Sacramento County
Department of Water Resources (Water Resources)
Drainage Study Requirements

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Water Resources General Policy for Drainage Studies

1. All drainage studies shall be developed in accordance with the latest versions of the Sacramento County Hydrology Standards, Improvement Standards, Floodplain Management Ordinance, Stormwater Quality Design Manual, Sacramento County General Plan Policies, Urban Level of Flood Protection Criteria (as applicable), and any other applicable standards and requirements. Any proposed deviation from these standards and policies must be provided in writing to Water Resources and are subject to approval by the Director of Water Resources (Director).
2. Modeling techniques shall be performed in accordance with current common industry practices and standards. The use of specific modeling software programs shall be discussed with Water Resources as part of the Scoping Agreement process.
3. Modeling shall extend sufficiently offsite upstream and downstream to identify impacts to surrounding properties.
4. Modeling may be required to include a cumulative impact analysis and a sensitivity analysis.
5. The hydrologic and hydraulic routing and mitigation features utilized in the model must be clearly shown in all the accompanying exhibits.
6. Project phasing:
    a. 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.
    b. If interim facilities are to be proposed, a full implementation plan must be submitted detailing timing, financing, and method to switching to ultimate conditions. All interim facilities shall be built per County standards and designed as if functioning as a permanent facility.
7. If state or federal permits are required, a narrative shall be supplied to discuss timing, permit responsibilities, and financing. All environmental permitting requirements placed upon Water Resources maintained facilities are subject to review and approval by Water Resources.
8. Shed shifts are strongly discouraged and require approval from the Director.
9. Levees are strongly discouraged. Water Resources will not be the maintaining agency for any levee, embankment, or floodwall that protects low-lying areas from flooding.
10. Existing infrastructure may be required to be evaluated to determine the ability to convey flow from a proposed development.
11. Water Resources shall not be the Preserve Manager for development projects.

Mutual Commitments

1. Drainage study review control measures will be established by Water Resources to ensure consistency of reviews including regular training of staff and a standard drainage study format.
2. Review by Water Resources staff will be conducted based on adopted standards and policies.
3. The Sacramento County website will be updated with the most up-to-date drainage policies and standards.
4. If a Drainage Master Plan in support of a Specific Plan is adopted by the Board of Supervisors, then its findings remain, 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.
5. Minor technical drainage adjustments should not trigger a new drainage master plan.
6. Design level details should not be provided at the Level 1 or 2 stage.
7. Prior to initiating a drainage study, the project applicant team shall complete a draft standard Scoping Form, 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.
    b. Sensitivity impact analysis requirements.
    c. Extent of analysis of existing infrastructure.
    d. Acceptable analysis methods.
    e. Appropriate level of technical detail.
    f. Identification of future changes that may trigger a modification to the agreed-upon scope.
8. After the scoping meeting, the project applicant will provide the final standard Scoping Form to Water Resources for review and approval.
9. Water Resources staff will estimate the initial drainage study review time based on the final standard Scoping Form and will send back the form to the applicant for signatures.
10. Quality control will be performed by the engineering firm submitting the study.
11. All resubmittals shall include a list of previous comments provided by Water Resources with a written response to each comment. Written responses shall specify changes to the modeling and/or the overall drainage plan needed to address Water Resources comments.
12. The following are some examples of when a drainage study will be deemed incomplete:
    g. The study is not consistent with County Improvement and Hydrology Standards.
    h. The study is not consistent with the requirements described herein.
    i. The study is contradictory to a previous, over-arching drainage study or does not match the proposed land use entitlement.
    j. The study does not follow the approved standard Scoping Form.
    k. The study does not include written responses to previous Water Resources comments.
    l. The study resubmittal does not address Water Resources comments.

