Ventura Countywide
Stormwater Quality
Management Program

Participating Agencies

Camarillo

County of Ventura

Fillmore

Moorpark

Ojai

Oxnard

Port Hueneme

San Buenaventura

Santa Paula

Simi Valley

Thousand Oaks

Ventura County
Watershed Protection
District

April 10, 2009

Ms. Tracy Egoscue
Executive Officer
Los Angeles Regional Water Quality Control Board
320 4th Street, Suite 200
Los Angeles, CA 90013

SUBJECT: FEBRUARY 24, 2009 TENTATIVE ORDER OF THE VENTURA COUNTY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT (NPDES No. CAS004002) FOR THE VENTURA COUNTY WATERSHED PROTECTION DISTRICT, COUNTY OF VENTURA AND THE INCORPORATED CITIES

Dear Ms. Egoscue:

The Ventura Countywide Stormwater Program ("Ventura Program") would like to take this opportunity to provide comments on the Regional Water Quality Control Board's ("Regional Water Board") Tentative Order of Waste Discharge Requirements for Storm Water Discharges from the Municipal Separate Storm Sewer System ("MS4") within the Ventura County Watershed Protection District, County of Ventura, and the Incorporated Cities therein (collectively referred to as the "Permittees") ("Tentative Order") (NPDES Permit No. CAS004002), which was released for public comment by the Regional Water Board on February 24, 2009.[1]

We wish to first express our appreciation of the Regional Water Board's staff efforts to meet and consider our concerns with the previous draft orders. These efforts aided in crafting a Tentative Order that is protective of water quality and builds upon an award winning stormwater management program. The Tentative Order is comprehensive and provides clear metrics for assessing the effectiveness of our program and addressing relevant water quality issues within our watersheds.

[1] In addition to the Permittees comments provided here, the Permittees have joined Heal-the-Bay and the Natural Resources Defense Council in a separate joint comment letter dated April 10, 2009 that articulates an agreement between the parties. As expressed in the joint letter, those comments and the positions expressed therein apply only to the extent that the Regional Water Board agrees with and revises the Tentative Order to reflect all of the comments contained in that letter. If the Regional Water Board determines that it is not appropriate to revise the Tentative Order accordingly, the Permittees comments expressed here on same or similar issues shall be considered the Permittees comments and position on those issues.

800 South Victoria Avenue • Ventura CA 93009-1610
805/654-2002 • FAX 805/654-3350

Before expanding upon our comments on the Tentative Order, we would like to highlight a couple of significant observations. First, the Tentative Order is, in every sense of the word, a ground breaking permit. From the development and use of municipal action levels, to establishing performance standards for treatment control best management practices (BMPs), to specifying specific BMP requirements for businesses, industries, and construction sites; the Tentative Order sets a high bar for California's municipal stormwater programs. Because of the ground-breaking nature of this Tentative Order, it will require the Permittees to substantially revise the existing Stormwater Management Program in Ventura County. As a result, costs associated with implementation of the Stormwater Management Program will also increase substantially.

Furthermore, the Tentative Order as proposed will protect existing high quality water and will lead to real water quality improvements. The Permittees take pride of the fact that we have some of the cleanest waterbodies and beaches in Southern California. This Tentative Order will continue to build on our existing efforts to protect these waters. However, as discussed further below, the Permittees would be remiss to not comment or acknowledge the substantial cost associated with implementing the Tentative Order. To that end, we encourage the Regional Water Board to carefully consider the potential economic impact of any future revisions or changes to the Tentative Order.

Our specific comments are organized around some of the overriding approaches acknowledged in this Tentative Order.[2] They include:

1. Economic Considerations
2. Municipal Action Levels (MALs)
3. Best Management Practice (BMP) Performance Standards
4. Construction BMPs
5. Planning and Land Development Program
6. Public Agency Trash Management Program
7. Total Maximum Daily Loads (TMDLs)
8. Monitoring

Each approach is discussed in this cover letter. More specific technical comments on the Tentative Order and its provisions are summarized in Attachment A. Additional Legal and Policy comments are provided in Attachment C.[3]

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[2] Although the Tentative Order addresses many of the concerns expressed in previous comments submitted by the Permittees, the Permittees still maintain a number of general concerns with the Tentative Order and its potential impact to Ventura County and its municipalities. To that extent, the Permittees hereby incorporate by reference all previous comments submitted on March 6, 2007, October 12, 2007, and May 28, 2008 in response to administrative draft versions of the Tentative Order.

[3] The additional comments provided in Attachments A and C are provided in attachment form for administrative ease only. The Regional Water Board shall consider all of the comments contained in the attachments as equal comments that are subject to the Regional Water Board's obligation under the Code of Federal Regulations to prepare responses thereto.

I. Economic Considerations

As a preliminary matter, the Regional Water Board must recognize that the Tentative Order will significantly increase program costs for the Ventura County Stormwater Management Program. In fact, we estimate that the program costs to implement the Tentative Order will double from the current level of $35 per household to $60 per household. In Finding E.28, the Regional Water Board characterizes the requirements in the permit as reasonable and that the cost of compliance does not justify a lessening of the requirements as proposed in the Tentative Order. (See Tentative Order at p. 21.) The substance of this finding is based on the Regional Water Board's assessment of program cost in its "Economic Considerations of the Proposed Ventura Permit." The Permittees are concerned that the economic analysis relied upon by the Regional Water Board is flawed because it did not assess the cost of the Tentative Order but rather estimated the cost for the Permittees to comply with the stormwater permit issued in 2000. It is an understatement to say the current Tentative Order is a significant expansion of the County's 2000 permit. In its assessment, the state estimated a cost of $29 per household. In contrast, the actual average household cost in Ventura County is $35 to implement the 2000 permit. Thus, the Regional Water Board's economic assessment greatly underestimates costs associated with implementing the proposed Tentative Order.

While the Permittees are committed to the protection of our water resources, we must point out the fiscal constraints that are facing municipalities and private citizens in Ventura County and across the State. Thus, as we move forward to implement the Tentative Order, if adopted as is, we must have sufficient flexibility to identify more cost effective BMPs that may be substituted for the ones identified in the Tentative Order. As you know, the Tentative Order provides for a BMP substitution option. In implementing this option, we believe it imperative that the Regional Board remain open to alternative approaches and schedules to provide the Permittees with flexibility in addressing fiscal constraints while still protecting water quality. This is especially true in these challenging economic times.

II. Municipal Action Levels

The Tentative Order significantly modifies the application of MALs from a numeric metric to assess compliance with the technology based Maximum Extent Practicable (MEP) standard to one of assessing the performance of the program. We believe, as noted in our previous comment letters, this revised approach is consistent with current USEPA guidance and regulations, and more recently the report prepared by the "Blue Ribbon Panel" as convened by the State Water Resources Control Board[4]. The Blue Ribbon Panel's (BRP) report clearly states the position **that numeric limits for municipal stormwater discharges are not possible at this time**. However, the BRP did agree that "action levels" may be used to identify "bad actor" catchments. Specifically, the BRP Report states:

> *It is not feasible at this time to set enforceable numeric effluent criteria for municipal BMPs and in particular urban discharges ....*

4 The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial, and Construction Activities (June 19, 2006).

> *For catchments not treated by a structural or treatment BMP, setting a numeric effluent limit is basically not possible. However, the approach of setting an 'upset' value, which is clearly above the normal observed variability, may be an interim approach which would allow "bad actor" catchments to receive additional attention. For the purposes of this document, we are calling this "upset" value an **Action Level** because the water quality discharge from such locations are enough of a concern that most all could agree that some action should be taken* ... . (BRP Report at p. 8, emphasis added.)

Although the Tentative Order revises the use of MALs from being a determination of MEP to being an assessment tool, please be assured that the revised MALs will require the Permittees to address discharges that exceed the MALs as the Tentative Order requires the Permittees to prepare and implement a MAL Action Plan. To our knowledge, this Tentative Order is the first of its kind to establish numeric metrics for assessing the effectiveness of a municipal program.

Notwithstanding the revisions to the language in the Tentative Order, we are concerned that the Fact Sheet/Staff Report discussion with respect to the revised language is inconsistent. As indicated immediately above, the MAL language in the Tentative Order alters the MALs from being an assessment of MEP to an assessment of performance of certain catchments and BMPs. The Fact Sheet/Staff Report, however, describes the MALs as a metric for determining MEP. (See Fact Sheet/Staff Report for the Municipal Storm Water and Urban Runoff Discharges within Ventura County Flood Control District (May 7, 2009) at pp. 17-18.) To avoid confusion and uncertainty with respect to the use and intent of MALs within the Tentative Order, the Fact Sheet/Staff Report must be revised accordingly. We have provided suggested revisions on Attachment A, No. 76.

Finally, to the extent that the Regional Water Board determines that MALs are appropriate for inclusion in the Ventura County MS4 permit, the MALs contained in the Tentative Order are more appropriate as compared to the MALs included in previous drafts because they are derived from a more relevant data-base. More specifically, the Tentative Order uses U.S. EPA zone 6 database, which reflects data from the arid southwest areas of the country. In contrast, the MALs in previous drafts were derived from the more general national dataset, which included numerous east coast communities with higher rainfall amounts. Use of the zone 6 regional database will allow the Ventura County Permittees to focus their attention on watersheds that more closely reflect the semi-arid nature of their communities. In a similar vein the use of the 80^{th} percentile value to establish the MAL is subject to debate. The Permittees recommend the substitution and the use of the 90^{th} percentile value in the Tentative Order as more appropriate to identify problematic discharges.

