
Floodplain Modeling Reports Requirements for Submitting to the City of Beaverton

These standards¹ are to be used to assist in the development and review of floodplain modeling reports. By establishing these standards, the City hopes to streamline the review process and give consultants a framework of expectations that need to be met in order to gain approval for a project. These standards are not an attempt to replace the FEMA requirements for submitting CLOMRs and LOMRs but are offered to assist in the City's review of projects in FEMA listed floodplains. FEMA Basin floodplains include: City of Beaverton Floodplain regulations found in [Chapter 60 of the City Development Code](#), [Chapter 9.05 of the City Code](#), and [Chapter 5, Section 5.10 of Clean Water Services Design & Construction Standards](#). The City of Beaverton is a member Agency of Clean Water Services.

A floodplain modeling report is required to ensure the property being developed meets all local and FEMA floodplain regulations, upstream or downstream properties are not adversely impacted, sufficient channel conveyance capacity is maintained or enhanced, and the channel will be stable. *The Floodplain Modeling Report should be a separate document from the Drainage Report.*

Floodplain modeling reports are required for:

1. Attempting to develop in a designated floodway and thus needing to meet the no-rise criteria. (See City Code 9.05.060 for allowed development in the floodway and no-rise certification requirements)
2. Attempting to develop in a FEMA Basin floodplain that does not have a mapped floodway requires that a 1.0 ft. floodway must be established.
3. Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) submittals, including channel modifications, corrected effective conditions changes in the floodway or changes in base flood elevations.
4. Changes to floodplains including channel modifications, corrected effective conditions changes in the floodway or changes in base flood elevations.
5. Documenting the proposed impact on the environmental health of the watercourse or erosion buffer zones. The channel stability, 100-year flood profile, velocities, drainage and flow characteristics, and the impact on surrounding properties must be assessed.
6. Documenting the proposed alteration of a natural floodplain, stream channel or natural protective barriers which accommodate or channel floodwaters. The impact to stream banks, trees, vegetation and wildlife habitat must be assessed.
7. Other unique special hazard projects.

The effort necessary for a floodplain modeling report is dependent on the amount of information previously generated, the type of project being proposed, the potential for impact on adjacent properties, the magnitude of flow in the channel, the size of the area affected, the need for channel stabilization, and the sediment transport and geomorphologic aspects of the stream.

¹ This document, information and guidelines are adapted from the City of Fort Collins, CO.

In addition, for the City to participate in the FEMA administered National Flood Insurance Program (NFIP), the City must have a floodplain management program that complies with FEMA requirements. A floodplain modeling report for changing a FEMA Basin floodplain must address compliance with the FEMA requirements for the project. This includes federal regulations published in [44 CFR Part 65](#) on technical submittal requirements for Conditional Letters of Map Revision or Letters of Map Revision.

Initial Meeting

An initial meeting with the City’s Floodplain Administrator, Site Development Division Manager, and Public Works Engineering, concerning the proposed project is **required** before any modeling work begins. This allows the consultant and the City to discuss the project, the required approach, models to be used, available mapping, etc. The City is also willing to meet with the consultant during the analysis phase to discuss any questions that may arise. This will hopefully assist in a streamlined analysis and City review process.

General Report Outline

The following is considered to be the **minimum** information necessary to be included in the **text** of any floodplain modeling report submitted to the City. Each item listed should be addressed. If the item is not applicable, please simply state “not applicable.” Specific projects may require additional information.

Chapter 1 – Background

- I. Project Area Description
 - Floodplain – name, description, FIS map panel #, date of FIS, etc.
 - Drainage Basin
 - Location – nearby streets, addresses, geographic coordinates.
 - Characteristics of study area – vegetation, channel planform, banks, channel stability, etc.
 - Map of area – vicinity map
- II. Flooding History – Describe basin as well as site-specific flooding history, if information is available.
- III. Previous Studies – discuss any previous Master Planning reports, Master Plan updates, Flood Insurance Studies, Map Revisions, other pertinent development reports, etc.

Project Description – describe all aspects of the project in detail. Describe the land-use (i.e., commercial, residential, and/or critical facility – school, hospital, nursing home, gas station, quick lube, police station, fire station, hazardous materials storage, etc.). Do not include detailed modeling description of proposed condition.

