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Project No: 133904

San Diego County Hydromodification Management Plan (HMP)

**Subject:** Minimum Criteria for Evaluation of Storm Water Controls to Meet Interim Hydromodification Criteria (IHC)

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This Draft Technical Memorandum details minimum criteria for the evaluation of storm water controls to mitigate the effects of hydromodification and meet standards set forth by the Interim Hydromodification Criteria (IHC) set forth by the County of San Diego and its NPDES Co-Permittees. The IHC was prepared as mandated by Regional Water Quality Control Board Order R9-2007-0001 Provision D.1.g, which requires that IHC apply until the final Hydrograph Modification Management Plan (HMP) is implemented. The purpose of the IHC is to prevent development-related changes in storm water runoff from causing, or further accelerating, stream channel erosion or other adverse impacts to beneficial stream uses.

As part of the HMP development, the Co-Permittees and Brown and Caldwell are preparing sizing tools to assess the effectiveness of hydromodification controls. Since those sizing tools are not yet available, Brown and Caldwell has prepared this memo to identify specific evaluation criteria for the design and analysis of interim condition hydromodification controls using continuous simulation hydrologic modeling. Evaluation criteria discussed herein focuses on the following items:

- Continuous Simulation Hydrologic Modeling
- Continuous Simulation Modeling Software
- Long-Term Hourly Precipitation Gauge Data
- Parameter Validation for Rainfall Losses
- Hydromodification Control Processes
- Peak Flow and Flow Duration Statistics

*Limitations:*

*This document was prepared solely for the County of San Diego in accordance with professional standards at the time the services were performed and in accordance with the contract between the County of San Diego and Brown and Caldwell. This document is governed by the specific scope of work authorized by County of San Diego; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work.*

## Continuous Simulation Hydrologic Modeling

Pursuant to criteria set forth by the San Diego Regional Water Quality Control Board and by the San Diego County Co-Permittees in the Interim Hydromodification Criteria, the use of continuous simulation hydrologic modeling is required to size storm water facilities to mitigate hydromodification effects. Continuous simulation modeling uses an extended time series of recorded precipitation data as input and generates hydrologic output, such as surface runoff, groundwater recharge, and evapotranspiration, for each model time step.

Continuous hydrologic models are typically run using either 1-hour or 15-minute time steps. Based on a review of available rainfall records in San Diego County, we are recommending the use of a 1-hour time step (15-minute time series rainfall data is very limited). Continuous models generate model output for each time step – in this case, hydrologic output would be generated for each hour of the continuous model. A continuous simulation model with 25 years of hourly precipitation data will generate 25 years of hourly runoff estimates, which corresponds to runoff estimates for 219,000 time steps for the 25-year simulation period.

Use of the continuous modeling approach allows for the estimation of the frequency and duration by which flows will exceed a particular threshold. The limitation of the frequency and duration that geomorphically significant flows occur is the key component to San Diego County's approach to hydrograph modification management.

For a more detailed review of continuous simulation modeling, refer to a memo prepared by Brown and Caldwell titled "Using Continuous Simulation to Size Storm Water Control Facilities" (May 2008). The memo can be accessed via the following link to the Project Clean Water web site.

[http://www.projectcleanwater.org/pdf/susmp/hydromod\\_continuous\\_modeling\\_may\\_08.pdf](http://www.projectcleanwater.org/pdf/susmp/hydromod_continuous_modeling_may_08.pdf)

## Continuous Simulation Modeling Software

The following public domain software models may be used to assess hydromodification controls for storm water facilities to meet Interim Hydromodification Criteria:

- HSPF - Hydrologic Simulation Program-FORTRAN, distributed by USEPA
- HEC-HMS – Hydrologic Modeling System; distributed by the US Army Corps of Engineers Hydrologic Engineering Center

Third-party and proprietary software, such as the San Diego Hydrology Model (SDHM), can be used to meet Interim Hydromodification Criteria provided that the software incorporates minimum design parameters outlined in this memo and summarized below:

- Input and output data from the software can interface with public domain software such as HSPF or HEC-HMS. In other words, input files from the third-party software should have sufficient functionality to allow export to public domain software for independent validation.
- Rainfall data is selected according to an existing rainfall gauge location that is geographically and meteorologically similar to the project site location.
- Validation of rainfall loss parameters is substantiated.
- The software's hydromodification control processes, detailed later in this memo, are substantiated.

All third-party and proprietary software will be subject to more rigorous review upon the issuance of Final

Hydromodification Criteria. This review would include full testing of various development and treatment scenarios as well as an in-depth analysis of software functionality and processes.

