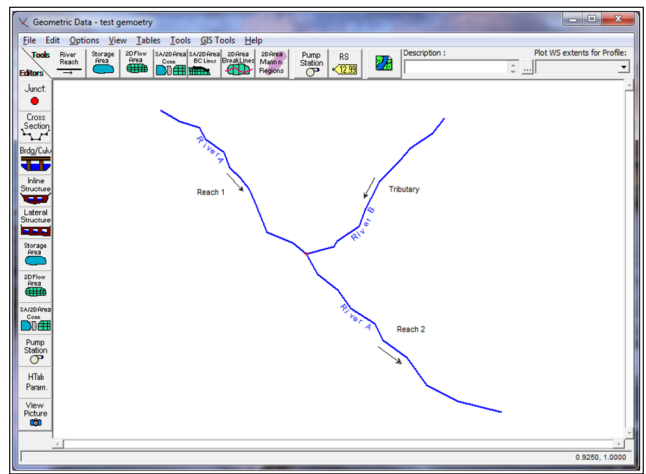
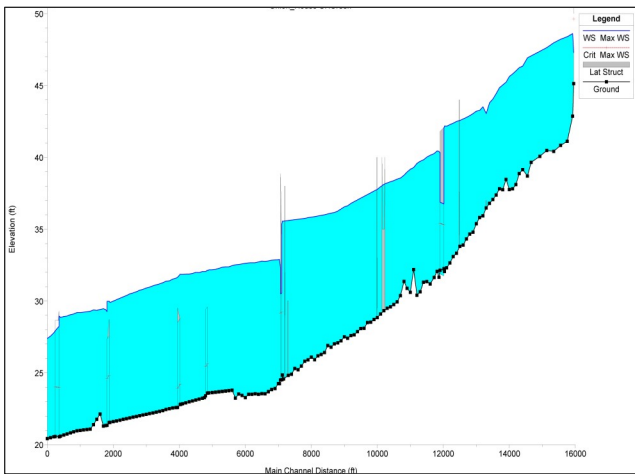
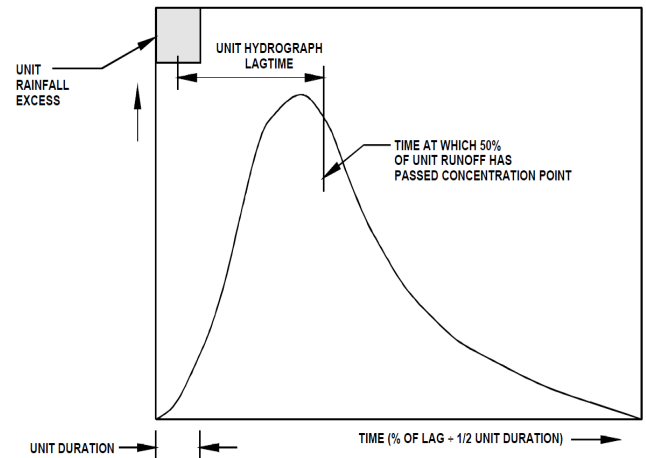
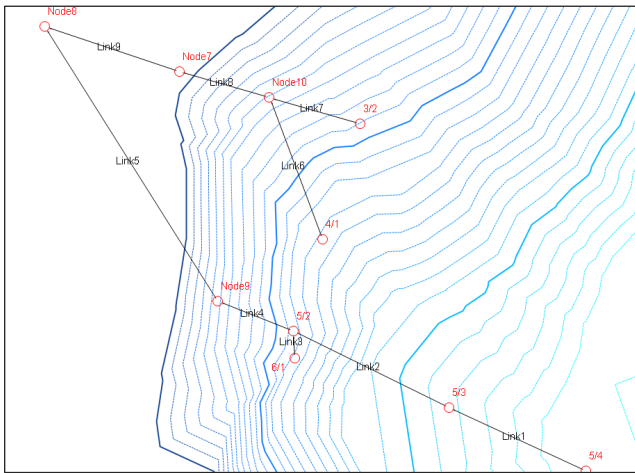


# Drainage Study Requirements



Steven L. Hartwig  
Deputy County Executive

Michael L. Peterson, Director  
Department of Water Resources



Navdeep S. Gill  
County Executive

## County of Sacramento

March 17, 2020

Dear Engineer:

We are pleased to provide these Drainage Study Requirements for use in preparing drainage studies that are submitted to the Sacramento County Department of Water Resources. Water Resources wants to give you the best opportunity to submit a study that meets our needs and ensures a successful and timely review.