Chapter 2 – Analysis

- I. Purpose and Scope – Describe the purpose and scope of the study. List all tasks associated with the analysis.
- II. Methods and Approach – Describe methods/approach for modeling all conditions.
 - Duplicate effective – use the exact parameters that are included in the effective model using current software. If the Duplicate effective output does not match the Effective output, contact the City before proceeding.
 - Corrected effective – Explain why a corrected effective model is needed and the techniques used. A meeting with the City upon completion of this model run is required.
 - Existing condition – Explain the purpose of the existing condition model and why it is needed, as well as the differences between it and the corrected/duplicate condition.
 - Proposed project – Explain how the proposed project is incorporated into the model. Include an explanation of all modeling techniques that have changed from the effective model.

Definitions of duplicate effective, corrected effective, existing condition, and proposed project conditions are included at the back of these guidelines.

- III. Vertical Datum – Per City Engineering Design Manual Section 150.4.B, use Vertical Control based on NGVD 1929 and show FEMA NAVD 88 for documentation. Please state benchmark number used, its approximate location and the elevation of that benchmark on the City's datum. In FEMA floodplains, include a note that the FIS and FIRMS are published in NAVD 88. The conversion is $NGVD29 + 3.5 \text{ ft} = NAVD88$.
- IV. Models Used – Discuss the model version, date of model, etc. Discuss the hydrology including the model used, from where it was obtained, any modifications to the model, provide a copy of the output in the appendix; discuss the discharges to be used in the hydraulic model. Correlate the location of the discharges developed in the hydrologic model to the cross-sections at which they will be applied in the hydraulic model (i.e., HEC-2 or HEC-RAS) and provide a drawing/figure with cross-sections. Also include a discussion on the starting water surface elevation used in the hydraulic analysis, as well as a discussion of other boundary conditions used.
- V. Additional Cross-Sections– If the proposed project is between effective cross-sections, then cross-sections will need to be added to accurately reflect the proposed project (i.e. new buildings, bridge, etc.). New cross-sections should be added to the corrected effective model if a corrected effective model is created for other reasons (i.e. better topographic mapping or correcting errors in original modeling). If a corrected effective model is not done, then the Water Surface Elevation (WSEL) for the new cross-section for the effective condition can be interpolated from the Duplicate Effective model. There should be a WSEL for all cross-sections for both the effective or corrected effective condition and proposed project condition unless the project prohibits determining a WSEL at a particular cross-section. Discuss methods and include all WSELs (modeled or interpolated) in the results.

- VI. Changes in Modeling Parameters and Why Changed – Discuss any deviations in modeling parameters from the effective model and explain why they were changed. (i.e. n-values, encroachments, contraction/expansion coefficients, etc.)
- VII. Discharges and Modeled Frequencies
- A. Discharges- Provide a table showing discharges for 10, 50, 100, and 500-year flows at all cross- sections. Include a table for existing and modified discharges if applicable. (This is for documentation purposes only.)
 - B. Frequencies – The frequencies to be modeled are as follows: 10-year, 25-year, 100-year, and 500-year. Frequencies included in the effective flood insurance study are required to be included in any subsequent updates to the study.

Chapter 3 – Results/Discussion

- I. Effective vs. Duplicate Effective Condition
- A. Text – Compare the two conditions even if there is no change.
 - B. Tables – Include a table (or multiple tables if necessary) within the text comparing WSELs between effective and duplicate effective models (WSELs should be rounded to the nearest 0.1 ft), floodway, velocities for all cross-sections not just published cross-sections, and include a column with the calculated difference in WSEL between effective and duplicate effective models (i.e., Floodway Data Table).
 - C. Model Input and Output – Include a copy of the duplicate effective model input and output in Appendix A (both hydrologic and hydraulic models).
 - D. Figures – Include for the duplicate effective condition, water surface profiles and cross-section plots for all cross-sections in the study area in Appendix A.
 - E. Maps – Include a copy of the effective condition map (Master Plan or FEMA Work Map) in back pocket of report. Map should be 22” x 34” or similar size based on original mapping (1inch = 400 ft. minimum). Include the following information on the map when producing new maps:
 - Topographic contours (existing contours)
 - Spot elevations used to develop cross-sections
 - Floodplain and floodway delineations
 - All cross-sections shown in hydraulic model (at least one cross-section upstream and downstream of the affected area) with cross-section numbering
 - Base flood elevations (rounded to nearest foot)
 - Property boundaries
 - All structures and roads including names of roads
 - Stream names
 - Vertical datum, benchmark number, and elevation used
 - Scale and north arrow
- II. Duplicate Effective vs. Corrected Effective Condition
- A. Text – Compare the two conditions and explain the differences.
 - B. Tables – Include a table (or multiple tables if necessary) within the text comparing WSELs between duplicate effective and corrected effective models (WSELs should be rounded to

the nearest 0.1 ft), floodway, velocities for all cross-sections not just published cross-sections, and include a column with the calculated difference in WSEL between effective and duplicate effective models (i.e., Floodway Data Table).

