Guidance for Flood Risk Analysis and Mapping

Quality Management

May 2014

FEMA

This guidance document supports effective and efficient implementation of flood risk analysis and mapping standards codified in the Federal Insurance and Mitigation Administration Policy FP 204-07801.

For more information, please visit the Federal Emergency Management Agency (FEMA) Guidelines and Standards for Flood Risk Analysis and Mapping webpage (http://www.fema.gov/guidelines-and-standards-flood-risk-analysis-and-mapping), which explains the policy, related guidance, technical references, and other information about the guidelines and standards process.

Nothing in this guidance document is mandatory other than standards codified separately in the aforementioned Policy. Alternate approaches that comply with FEMA standards that effectively and efficiently support program objectives are also acceptable.

Document History

Affected Section or Subsection	Date	Description
First Publication	May 2014	Initial version of new transformed guidance. The content was derived from the *Guidelines and Specifications for Flood Hazard Mapping Partners*, Procedure Memoranda, and/or Operating Guidance documents. It has been reorganized and is being published separately from the standards.

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1.0 Quality Management Overview

An effective functioning Quality Management System (QMS) is normally comprised of the following interrelated elements, which are often best described and documented in a Quality Management Plan (QMP).

1.1 Prevention

Preventive Quality Assurance protocols maximize the potential for compliance with Standards for Flood Risk Analysis and Mapping during execution of the production process. This includes the following sub-elements below:

- Staff Training Infrastructure to ensure that individuals with appropriate skills and qualifications are available to execute production and validation efforts
    - This should include provisions for proactive training for general framework knowledge, reactive training to address root cause analysis on corrective actions, and just-in-time training for staff that are preparing to execute work
- Knowledge Management System (KMS) to ensure that staff conducting production work have standards, guidance and associated resources easily accessible to ensure the greatest possible chance of performing the work to program expectations, thereby minimizing the need for costly validation and corrections
    - Outdated, incomplete or erroneous information in the hands of production staff often leads to costly mistakes and rework. Therefore, whatever KMS is in place should have robust maintenance protocols to ensure the information stays current
- Defined & documented processes for execution of production efforts
    - Quality Management is founded on process management; for that reason, it is critical that all core processes be well defined and documented to the greatest degree possible. Having core processes clearly defined minimizes reliance on institutional knowledge and ensures that all production staff members follow similar production protocols
    - It is not critical that all sub-processes be documented; for this reason it is critical that an entity identify and document those core processes that contain the greatest risk of failure

1.2 Validation

Validation (inspection) is a key element of a well-functioning QMS. It should not be used as a primary method to build quality into the deliverables, but rather, it should be used to determine how well the prevention measures achieved the desired results. There are two primary methods advocated as validation techniques; Internal Review by the production firm and External (Independent) Review by a partner firm from within a Joint Venture or a separate company altogether. Those two methods are described below in Sections 1.2.2 and 1.2.3.

1.2.1 General Validation Guidance

Validation is intended to be a method whereby processes put in place to achieve compliance with standards is yielding the desired results. For FEMA projects, a set of codified standards has been adopted as policy with clear exception protocols also established to enable flexibility on a project-specific basis. Guidance on procuring an exception to FEMA's flood risk analysis and mapping standards is available on the Knowledge Sharing Site (KSS).