These Drainage Study Requirements were created to provide a consistent set of requirements and expectation for preparing drainage studies to support the various development processes in the County. The Drainage Study Requirements provides a comprehensive set of commitments that both Water Resources and the applicant agree to follow and implement. The Drainage Study Requirements were developed in close coordination with the North State Building Industry Association and select members of the local engineering community.

As a customer of Sacramento County, you are an essential part of the region's economic vitality, and we want to work as partners with you toward our mutual success.

Sincerely,

Michael L. Peterson, PE  
Director, Sacramento County Department of Water Resources

Sacramento County  
Department of Water Resources  
Drainage Study Requirements

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# **Mutual Commitment**

## **County Commitments**

1. Drainage Studies will be reviewed for consistency with the most recent Board of Supervisors adopted General Plan, Hydrology Standards, Drainage Study Requirements, and most current drainage and maintenance policies set forth by the Department. Personal preferences will not be a basis for staff study review.
2. The Sacramento County public website will be updated with the most up to date drainage policies and standards.
3. If a Drainage Master Plan in support of a Specific Plan is adopted by the Board of Supervisors then its findings live on, unless there are significant and material physical changes to the property or amendment to the Specific Plan that requires an update to the Drainage Master Plan.
4. Technical drainage adjustments should not trigger a new drainage master plan. Design level details should not be done at the Level 1 or 2 stage.
5. Prior to initiating a drainage study, a scoping meeting with DWR staff and project applicants will be conducted to get agreement and confirmation of required scope, acceptable analysis methods, and appropriate levels of technical details. The scoping discussion should also identify future changes which may trigger a modification to the agreed upon scope as well as realistic and achievable turnaround times for DWR review of submittals.
6. After submittal of completed studies and review by DWR staff, if DWR staff and project applicants cannot reach agreement regarding satisfactory completion of required study scope, adequacy of works products, or DWR turnaround times, the DWR Senior Engineer will be engaged to resolve outstanding issues. If resolution cannot be reached to the satisfaction of the project applicant the decision can be appealed directly to the Director of Water Resources who will make a final determination. Studies submitted to the County will be reviewed for completeness per the timeframe stated in the Scoping Agreement signed by the DWR and project applicant.
7. Incomplete study submittals will not be accepted for review and the study will be returned to applicant engineers until the submittal meets the minimum requirements. Any rejection of a study by Water Resources for reasons of incompleteness will include a letter which clearly identifies the reasons for rejection. (akin to Planning's 884 letter). If the project applicant does not agree with this determination an appeal can be made to the DWR Senior Engineer for review. If resolution cannot be reached, the project applicant can appeal directly to the Director of Water Resources for final determination.
8. Water Resources will be responsible for meeting review turnaround times identified in the project scoping document. At the discretion of the County, this may include utilizing third party engineering consultants to supplement DWR staff on an as-needed basis.. County staff will review the input parameters, modeling techniques, accuracy of the model, and proposed mitigation. If deficiencies or conflicts with Water Resources policies are identified, the review will stop, and the model returned. Any rejection will include a letter which clearly identifies conflicts and deficiencies. If the project applicant

does not agree with this determination an appeal can be made to the DWR Senior Engineer for review. If resolution cannot be reached, the project applicant can appeal directly to the Director of Water Resources for final determination.