Also, if cross-sections were added as part of the corrected effective condition, an interpolated WSEL (or pull the WSEL off the profile if developed) should be included for the same cross-section in the duplicate effective model. See FIS for example of format – HEC-2 Summary Table 200 or FIA Table 1.

- C. Model Input and Output – Include a copy of the corrected effective model input and output in Appendix B (both hydrologic and hydraulic models as appropriate). An echo of the input and the individual cross-section output display should be included in the output printout and electronic file.
- D. Figure – Include for the corrected effective condition, water surface profiles and cross-section plots for all cross-sections in the study area in Appendix B.
- E. Maps – Include a copy of the corrected effective condition in back pocket of report. Map should be 22" x 34" or similar size based on original mapping (1inch = 400 ft. minimum). Include the following information on the map when producing new maps:
 - Topographic contours (existing contours – use the more detailed topographic data if that is the reason for doing a corrected effective model)
 - Spot elevations used to develop cross-sections
 - Floodplain and floodway delineations
 - All cross-sections shown in hydraulic model (at least one cross-section upstream and downstream of the affected area) with cross-section numbering
 - Base flood elevations (rounded to nearest foot)
 - Property boundaries
 - All structures and roads including names of roads
 - Stream names
 - Vertical datum, benchmark number, and elevation used
 - Scale and north arrow

III. Duplicate Effective vs. Existing Conditions or Corrected Effective Condition vs. Existing Conditions (Select the appropriate comparison used in the analysis)

- A. Text – Compare the two conditions and explain the differences.
- B. Tables – Include a table (or multiple tables if necessary) within the text comparing WSELs between duplicate effective/corrected effective model and the existing conditions model (WSELs should be rounded to the nearest 0.1 ft), floodway, velocities for all cross-sections not just published cross-sections, and include a column with the calculated difference in WSEL between effective and duplicate effective models (i.e., Floodway Data Table). Also, if cross-sections were added as part of the existing condition, an interpolated WSEL (or pull the WSEL off the profile if developed) should be included for the same cross-section in the duplicate/corrected effective model. See FIS for example of format – HEC-2 Summary Table 200 or FIA Table 1.
- C. Model Input and Output – Include a copy of the existing conditions model input and output in Appendix C (both hydrologic and hydraulic models as appropriate). An echo of the input and the individual cross-section output display should be included in the output printout and electronic file.
- D. Figures – Include for the existing condition, water surface profiles and cross-section plots for all cross-sections in the study area in Appendix C.

- E. Maps – Include a copy of the existing condition in back pocket of report. Map should be 22" x 34" or similar size based on original mapping (1 inch = 400 feet minimum). Include the following information on the map when producing new maps:
- Topographic contours (existing contours)
 - Spot elevations used to develop cross-sections
 - Floodplain and floodway delineations
 - All cross-sections shown in hydraulic model (at least one cross-section upstream and downstream of the affected area) with cross-section numbering
 - Base flood elevations (rounded to nearest foot)
 - Property boundaries
 - All structures and roads including names of roads
 - Stream names
 - Vertical datum, benchmark number, and elevation used
 - Scale and north arrow
- IV. Existing Conditions vs. Proposed Project or Corrected Effective vs. Proposed Project or Duplicate Effective vs. Proposed Project (Select the appropriate comparison used in the analysis)
- A. Text – Compare the two conditions and explain the differences.
- B. Tables – Include a table (or multiple tables if necessary) within the text comparing WSELs between duplicate effective/corrected effective/existing conditions and proposed project models (WSELs should be rounded to the nearest 0.1 ft), floodway, velocities for all cross-sections not just published cross-sections, and include a column with the calculated difference in WSEL between effective and duplicate models (i.e., Floodway Data Table). Also, if cross-sections were added as part of the proposed condition, an interpolated WSEL (or pull the WSEL off the profile if developed) should be included for the same cross-section in the duplicate/corrected/existing condition model. See FIS for example of format – HEC-2 Summary Table 200 or FIA Table 1.
- C. Model Input and Output – Include a copy of the proposed project model input and output in Appendix D (both hydrologic and hydraulic models as appropriate). An echo of the input and the individual cross-section output display should be included in the output printout and electronic file.
- D. Figures – Include for the proposed project condition, plots of the water surface profiles and cross-section for all cross-sections in the study area in Appendix D.
- E. Maps – Include a copy of the proposed project condition in back pocket of report. Map should be 22" x 34" or similar size based on original mapping (1inch = 400 ft. minimum). Include the following information on the map when producing new maps:
- Topographic contours (proposed contours)
 - Spot elevations used to develop cross-sections
 - Floodplain and floodway delineations
 - All cross-sections shown in hydraulic model (at least one cross-section upstream and downstream of the affected area) with cross-section numbering
 - Base flood elevations (rounded to nearest foot)
 - Property boundaries
 - Proposed project
 - All structures and roads including names of roads
 - Minimum opening elevation for proposed structures or any potentially impacted structures