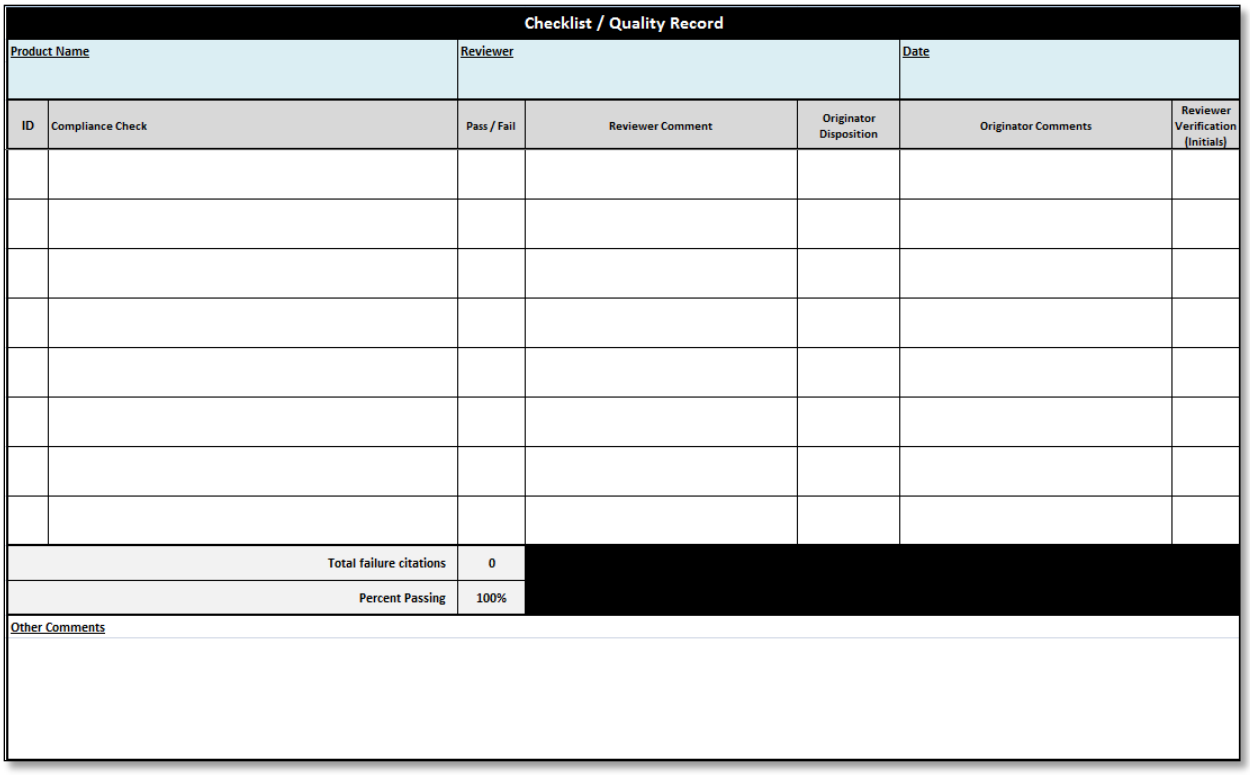
The following are general validation guidance points:

- Validation protocols should be executed by qualified reviewers who are not only subject matter experts in the deliverable being reviewed, but also who have been trained as reviewers. It is critical that staff performing validation activities understand the relative importance of each product or data standard being checked and apply good judgment in determining the requirement to make changes to the product and/or recommending changes to the process that yielded the product.

- Reviewers should always be independent of the production process, and should be free of associated production pressures including schedule and cost constraints.

- Checklists should be used to validate compliance with ***Standards for Flood Risk Analysis and Mapping***. The checklists should include the producer's response to all non-compliance citations as well as the reviewer's concurrence (indicated by signature) that they agree with the action taken. As stated in Standard ID 190 (see Table 1 below) no product subject to internal or external quality reviews should be allowed to proceed through the production process with unresolved quality concerns arising from validation activities. Checklists should contain the following 5 basic elements:
  - Description of item being reviewed
  - Indication of passing or failing the compliance check
  - Ability for the reviewer to comment on the specific item
  - Ability for the product originator to respond to each non-compliance citation indicating how the citation will be addressed and allowing additional comments to be made.
  - Ability for the reviewer to sign off on the resolution

- A sample checklist format is shown below as Figure 1; checklists used for validation activities should be retained as quality records.



Checklist / Quality Record						
Product Name		Reviewer			Date	
ID	Compliance Check	Pass / Fail	Reviewer Comment	Originator Disposition	Originator Comments	Reviewer Verification (Initials)
	Total failure citations	0				
	Percent Passing	100%				
Other Comments						

Figure 1: Sample QC Checklist

1.2.2 Internal Review

To eliminate the potential conflict of interest associated with producers reviewing their own work, it is FEMA's expectation that all products be validated internally by the production firm responsible for the work. If the production firm is part of a Joint Venture (JV), it is recommended that the review be conducted by independent staff working in a partner company of the JV that is not associated with the production tasks. If the production firm is not a part of a JV, it is expected that the staff who execute prescribed reviews be independent of the production staff and, accordingly, independent of the project schedule and budget pressures not associated with their review. In short, all internal reviews should be properly resourced, scheduled and executed by qualified reviewers who are completely independent of the production process.