9. A resubmittal will not be accepted if previous comments were not addressed or discussed with Water Resources staff and resolved.
10. Once the study is deemed technically adequate, county staff will develop coordinating Conditions of Approval for the current land use entitlement. All successive land use entitlements will be reviewed for adequacy and consistency with the overarching study.
11. On occasion, Water Resources will utilize third party review for technical review. In this instance, Water Resources staff will review for conformance with Water Resources policy and act as the main point of contact.
12. Study review control measures will be instituted by County to ensure consistency and accuracy of reviews including regular training of staff, standard study format, and checklists made available to applicants detailing submission and technical requirements.
13. If further information or explanation is desired, County staff will be available by appointment.
14. When deeming a study technically adequate, Water Resources will clearly note which elements were reviewed and which elements were not required for this level and therefore not reviewed.

## **Applicant/ Developer/Engineer/Customer Commitments**

1. Prior to initiating a drainage study, the Applicant team shall reach out to Water Resources and schedule a Scoping Meeting to discuss assumptions and approach. At the meeting the following will be discussed:
  - a. Cumulative impact analysis requirements are to be determined
  - b. Sensitivity impact analysis requirements are to be determined.
  - c. Extent of analysis of existing infrastructure.
  - d. After the meeting a detailed scope of work will be prepared by Applicant Team outlining Elements/requirements of the study to be prepared.
  - e. The scope of work will be reviewed by DWR staff. Once agreement is reached a scoping document will be prepared detailing the agreed upon scope, acceptable analysis methods, appropriate levels of technical details, identification of future changes which may trigger a modification to the agreed upon scope, as well as realistic and achievable turnaround times for DWR review. The scoping document shall be signed by the DWR Senior Engineer, Project Applicant, and authorized engineering representative of the project applicant.
2. Quality control will be performed by the engineering firm submitting the study.
3. Applicant Engineers understand that a study will be deemed incomplete when the following conditions are present:
  - a. Study is clearly inconsistent with County Drainage Standards
  - b. Study is clearly inconsistent with Drainage Study Requirements
  - c. Study is contradictory to previous, over-arching drainage study or does not match proposed land use entitlement.
  - d. Study does not follow scoping memo, unless there is a valid reason.
4. If comments are ambiguous or require additional explanation, the engineer will initiate a meeting with Water Resources staff to resolve the comment prior to resubmittal.
5. All resubmittals shall include a list of previous Water Resources comments with a written response.
6. If a resubmittal is given to the County more than 1 calendar year from the prior submittal, all previous comments will expire, and the study will be subject to the most current standards and policies.
7. With Water Resources' prior approval, review of drainage studies may be comprised of phased approvals through technical memorandums. In this situation, meeting times and review times may be negotiated with Water Resources, workload and availability permitting.
8. All environmental permitting requirements placed upon Water Resources maintained facilities are subject to Water Resources review and approval.

## **Water Resources Policy for Drainage Infrastructure**

- All Drainage Studies shall be developed in accordance with the current versions of the Sacramento County Hydrology Standards: Volume 2, Improvement Standards, Floodplain Management Ordinance, Sacramento County General Plan Policies, and Urban Level of Flood Protection Criteria (as applicable).
- Modeling techniques shall be performed in accordance with current HEC-RAS and XP Strom practices and common industry standard. Other modeling software programs may be used with approval of Water Resources.
- Modeling shall extend offsite upstream and downstream to determine impacts to surrounding properties. (If any).
- Modeling may include cumulative impact analysis and a sensitivity analysis.
- The hydrologic and hydraulic routing and mitigation features utilized in the model must be clearly shown in all of the accompanying exhibits.
- Phasing
  - If phasing is to be included, a full logistics plan is required to document the timing and financial aspects of which ultimate facilities will be built.
  - If interim facilities are to be proposed, a full implementation plan must be submitted and detail timing, financial, and method to switching to ultimate. All interim facilities shall be built per County standard and designed as if a permanent facility.
- If permitting is required, a narrative shall be supplied to discuss timing, responsibility, and finance.
- Shed shifts are strongly discouraged and require approval from the Director of Water Resources.
- Levees are strongly discouraged. Water Resources will not be the maintaining agency for any FEMA accredited levees.
- Existing infrastructure may be required to be evaluated to determine ability to convey flow for proposed development.
- Water Resources shall not be the Preserve Manager for development projects.