III. BMP Performance Standards

The Tentative Order establishes for the first time in California performance standards for treatment control BMPs. As noted in our previous comments, the Permittees support the idea of performance standards. Our previous concerns were directed to the derivation and application of the standards proposed. The Tentative Order addresses our concerns because it provides the

Permittees with the appropriate structure for elevating BMP performance and for holding developers accountable for their BMP design and construction.

IV. Construction BMPs

The Tentative Order establishes a risk-based approach for addressing runoff from construction sites. The Permittees support this BMP tiered approach as a constructive and implementable program. By establishing a defined set of BMPs as a function of the project size and impact on local water bodies, the Tentative Order provides the Permittees with the structure and flexibility necessary to direct local resources to real water quality concerns. Furthermore, the Permittees support the removal of the wet weather variance program for high-risk sites, as this variance program as originally proposed would have been cumbersome and expensive to implement. It also would have been susceptible to litigation because it was not adopted consistent with U.S. EPA regulations for developing technology based effluent limits.

V. Planning and Land Development Program

The Planning and Land Development Program contains extensive requirements for on-site low impact development (LID) strategies, hydromodification controls and treatment control BMPs. With respect to the LID strategies, the proposed requirements will fundamentally change land development in Ventura County. The Tentative Order will require municipalities to implement LID strategies (i.e., LID BMPs) by complying with an effective impervious area (EIA) of 5% for undeveloped sites. To render an impervious area ineffective the developer must implement LID BMPs for the water quality storm (e.g. 85%, 24 hour storm event) through infiltration, capture and reuse or through vegetated BMPs. While we support the concept of well designed BMPs to address the water quality storm, we would submit that the LID BMP(s) should be sized, at a minimum, to infiltrate, evapotranspire, reuse, or collect and detain the "delta" runoff volume, which is defined as the excess runoff[5] from the water quality (SQUIMP) design storm event.

As part of the Permittee's effort to assess the practicality of various approaches for LID, we prepared the attached white paper: *"Low Impact Development Metrics in Stormwater Permitting"* (Attachment B). This paper carefully examined the feasibility of implementing LID strategies for a range of development projects under various rainfall conditions in both Ventura and Orange Counties. The paper demonstrates the feasibility of certain strategies as well as identifies the challenges associated with the various strategies. For redevelopment projects the Tentative Order allows more flexibility in meeting the 5% EIA standard although still requiring compliance to treat the water quality storm event. The Permittees continue to support such an approach.

With respect to the EIA criterion, the Permittees would submit that there is considerable debate and concern within the stormwater quality management/science community as well as among planners and practicing landscape architects as to the efficacy of EIA as a controlling criterion. Specific aspects of this concern have been noted in our previous comments on the draft orders

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[5] Excess storm water runoff = volume of post-development runoff minus pre-development runoff for the 85th percentile storm event (or equivalent water quality design event).

and include whether this EIA criterion should be used and, if used, whether it should be applied on a site-by-site basis. We have also commented previously on our concerns regarding its potential implications to urban redevelopment, smart growth, and urban sprawl. Thus, the proposed EIA criterion should be further evaluated in light of larger environmentally beneficial societal goals, such as redevelopment, brownfield development, and infill development to avoid unintended consequences and further complications.

With respect to hydromodification criteria, the Tentative Order correctly identifies the need for such criteria but appropriately identifies exemptions for conditions where warranted. The Tentative Order also allows for the continued coordination and support of the Southern California Storm Water Monitoring Coalition's (SMC) efforts to develop a regional methodology to mitigate adverse impacts of hydromodifcation due to urbanization. The Permittees support such an approach because it is practical, while being protective of stream-bed integrity. We also support the interim hydromodification requirements until such time that the SMC completes the Hydromodification Control Study. Lastly, the exemption provisions address many of our concerns expressed on the previous draft orders. These provisions should allow the Permittees to focus on those discharges that pose the most significant threat to stream bed integrity and water quality.

VI. Public Agency Trash Management Program

The Tentative Order includes a comprehensive approach for addressing trash in Ventura County. Although trash is not a significant issue in the water-ways of Ventura County (e.g., less than 12 miles of water ways are listed as trash impaired for the entire County), the Permittees support taking an aggressive approach to trash management. The Tentative Order provides the Permittees with the necessary flexibility to prioritize drainage systems for trash generation, and subsequent clean-up and removal. Furthermore, the Tentative Order allows the Permittees to develop alternative approaches that reflect the nature and composition of the municipality. The Permittees support the flexibility provided for in the Tentative Order and encourage the Regional Water Board to continue providing the flexibility needed to tailor municipal programs for relevant and identified water quality issues.

VII. TMDLs

Consistent with 40 C.F.R. § 122.44(d)(1)(vii)(B), the Tentative Order incorporates wasteload allocations (WLAs) for effective TMDLs as permit limits. As required by 40 C.F.R. § 122.44(d)(1)(vii)(B), the permit limits in the Tentative Order have been modified from previous drafts of the permit to be "consistent with the assumptions and requirements of available WLAs" by being incorporated as receiving water limits in the permit. Additionally, the WLAs have appropriately been expressed in the form of BMPs consistent with EPA's 2002 Memorandum *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs*. (See Attachment C for further legal and policy discussions on this issue.) As stated in that memorandum:

- WQBELs for NPDES-regulated storm water discharges that implement WLAs in TMDLs may be expressed in the form of best management practices (BMPs) under specified circumstances. (See 33 U.S.C. §1342(p)(3)(B)(iii); 40 C.F.R. §122.44(k)(2)&(3).) If BMPs alone adequately implement the WLAs, then additional controls are not necessary.

- EPA expects that most WQBELs for NPDES-regulated municipal and small construction storm water discharges will be in the form of BMPs, and that numeric limits will be used only in rare instances.
- When a non-numeric water quality-based effluent limit is imposed, the permit's administrative record, including the fact sheet when one is required, needs to support that the BMPs are expected to be sufficient to implement the WLA in the TMDL. (See 40 C.F.R. §§ 124.8, 124.9 & 124.18.)
- The NPDES permit must also specify the monitoring necessary to determine compliance with effluent limitations. (See 40 C.F.R. § 122.44(i).) Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved (e.g., BMP performance data).
- The permit should also provide a mechanism (e.g. iterative, adaptive management BMP approach) to make adjustments to the required BMPs as necessary to ensure their adequate performance.

In accordance with EPA's Guidance, the BMPs included in the permit will be sufficient to implement and achieve the WLAs in the TMDLs. Further, the specified monitoring program is sufficient to determine compliance load reductions resulting from BMP implementation. This combined with the incorporation of the "iterative process" is consistent with USEPA's Guidance.

While the Permittees believe that the language in the Tentative Order meets the requirements of 40 C.F.R. §122.44(d)(1)(vii)(B) and is consistent with EPA's Guidance, we recommend the following revisions to provide further clarification that the WLAs will be implemented through BMPs and to provide a mechanism for making adjustments to the BMPs to ensure their adequate performance. Our suggested revisions to the findings and to Part 6 of the Tentative Order are as follows:

Finding F.3

The permit provisions and BMPs ~~implementation of measures~~ set forth in this Order are reasonably expected ~~to reduce the discharge of pollutants conveyed in storm water discharges into receiving waters, and~~ to implement ~~meet~~ the TMDL WLAs for discharges from MS4s that have been adopted by the Regional Water Board.

Part 6 – Total Maximum Daily Load Provisions

II. ~~Each permittee shall attain the storm water WLAs incorporated into this Order by implementing BMPs in accordance with the MS4 effluent quality workplan and source identification approved by the Executive Officer.~~The permit provisions and BMPs identified in Parts 1, 2, 3, 4, and 5 implement the approved WLAs for all TMDLs identified in this section. Each permittee shall modify their SMP to include BMPs to implement the approved WLAs.

Provision (b)(2) under each TMDL, to read as follows:

> If any WLA is exceeded at a compliance monitoring site, permittees shall implement BMPs in accordance with the TMDL Technical Reports, Implementation Plans or as identified as a result of TMDL Special Studies identified in the Basin Plan Amendment. Following these actions, Regional Water Board staff will evaluate the need for further enforcement action. Exceedances of the WLAs at the receiving water compliance locations will initiate the implementation of additional BMPs identified in the permit and modification of the SMP to include additional BMPs to further reduce discharges of pollutants to achieve compliance with the WLAs.

With these modifications, the Tentative Order will clearly implement the TMDL in accordance with EPA's 2002 memorandum.

VIII. Monitoring

The Tentative Order reflects the great deal of work that has been done to resolve many technical issues and ultimately creates a monitoring and reporting program that will support and protect water quality. The Ventura Countywide Stormwater Management Program currently has an exemplary monitoring program with a state-of-the-art data management system; the new monitoring program will greatly expand upon this effort. The addition of special studies, outfall monitoring and beach water quality monitoring will more than double the cost of the monitoring program, all which is in addition to a significant amount of other monitoring occurring within the County: TMDLs, Ocean outfall, SWAMP, inland wastewater treatment plants and AB 411 (beach water quality) Programs.

The Permittees have put a great deal of effort into identifying appropriate urban outfall monitoring sites for each Permittee by utilizing Ventura County's Geographic Information System, overlying various land uses (residential, commercial, industrial, agricultural, open space) and jurisdictional responsibilities with watershed/subwatershed boundaries. The result of this effort is monitoring locations that capture a significant portion of each Permittees' urban runoff or signature independent of other land uses or pollutant sources. This will generate data that will support each Permittee's Stormwater Program, allowing each Permittee to use this data to improve their Program's effectiveness, which ultimately will improve water quality.