13. Incomplete submittals will be rejected, and Water Resources will notify the project applicant in writing within 7 workdays from the day a formal submittal is received.
14. Both project applicant and Water Resources will attempt to provide clear and direct communication verbally and in writing. Before completing reviews and resubmitting studies, both parties will make an effort to reach out if there are questions or concerns. If a resubmittal is given to Water Resources more than one calendar year from the prior submittal, all previous comments will expire, and the study will be subject to the most current standards and policies if they have changed.
15. With prior approval by Water Resources, the review of drainage studies may be comprised of phased approvals through technical memorandums. In this situation, meeting times and review times may be discussed with Water Resources and will be based on staff workload and availability. It is understood that the review and approval of separate technical memorandums is not meant to replace a single drainage study that still requires review and approval. Technical memorandums may be used to reach an agreement on specific technical aspects of a study, and their approval does not translate to automatic approval of the drainage study.
16. When deeming a drainage study technically adequate, Water Resources will note which elements were not required for the corresponding level and therefore not reviewed.
17. If project applicants and Water Resources staff cannot reach an agreement at any phase of review, the Water Resources Principal Engineer will be engaged to address outstanding issues in a timely manner. If a resolution is not reached, the project applicant can appeal to the Director.

Drainage Study Overview

Level 1 – Master Plan

The purpose of a Level 1 drainage study is to outline the necessary backbone drainage and flood control features needed to implement the proposed master plan area, provide a guiding document that subsequent Tentative Maps and improvement plans can substantially follow, and support the following:

- Specific Plans, Community Plans, Master Plans, and Special Planning Areas
- Rezonings
- Large Lot Tentative Maps (typically not required if there are no development rights. A level 1 study may be required if the Large Lot Map will define specific parcels for drainage/flood control features)
- Financing Plans

Specifically, a level 1 study shall at a minimum:

- Present the proposed land uses.
- Develop a preliminary grading and drainage plan focused on major topography and backbone infrastructure.
- Establish on- and off-site pre-project and with-project floodplains.

- Preliminarily size major flood control facilities (i.e., channels and basins), and trunk storm drain pipes (draining 30 or more acres).
- NPDES requirements (stormwater quality facilities, Low-Impact Development (LID) measures, hydromodification, and trash capture as applicable).
- Identify any offsite drainage improvements required to support the Master Plan.
- Identify any proposed watershed shifts and requested deviations from County Standards and/or Policy, all subject to approval by Water Resources.
- List and describe further analyses needed at the Tentative Map and Improvement Plan levels.
- Include a general narrative describing the maintenance, proposed joint-use drainage facilities, and operation and maintenance funding mechanism.

The level of detail needed will vary depending on the complexity of the project and the extent of existing drainage issues. In general, the level of detail should be sufficient to adequately support proposed land uses and infrastructure financing documents and should be discussed during the scoping process. Level 1 studies need not include details such as minor drainage pipes and manholes, and subdivision layouts.

Subsequent land use entitlements will require level 2, 3, and 4 studies.

Level 2 – Tentative Subdivision Map

The purpose of a Level 2 drainage study is to demonstrate the general viability of the proposed Tentative Subdivision Map (TSM) or similar land use entitlement application. This is accomplished by demonstrating that mitigation can be achieved and there are no adverse offsite impacts, and outlining drainage facilities that are required for the proposed TSM.

The level 2 study shall at a minimum:

- Demonstrate compliance with any applicable and approved level 1 study. Due to the phased nature of master plans, level 2 studies may be required to evaluate interim and ultimate conditions.
- Refine the facilities from the Level 1 study that provide major flood control, major trunk drainage, and general compliance with NPDES requirements (stormwater quality facilities, LID, and hydromodification) that are needed for the proposed TSM.
- Evaluate overland release consistent with the Improvement Standards. Overland release through private residential lots shall be identified and preliminarily sized.
- Establish preliminary building pad elevations consistent with the Improvement Standards and the Floodplain Management Ordinance.
- Demonstrate that minimum buildable areas consistent with the Floodplain Management Ordinance can be achieved for proposed parcels within an identified floodplain.
- Identify and mitigate adverse impacts.
- Develop a preliminary grading and drainage plan to support the level 2 analysis, including overland release through the project area.