## **Drainage Study Overview**

### **Level 1 – Master Plan**

The purpose of a Level 1 drainage study is to provide a guide for development within a plan area and support the Environmental Impact Report (EIR) for the following land use documents:

- Specific Plans
- Special Planning Areas
- Rezoning
- Large Lot Tentative Maps
- Financing Plans

The key elements of the study will establish a baseline (existing) condition for existing floodplain elevations on the site, neighboring parcels, and in adjacent drainage features, present the proposed land uses, analyze the developed conditions floodplain, and propose necessary and buildable drainage mitigation. Specifically, the study shall address major topography and offsite overland release, major flood control facilities (channels and basins), major trunk drainage facilities, and NPDES requirements (Stormwater quality facilities, Regional Low-Impact Development (LID) measures, and Hydromodification, if any). The study shall identify any requested shed shifts and requested deviations from County Standards and/or Policy. The study NEED NOT include details such as Minor drainage pipes and manholes, and subdivision layouts.

The study shall very clearly depict ANY offsite improvements required to support the Master Plan.

The Level 1 drainage study shall also include a general narrative describing the aesthetic maintenance, proposed joint use facilities, identify general or programmatic level of detail appropriate to the level of study for environmental impacts and expected mitigation measures, permitting requirements, and operation and maintenance funding mechanism.

The objective of the Level 1 Study is to outline the necessary backbone drainage features needed to implement the proposed master plan area and provide a guiding document that subsequent tentative maps and improvement plans can substantially follow. Subsequent land use entitlements will require a Level 2 and Level 4 Study. The Level 1 study shall list and describe the need for further analysis at the tentative map and improvement plan level. In most cases, Water Resources will issue a response similar to the following;

This Study adequately outlines the backbone drainage infrastructure required for the project area. This study is not acceptable for design; further studies will be required to complete the design analysis and allow construction of improvements.



## **Level 2 – Tentative Subdivision Map**

The purpose of a Level 2 drainage study is to support the Tentative Subdivision Map (TSM) application or similar land use entitlement application. The Level 2 study shall demonstrate the general viability of the proposed TSM. The level of detail required may vary per project however the overall objective is to determine ability to mitigate project, confirm no adverse impacts can be achieved, and set clear expectations of viability of the proposed TSM. The study shall identify the facilities from the Level 1 study that provide major flood control, major trunk drainage, and general compliance with NPDES requirements (Stormwater quality facilities, Low-Impact development (LID), and Hydromodification) that are needed for the proposed TSM. Necessary refinement of Level 1 facilities shall be included as well as expand the analysis to include overland release paths and secondary impacts (as they relate to the Conditions of Approval for the TSM). Within the report of the study the engineer must note any shed shifts and requested deviations from County Standards and/or Policy.

The study generally identify in concept (not final engineering) ANY offsite drainage improvements required to support the TSM. All offsite easements are to be conditioned as a requirement for a level 4 study, as appropriate

The Level 2 drainage study shall also include a general narrative describing conformance with the Level 1 proposed joint use facilities and permitting requirements.

The objective of the Level 2 study is to outline the necessary drainage features needed for the proposed TSM and provide a guiding document that subsequent study and improvement plan can substantially follow. Improvements plans will require a Level 4 study. In most cases, Water Resources will issue a response similar to the following:

The study adequately outlines the drainage infrastructure required for the TSM project area. This study is not acceptable for design: further study(s) will be required to complete the design analysis and allow for approval of improvement plans.

## **Level 3 – Parcel Maps / Use Permits / Infill Tentative Subdivision Maps**

The purpose of a Level 3 drainage study is to support the Parcel Map, Use Permit, or minor infill Tentative Subdivision Map land entitlement applications. The Level 3 study shall identify facilities that provide for flood control, conveyance of storm water, compliance with NPDES requirements (Stormwater quality facilities, Low-Impact Development (LID), and Hydromodification), (Hydromodification mitigation is only required for SFR development greater than 20 acres or HDR, commercial, and BP greater than 1 acre in size.) and overland release for the proposed entitlement. The level of detail required may vary per project however the overall objective is to determine ability to mitigate project, confirm no adverse impacts can be achieved, and set clear expectations of buildable area. Water Resources will conduct an initial

assessment of the project's preliminary Drainage and Grading Exhibit and determine if a Level 3 study is required or analysis can be deferred to improvement plan. In either situation, a Level 4 study shall be required prior to Improvement Plan approval.

