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Memorandum

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Subject: Regional Watershed Management Area Analysis Hydromodification Exemption Analysis – Memorandum to Document Factors of Safety Contract No. 537081; Task Order No. 23

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1. BACKGROUND

The Draft Regional Watershed Management Area Analysis (WMAA) that was submitted to the San Diego Regional Water Quality Control Board in January 2015 included analyses to evaluate hydromodification exemptions in accordance with the Regional MS4 Permit provision B.3.b.(4)(c) for the following receiving water bodies:

- Major River Reaches
    - Otay River from Outfall at San Diego Bay to Interstate 805;
    - San Diego River from Pacific Ocean to confluence with San Vicente Creek;
    - San Dieguito River from upstream edge of the railroad crossing to Lake Hodges Dam;
    - San Luis Rey River from Pacific Ocean to upstream river limit of Basin Plan subwatershed 903.1 upstream of Bonsall and near Interstate 15; and
    - Sweetwater River from San Diego Bay to Sweetwater Reservoir Dam.

- Stabilized Conveyance Systems Draining to Exempt Water Bodies
    - Methodology for exemption stabilized conveyance systems; and
    - Forester Creek stabilized reach from the confluence with the San Diego River to Prospect Avenue.

This memorandum summarizes the implicit factors of safety used while performing the hydromodification exemption analysis.

2. MAJOR RIVER REACHES

Hydromodification impacts can be caused due to increase in flows, changes in sediment transport capacity and changes in sediment supply to the streams. In order to evaluate the cumulative impacts due to development and determine if hydromodification exemption could be recommended, an erosion potential (Ep) analysis was used to evaluate the increase in flows and changes in sediment transport capacity to the selected receiving waters for the built-out condition. In addition, sediment supply potential (Sp) analysis was used to evaluate the changes in sediment supply. The implicit factors of safety in each analysis are presented as follows:

1.1 Erosion Potential:

The analysis conducted to evaluate the Ep metric for the selected water bodies has three fundamental implicit (non-quantified) factors of safety including:

1. The analysis assumes all impervious area in the watershed is directly connected impervious area. In actuality, some portion of these impervious areas will sheet flow through pervious areas prior to discharging to the streams. This dispersion will result in attenuation of flow rates and durations that are not accounted for while estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit factor of safety.

2. New priority development projects, including projects that are proposed to be exempt from hydromodification management requirements through the Regional WMAA study, must implement retention BMPs to the extent feasible if participation in alternative compliance is not selected or allowed. This requirement will result in attenuation of flow rates and durations that are not accounted for while estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit factor of safety.

3. Redevelopment priority development projects in the watershed that do not directly discharge to the exempt river reach must mitigate flows to the pre-developed condition. This will result in over mitigation of flow rates and durations for redevelopment projects which are not accounted for while estimating the sediment transport capacity of the built-out condition. This conservative assumption provides an implicit factor of safety.

If the above three factors were quantified in the analysis, it is anticipated that the resultant Ep would be smaller than the Ep reported in the Regional WMAA.

1.2 Sediment Supply:

The Technical Advisory Committee, formed to provide input on the development of the 2011 San Diego County Final Hydromodification Management Plan, indicated (based on field observations and years of historical perspective) that the above river reaches have very low gradients, were depositional (aggrading), have very wide floodplain areas when in the natural condition, and that the effects of cumulative watershed impacts to these reaches are minimal provided that outfalls to the rivers have properly sized energy dissipation, and hence could be exempt from hydromodification management.

Since these river systems are depositional, they can support some losses in sediment supply as these systems seek equilibrium prior to experiencing hydromodification. Available literature consulted for this analysis indicates that having less than a 10% reduction in sediment supply for an equilibrated system is unlikely to instigate, as an independent condition, significant channel changes. Based on the analysis performed in Regional WMAA, the losses in sediment supply was estimated to be less than 7% (30% factor; Appendix B.1.1.3); and when considering these rivers to be depositional, provides an implicit factor of safety.

3. STABILIZED CONVEYANCE SYSTEMS DRAINING TO EXEMPT WATER BODIES

To qualify for exemption, an engineered stabilized conveyance system must meet the following criteria:

- It must be demonstrated that shear stress in the engineered conveyance system will be less than critical shear stress when the system conveys the 10-year flow rate determined based on the Hawley & Bledsoe 2011 equation presented in "How do flow peaks and durations change in suburbanizing semi-arid watersheds? A southern California case study," (Hawley, R.J., and Bledsoe, B.P. 2011). Critical shear stress shall be determined from

> "Stability Thresholds for Stream Restoration Materials" (Fischenich 2001) or similar published data.

This means that an engineered stabilized conveyance system could be exempt if it will be non-erosive in the range of flows relevant to hydromodification management. Determination that the conveyance system is non-erosive would be established when the shear stress in the conveyance system at Q_{10} (determined using specific procedures relevant for hydromodification management different from flood control Q_{10}, herein "HMP Q_{10}") is less than critical shear stress. A "stabilized" channel means an engineered channel stabilized with materials other than concrete (e.g., riprap, turf reinforcement mat, vegetation, including rehabilitated channels). Critical shear stress (the maximum shear stress the stabilizing material can tolerate without movement) for such channels can be determined from reference sources. When the shear stress in the conveyance system is less than critical shear stress, there is no excess shear stress or "work" (i.e., erosion) occurring in the system.

This criteria is conservative because it requires shear stress be evaluated at a flow rate relevant to hydromodification management, and <u>no</u> excess shear stress (i.e., no work, no erosion) to occur at the study flow rate. This is a significant change from the exemption criteria for stable, unlined channels that was presented in the Final HMP, which only required evaluation of the channel capacity and did not require evaluation of shear stress in the channel.

For Forester Creek, recommended for exemption in the Regional WMAA and San Diego River WMAA, the upper range of geomorphically-effective flows based on procedures presented in the referenced Hawley & Bledsoe paper was 836 cfs, and the HMP Q_{10} was 2,120 cfs based on the Hawley & Bledsoe equation. Forester creek can convey approximately 2,150 cfs before critical shear stress is reached in the cross section that is expected to be the most sensitive (i.e., the cross section with a combination of narrow geometry and steep slope that is expected to experience the greatest shear stress at any given flow rate).

Forester Creek is stabilized with vegetation, and therefore would have a relatively low allowable shear stress compared to other stabilizing materials. The same exemption study process would be applied for channels stabilized with other materials such as riprap, which can tolerate greater shear stress than vegetation.

In addition to the criteria to determine that a conveyance system is stable, the Regional WMAA sets limitations on the use of the exemption: it is only for engineered conveyance systems that are stabilized, no natural channels, and the engineered conveyance system must continue uninterrupted to an exempt water body.

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