1.2.3 External Review

In addition to internal reviews executed by mapping partners, there are mandated external reviews for FEMA's regulatory Flood Risk Products (Flood Insurance Study [FIS], Flood Insurance Rate Map [FIRM], and FIRM Database). Those reviews are expressed in the FEMA standards shown in Table 1 below with their Standard ID. Ensuring that these mandated reviews are properly executed and that these reviews leverage the prescribed checklists and Self-Certification forms is a responsibility of each Mapping Partner. Additional guidance on this topic is provided separately in the *Quality Review Guidance* document that is available on the FEMA KSS.

Table 1: Quality Management Standards

SID	Standard
190	All technical review comments associated with the FIS Report, FIRM, or FIRM database must be fully addressed and resolutions must be fully documented.
508	Quality Reviews 1 through 8 must be conducted. Associated requirements for each review are as follows: • **QR1:** The draft FIRM database shall be uploaded to the Mapping Information Platform (MIP) for auto-validation and must pass before QR2 is conducted. • **QR2:** The preliminary FIRM database shall be uploaded to the MIP for auto-validation and must pass before QR3 is conducted. • **QR3:** The preliminary FIS Report, FIRM, and Summary of Map Actions (SOMA) shall be reviewed using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 after the work has been self-certified as meeting FEMA standards. The FIS Report, SOMA, FIRM and FIRM database shall not be issued at preliminary until written certification is provided indicating that all issues cited at this review were properly addressed and resolved. • **QR4:** This review validates the Proposed Flood Hazard Determination (FHD) Notice, Appeal Period Docket, and 90-day Start Letter(s). If a 90-day appeal period is required, the proposed flood hazard determination notice information must be entered into the FHD Notices on the Web tool. An approved docket must be received from FEMA prior to the issuance of the 90-day Start Letter(s) • **QR5:** The FIRM database shall be auto-validated in the MIP and a visual review shall be conducted using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 to compare the FIRM database to the printed FIRM and all cited issues must be resolved before the Letter of Final Determination (LFD) will be distributed. • **QR6:** This review validates the LFD prior to the distribution of the final products. As part of the "Prepare LFD Docket" MIP task, the LFD Summary Sheet/Docket, FEDD Files, and LFD Questionnaire must be prepared and submitted, concurrent with QR5 and QR7. All cited issues must be resolved before the LFD will be distributed. • **QR7:** The final FIS Report, FIRM and associated paperwork shall be reviewed using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 before delivery to the Map Service Center (MSC) and all cited issues must be resolved before the LFD will be distributed. • **QR8:** A review of the FIS Report, FIRM, MSC paperwork, and delivery manifest shall be conducted by the FEMA MSC using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 and all cited issues must be resolved before delivery of the final products to the end users.
509	All Quality Compliance Check issues noted during the QR1 through QR8 process must be fully addressed, documented and resolved.
510	Standardized checklists must be used at FEMA-designated Quality Reviews. Those checklists, which are located at http://www.fema.gov/library/viewRecord.do?id=7577 must be retained as quality records, and delivered as part of the Technical Support Data Notebook.
512	Self Certification of compliance with FEMA standards must be provided before a QR3 review may be executed. A template for this requirement is available at http://www.fema.gov/library/viewRecord.do?id=7577.

SID	Standard
513	Written certification must be provided, documenting that all QR3 non-compliance citations were properly addressed and resolved, in order to complete the QR3 process. A template for this requirement is available at http://www.fema.gov/library/viewRecord.do?id=7577.
514	Following the QR4 review, any identified errors must be corrected prior to the 90-day Start letter distribution.
518	All outstanding map changes must be incorporated into the FIRM before proceeding with the QR5 database and visual review.
521	At least 60-days prior to the projected LFD date after receiving a passing QR5 auto-validation report for the FIRM database, the QR5 visual, QR6, and QR7 reviews at the "Produce Final Map Products" MIP task must be conducted.

1.3 Corrective Action

During validation activities, product originators should expect that some level of correction action will follow. For this reason it is important to ensure that rapid response is enabled to minimize production delays when non-compliance citations arise from validation activities. It is also critical that producers consider all validation activities as "value-added" to minimize conflicts between reviewers and producers.

Ideal corrective action processes include provisions for making the correction and then performing a back-check to ensure that each non-compliance citation has been properly addressed.

1.4 Process Improvement

Through the validation and corrective action process, there will often be opportunities identified for minimizing recurrence of the non-compliance citation; simply making the correction is not sufficient if the non-compliance citation is likely to be repeated using existing processes. For this reason, it is encouraged that a root cause analysis for significant issues be executed to clearly identify contributing factors leading to the non-compliance. This is often best expressed as causes associated with people (training and skills), production process, and/or tools (automated or otherwise).