#### **Level 4 – Improvement Plan**

The Level 4 drainage study is the detailed design analysis of the drainage system for a specific project site and forms the basis for the improvement plans. The study will confirm consistency with and a final refinement of major flood control, major trunk drainage, and compliance with NPDES requirements (Stormwater quality facilities, Low-Impact Development (LID), and Hydromodification) noted in the Level 1 and 2 or 3 study. The study shall also include a complete analysis of non-trunk pipes, structures, and overland release, incl. dimensions and locations. Any request for shed shifts or non-standard facilities must include supporting documentation and are subject to approval from WATER RESOURCES.

When the Level 4 study is approved, Water Resources will respond in a manner similar to the following:

This study is approved. Any significant changes in the project features and design may require a revision to this study. Improvement plans that are consistent with the Level 4 study associated with this project may be approved.

## **Detailed Drainage Study Description**

### **Level 1**

#### **Table of Contents**

1. Cover
  - a. Project Title
  - b. Level of Analysis
  - c. Planning Application Number
  - d. Watershed
  - e. Date
  - f. Professional Engineer Stamp and Signature
2. Table of Contents
  - a. Sections and Appendices, List of Tables, List of Figures, and List of Exhibits
3. Introduction
  - a. Existing Conditions
  - b. Project Description
  - c. Applicable Standards
  - d. Previous Studies
  - e. Objectives of Analysis
4. Baseline (Existing Conditions)
  - a. Historical Land use
  - b. Topographic Sources (include certification information)
  - c. Offsite Drainage
    - i. Upstream
    - ii. Downstream
  - d. On-site Drainage
    - i. Creeks/Streams
    - ii. Other conveyance
  - e. Hydrologic Modeling Assumptions
    - i. Software Application and Version
    - ii. Watershed Delineation
    - iii. Soils
    - iv. Land Use
    - v. Lag Transformation Method
    - vi. Routing
    - vii. Storage
    - viii. Summary of Discharges
  - f. Hydraulics Modeling Assumptions
    - i. Software Application and Version
    - ii. Description of HEC-RAS model, geometry, and flow plans.
    - iii. Hydraulic Computational Method ()
    - iv. Limits of Study (Adequately upstream and downstream of the project site – should be agreed to by DWR prior to study initiation)

- v. Boundary Conditions
  - vi. Manning's "n" Value
  - vii. Model layout
    - 1. Cross-Section, Bridges/Culverts, Lateral Structures, Storage Areas, Pumps, etc.
  - viii. Summary of Discharges and Stages
- g. Profiles
- h. Floodplain Extents
- 5. Mitigated Project (Proposed Condition)
  - a. Proposed Landuse
  - b. Grading Plan
  - c. Offsite Channel Drainage Improvements
  - d. Onsite Improvements (Channels, Basins, Bridges / Culverts, Berms, etc.)
  - e. Hydrologic Modeling Assumptions
    - i. Software Application and Version
    - ii. Watershed Delineation
    - iii. Soils
    - iv. Land Use
    - v. Lag Transformation Method
    - vi. Routing
    - vii. Storage
    - viii. Summary of Discharges
  - f. Hydraulics Modeling Assumptions
    - i. Software Application and Version
    - ii. Hydraulic Computational Method (Unsteady Modeling must be approved prior to submittal).
    - iii. Limits of Study (Adequately upstream and downstream of the project site)
    - iv. Boundary Conditions
    - v. Manning's "n" Value
    - vi. Model layout
      - 1. Cross-Sections, Bridges/Culverts, Lateral Structures, Storage Areas, Pumps, etc.
    - vii. Summary of Discharges and Stages
  - g. Profiles
  - h. Floodplain Extents
  - i. Storm Trunk Drainage (Support Finance Plan)
  - j. Stormwater Quality Treatment
  - k. Hydromodification
  - l. LID
  - m. Description of anticipated permits required for proposed mitigation
- 6. Summary if Findings
  - a. Discussion of Baseline and Fully Mitigated project results
    - i. Upstream, Downstream, and through project impacts