We would also like to point out that the Tentative Order identifies a number of special studies. Two of them, *Hydromodification Control Study* and *Low Impact Development*, are done in regional partnerships (Southern California Monitoring Coalition and Southern California Coastal Watershed Research Project (SCCWRP)) and will lead to better land development practices. The other special studies will help provide a detailed picture of the habitat and water quality of Ventura County. One of these is the expanded bioassessment study, also to be done in partnership with SCCWRP. As you know, Ventura County participates in SCCWRP as both a Commission member, and through SCCWRP's Technical Advisory Group. SCCWRP's regional study will cover all of Ventura County and south to the state border, going well beyond the established bioassessment currently performed by the Program. It includes new labor intensive field measurements along with new requirements for extensive chemistry and toxicity analysis at 75 sites. Additionally, a pyrethroid study will periodically examine local watersheds to determine: 1) if there is a problem; where the problem may exist; and 3) if any trends can be identified. Thus, in total the Permittees are supporting either directly or indirectly extensive monitoring efforts. Such support must also be balanced with other permit obligations.

Summary

The Permittees recognize that the Tentative Order is a significant step forward in addressing urban runoff in Ventura County. We would submit that the Tentative Order, when viewed in the whole and not as individual parts, is comprehensive and protective of water quality. However, the comprehensive nature of the Tentative Order will significantly increase local agency and citizen costs to implement the program. In light of these increased costs, we encourage the Regional Water Board to carefully consider the implications associated with any future modifications as such modifications to one program element would likely come at the expense of another. Again, we thank you and your staff for the time and effort in meeting with the Ventura County Permittees to work through the many issues in the previous draft orders. Although it will come with substantial costs, overall the Tentative Order is a significant improvement and will result in protection of water quality in a constructive and effective manner. If you have any questions, please contact me at (805) 654-5051, or via email at Gerhardt.Hubner@ventura.org

Sincerely,

Gerhardt J. Hubner
On Behalf of the Entire
Ventura Countywide
Stormwater Management Program

cc: LARWQCB Board Members
Sam Unger, Los Angeles Regional Water Quality Control Board
Ventura County City Managers
Marty Robinson, Ventura County Executive Officer
Jeff Pratt, Ventura County Public Works Director
Ventura Countywide Stormwater Management Program Permittees

Attachments

A. Specific Technical Comments Matrix
B. White Paper: "*Low Impact Development Metrics in Stormwater Permitting*", dated January 2009, prepared for the Ventura Countywide Program and Orange County Stormwater Program, prepared by Geosyntec Consultants and Larry Walker Associates with assistance from Hawks and Associates; and "*Response to Critical Comments on "Low Impact Development Metrics in Stormwater Permitting"*", dated April 9, 2009
C. Legal and Policy Comments

ATTACHMENT A
SPECIFIC TECHNICAL COMMENTS
FEBRUARY 24, 2009 VENTURA COUNTY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT (NPDES NO. CAS004002)
FOR THE
VENTURA COUNTY WATERSHED PROTECTION DISTRICT, COUNTY OF VENTURA, AND THE INCOPRORATED CITIES

No.	Page	Citation	Comment
1	2	Finding B.2	Suggest the term "trash" be added as common pollutant found in urban runoff, thereby providing the basis for including requirements for trash management.
2	3	Findings B.5	A references for studies is needed: "local and national epidemiological studies indicate there is a causal relationship between adverse health effects and recreational water quality . . . " A 2003 SCCWRP Mission Bay Epidemiological Study found "The risk of illness was uncorrelated with levels of traditional water quality indicators and state water quality thresholds were not predictive of swimming-related illnesses".
3	4	Findings B.12	References for the studies are needed: "Studies have demonstrated a direct correlation between degree of imperviousness and receiving water degradation." Also suggest editing the first line to read " . . .runoff from developed areas has the potential to ~~greatly~~ accelerate downstream erosion . . "; and the last sentence to read " pervious cover is ~~a reliable~~ <u>one</u> indicator ...." There is some debate as to whether it's a reliable indicator, and the primary cause of water quality degradation from new development is the <u>unabated</u> discharge of stormwater. With proper BMPs these discharges can be mitigated. Please include reference and amend finding accordingly.
4	4	Findings B.12	Add clarity: "Significant declines . . . with as little as 3-10 percent conversion from natural to impervious surfaces <u>in a subwatershed".</u> As currently worded, the finding implies a 3-10 percent conversion at a lot level is also significant. To avoid confusion and provide clarity, the language should be revised to indicate that significant declines may occur if there are conversions for the entire subwatershed.
5	5	Findings B.13,14,	Please provide references for studies.
6	5	Findings B.16	Environmentally Sensitive Areas (ESA) as described here does not match definition, missing all unimproved 303(d) reaches.
7	6	Findings B.17,19	Please provide references for studies.
8	8	Findings C.6	No trash and debris study is included in the Monitoring and Reporting Program, please delete this reference.

ATTACHMENT A
PERMITTEES' COMBINED TECHNICAL COMMENTS
TENTATIVE VENTURA COUNTY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT (NPDES NO. CAS004002)

No.	Page	Citation	Comment
9	8	Finding C.6	Recommend modifying finding to read "This Order requires a monitoring program consisting of mass emission, outfall and special studies ~~, toxicity,~~ to support program evaluation and TMDLs ~~storm water (wet weather) MS4 water quality-based effluent limits, TMDL non-storm water (dry weather) MS4 water quality-based effluent limits~~,… " The current language is confusing and inconsistent with the intent of the finding.
10	8	Finding D.1	Recommend modifying the finding to read "The area covered by this Order includes all urbanized areas within Ventura County boundaries…" This permit is for discharges from urbanized areas of the County and does not apply countywide for un-urbanized areas. (See also Letter to Mr. Jonathan A. Bishop, Executive Officer, Los Angeles Regional Water Quality Control Board from Gerhardt Hubner, Chair, Ventura Countywide Stormwater Quality Management Program (March 6, 2007) (March 2007 Letter) at pp. 13-14.)
11	9	Finding D.6	Recommend modifying the finding to read "The CWA and the California Water Code contain specific provisions on how ~~wastewater~~ discharges of waste from point sources are to be permitted, including urban stormwater and non-storm water. We believe the intent of this finding is to establish the fact that stormwater discharges are regulated under the CWA and CWC.
12	10	Finding E.4	When referring to the Porter-Cologne Water Quality Control Act (California Water Code), it should be clear that the State and Regional Water Board's have the authority to regulate the discharge of "wastes that could affect the quality of waters of the state." Thus, we recommend that the second sentence of the finding by revised as follows: The Porter-Cologne Water Quality Control Act (California Water Code) authorizes the State Water Resources Control Board (State Water Board), through the Regional Water Boards, to regulate and control the discharge of ~~pollutants~~ wastes that could affect the quality of waters ~~into all waters~~ of the State, including waters of the United States, and tributaries thereto.
13	13	Finding E.7	The Permittees disagree with the conclusive statements made in Finding E.7. In general, we do not agree that all requirements contained in the Tentative Order are required by federal law. Many of the provisions may in fact be more stringent than required by federal law and may therefore potentially be considered an unfunded local mandate subject to subvention under Article XIIIB, Section (6) of the California Constitution. Additional legal and policy comments on this finding are provided on Attachment C.

No.	Page	Citation	Comment
14	21	Findings E.26 & E.27	The Permittees disagree with the conclusive statements made in findings as some of the requirements contained in the Tentative Order may well exceed the maximum extent practicable (MEP) standard. Additional legal and policy comments on this finding are provided on Attachment C. Furthermore, this finding as drafted is confusing because it blurs the distinction between the effective elimination of non-storm water discharges and the reduction of stormwater pollutants to the maximum extent practicable.
15	23	1:F. 6.	Please clarify not all impervious area is intended to be minimized but rather effective impervious area by adding the word "effective": "Smart growth techniques include the minimization of <u>effective</u> impervious area"
16	24	Finding F.9	This finding implies that under the CWA the Permittees are required to "attain water quality objectives from new development and redevelopment activities." Such a statement is incorrect. We recommend revising the finding accordingly be deleting this part of the sentence.
17	25	Finding F.12	This finding needs a lead in statement to support the position that the permit has established BMP performance, which are based on the ASCE and USEPA database.
18	27	Finding F.19	This finding claims that the Fact Sheet includes an analyses of the factors required by California Water Code section 13241. We disagree. The Fact Sheet does not include any analysis that is consistent with the statutory factors identified in Water Code section 13241. Thus, we recommend either deleting the finding, or revising the Fact Sheet to appropriately include the analysis identified.
19	29 – 32	Footnotes	The footnotes are redundant and should only be stated once. Further, footnotes are not formatted properly.
20	30	Part 1.A.1.(c)	The Tentative Order does not properly explain or describe the purpose of the information contained in Table 1. If the purpose of Table 1 is to identify conditions that apply to the categories of allowed non-storm water discharges identified in Part 1.A.1.(c), it should be explained accordingly. Otherwise, as currently incorporated there is no correlation between the Discharge Prohibition language and the information contained in Table 1.
21	30	Table 1	It is unclear of the distinction between the columns labeled: "Conditions under which allowed" and "Required conditions for discharge to occur". Recommend deleting one and if necessary expanding the explanation in the remaining column. Also it is unclear what is meant by "Permittees shall comply with all conditions in the authorization", specifically what authorization?
22	32 & 108	Table 1	Required conditions for discharge from sidewalk rinsing refers to the glossary description of "Sidewalk Rinsing" where it says "any waste generated from the activity must be collected". Please describe under what circumstance a discharge from sidewalk rinsing is allowed.