- Once the root cause of significant non-compliance citations is known, solutions should be considered and executed (and monitored for effectiveness) to ensure that the cited issue is not repeated.
- Corrective Action / Process Improvement Plans are an ideal way to document and manage corrective action and process improvement activities. Plans of this sort often include the following elements.
    - Description of the product / deliverable and background information to frame the issue
    - Description of the issue leading to the corrective action / process improvement

- Identification of how the issue was noted (internal, external, etc.)
- Description of the extent of the noted issue
- Description of what needs to be done to correct the noted non-compliance citation
- Identification of the entity responsible for making the correction
- Identification of the due date for the correction being made and identification of the date the correction was completed.
- Root cause analysis to identify contributing factors in terms of people, process or tools.
- Solutions considered and applied to eliminate future recurrence of the issue
- Provisions for monitoring the effectiveness of the solution

1.5 Quality Management System Audits

Even the best QMS will not ensure high compliance with *Standards for Flood Risk Analysis and Mapping*. It is therefore critical that regular internal and external audits of compliance with the QMS are conducted.

- The process and the nature of these audits may vary, but should include the following elements at a minimum:
  - Validation of proper execution of documented production processes
  - Validation that all staff have access to, and are properly using, the provided Knowledge Management System
  - Validation that properly qualified staff are used to execute validation activities
  - Validation that all non-compliance citations are properly resolved
  - Validation that quality records are being properly maintained
- To ensure the highest possible chance of consistent compliance with the QMS, regular internal audits of QMS compliance should be scheduled and executed.

1.6 Quality Management Plan Development and Maintenance

A QMP should describe the processes and tools that are to be followed in order to enable the QMS to function properly. In addition to crafting a QMP that describes the QMS and its associated implementation protocols, it is expected that quality management processes will evolve over time due to lessons learned rolling up to best practices within an organization. For this reason, there should be a formal schedule for regularly updating the QMP.

2.0 Quality Validation for Regulatory Products

Validating compliance with regulatory product standards (for the FIRM, FIRM Database, and FIS report) is a cornerstone of quality management. This validation activity should be performed internally by Mapping Partners executing the work, and must also be conducted externally

following FEMA-mandated reviews at eight checkpoints in the work lifecycle known as QR1 through QR8.

2.1 Internal Validation Review

As noted above in Section 1.2.2, to ensure compliance with FEMA standards, Mapping Partners should have internal validation protocols in place that are integrated into the production workflow. It is expected that qualified reviewers will be identified and available to execute internal reviews and that quality records documenting these reviews will be maintained.

2.2 External Validation Review

As noted above in section 1.2.3, FEMA standards call for the execution of 8 unique external quality reviews through the FIS/FIRM lifecycle. Guidance on the external review process is documented in the *Quality Review Guidance* document available on the FEMA KSS.

2.3 Disposition of Review Comments

Before any products move past the review phase, it is critical that all non-compliance citations arising from internal or external reviews are properly addressed.

2.4 Quality Validation Tools

The following quality assurance and quality control tools are provided to enable the deliverable of high quality products in compliance with FEMA standards.

2.4.1 Self Certification

Per FEMA standards 512 and 513, self certification of work performed, and of corrections made, must be provided by Mapping Partners before a product may be issued in preliminary form. This certification should specify that all FEMA standards have been met and should include documentation of unusual situations that could constitute an approved exception to specific FEMA standards. QR3 Self-Certification Templates and samples of this type of certification are provided on the FEMA site at http://www.fema.gov/library/viewRecord.do?id=7577.

Additionally, after the review is conducted for QR3, a Post-QR3 Self-Certification form must be filled out to verify that all issues cited at the QR3 review have been properly addressed and that the study is in compliance with FEMA standards. A template and sample Post-QR3 Self-Certification form is provided on the FEMA site as a sample at http://www.fema.gov/library/viewRecord.do?id=7577.

2.4.2 Internal Validation Checklists

Mapping Partners should validate, at strategic points in their workflow, that the data and products being developed are in compliance with all applicable FEMA standards. This is normally best executed using standardized checklists developed by Mapping Partners. Those checklists should be retained as quality records and should be used during root cause analysis (as needed) if a significant non-compliance citation is noted late in the study development lifecycle and/or after a study is printed and distributed.