- Stream names
- Vertical datum, benchmark number, and elevation used
- Scale and north arrow

Digital Files for Changes to the Floodplain Mapping – If there are changes to the floodplain as a result of the project or as a result of a corrected effective condition, then a digital copy (ARC/INFO or AutoCAD) of the floodplain map must be produced that ties in with the existing digital floodplain map.

- V. Emergency Response/Worst-Case Scenario – Describe the worst-case scenario for this project and surrounding areas (emergency response component). If the project includes a bridge, assume the bridge is completely blocked, and answer in your best judgment “Where does the water go?” This should include, at a minimum, a qualitative analysis if a quantitative analysis cannot be provided. Each project will need to be evaluated by City staff to determine if there are any emergency response or worst-case scenario questions that need to be answered.
- VI. Changes in WSEL – Discuss in the text any changes in the 100-year WSEL for both the with floodway and without floodway conditions. Discuss the best interpretation of why the change is occurring. Also confirm that any rise is allowable per the regulations. If other frequencies are modeled, and there is a significant change in the water surface elevation due to the project, these changes should also be discussed.
- VII. Floodway – Does this floodplain have a mapped floodway? If modifying a FEMA floodway, either 0.00-rise criteria must be met and there are no changes to the floodplain or floodway boundaries or a CLOMR must be submitted to FEMA. If modifying a floodway, the modelling must demonstrate no adverse impacts to upstream or downstream properties.
- VIII. Impact on Structures – There cannot be any increase in WSEL on structures in the 100-year FEMA Basin floodplain if modifying a FEMA floodway.
- IX. Mitigation – Are there any mitigation measures being incorporated in the project? Please describe.
- X. Flood proofing – If flood proofing a building, consult with Building Division to describe and show drawings of flood proofing technique, catalog cuts, manufacturer specs, etc. and include any necessary calculations. If the flood proofing is not permanent (i.e. requires human intervention) describe: Where will closures, shields, etc. be stored? Whose responsibility is it to insure closure? What kind of maintenance is required?
- XI. Bed and Bank Stabilization – Describe any bed and bank stabilization measures that were used in the project (i.e., riprap, drop structures, grade control, bank protection fabric, etc.). Sediment transport and/or fluvial geomorphologic analyses may be required.
- XII. Compliance with Criteria – Is all criteria being met? – elevation, flood proofing, critical facilities, tie- in of upstream and downstream WSEL, no impact to structures in FEMA floodplains when modifying a floodway, floodway criteria, street criteria, blockage criteria, etc. See City Code and 44 CFR for complete regulations.

XIII. ESA Compliance – CLOMR applicants are responsible for documenting to FEMA that the Endangered Species Act (ESA) compliance has been achieved prior to FEMA’s review of the CLOMR application. For requests without a Federal action, compliance with Sections 9 and 10 of the ESA must be achieved independently of FEMA’s process. Documentation that the project is compliant with the ESA may be submitted in the form of a written and signed statement confirming that the project will not result in the taking of any endangered or threatened species from the community official responsible for floodplain management. For actions authorized, funded, or being carried out by Federal or state agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA must be submitted. The ESA documentation may include a “No Effect” determination made by an appropriate source; a “Not Likely to Adversely Affect” determination from the Services; a “No Jeopardy Opinion”; or a copy of a federally issued permit with justification that the subject of the CLOMR is part of the area investigated.