ATTACHMENT A
PERMITTEES' COMBINED TECHNICAL COMMENTS
TENTATIVE VENTURA COUNTY MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT (NPDES NO. CAS004002)

No.	Page	Citation	Comment
23	32	Part 1.A.2	This provision would require the Permittees to take certain actions if the Regional Water Board's executive officer determined that any of the preceding categories of non-storm water discharges are a source of pollutant that may exceed water quality standards. However, the provision does not specify that the Permittee's obligations occur only after receiving notice of the Executive Officer's determination. To ensure that the Permittee's obligations occur only after proper notice, we recommend that the first sentence be revised as follows: "If the Regional Water Board Executive Officer determines that any of the preceding categories of non-storm water discharges are a source of pollutants that exceed water quality standards, the Permittee(s), upon receiving written notice of the Executive Officer's determination, shall either:…."
24	33	Part 1.A.3	This provision should be deleted as it is redundant with requirements noted in Table 1.
25	34	Part 2.4	There is a conflict with the timelines given for two of the requirements. More specifically, the statements "Beginning year 3 after adoption" and "first MAL Action Plan due Dec. 15, 2011" conflict because year 1=2009-2010, year 2= 2010-2011, and year 3=2011-2012. By December of 2011, only the first wet season's data (four sites) will be available. To avoid the conflict, we recommend that the first sentence be modified as follows: At the end of ~~Beginning~~ Year 3 after Order adoption date, each Permittee shall submit a MAL Action Plan with the Annual Report (e.g. the first MAL Action Plan would be due with ~~Dec. 15, 2011~~ the 2011/2012 Annual Report if the Order is adopted in 2009) to the Executive Officer …
26	37	4.B.3	There are conflicting timelines for several of the provisions related to adoption and/or revision of municipal codes (i.e. one year to adopt ordinance to enforce all requirements of this order conflicts with 4.B.4, which allows two years for legal counsel statement, and 4.D.1, which allows two years for municipal codes to be consistent with requirements). To avoid the conflict, we recommend revising Part 4.B.3 to allow two years after Order adoption for each permittee to ensure that its Storm Water Quality Ordinance authorizes the Permittee to enforce all requirements of this Order.
27	38	4.C.1.(a).1.(B)	The budget provisions imply that the Program Implementation Activities apply only to storm water related activities. As stated throughout the Tentative Order, it contains requirements with respect to storm related activities as well as non-storm water discharges. Because this may imply that the costs of implementing the program are less than actually required, we recommend revising the phrase "storm water related activities only" to permit related activities as it would be more inclusive.
28	39	4.E.1.(e) & (g)	Subsections (e) and (g) appear to be duplicative.
29	39	Part 4.E.1.(i)	The District (i.e. Principal Permittee) does not have the same pollutant generating activities, legal authority and land use decision capability as the municipalities (i.e. Permittees) therefore (i) should be deleted.

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No.	Page	Citation	Comment
30	40	Part 5.B.2	Redundant – this section is repeated in Monitoring Program Attachment H
31	42	Part 5.C.2.(c)(1)(C)	Request 365 days to develop and distribute materials to retail stores. No time frame is currently provided.
32	44	Part 5.D.1.	Laundries are not listed as a Critical Sources under commercial facilities but are listed in attachment "D". Please clarify if the intent is to include laundries as a Critical Source, and if so a clear definition of size and function of the included business.
33	45	Part 5. D.1.(a)(2)	Please provide a definition for Phase II facilities. Phase I facilities are included in the definitions, but Phase II facilities are not.
34	45	Part 5.D.2.(a)	The sentence that refers to subpart 5.D.2 should be modified to refer to subpart 5.D.1.
35	46	Part 5.D.2.(a)(2)	The phrase "in cooperation with its appropriate department . . ." is unnecessary as all departments of a permittee are responsible for permit compliance and internal cooperation and communication would be expected.
36	49	Part 5.D.2.(b)(1)(A) &(B)	Part (A) refers to an "initial inspection" and "second mandatory compliance inspection," while part (B) refers to both "first mandatory compliance inspection" and "second mandatory compliance inspection." Please clarify the difference between the initial inspection and the first mandatory compliance inspection. Further, the Permittees continue to be concerned that the inspection requirements for industrial facilities is in fact an unfunded local mandate because determination of compliance with the State's General Permit is a state function, not a local function. Additional comments on this issue are provided in Attachment C.
37	50	Part 5.D.2.(b)(2)(B)	The last sentence in this provision, "[t]he Permittees shall require implementation of additional BMPs where the storm water from the MS4 discharges to a CWA 303(d) listed waterbody" is redundant with provisions contained in sub-section D.3.(b).. Thus, this sentence should be deleted.
38	50	Part 5.D.3.(a)	The reference to part 5.D.3 should be changed to part 5.D.2.
39	51	Part 5.D.4(c)	This provision seems to be inconsistent with a similar provision in the Construction section (see page 73) regarding investigating complaints received from the Regional Board. The provision should read as follows: Each Permittee shall initiate, within one business day,[1] investigation of complaints ~~of~~ (other than non-storm water discharges) to the MS4 from facilities within its jurisdiction ~~(other than non-storm water discharges)~~.

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No.	Page	Citation	Comment
40	52	Part 5.E.(1)	Smart Growth should be included as one of the purposes for this section. We recommend that a new purpose be added as follows: (a) Lessen the water quality impacts of development by using smart growth practices such as compact development, directing development towards existing communities via infill or redevelopment, safeguarding of environmentally sensitive areas, mixing of land uses (e.g., homes, offices, and shops), transit accessibility, and better pedestrian and bicycle amenities.
41	52	Part 5.E.(1).(b)	"Minimize the percentage of impervious area" should be revised as follows: minimize the percentage of effective impervious area.
42	52	footnote	48 hour drain time is in conflict with table on page 32 calling for 72 hour drain time which is the time most BMPs use in design.
43	52	Part 5.D.4.(e)	Please clarify, is the Stormwater Task Force the same as the California Association of Stormwater Quality Agencies (CASQA)?
44	53	Part 5.E.II.1.(a)(6)	Please clarify by stating "25 or more exposed parking spacing"
45	54	Part 5.E.II.2.(a)(3)	The effective date for public projects is more strict than private projects and can create a hardship in costly redesigns of a project. A project is completely designed at the point a governing body approves authorization to bid the project. Requiring compliance with this section of the permit at that time would mean a costly re-design of the project. Language more comparable to the trigger for private projects would be preferable. We suggest: "For Permittee's projects the effective date shall be the date the governing body or their designee approves initiation of the project design."
46	55	Part 5.E.III.1 (b)	The reference in the last sentence should be changed from 5.E.III.4 to 5.E.III.3
47	55	Part 5.E.III.1 (c) – (e)	We would recommend that these three provisions be combined to read as follows: (c) All features structured constructed to render impervious surfaces "ineffective" as described in provision (b), above, shall be properly sized to ~~infiltrate or store for beneficial reuse at least~~ capture the volume of water that meets the criteria in subpart 5.E.III.3 (water quality volume). The hierarchy of BMPs for capturing the water quality volume are: (1) infiltration, harvesting, or evapotranspiration BMPs; and, (2) vegetated BMPs such as bioretention. The water quality volume not captured by BMPs shall be treated consistent with Part 4.A.3 and Attachment C, Table 3.
48	57	Part 5.E.III.2.(a)(1)(F)	Reference to 5.E.III.3 (a)(2) should be 5.E.III.2. (a) (3) (A)

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No.	Page	Citation	Comment
49	58	Part 5.E.III.3.(a)	Numbering format needs correction
50	62	Part 5.E.IV.3(b)(3)	To be consistent with the rest of the Effective Impervious Area language please change "less than 5 percent" to "5 percent or less"
51	68	Footnotes	Footnotes 17 and 18 are redundant.
52	69	F I.4. (c)	Delete obligation of Permittees to require project proponents to collect samples in accordance with general construction permit. As indicated previously, any requirement placed upon the Permittees that requires them to implement or enforce the State's General Permit is an unfunded mandate for which subvention funds must be provided.
53	69	Part 5.F.5	The reference to subpart F.5 should be subpart F.4
54	66-69	Tables in Part 5.F	Tables 6 -9 are intended to build on each other. There is no need to repeat the BMPs in every table as the text requires the Discharge to implement appropriate BMPs in addition to the ones already identified in the previous tables. See provision F.2, F.3, or F.4. In general these provision state "Each Permittee shall require the implementation of an effective combination of appropriate erosion and sediment control BMPs from Table 7 **in addition** to the ones identified in Table 6 to prevent erosion and sediment loss…" (emphasis added).
55	70	Part 5.F.6.	Section is missing punctuation. Please include a footnote defining chance of rain (POP >50%).
56	74	Part 5.G.2.(a)	Table 9 should read Table 10.
57	74	Part 5.G.2.(a)	Please revise the provision as follows: "(a) Each Permittee shall implement the activity specific BMPs listed in Table 10 or related BMPs as listed in the *2003 California Stormwater Municipal BMP Handbook* when such activities . . ."
58	77	Part 5.G.(4)(a)	No time frame given for implementing an Integrated Pest Management Program – request 365 days