As stated previously, the Co-Permittees and Brown and Caldwell are currently preparing sizing tools to assess the effectiveness of hydromodification controls. These tools will be available in association with implementation of the final Hydromodification Management Plan (HMP).

### Long-Term Hourly Precipitation Gauge Data

Prior to the commencement of hydromodification control modeling to meet Interim Hydromodification Criteria for a project site, the project proponent should take the following steps to ensure use of the appropriate precipitation gauge data.

- For projects in the unincorporated areas of San Diego County, the project proponent should contact the appropriate Department of Planning and Land Use (DPLU) Project Manager
- For projects located in other jurisdictions within San Diego County, the project proponent should contact the jurisdiction's NPDES coordinator.

Upon completion of the Hydromodification Management Plan and implementation of final hydromodification criteria, the sizing tool currently in development by the Co-Permittees and Brown and Caldwell will automate the rainfall gauge selection process.

Upon preliminary review of all available San Diego County rainfall records, Brown and Caldwell has identified 20 precipitation rain gauges throughout the County for input to continuous simulation models. The gauge locations were selected to provide adequate geographic coverage of the County. Specifically, gauges were distributed among major watersheds to provide coverage in coastal, inland valley, foothill and mountain areas of the County.

Gauge selection was further governed by minimum continuous simulation modeling requirements including the following:

- The selected precipitation gauge data set should be located near the project site to ensure that long-term rainfall records match the anticipated rainfall patterns for the site. Thus, gauges were selected in proximity to areas planned for future development and redevelopment.
- Recording frequency for the gauge data set should be hourly (or more frequent).
- The gauge rainfall record should extend for the entire length of the record. Where the gauge record length exceeds 40 years, then the length of the rainfall record can be truncated at 40 years.

Precipitation gauges identified by Brown and Caldwell, summarized in the Table 1 below and graphically depicted in Figure 1, all have recording frequencies of one hour and recording data ranges between 23 and 40+ years.

Station	Elevation	Watershed
Bonita	120	Sweetwater River
Encinitas	242	Between San Elijo Creek and San Marcos Creek ocean outfalls
Escondido	645	Escondido Creek
Fallbrook	675	San Luis Rey River (near ridge with Santa Margarita River watershed)
Fashion Valley	20	San Diego River

Station	Elevation	Watershed
Flinn Springs	880	San Diego River
Kearny Mesa	425	San Diego River (near ridge with San Clemente Canyon watershed)
La Mesa	420	San Diego River (near ridge with Chollas Creek watershed)
Lake Cuyamaca	4590	Upper San Diego River
Lake Heneshaw	2990	Upper San Luis Rey River
Lake Hodges	327	San Dieguito River
Lake Wohlford	1490	Upper Escondido Creek
Lindbergh Field	Near Sea Level	Coastal – San Diego Bay
Lower Otay Reservoir	491	Otay River
Oceanside	30	San Luis Rey River
Poway	440	Los Penasquitos Canyon
Ramona	1450	Upper San Dieguito River
San Onofre	162	North County Coastal – Pacific Ocean
San Vicente Reservoir	663	San Diego River
Santee	300	San Diego River

*\* Additional gauges may be added*

Sources for data used in the selection of the appropriate rainfall gauge locations include the following:

- ALERT information from County of San Diego
- Historical (pre-1982) rainfall station information from County of San Diego
- NOAA / National Climatic Data Center
- Western Regional Climate Center
- California Irrigation Management Information System

Prior to implementation of the final Hydromodification Management Plan (HMP), Brown and Caldwell will provide rainfall gauge information to consultants in a WDM format compatible with HSPF. As stated previously, consultants should submit rainfall gauge information requests through the appropriate representative in the governing jurisdiction. The jurisdiction will in turn forward the request to the County HMP Program Coordinator, who will submit the request to Brown and Caldwell. At the time of this memo, 4 requests have been submitted (three via the County of San Diego and one from the City of Chula Vista).

Use of the most applicable long-term rainfall gauge data, as opposed to the scaling of rainfall patterns from Lindbergh Field, is required to account for the diverse rainfall patterns across San Diego County.

Winter-event rainfall patterns in the San Diego area are typically convective in nature and highly variable between topographic regions. From the center of the active storm system, rainfall has historically decreased from north to south across the County. Analysis of long-term records indicates that seasonal rainfall in the northern portion of the County is 25-35 percent greater than in the southern portion of the County. Furthermore, the northern portion of the County has historically experienced more rain days on average as compared to the southern regions.

Rainfall patterns between coastal, foothill and mountain areas of the County are also significantly varied.

