.

Step 3 – Backchecking

The Originator responds to the QC Comments and changes the comment status of "Requires Attention" to:

(a) "Agree" (associated color is green) – Indicates that revisions will be made to resolve the QC Comment.

(b) "Disagree" (associated color is red) – Indicates that the Reviewer and Originator have determined that no change is required (STET).

Step 4 – Updating

The Originator oversees revisions for QC Comments with the "Agree" and changes the comment status to:

(a) "Updated" (associated color is blue) – Indicates that the BIM has been revised.

(b) "Clarification Required" (associated color is light blue) – Indicates that additional information or discussion with the Reviewer is required.

Step 5 – Verifying

The Reviewer determines that the QC Comment has been appropriately interpreted and addressed, and changes the "Updated" comment status to:

(a) "Accepted" (associated color is yellow) – Indicates that the QC Comment has been resolved and no further action is required.

(b) "Rejected (associated color is red) – Indicates that the QC Comment requires further action to fully resolve.

124.5 Certificate of Compliance

For consultant produced deliverables, the firm's designated person for overseeing quality control activities (e.g., Quality Control Officer, Quality Assurance Manager) must review and certify that established quality control procedures have been performed. The purpose of the Certificate of Compliance is to attest that the level of effort used to complete the quality control review adheres to industry standards.

Coordinate requirements for the Certificate of Compliance with the Department PM.

124.6 Independent Peer Review

An independent peer review is supplemental to the Quality Control Review and is performed on selected consultant projects. This review is conducted by an independent team of qualified reviewers on specific design elements or portions of a project. Members of the independent peer review team are not assigned to the same organizational unit that managed and produced the project.

124.7 Field Review

A field review (A.K.A. Plans-in-Hand Review) is supplemental to the Quality Control Review. The review is held at the project site for the purpose of verifying the compatibility of the design with the field conditions to be encountered during construction. A record of the field review includes the following:

- Date and time.
- List of attendees.
- Documented site conditions and observations; may include marked-up plan sheets, photographs or any other method deemed appropriate.

For consultant projects, provide the Department PM with a copy of the review record.