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No.	Page	Citation	Comment
59		Part 5.G.I.4(a)(7)(C)	Several agencies have been implementing Integrated Pest Management programs for several years and have therefore already made significant reductions in pesticides used by the agencies. By requiring these same proactive agencies to now "demonstrate reductions in pesticide use" will be very difficult because reductions have already occurred. Further, the primary goal and purpose of Integrated Pest Management programs is to address pest issues in a holistic manner using a number of different types of control methods. The implementation of such programs may or may not result in the reduction of the use of pesticides. The need for pesticides even when implementing an Integrated Pest Management program may also vary based on the type of weather year and other circumstances beyond the control of local agencies. As such, we are concerned that a requirement "to demonstrate reductions in pesticide use" may not be feasible in all circumstances. Thus, we recommend revising the language as follows: "Demonstrate implementation of IPM alternatives where feasible to reduce pesticide use."
60	79	Part 5.G.(d)(1)	"rainy season" should be replaced with the defined term "wet season"
61	79	Part 5.G.(f)(1)(b)	"storm season" should be replaced with the defined term "wet season"
62	80	Part 5.G.(g)(1)	Section should specify that it pertains to spills by permittee facilities or activities.
63	81	Part 5.G.6.(b)	Redundant because G.1(b) requires compliance with 5.F.6 which is the exact same language.
64	83	Part 5.H.I.3(a)(2)	Please include the language that is used in the fact sheet noting "this provision is not meant to exclude Permittees from using equally effective alternative methods not listed in the manual."
65	83	Part 5.H.(1).(b)	Confusing request and time frame. Requirement is to map all known connections to storm drain system in 3 years, but 5.H.(3) give 5 years for pipes 18 – 35 inches in diameter. Also, storm drain system is not defined, if this is synonymous with the MS4 this task would be extremely difficult. Request that the purpose of this requirement be made clear so the intent and criteria of what is a connection are easier to determine.
66	85	Part 5.I.1	Electronic reporting program submitted 12 months after permit adoption conflicts with Dec. 15 reporting deadline given at Part 2.4. (page 34) and in Attachment H.

No.	Page	Citation	Comment
67	85	Part 6.II	Although the Regional Board corrected the individual TMDLs throughout this section to remove the requirement for a "MS4 effluent quality workplan..." , they did not change Part 6.II to add the new language, which should read as follows: "II. Each permittee shall attain the storm water WLAs incorporated into this Order by implementing BMPs in accordance with the TMDL Technical Reports, Implementation Plans or as identified as a result of TMDL specialstudies identified in the Basin Plan Amendment." This is the language used for each identified TMDL under (b) Compliance Monitoring (2).
68	86	Part 6 III.8	The "effective date" of the Harbor Beaches TMDL is December 18, 2008 – not September 23.
69		Definitions	Please add a definition for "Smart Growth" as follows: Development in or near cities intended to lessen or reverse suburban sprawl, decrease the use of automobiles, and shorten daily travel. It uses compact building design to cluster together residential, shopping, and work areas and encourages walking and public transportation. Smart Growth is considered a stormwater BMP in the 2005 EPA publication *Using Smart Growth Techniques as Stormwater Best Management Practices*, EPA 231-B-05-002
70	F-2	A.I.1.10	Other constituents are properly sampled as grabs (ammonia, conductivity, perchlorate, O&G, TRPH, phenols, cyanide). Suggest stating samples are to be taken according to Standard Methods, or citing appropriate EPA methods.
71	F-3	A.I.15.c	Reference to "J" should be to "K".
72	F-3	A.12	If a constituent is not detected at the MDL then it will not be an "observed occurrence" and so cannot show a concentration greater than the State WQOs or CTR acute criteria. Suggest "If a constituent is not detected at the Method Detection Limit (MDL) for its respective test method it need not be further analyzed. ~~unless the observed occurrence shows concentrations greater than the state water quality objective, and/ or the California Toxics Rule (CTR) for acute criteria.~~"
73	F-4	B.1.d	Reference to attachment "H" should be attachment "I"
74	F-5	B.7	Attachment "C" constituents (Tables 1 and 2) don't match constituents listed in B7. Suggest deleting the list of constituents included in B.7.
75	F-6	B.8	Request to the same language used as A.12 for screening of all constituents (first storm event of the wet season) with same modification to language to eliminate contradictory statement, i.e. "If a constituent is not detected at the Method Detection Limit (MDL) for its respective test method it need not be further analyzed. ~~unless the observed occurrence shows concentrations greater than the state water quality objective, and/ or the California Toxics Rule (CTR) for acute criteria.~~" because if a constituent is not detected at the MDL then it cannot be an "observed occurrence" and so cannot show a concentration greater than the State WQOs or CTR acute criteria.
76	F-6	B.11.c	Standard Monitoring Provisions are part "K" (not "J")

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No.	Page	Citation	Comment
77	F-7	B.13	A reference should be added to attachment "A" for "Pollutants of Concern"
78	F-12	D.14	Add "significant" to first sentence, i.e. "... TIEs for all sites showing <u>significant</u> toxicity." To match language in the trigger for TIE in the same section.
79	F-14	E.1.a,d/e & E.2.a	Inconsistent frequency of pyrethroid monitoring: E.2 "shall monitor 1 sampling event per station per monitoring year" should be deleted or changed to match E.1.a,d/e it is to begin "no later than the second year of this Order" at "at least 2 stations [per watershed]" and is to be "repeated in the fifth year of the permit term" and in
80	F-17	I.1.a.1.A	Suggest clarifying frequency i.e. "Level of effort per watershed <u>per year</u>"
81	F-19	K.6.b	The intercalibration study consists of a small number of constituents (TSS, nutrients, metals, chlorinated hydrocarbons, and pyrethroid pesticides). Request change of language at end of K.6.a and K.6.b to add "where applicable" to allow use of laboratories to test for constituents not included in the intercalibration study (i.e. bacteriological, toxicity, and other chemical analyses).
82	F.7	B.12	This section requires results from major outfall stations to be compared to Basin Plan water quality objectives. Comparisons with WQO can be done for informative purposes, however these objectives are set for receiving waters and are not appropriate to determine compliance with the NPDES permit through the quality of discharges from MS4s
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Low Impact Development Metrics in Stormwater Permitting

Prepared for the Ventura Countywide Stormwater Quality Management Program and the Orange County Stormwater Program

Prepared by Geosyntec Consultants and Larry Walker Associates with assistance from Hawks and Associates

January 2009

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Low Impact Development Metrics in Stormwater Permitting

I. Introduction and Purpose

Over the past decade, the U.S. EPA, the State Water Resource Control Board, and the Regional Boards have begun promoting and requiring the preferential use of Low Impact Development (LID) strategies to protect and improve water quality from new development and redevelopment projects. LID may be defined as site design incorporating LID Best Management Practices (BMPs) that strive to more closely mimic natural hydrology so as to reduce pollutant loads in post-development discharges and reduce hydromodification impacts. LID begins with functional conservation of watershed resources, reducing impacts of development, and then using innovative management practices to meet stormwater objectives; it is not the use of the management practices alone[1]. Site preservation practices coupled with small-scale BMPs that rely on the environmental services of vegetation and soils or systems that mimic these services comprise the LID approach.

It has also become increasingly clear that site design using LID alone cannot solve the problems with urban stormwater runoff. A watershed level approach that includes preventative actions is needed. Recently, a report prepared by the National Research Council for the US EPA[2] found that a comprehensive strategy must address impacts at a variety of scales and work to curb the development patterns that drive excess imperviousness and watershed disturbance. This marks the next phase in the evolution of stormwater management. It requires a much broader range of planning strategies, including urban infill, redevelopment, mixed use development, compact neighborhood design, and multi-modal transportation systems – all hallmarks of smart growth – to minimize watershed disturbance and impervious cover through compact community form, reuse of land, and shrinking the transportation footprint. This progression merges smart growth, urban design, and LID to address impacts at the site and builds on a growing body of research that is changing the way we look at the problem of stormwater runoff and the solutions we use to solve it. It presents the opportunity to apply new solutions across a wider range of scales and development contexts: using green infrastructure at site, neighborhood, district, community, and regional scales; minimizing pavement not only through permeable alternatives, but also by planning to reduce the overall transportation footprint; not only disconnecting impervious surfaces, but making fewer of them while reusing and retrofitting those that already exist.

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1 *A Review of Low Impact Development Policies: Removing Institutional Barriers To Adoption.* Commissioned and sponsored by the California State Water Resources Control Board Stormwater Program and The Water Board Academy. December 2007.

2 *Urban Stormwater Management in the United States.* Committee on Reducing Stormwater Discharge Contributions to Water Pollution, Water Science and Technology Board, Division on Earth and Life Studies, National Research Council of the National Academies.

Currently, there is intense discussion among the regulatory agencies, regulated communities, and environmental groups as to an appropriate metric for ensuring reasonable consideration and implementation of LID by new development and redevelopment projects. Recent draft MS4 permits have created an opportunity to further the discussion. Concurrently, the Southern California Coastal Water Research Project (SCCWRP) has undertaken technical studies related to developing analysis tools for hydromodification. This white paper has been prepared to: 1) to assess the practicality and environmental outcomes of the LID metrics proposed in the draft April 2008 Ventura Countywide and the November 2008 Orange Countywide NPDES permits, and 2) to identify and evaluate alternative metrics for implementation of LID strategies and improving environmental outcomes.