Rainfall totals in mountain areas are typically 100-200 percent greater than totals in coastal areas. As compared to Lindbergh Field daily rainfall totals, north county foothill areas typically experience 50 percent higher rainfall totals while south county foothill areas experience increases of 25-30 percent.

### Parameter Validation for Rainfall Losses

In preparing computer models to assess storm water controls and meet Interim Hydromodification Criteria, rainfall loss parameters describing soil characteristics, land cover descriptions, and evapotranspiration data should be validated to prove consistency with the local environment and climatic conditions.

Soil and land cover parameter validation should be based on the following:

- Calibration to local stream flow data, where applicable.
- Published parameter values consistent with previous studies for San Diego County and Southern California, such as HSPF-related regional calibration studies, research projects, regional soil surveys, etc.
- Specific data prepared as part of a site-specific geotechnical investigation

Prior to implementation of the final Hydromodification Management Plan, studies prepared to meet Interim Hydromodification Criteria should specify the source of data used for soil, land cover and evapotranspiration parameter estimations and provide commentary regarding the relevance of such data to the subject project site. Examples of local calibration studies include, but are not limited to, TMDL modeling efforts prepared for the San Diego Regional Water Quality Control Board. If parameters are transposed from calibration efforts outside of Southern California, then justification should be provided stating why such data should be applicable for San Diego County.

To meet Interim Hydromodification Criteria, the evapotranspiration parameter validation process should include documentation of the source of evapotranspiration data and commentary of the effects of varying evapotranspiration patterns between the subject site and parameter data source. A full review of local pan evaporation and potential evapotranspiration data will be included as part of development of the final hydromodification sizing tool.

Development of recommended soil characteristic, land cover, and evapotranspiration data will be included with the final hydromodification sizing tool to be developed in association with the final Hydromodification Management Plan (HMP). The information contained in this section refers to documentation required in association with the submittal of analyses to meet Interim Hydromodification Criteria (IHC) prior to implementation of final HMP criteria.

### Hydromodification Control Processes

Storm water devices designed to meet Interim Hydromodification Criteria, such as bioretention basins, should be analyzed pursuant to the following criteria:

- Infiltration processes should be modeled with sufficient complexity to properly quantify the flow control benefit to the receiving streams. This infiltration process should be transparent and fully documented.
- Infiltration quantification should include provisions for water head and pore suction effects for multiple layers of varying materials (i.e., ponding areas, amended soil layer, gravel layer, etc.), or provide justification why such complex processes are not included.

- Storage processes associated with each layer of the storm water device should be fully explained and quantified.
- Device outflow curves should consider controls associated with device underdrains. The methodology by which such state-discharge relationships are developed should be fully documented.

### Peak Flow and Flow Duration Statistics

To assess the effectiveness of storm water devices in controlling hydromodification effects to meet Interim Hydromodification Criteria, peak flow frequency statistics should be developed using either a partial-duration or peak annual series. Peak flow frequency statistics estimate how often flow rates will exceed a given threshold. In this case, the key peak flow frequency values would be the lower and upper bounds of the geomorphically significant flow range.

The use of peak annual series data to meet Interim Hydromodification Criteria may be used because:

- IHC lower thresholds are set at  $0.2 \cdot Q_5$  (based on the 5-year flow)
- Peak flow versus recurrence interval curves for the peak annual series and the partial-duration series tend to converge between  $Q_5$  and  $Q_{10}$

It should be noted that peak annual series data may not be acceptable if the lower flow control thresholds, as determined as part of the final HMP development, are based on  $Q_2$  instead of  $Q_5$ . The need for partial-duration statistics is more pronounced for control standards based on more frequent return intervals, since the peak annual series does not perform as well in the estimation of such events.

Flow duration statistics must also be summarized to determine how often a particular flow rate is exceeded. To determine if a storm water facility meets hydromodification criteria, peak flow frequency and flow duration curves must be generated for pre-project and post-project conditions. For a more detailed review of peak flow frequency and flow duration curves, refer to the aforementioned Brown and Caldwell memo titled "Using Continuous Simulation to Size Storm Water Control Facilities" (May 2008).

### Conclusion

Until the Co-Permittees and Brown and Caldwell complete development of the final hydromodification sizing tool, the use of alternate methods may be used to meet Interim Hydromodification Criteria, provided that adherence to specific evaluation criteria detailed in this memo is demonstrated. The information in this Draft Technical Memorandum is subject to minor revision pending final review by the County of San Diego, NPDES Co-Permittees, and the Technical Advisory Committee.