2.4.3 External Quality Review Checklists

The *Quality Review* Guidance document available on the FEMA KSS provides information on the use of checklists for QR3, QR5, QR7, & QR8.

2.4.4 MIP Test Environment

As part of a successful quality management system it is recommended that Mapping Partners submit their data through the MIP test environment prior to submitting for the following quality reviews. By using the test environment the Mapping Partner can see what initial errors are present and correct those before the official submission in the MIP workflow. This process will help proactively build quality into the data and products rather than relying on reactive inspection after the data and products are developed. The following guidance is provided for QR1, QR2, and QR5, which is where the MIP Test Environment is applicable.

- **QR-1:** The FIRM Database is validated by an auto-validation tool in the MIP. The auto-validation tool posts a pass/fail notification and provides a Web link to an automatically generated and detailed Quality Control (QC) report.
- **QR-2:** The preliminary FIRM is validated by an auto-validation tool in the MIP. The auto-validation tool posts a pass/fail notification and provides a Web link to an automatically generated and detailed QC report. Once the FIRM products are approved, the final versions of the preliminary FIRM products are uploaded to the MIP.
- **QR-5:** The final FIRM Database and metadata is submitted to the MIP for automated validation. Once the FIRM products are approved, the final versions of the FIRM products are uploaded to the MIP.

2.4.5 Metadata Management Tool

Metadata development is an important process within FIRM production and a requirement that should be met by Mapping Partners when submitting data to the MIP. As data are developed during FIRM production, Mapping Partners produce or modify metadata for multiple datasets, including those related to base maps, terrain, engineering, field survey, and ultimately, the FIRM Database itself. It is recommended that Mapping Partners utilize the Metadata Management (MetaMan) tool in the MIP to validate that the submitted metadata meet FEMA specifications. MetaMan should be utilized prior to submitting/uploading data in the MIP workflow. MetaMan will perform the same validation as the MIP and can be used prior to submission. This activity will help build quality into the process.

2.4.6 National Flood Hazard Layer (NFHL) Quality Checks

Refer to the *National Flood Hazard Layer Guidance* document for guidance on compliance with NFHL standards.

2.4.7 Database Validation Tool

In order to achieve national consistency and ensure compliance with FEMA's FIRM Database standards, in December 2009, FEMA integrated the FIRM Database Validation Tool (DVT) into the MIP to check the quality of FIRM Database submittals. DVT provides embedded quality control checks that Mapping Partners must pass in order to advance MIP tasks that require draft,

preliminary or final FIRM Databases. The tool checks database field requirements (i.e., type, size, precision, scale, etc.), defined attribute domain values, topologic standards, and metadata compliance. The DVT also utilizes a series of logic statements to confirm proper attribute values are used in the correct manner.

In May 2014, a new version of DVT was deployed to accommodate the 2011 and 2013 table structures for the FIRM Database. For more information on the new FIRM Database table structure, DVT check logic, questions about DVT bypasses, and any other needed DVT guidance please go to the MIP User Care page at https://hazards.fema.gov/femaportal/wps/portal/usercare.

3.0 Quality Validation for Non-Regulatory Products

The following is offered as guidance for Risk MAP practitioners who are tasked with creation of non-regulatory datasets and products in compliance with FEMA standards.

3.1 Integrated Validation

To ensure the highest chance of delivering quality non-regulatory flood risk datasets and products, Mapping Partners should map out a process that calls for iterative reviews of the non-regulatory datasets and products (shown in Table 2) conducted at strategic points in the data and product development lifecycle. Figure 2 provides a macro overview of a generic non-regulatory dataset and product development cycle that identifies recommended integrated checkpoints.

Table 2: Non-Regulatory Data and Products

Non-Regulatory Data	Non-Regulatory Product
Water Surface Elevation Grid	Discovery Map
Water Surface Elevation Change Grid	Discovery Report
Changes Since Last FIRM Dataset	Flood Risk Map
Depth Grid	Flood Risk Report
Velocity Grid	Flood Risk Database
Percent Annual Chance Grid	
Percent 30-year Chance Grid	
1% Plus (Elevation) Grid	
1% Plus (Depth) Grid	
Flood Risk Assessment Dataset	
Areas of Mitigation Interest Dataset	
Levee Dataset	
Dams Dataset	
Coastal Dataset	

Mapping Partners who do not already have QC checklists for the review of the items shown in Table 1 may use the checklists posted at http://www.fema.gov/library/viewRecord.do?id=7577.