II. Background

The municipal separate storm sewer system (MS4) permits issued throughout the state since the early 1990's have required permittees to address the adverse impacts to creeks, rivers, streams and coastal waters that can arise from the imprint of urban development on the landscape. Urbanization creates rooftops, driveways, roads, and parking lots (Schueler and Holland[3] use the term *imperviousness* as the unifying theme for understanding the adverse hydrologic impacts of urbanization) which (1) increase the timing and volume of rainfall runoff (compared to pre-development conditions) and (2) provide a source of pollutants that are flushed or leached by rainfall runoff into aquatic systems. The environmental consequences of these impacts can be loss or impairment of aquatic beneficial uses due to:

- Water quality degradation from increased loadings of sediment, nutrients, metals hydrocarbons, pesticides, and bacteria;
- Stream channel instability and habitat loss from increased stream flows;
- Increased water temperatures from solar energy absorption by urban surfaces and elimination of riparian shading, and
- Loss of groundwater recharge.

Assessments of stream system integrity show that these adverse impacts start to become apparent when as little as 3% to 5% of the watershed is urbanized without adequate runoff controls. These findings have led to the incorporation of a 5% effective impervious area requirement as one element of a prescribed performance standard for land development projects in recently issued MS4 permits in Southern California.

BMPs for controlling stormwater quality and hydrologic impacts from new development and redevelopment projects include site design (LID; smart growth), source control, treatment control, and hydromodification control BMPs. Effective management of wet and dry weather runoff water quality begins with limiting increases in runoff pollutants and flows at the source. Site design and source control BMPs are practices designed to

[3] Schuler, T.R. and H.K. Holland. The Practice of Watershed Protection, The Center for Watershed Protection, 2000.

minimize surface runoff and the introduction of pollutants into runoff. Treatment control BMPs are designed to remove pollutants once they have been mobilized by rainfall and runoff but can also reduce runoff volume. Hydromodification control BMPs are specifically designed to control increases in post-development runoff flows and/or volumes. Hydromodification control can be accomplished with a combination of site design, hydrologic source control, and/or detention.

On April 29, 2008 the Los Angeles Regional Water Quality Control Board (LA Regional Water Board) issued the draft tentative NPDES permit for the Ventura County MS4. This draft permit applies to the Ventura Watershed Protection District, Ventura County, and the 10 incorporated cities within Ventura County. The relevant provision of this draft permit for this discussion is Part 4, Section E, Planning and Land Development Program. Although this provision has multiple requirements for new development and redevelopment, it may be summarized as follows:

- Reduce the effective impervious area to 5% or less of the total project area[4];
- Treat the volume of runoff from the 85th percentile storm event (a minimum of 0.75 inches) and meet the performance standards in the form of effluent limitations noted in attachment C of the draft permit; and
- Install hydromodification controls such that Erosion Potential (Ep) in streams is maintained at a value of 1, unless an alternative value can be shown to be protective.[5]

Similarly, on November 10, 2008 the Santa Ana Regional Water Quality Control Board (Santa Ana Regional Board) issued the draft NPDES permit for Orange County Resources and Development Management Department and the incorporated cities in Orange County that are located within the Santa Ana River watershed. The relevant provision of this draft permit is Section XII, New Development (including Significant Redevelopment). As with the Ventura draft permit, the section is extensive but may be summarized as follows:

- Reduce the effective impervious area to 5% or less of the total project site[6];

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[4] In the draft permit, impervious surfaces may be considered "ineffective" if the storm water runoff is: (1) drained into a vegetated cell, over a vegetated surface, or through a vegetated swale, all having soil characteristics either as native material or amended medium using approved soil engineering techniques; or (2) collected and stored for reuse such as irrigation, or other reuse purpose; or (3) discharged into an infiltration trench or other infiltration system. The draft Ventura Permit does not include sizing criteria for these three options.

[5] The draft Ventura Permit requires the permittees to develop watershed specific Hydromodification Control Plans (HCPs) that establish hydromodification management standards. In the interim, projects that impact less than 50 acres shall implement hydromodification controls such that the 2-year, 24-hour storm event post development peak flow and volume match the pre-development peak flow and volume within 1%. "Pre-developed" is defined in the draft permit as "native vegetation and soils that existed at the site prior to first development."

[6] The pervious areas to which the runoff from the impervious areas are connected should have the capacity to percolate at least the excess runoff volume from a two-year storm event.

- Treat the volume of runoff from the 85th percentile storm event; and
- Evaluate potential for hydromodification impacts and if potential for impacts is identified then implement hydromodification controls to mitigate those impacts. There are no hydromodification impacts if:

    1. The volumes and the time of concentration of storm water runoff for the post-development condition do not exceed those of the pre-development condition for a two-year frequency design storm event by more than 5%; or
    2. All downstream conveyance channels are engineered, hardened and regularly maintained to ensure design flow capacity, and no sensitive stream habitat areas will be affected; or
    3. The total effective impervious area on a site is increased by less than 5% in new development projects; or
    4. The post-development 2-year hydrograph is no more than 10% greater than pre-development hydrograph.

- If a hydrologic condition of concern exists, then the Water Quality Management Plan shall include an evaluation of whether the project will adversely impact downstream erosion, sedimentation or stream habitat. In cases where excess volume cannot be infiltrated or captured and reused, discharge from the site must be limited to a flow rate no greater than 110% of the pre-development 2-year peak flow.

Another relevant effort, mentioned in both the draft April 2008 Ventura Countywide and the November 2008 Orange Countywide NPDES permits, is an ongoing technical study by SCCWRP on the assessment and management of hydromodification effects[7]. The goal of this SCCWRP project is to develop a series of predictive models, applicable to a range of stream types that support implementation of hydromodification management measures. This project will answer the following questions:

1) Which streams are at the greatest risk of hydromodification effects?
2) What are the anticipated effects (in terms of increased erosion, sedimentation, or habitat loss) associated with increases in impervious cover?
3) What are some potential management measures that could be implemented to offset hydromodification effects? How effective are they likely to be?

This SCCWRP project was initiated in 2007 and is anticipated to be completed in 2010.

[7] See: http://www.sccwrp.org/view.php?id=247.

Although slightly different, the two draft permits rely on the use of effective impervious area (EIA) as a key element of the metric to gage the level of implementation of LID strategies.

The Permittees' concerns related to these LID requirements are as follows:

1. The draft permits lack fully integrated and technically sound approaches to stream protection for new development. The separated provisions for LID, treatment controls, and hydromodification controls are disjointed, confusing and in some cases duplicative. These provisions, as written, leave much to the discretion of design engineers and compliance assessment extremely difficult.

2. The draft permits potentially create significant disincentives for redevelopment and smart growth projects. The application of single metrics for all types of development and individual sites (e.g., 5% EIA) in the draft permits work against redevelopment, infill, and smart growth projects, and other mandates, such as AB375, for more sustainable patterns of urban development. Furthermore the cost for complying for redevelopment projects is disproportionately higher than for new development projects.

3. The draft Ventura permit does not account for scale of application. All sites must meet the 5% EIA standard even though this metric was derived from watershed-scale studies[8].

4. The EIA standard may lead to poor LID implementation. Compliance with 5% EIA can be manipulated and not result in the goal of mimicking pre-development hydrology.

5. The requirement for 5% EIA and encouragement of infiltration does not allow considerations of the overall site water balance and could lead to unnatural levels of deeper infiltration. Excessive infiltration could cause groundwater issues, including habitat changes in downstream water bodies that were formerly dry most of the year, raised groundwater levels and associated geotechnical issues, and/or issues with brownfields or naturally occurring pollutants being mobilized (e.g., selenium).

6. Preliminary results of the SCCWRP hydromodification study are available.[9] The project report states that management actions aimed at mitigating the effects of hydromodification will be most effective when tailored to different stream types. One-size-fits-all practices based on "single factor" geomorphology (e.g., a simple erosion index) or extrapolation of impervious area studies across stream types is not

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[8] Stein, Eric D. and Susan Zaleski, 2005. Managing Runoff to Protect Natural Streams: The Latest Developments on Investigation and Management of Hydromodification in California. Southern California Coastal Water Research Project Technical Report 475. December 2005.

[9] Bledsoe, Brian, Robert Hawley, and Eric D. Stein. Stream Channel Classification and Mapping Systems: Implications for Assessing Susceptibility to Hydromodification Effects in Southern California. Southern California Coastal Water Research Project Technical Report 562. April 2008.

likely to protect streams. Tools that account for land use change effects on both the continuous flow regime and sediment delivery are much more likely to manage hydromodification effects on streams in southern California.

7. The EIA metric, though conveniently simple, does not reflect the current understanding of stream dynamics and susceptibility to hydromodification as indicated in current and ongoing research.[10] To protect stream channel geomorphology and habitat, permit standards ideally should reflect channel conditions and rely on channel-related metrics.

In addition to these concerns, any effort to prescribe the implementation of LID must also address the enforceability of design standards, public acceptance, long-term maintenance and operation of numerous small-scale systems, and potential conflict with water conservation goals and broader sustainable development objectives. Another key consideration needs to be the context of the management effort, specifically the beneficial use that can be realized in highly modified stream channels within urbanized floodplains. For the purpose of this white paper, the discussion is focused on EIA requirements and the integration of LID controls, treatment BMPs, and hydromodification controls into one cohesive water quality protection strategy.