- Identify any proposed watershed shifts and requested deviations from County Standards and/or Policy, all subject to approval by Water Resources.
- Preliminarily identify any offsite drainage improvements required to support the TSM. Include a general narrative describing conformance with the Level 1 drainage study as applicable.
- Include a general narrative describing the aesthetic maintenance, proposed joint-use drainage facilities, and operation and maintenance funding mechanism.

The level of detail should be sufficient to demonstrate that all proposed drainage/flood control facilities can be accommodated within the proposed parcels. This typically requires a finer depiction of basin and channel grades as well as consideration of required access roads and ramps. Details such as manhole sizes and minor storm drain pipes are not required.

Deviations from the Level 1 study may require an amendment to the Level 1 study consistent with the latest Sacramento County "Specific Plan Ordinance" and "Master Plan Procedures and Preparation Guide."

Projects that identify offsite improvements outside the public right-of-way must follow County public notification requirements and notify in writing all affected property owners prior to approval of the Level 2 study. TSMs will be conditioned to dedicate offsite easements prior to approval of eventual 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 stormwater, minimum buildable area consistent with the Floodplain Management Ordinance, compliance with NPDES requirements (Stormwater quality facilities, Low-Impact Development (LID), hydromodification, and any other requirement effective at the time of the application), and overland release for the proposed entitlement. The level of detail required may vary per project however the overall objective is to determine the ability to mitigate the 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 if the analysis can be deferred to the improvement plan stage. In either situation, a Level 4 study shall be required prior to Improvement Plan submittal unless the requirements described in the Parallel Review Program Agreement are satisfied. Deviations from the Level 1 study (if applicable) may require an amendment to the Level 1 study consistent with the latest Sacramento County "Specific Plan Ordinance" and "Master Plan Procedures and Preparation Guide."

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 shall at a minimum:

- Confirm final design of major flood control and major trunk drainage facilities, overland release, and compliance with NPDES requirements (stormwater quality treatment facilities, LID, source control features, and hydromodification) noted in the Levels 1/2/3 study and any additional requirement effective at the time of the study submittal.
- Include a complete analysis of non-trunk pipes, structures, and overland release, including final dimensions and locations.
- Identify any proposed watershed shifts and requested deviations from County Standards and/or Policy, all subject to approval by Water Resources.

Deviations from the Level 1 study (if applicable) may require an amendment to the Level 1 study consistent with the latest Sacramento County "Specific Plan Ordinance" and "Master Plan Procedures and Preparation Guide."

Level 4 drainage studies shall be submitted for review and approval by Water Resources before improvement plans can be accepted for review unless the requirements described in the Parallel Review Program Agreement are satisfied.

Detailed Drainage Study Documentation

The following documentation requirements apply to all study levels. Studies that tier off a higher-level study (i.e., Level 2 Tentative Subdivision Map study based on a Level 1 Drainage Master Plan, or a Level 4 study based on a Level 3 or Level 2 study) must incorporate additional technical detail appropriate for each level as described in the Drainage Study Overview section of this document and must include all related previous higher level studies as an attachment or reference. All studies must provide electronic copies of models produced.

1. Cover
    a. Project Title
    b. Level of Analysis
    c. Planning Application Number
    d. Watershed
    e. Vertical Datum
    f. Date
    g. Professional Engineer Stamp and Signature
2. Table of Contents (Sections and Appendices, List of Tables, List of Figures, and List of Exhibits)
3. Introduction
    a. Existing Conditions
    b. Project Description
    c. Applicable Standards (including stormwater quality)
    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 Water Resources prior to study initiation)
        v. Boundary Conditions
        vi. Manning's "n" Values
        vii. Model layout (cross-section, bridges/culverts, lateral Structures, storage areas, pumps, pipes, overland release paths, etc.)
        viii. Summary of Discharges and Stages
    g. Profiles
    h. Floodplain Extents
5. Mitigated Project (Proposed Condition)
    a. Proposed Land Use
    b. Grading and Drainage Plan
    c. Offsite Drainage Improvements
    d. Onsite Improvements (channels, basins, bridges/culverts, berms, pipes, overland release paths, 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
   iii. Limits of Study (adequately upstream and downstream of the project site – should be agreed to by Water Resources prior to study initiation)
   iv. Boundary Conditions
   v. Manning's "n" Value
   vi. Model layout (Cross-Sections, Bridges/Culverts, Lateral Structures, Storage Areas, Pumps, pipes, overland release paths, etc.)
   vii. Summary of Discharges and Stages

g. Stormwater Quality (SWQ)