- b. Identify how Applicable Standards are satisfied
7. Quality Assurance / Quality Control
  - a. Model Calibration (if data is available)
  - b. Model Warnings and Errors have been addressed (Check RAS by FEMA)
8. Conclusion

#### **List of Exhibits**

1. Vicinity Map
2. FEMA Flood Maps
3. Proposed Land Use Plan
4. Existing Drainage Conditions
5. Hydrologic Input Map
6. Hydraulic Routing Map
7. Flood Control Mitigation Exhibit
8. Stormwater Quality Exhibit
9. Hydromodification Exhibit

#### **List of Tables**

1. Existing Condition Watershed Parameters (including land uses, soil types and lag time calculation parameters)
2. Proposed Condition Watershed Parameters (including land uses, soil types and lag time calculation parameter)
3. Detention Basin Parameters (including elevation-storage relationships and outfall assumptions)
4. Stormwater Quality Basin Parameters (including elevation-storage relationships and outfall assumptions)
5. LID Assumptions (if used to reduce required stormwater quality or hydromodification volumes)
6. Compliance Points
7. Existing Condition Results (noting shed/node/cross-section numbers, peak flows, and peak elevations)
8. Proposed Condition Results (noting shed/node/cross-section numbers, peak flows, and peak elevations)
9. Detention Basin Results (Including Peak elevations and draw down times for online detention basins)

## Level 2

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3. Introduction
  - a. Existing Conditions
  - b. Project Description
  - c. Applicable Standards
  - d. Previous Studies
  - e. Drainage Conditions of Approval
  - f. Objectives of Analysis
4. Regional Flood Control and Stormwater Quality
  - a. Demonstrate Consistency with Facilities Described in Level 1 Study (if applicable)
    - i. If all Regional Flood Control and Stormwater Quality facilities are to be constructed with the proposed Tentative Subdivision Map, provide the Level 1 study as an attachment.
    - ii. If a portion of the Regional Flood Control and Stormwater Quality Facilities are to be constructed as part of this project, provide a site-specific analysis
5. Summary of Findings
  - a. Discussion of project results
    - i. Upstream, downstream and through project impacts
  - b. Identify how Applicable standards are satisfied
6. Quality Assurance/ Quality Control
  - a. Model Calibration (if data is available)
  - b. Model Warnings and Errors have been addressed (Check RAS by FEMA)
7. Conclusion

## **List of Exhibits**

1. Vicinity Map
2. FEMA Flood Maps
3. Hydrologic Soil Group Map
4. Proposed Land Use Plan
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6. Hydrologic Input Map
7. Hydraulic Routing Map
8. Flood Control Mitigation Exhibit
9. Stormwater Quality Exhibit
10. Hydromodification Exhibit

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4. Stormwater Quality Basin Parameters (including elevation-storage relationships and outfall assumptions).
5. LID Assumptions (if used to reduce required stormwater quality or hydromodification volumes)
6. Compliance Points
7. Existing Condition Results (noting shed/node/cross-section numbers, peak flows and peak elevations).
8. Proposed Condition Results (noting shed/node cross-section numbers, peak flows and peak elevations)
9. Detention Basin Results (including peak elevations and drawdown times for online detention basins.)