III. LID Case Studies

Approach

Three case studies were conducted using actual redevelopment projects to evaluate the feasibility of utilizing landscaping and other LID BMPs, consistent with preserving the fundamental character of the development, while evaluating the effectiveness of such an approach in meeting draft MS4 permit LID BMP performance standards.

The first two case studies (i.e., Walnut Village and 60 California) were completed utilizing the following three performance standards:

1) Reduction of effective impervious area[11] to less than 5%;
2) Retention[12] of the difference between pre-development and post-development runoff volume for the water quality storm (SUSMP) event (i.e., the "delta" WQ volume); or

[10] Roesner and Bledsoe, 2003. Research Needs: Physical Effects of Wet Weather Flows on Aquatic Habitats, WERF; and Pomeroy, Roessner, Coleman, and Ranking, 2008. Protocols for Studying Wet Weather Impacts and Urbanization Patterns, WERF.

[11] As defined by the Ventura County Draft Permit, impervious surfaces may be rendered "ineffective" if the stormwater runoff is: (1) drained into a vegetated cell, over a vegetated surface, or through a vegetated swale, having soil characteristics either as native material or amended medium using approved soil engineering techniques; (2) collected and stored for reuse such as irrigation, or other reuse purpose; or (3) discharged into an infiltration trench. The draft Ventura Permit does not include sizing criteria for these three options.

3) Retention of the difference between pre-development and post-development runoff volume for the 2-year design storm event (i.e. the "delta" 2-year volume).

The first two case studies were completed with the underlying philosophy that for the proposed LID requirements to be implementable, the fundamental character of the development project should not change. The following assumptions were made for these case studies:

1) Site boundaries are fixed and LID requirements cannot be fulfilled on adjacent parcels of land.
2) Building and parking footprints are fixed in size.
3) Limited modifications to site design may be considered feasible if conditions 1 and 2 are met.
4) Pervious pavement constitutes disconnection of that area, but cannot be used in high-traffic areas.
5) Proprietary BMPs do not constitute disconnection of impervious areas unless they incorporate substantial volume-reduction mechanisms.

An additional redevelopment case study of a commercial site in the City of Ventura (i.e., the Kmart site) was conducted. This case study investigated the cost impacts of the following two performance standards:

1) Retention of the difference between pre-development and post-development runoff volume for the water quality storm (SUSMP) event (i.e., the "delta" WQ volume); or
2) Retention of the difference between pre-development and post-development runoff volume for the 2-year design storm event (i.e. the "delta" 2-year volume).

Note that the intent of the third case study was primarily to evaluate the cost of implementing LID BMPs, while the intent of the first two case studies was to evaluate the feasibility and hydrologic effectiveness of various interpretations of the LID BMP performance standards in both draft permits, regardless of the cost to the project.

The following limitations to all three case studies are acknowledged:

- The case studies, as is the case with most investigations of feasibility, relied on subjective assumptions and interpretations which were based on professional judgment; and

[12] Retention is defined as the capture and elimination of stormwater through percolation, evapotranspiration, or use.

- Computational methods used to evaluate effectiveness were simplified, as utilization of complex methods could be interpreted as reducing transparency while increasing the required level of effort.

Case Study Results

The case study results are summarized below. Each case study is presented in its entirety in Attachment A.

Walnut Village

Walnut Village is a 7.6 acre multi-family redevelopment project in the City of Anaheim in Orange County. Proposed development consists of a main building with interior courtyards and two sets of smaller structures. Primary parking is provided below the grade of the large central building with some parking at the surface. The site is bordered on the west and north by a fire access road. Landscaping is generally present as narrow strips along some building edges and around the perimeter of the sites. Except for one vegetated filter strip, the landscaping in the proposed design does not accept runoff from adjacent impervious area.

The project as proposed has a total imperviousness of 84% and an EIA of 76%. Soils at the site are characterized as Class B[13] soils and the site and surrounding area are flat. The water quality design storm depth for this location was estimated to be 0.7 inches and the 2-year storm depth was estimated to be 2 inches.

Reduction of Effective Impervious Area

Modifications to stormwater routing and site design were identified in an attempt to meet the goal of reducing effective impervious area (EIA) to less than 5%. In this effort, it was critical to understand which areas of the site could be made available for vegetated treatment and/or infiltration. Based on site plans, the courtyard areas located over the underground parking structure could not accept runoff from adjacent impervious areas because water could not be infiltrated over the parking structures. Perimeter landscaping was deemed potentially appropriate for infiltration, thus disconnection of impervious area was achieved by routing runoff through these areas. Parking areas, driveways, and fire roads were routed to drain to landscaping where possible. It was assumed that entry driveways represented high traffic areas that would not be suitable for pervious pavement.

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[13] Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. Soil groups do not necessarily correspond to soil types, however, in southern California. Group B is generally consistent with silt loam or loam. It has a moderate infiltration rate when thoroughly wetted.

A reduction from 76% EIA to 18% EIA was achieved by converting passive landscaped areas (those that do not accept runoff from adjacent impervious areas) to active landscaped areas (those that do accept runoff from adjacent impervious areas) and routing rooftop and some parking lot drainage over this area. A reduction to 0% EIA was achieved through converting non-essential hardscape to active landscaping.

Reduction of effective impervious area to less than 5% of the project area appears to be feasible, but in order to achieve this goal, additional active landscaping was created. It is important to note that this conclusion is based on limited available information of site constraints that may not have been evident from project documentation.

To estimate the approximate effectiveness of the disconnection scenarios in retaining stormwater, simple exploratory calculations were used for three levels of implementation:

A. All actively landscaped areas assumed to retain and infiltrate or evapotranspire one inch of water over its surface,
B. Half of the actively landscaped areas assumed to retain and infiltrate or evapotranspire six inches of water over its surface, or
C. All of the actively landscaped areas assumed to retain and infiltrate or evapotranspire six inches of water over its surface.

The results of these calculations, expressed as the amount of runoff retained in a given storm event (in watershed inches), are presented in Table 1 below.

Table 1: Approximate Retention Depth for Various Disconnection Scenarios and Types of Active Landscaping Employed

Disconnection Scenarios		Effective Retention Depth (Watershed Inches)		
		76% EIA	18% EIA	0% EIA
A	1" retention over all active landscape	0.01	0.06	0.08
B	6" retention over half of active landscape	0.04	0.19	0.24
C	6" retention over all active landscape	0.08	0.39	0.47

The depth retained on the site was both a function of the reduction in impervious area and EIA and the increase in depth retained in actively landscaped areas. The results in Table 1 show that an increase from 1 inch retained to 6 inches retained over active landscaping (moving down the columns in Table 1) had a more pronounced effect than reducing the EIA from an easily achieved value (18%) to a more difficult to achieve value (0%) (moving left to right in Table 1). Certainly this result is a function of the cases that were selected, but nonetheless illustrates that LID benefits can be achieved by both extensive implementation (i.e., routing of runoff to vegetated systems) and more intensive design of active landscaping (i.e., greater retention depth) where opportunities exist. A fixed percent EIA LID metric promotes only the former option, but does not address the design of the LID BMP that is being used to disconnect the impervious area, and therefore does not address the different levels of effectiveness that might be achieved for the same % EIA.

Volume Retention Scenarios

Storage volumes required to retain the delta water quality and delta 2-year events were calculated using the methodology contained in the Orange County Drainage Area Management Plan (DAMP). Assumptions and resulting volumes are provided in Table 2 below.

Table 2: Differential Volume of Runoff in WQ and 2-year Storm Event

Storm	Storm Depth (inches)	Imperviousness[1]	Runoff Coefficient[2]	Runoff Depth (watershed inches)	ΔV (watershed inches)
WQ	0.70	0	0.15	0.11	0.45
	0.70	84	0.79	0.55	
2-year	2.05	0	0.15	0.31	1.31
	2.05	84	0.79	1.62	

[1] Imperviousness = 0 in the undeveloped condition and 84% in the post-developed condition.
[2] Table A-1 of OC DAMP, page 7-II-46

The required retention depths over all active landscaping for the delta water quality and delta 2-year events were computed using simplified volumetric routing assumptions and are shown in Table 3 below for two scenarios. Scenario X represents the case where the volumetric retention requirements are provided in active landscaping, while scenario Y represents the case where all pavement is assumed to be pervious pavement (i.e., self-mitigating) and remaining volumetric requirements are provided in active landscaping. An infiltration rate under active landscaping representative of compacted B soils (0.2 inches per hour) was assumed to explore the range of drawdown times that could be expected for the required retention depths.

Table 3: Required Depth of Retention in Active Landscaping to Achieve Volumetric Retention Requirements and Range of Approximate Drawdown Times

Disconnection Scenarios[1]		Required Retention Depth in All Active Landscaping (inches): Delta WQ (0.45 watershed inches)	Required Retention Depth in All Active Landscaping (inches): Delta 2-yr (1.31 watershed inches)	Time to Drain at 0.2 inches per hour[3] (hours)
X	Retention over all Active Landscaping	5.7	16.6	28 – 83
Y	Retention of 0.70 inches over all pavement[2], with remaining volume retained in active landscaping	3.7	14.6	18 – 73

[1] Analysis is for the 0% EIA case, which assumed 8% of the site was active landscaping.
[2] Based on assumption that all paved areas can be designed to be self-mitigating (i.e. pervious pavement) for entire WQ storm; however, pavement does not accept building runoff.
[3] 0.2 inches per hour is at the high end of typically assumed saturated hydraulic conductivity for compacted B soils under long-term operation. Actual infiltration rates must be based on site-specific testing which

was not available for this site. The low end of the reported range is for the Delta WQ volume and the high end is for the Delta 2-yr volume.