Appendices

Appendix A – Duplicate Effective Condition

- Model Input/output (HEC and SWMM with cross-sections and schematic/basin maps).
- Water Surface Profiles
- Cross-Section Plots

Appendix B – Corrected Effective Condition (if applicable)

- Model Input/output (HEC and SWMM with cross-sections and schematic/basin maps), HEC output should include the individual cross-section output display and an echo of the input.
- Water Surface Profiles
- Cross-Section Plots

Appendix C – Existing Condition (if applicable)

- Model Input/output (HEC and SWMM with cross-sections and schematic/basin maps), HEC output should include the individual cross-section output display and an echo of the input.
- Water Surface Profiles
- Cross-Section Plots

Appendix D – Proposed Project Condition

- Model Input/output (HEC and SWMM with cross-sections and schematic/basin maps), HEC output should include the individual cross-section output display and an echo of the input.
- Water Surface Profiles
- Cross-Section Plots

Back Pocket of Report

Maps: All Maps 22” X 34” (duplicate effective, corrected effective, existing, and proposed project – as applicable). Maps should use the following color coding whenever possible:

- Yellow = 500-year floodplain
- Green = moderate risk 100-year floodplain (<1 ft. sheet_flow)
- Light Blue = high risk 100-year floodplain

- Dark Blue & hatch = floodway

Electronic Files: Digital copy with all models (HEC, SWMM, Extran, Digital Floodplain Map, etc.)

Additional Requirements

FEMA Submittals

The City of Beaverton is required to make submittals for floodplain map revisions to FEMA for projects which propose floodway revisions, changes in the BFE, or changes using a corrected effective model. As part of the Floodplain Modeling report submittal to the City, the applicant will submit all appropriate FEMA submittal forms for review. Once the floodplain modeling report is approved by the City, the City will sign the FEMA submittal application. It is the responsibility of the applicant to mail the submittal package to FEMA and ensure the proper FEMA application fees are mailed and received by FEMA.

Over lot grading or other construction cannot begin in the floodway until a CLOMR is issued by FEMA. Any other work done in the flood fringe prior to the issuance of the CLOMR is done at the applicant's risk of possibly needing to make changes based on FEMA's comments. A permit must be obtained from the City of Beaverton before any work can be done in a floodplain.

The LOMR submittal is required immediately after a project is constructed. The floodplain modeling report should be revised to include as-built information (record drawing not acceptable). A complete submittal package is required to be reviewed by the City. Once the floodplain modeling report is approved by the City, the City will sign the FEMA submittal application go along with the FEMA submittal. It is the responsibility of the applicant to mail the submittal package to FEMA and to ensure that the proper FEMA application fees are mailed and received by FEMA. Remember the FEMA maps are not changed until the LOMR is issued by FEMA.

Development in Floodplain Permit

A permit is required for any and all work done in the floodplain. A permit must be submitted and approved prior to the start of construction. Please see 9.05.060 of City Code for floodplain permit requirements, Chapter 60.10 of City Development Code for floodplain regulations and Chapter 5, Section 5.10 of Clean Water Services Design & Construction Standards for flood management standards.

Definitions

CLOMR Conditional Letter of Map Revision, required by FEMA to gain approval for a project before construction.

LOMR Letter of Map Revision, required by FEMA to change the Flood Insurance Rate Maps based on a completed project or new updated information.

Effective Model The model that is currently in use by the City and/or FEMA and from which the published values have been obtained.

Duplicate Effective Model This model is developed by the consultant from running the effective model on the consultant's computer without any changes to the effective modeling parameters (i.e. n-values, encroachments, expansion/contraction coefficients, topography, etc.). There should be no differences between the effective model and the duplicate effective model results. This will ensure that this is the correct version of the model. If there are discrepancies, the consultant must contact the City to determine if the discrepancies are valid and if so, provide explanations of the differences in the report text.

Corrected Effective Model This model builds on the duplicate effective model and includes only those changes for which there were errors in the modeling of the effective condition or if better (i.e. more detailed) topographic mapping is available. Changes as a result of the proposed project should not be included in the model. However, if cross-sections need to be added for the proposed project model in order to accurately represent the proposed project, then these cross-sections should be added to the corrected effective model. A corrected effective model that is approved by either the City or FEMA becomes the new effective model (base-line condition). Therefore, the proposed project will be compared to the corrected effective model to determine compliance with criteria.

Existing Conditions Model This model builds on either the duplicate effective model or the corrected effective model and includes only those changes that have occurred due to man since the date of the Effective Model. These changes are not part of the proposed project. However, if cross-sections need to be added for the proposed project model in order to accurately represent the proposed project, then these cross-sections should be added to the existing condition model. An existing condition model that is approved by either the City or FEMA becomes the new effective model (base-line condition). Therefore, the proposed project will be compared to the existing condition model to determine compliance with criteria.

Proposed Project Model The model that incorporates all changes due to the proposed project. This includes any new structures, bridges, streets, culverts, parking lots, berms, modeling parameter changes, grading changes, etc.