Note: The workflow shown in Figure 2 does not include the Discovery process; however, there are checklists available for the Discovery Report and Discovery Map that arise from the Discovery process.

3.2 Disposition of Review Comments

Before any products move past the review phase, it is critical that all non-compliance citations arising from internal or external reviews are properly addressed.

Non-Regulatory Dataset and Product Workflow

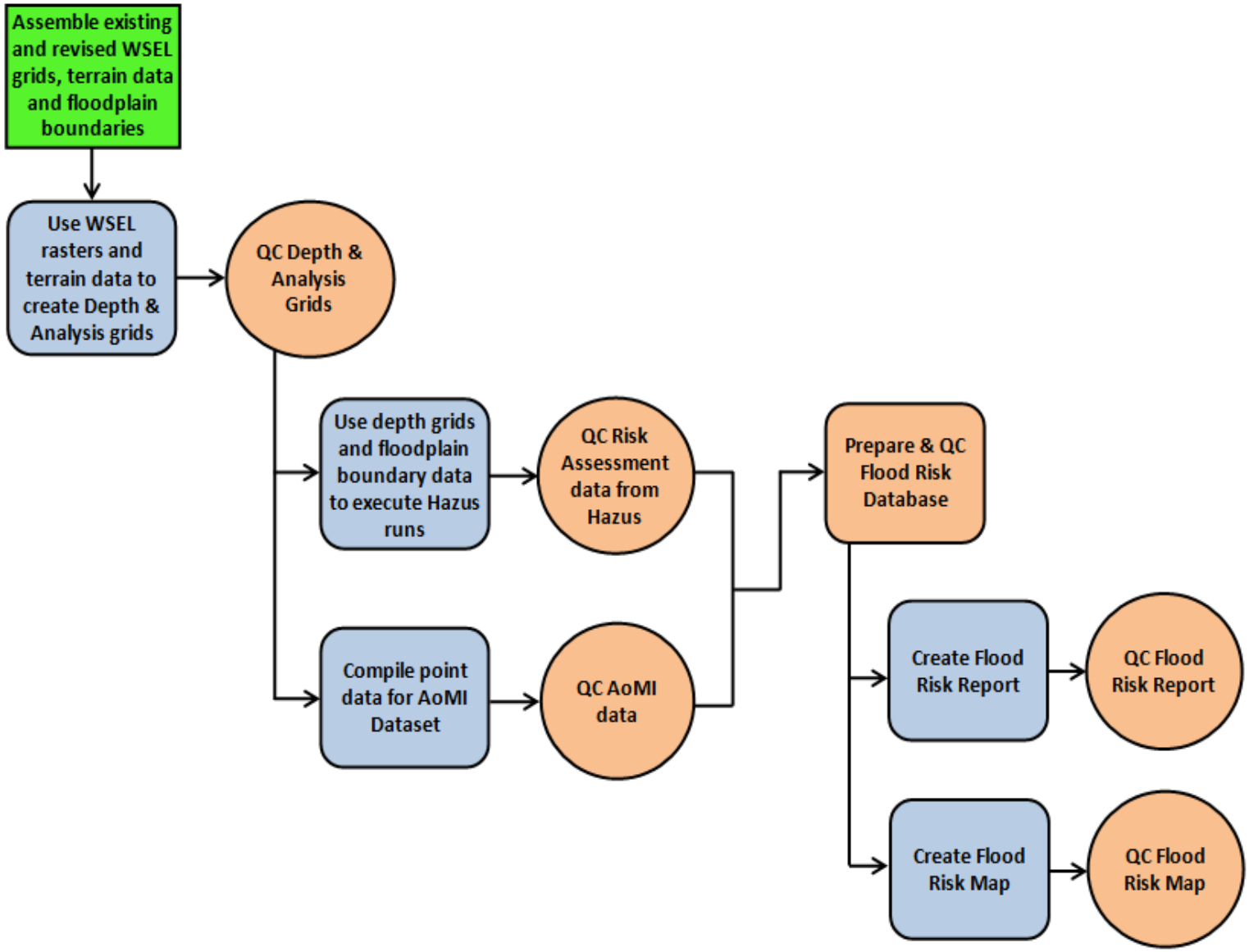


Figure 2: Non-Regulatory Product Development Workflow Showing Integrated Validation Points