   For Level 1 through 3 studies:
   i. Total project area (sum of items below)
      - Impervious area (this includes new and/or replaced surfaces such as rooftops, asphalt paving, gravel parking/drive areas, etc.)
      - Pervious area (landscaping and open spaces)
      - Low Impact Development (LID) features
   ii. LID feasibility analysis
      - Demonstration of 100 points using LID worksheet or Sacramento Area Hydrology Model (SAHM) - (not required for level 1 studies)
      - General description of anticipated LID strategy or general size and location of LID features
      - Ensure that sheds are developed to reflect the water entering the SWQ feature (not required for level 1 studies)
   iii. Hydromodification feasibility analysis. The level of detail will vary depending on the level of the study.
   iv. Preliminary SWQ treatment description, design, and calculations including draw-down time as applicable.

   For Level 4 studies:
   i. Post-Construction Stormwater Plan
      - Indicate locations where site discharges to the municipal storm drain system (points of compliance)
      - Proposed SWQ Drainage Management Areas (DMAs)
        - Name of DMA
        - Impervious area (this includes new and/or replaced surfaces such as rooftops, asphalt paving, gravel parking/drive areas, etc.)
        - Pervious area (landscaping and open spaces)
        - Runoff treatment, hydromodification, and LID features
      - Clearly identify SWQ features for each DMA (DMA and SWQ features should have associated numbering conventions).

- Provide sufficient design grades and flow arrows to demonstrate that sheds are developed to direct stormwater runoff to each SWQ feature.

ii. Description of SWQ treatment, LID, and hydromodification plans as applicable.
iii. Construction details for SWQ treatment, LID, source control, and hydromodification features (flow lines, number of cartridges for proprietary devices, elevation-area-volume rating curves for basins and detention systems SWQ treatment elevations, etc.).
iv. Include calculations for SWQ treatment features including draw-down time as applicable.
v. Include LID Credit Worksheet (excel file) for commercial or residential development consistent with the detailed design (use one worksheet for each DMA for LID). Each sub-shed should reach 100 points or provide a weighted average of 100 points for the overall project.
vi. Include hydromodification plan and .whm file (SAHM) if applicable.

h. Floodplain Extents
i. Underground Storm Drain Pipe System. For Level 1 through 3 studies, preliminary Nolte analyses are required only for public trunk pipes. For Level 4 studies Nolte analyses are required for the entire public pipe network.
j. Description of anticipated permits required for proposed mitigation

6. Summary of Findings
    a. Discussion of Baseline and Fully Mitigated project results (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. Floodplain Maps
3. Proposed Land Use Plan
4. Existing Drainage Conditions
5. Hydrologic Input Maps
6. Hydraulic Routing Maps (overland release, underground pipes, channels, etc.)
7. Profiles (for pipes and channels as applicable. For Level 1 through 3 studies, pipe profiles are required for trunk pipes only. For Level 4 studies the entire pipe network is required.)
8. Flood Control Mitigation Exhibit
9. Stormwater Quality, Hydromodification, and LID 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 parameters).
3. Detention Basin Parameters (including elevation-storage relationships and outfall assumptions).
4. SWQ 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 elevations, and hydraulic grade lines).
8. Proposed Condition Results (noting shed/node/cross-section numbers, peak flows elevations, and hydraulic grade lines).
9. Nolte Results (noting pipe segment naming convention consistent with corresponding hydraulic routing maps, Nolte flow, ground/rim elevation, hydraulic grade line elevation, and freeboard).
10. Detention Basin Results (Including Peak elevations and draw-down times for online detention basins).