## Level 3

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  - b. Project Description
  - c. Applicable Standards
  - d. Conditions of Approval
  - e. Previous Studies
  - f. Objectives of Analysis
4. Baseline (Existing Conditions)
  - a. Historical Landuse
  - b. Topographic Sources (include certification information)
  - c. Offsite Drainage
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    - ii. Downstream
  - d. Onsite Drainage
    - i. Creeks / Streams
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  - e. Hydrologic Modeling Assumptions
    - i. Software Application and Version
    - ii. Watershed Delineation
    - iii. Soils
    - iv. Landuse
    - v. Lag Transformation Method
    - vi. Routing
    - vii. Storage
    - viii. Summary of Discharges
  - f. Hydraulics Modeling Assumptions
    - i. Software Application and Version
    - ii. Hydraulic Computational Method (Unsteady modeling must be approved prior to submittal)
    - iii. Limits of Study (Adequately upstream and downstream of this project site)
    - iv. Boundary Conditions



- v. Manning's "n" Value
  - vi. Model layout
    - 1. Cross-Sections, bridges / Culverts, Lateral Structures, Storage Areas, Pumps, etc.
  - vii. Summary of Discharges and Stages
- g. Profiles
- h. Floodplain Extents
- 5. Mitigated Project (Proposed Condition)
  - a. Proposed Landuse
  - b. Grading Plan
  - c. Offsite Channel Drainage Improvements
  - d. Onsite Improvements (Channels Basins, Bridges/Culverts, Berms, etc.)
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    - iii. Soils
    - iv. Land Use
    - v. Lag Transformation method
    - vi. Routing
    - vii. Storage
    - viii. Summary of Discharges.
  - f. Hydraulics Modeling Assumptions
    - i. Software Application and Version
    - ii. Hydraulic Computational Method (Unsteady modeling must be approved prior to submittal)
    - iii. Limits of Study (Adequately upstream and downstream of the project Site)
    - iv. Boundary Conditions
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    - vii. Summary of Discharges and Stages
  - g. Profiles
  - h. Floodplain Extents
  - i. Storm Trunk Drainage (if any)
  - j. Stormwater Quality Treatment (if required)
  - k. Hydromodifications (if required)
  - l. LID (if required)
  - m. Description of required permits for proposed mitigation
  - n. Description of Operation and Maintenance cost and funding sources (if required)
  - o. Description of beautification plan (if required)
- 6. Summary of Findings
  - a. Discussion of Baseline and Fully Mitigated project results

- i. Upstream, Downstream, and through project impacts
    - b. Identify how applicable Standards are satisfied
7. Quality Assurance/ Quality Control
  - a. Model Calibration (if data is available)
  - b. Model Warnings and Errors have been addressed (Check RAS by FEMA)
8. Conclusion

### **List of Exhibits**

1. Vicinity Map
2. FEMA Flood Maps
3. Hydrologic Soil Group Map
4. Proposed Land Use Plan
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6. Hydrologic Input Map
7. Hydraulic Routing Map
8. Flood Control Mitigation Exhibit
9. Stormwater Quality Exhibit
10. Hydromodification Exhibit

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5. LID Assumptions (if used to reduce required stormwater quality or hydromodification volumes)
6. Compliance Points
7. Existing Condition Results (noting shed/node/cross-section numbers, peak flows and peak elevations).
8. Proposed Condition Results (noting shed/node cross-section numbers, peak flows and peak elevations)
9. Detention Basin Results (including peak elevations and drawdown times for online detention basins.)

## **Level 4**

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  - a. Existing Conditions
  - b. Project Description
  - c. Applicable Standards
  - d. Conditions of Approval
  - e. Previous Studies
  - f. Objectives of Analysis
4. Regional Flood Control and Stormwater Quality
  - a. Demonstrate Consistency with Facilities Described in Level 1, 2, & 3 study, if applicable.
    - i. If all regional Flood Control and Stormwater Quality facilities are to be constructed with the proposed Tentative Subdivision Map, provide the Level 1, 2, & 3 study as an attachment.
    - ii. If a portion of the Regional Flood Control and Stormwater Quality facilities are to be constructed as part of this project, provide a site-specific analysis.
5. Summary of Findings
  - a. Discussions of Fully Mitigated project results
    - i. Upstream, downstream, and through project impacts
  - b. Identify how Applicable standards are satisfied
6. Quality Assurance / Quality Control
  - a. Model Calibration (if data is available)
  - b. Model Warnings and Errors have been addressed (Check RAS by FEMA)
7. Conclusion

### **List of Exhibits**

1. Vicinity Map
2. FEMA Flood Maps
3. Hydrologic Soil Group Map
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