The range of required retention depths over the active landscaping shown in Table 3 is not unreasonable, at least to retain the delta water quality volume, but it would require priority to be placed on converting all active landscaping to an LID BMP designed and maintained specifically as a retention facility. However, the 14-17 inches of retention required to capture the delta 2-year volume is much less feasible, as it would require a combination of fairly deep amended soils and significant surface storage. The drawdown time for such a depth is at or above the upper limit of what would typically be allowed for a surface storage facility to avoid vector concerns (72 hrs), which could be mitigated by the storage of some volume in soil pores but indicates that performance would be substantially reduced in sequential storm events. From this calculation, it is also apparent that feasibility is strongly dependent on site-specific infiltration rates. The retention of the lesser delta volume (i.e., Delta WQ) appears to be more feasible, but is also dependent on the ability to make use of all active landscaping for intensive BMPs and the site-specific infiltration rates. In addition, landscape plans typically include features that restrict usage of landscaping for runoff control (e.g., tree choice can limit inundation depths and duration), therefore, it is unreasonable to assume that all landscaping may be available.

60 California

60 California Street is a proposed four-story, multi-use commercial/retail redevelopment project in the City of Ventura in Ventura County. The site encompasses 0.14 acres in the downtown area. Nearly the entire project site is covered by the building roof, with only a negligible buffer around the edges. The surrounding area is highly urbanized and no vegetation exists directly on the site with the exception of two palm trees in planters on the sidewalk. These planters do not accept runoff from the site or the adjacent road. The total project imperviousness and EIA are 100%. Soils at the site are characterized as C soils and the slope of site and surrounding land is approximately 2 percent. The water quality design storm depth was assumed to be 0.75 inches and the 2-year storm depth was estimated to be 2.7 inches.

Reduction of Effective Impervious Area

For this case study, the project land cover and proposed drainage patterns were first identified. Next, opportunities for "disconnection" of impervious area through the use of green roofs and cisterns for reuse were identified. The practicability of meeting the first goal (<5% EIA) was evaluated based on what could be achieved on the site in this manner without changing the fundamental site characteristics. Because the nature of the project is that of a multi-story building built to the lot lines, there is no opportunity to create vegetated areas for infiltration. The volume of cistern storage and effective retention depth of green roofs were computed and evaluated for their reasonableness and probable effectiveness.

Green roofs rely on highly porous media and moisture retention layers to store intercepted precipitation and to support vegetation that can reduce the volume of stormwater runoff via evapotranspiration. As proposed,[14] the building's roof contains several features that limit the spatial applicability of a green roof (e.g., a tower, 2V:1H sloped perimeter). Thus, approximately 4,300 ft^2 of the total 6,200 ft^2 roof is available to support vegetated cover. Runoff from roof area that cannot be covered in green roof would need to be captured through the use of a cistern for reuse in flushing toilets and irrigating indoor plants in the building. Dry wells are also considered an acceptable means to disconnect impervious area, but were not considered to be feasible given the high density of development (dry wells are generally located away from building foundations) and the indication of poor soil infiltration rates (C soils) at the project site. The case study found that a reduction in EIA to less than 5% can be achieved, but with a combination of green roof and cisterns.

Green roofs can be engineered to store a range of precipitation depths through the use of different design features. It is important to note that green roofs do not eliminate volume through infiltration; only through evapotranspiration (ET). Regeneration of storage by means of ET is generally slower than by means of infiltration, indicating that antecedent conditions may be more important for performance of green roofs than for infiltration-based BMPs. Similarly, cisterns may be designed for any volume, but do not infiltrate water; rather water is held for reuse, the rate of which may be the limiting factor in how much water should be stored or the availability of storage during sequential rainfall events.

Reduction of effective impervious area to less than 5% of the project area appears to be feasible if the definition of EIA does not include a volumetric retention requirement to render an area ineffective or the cost implication of the improvements. The retention depth values shown in Table 4 below are based on typical design parameters for green roofs and cisterns, which are BMPs that are generally beyond the level of BMP implementation in common practice in the United States at this time. In order to achieve <5% EIA, rainwater collection and reuse or re-engineering of the building roof to eliminate areas of steep slope would be required. It is important to note that this conclusion is based on limited available information of site constraints that may not have been evident from project documentation.

To estimate the approximate effectiveness of the disconnection scenarios in retaining stormwater, simple exploratory calculations were used for two levels of implementation. Runoff volumes were generated by assuming that all rainfall on rooftops would run off, and were reduced as a function of the type of disconnection implemented. Results are presented as the amount of runoff retained in a given storm event, expressed as watershed inches (Table 4), assuming dry antecedent conditions.

[14] Note, the project consists of construction of a new building; retrofit of green roofs onto existing buildings is a much more challenging proposition.

Table 4: Approximate Retention Depth for Two Disconnection Scenarios

Disconnection Scenarios		Effective Retention Depth (Watershed Inches)		
		100% EIA	31% EIA (no cistern)	3% EIA (Green roof and cistern)
A	0.5 in of retention over green roof	NA – No retention BMPs	0.15	0.27[1]
B	2 in of retention over green roof		0.58	1.08[2]

[1] With 1-500 gallon cistern.
[2] With 1-2,000 gallon cistern.

Table 4 shows that the depth retained on the site due to LID BMPs was dependent on the design criteria selected for the green roofs and cisterns. It was generally difficult to achieve fairly high retention depths within typical ranges of design criteria for these BMPs, especially for Scenario B.

Volume Retention Scenarios

Storage volumes required to retain the delta water quality and delta 2-year events are provided in Table 5 below.

Table 5: Differential Volume of Runoff in WQ and 2-year Storm Event

Storm	Storm Depth (inches)	% Imperv	Runoff Coefficient[1]	Runoff Depth (watershed inches)	ΔV	
					(watershed inches)	(gallons)
WQ	0.75	0	0.15	0.11	0.64	2,550
	0.75	100	1.0	0.75		
2-year	2.7	0	0.15	0.31	2.39	9,530
	2.7	100	1.0	2.7		

[1] Table A-1 of OC DAMP, page 7-II-46; all rainfall on rooftops assumed to run off

To help understand the quantity of storage that would be required to retain the delta volumes, the two scenarios were explored (Table 6).

Table 6: Required Cistern Storage Volume to Achieve Volumetric Retention Requirements

Disconnection Scenarios[1]		Required Cistern Volume (gal)	
		Delta WQ (2,550 gal)	Delta 2-yr (9,530 gal)
X	Green roof retaining 0.5 in of water and remainder captured by cistern.	1,210	8,200
Y	Green roof retaining 2 in of water and remainder captured by cistern.	Cistern not required	4,170

[1] Analysis is for 0% EIA, assuming use of green roof and a cistern.

The range of required storage volumes is not unreasonable but would require that a viable and sufficient demand exists for the stored water and that reuse of stormwater within the buildings would be permitted. An exception is noted for Scenario Y, in which the volume of water stored by the green roof is sufficient to mitigate the delta of the water quality-sized storm and does not rely on storage and reuse.

It is important to note that suitability of both green roofs and storage/reuse systems for southern California is not well understood and there is a lack of test data on long term performance. Generally, during the rainiest times of the year in southern California, the potential evapotranspiration is the lowest, meaning that the ability to regenerate storage capacity between storms is low. During the summer, green roofs would likely need to be irrigated to sustain healthy vegetation and to reduce fire danger. Likewise, irrigation demand for stormwater stored in a cistern is generally highest over the long summer months when limited rainfall is likely to occur. This is not meant to say that the solutions would not work, but that they are possibly not the most climate-appropriate technologies. In addition, their use may conflict with existing building and health codes.

Kmart Site

This case study site is of a former Kmart center located within the City of Ventura. The 12.4 acre site is in a highly urbanized area along South Victoria Avenue and includes a department store, a grocery store, and two restaurants. Currently, the site is covered by building roof and parking lot, with some inactive vegetation (curbed off trees) within the main parking lot.

The focus of this case study was to evaluate the cost of complying with the draft Permit requirement. As the draft Ventura County permit does not include volumetric criteria for the disconnection of impervious area, it was necessary to assume a range of volumetric criteria to render impervious area "ineffective." To facilitate this study, two possible volumetric interpretations of the draft Ventura permit requirement were considered:

- High volume interpretation – the difference between pre-development[15] and post-development runoff for a 3.1-inch storm (2-year, 24-hour rainfall event).
- Low volume interpretation – the difference between pre-development and post-development runoff for a 0.75-inch storm (approximate SUSMP water quality event).

It is recognized that the draft stormwater permit hydrologic controls are related to other drainage controls set by county or cities for the rarer, but larger runoff and flood events. For this case study, drainage/flood control and water quality BMPs were assumed to be the same for both scenarios and no cost was assigned to them. This assumption means that the cost developed for the low volume retention scenario would need to be increased to account for appropriately sized treatment BMPs, and potentially hydromodification controls, whereas the high volume retention scenario would have already fulfilled treatment requirements and potential hydromodification requirements.

[15] Consistent with Draft Ventura County permit language, "pre-development conditions" were assumed to refer to the site condition prior to any development.

The case study included estimating required detention volume, selecting and sizing LID BMPs, and estimating the order of magnitude lifecycle costs. These costs are also compared to a range of potential site redevelopment costs to provide prospective on the total cost of redevelopment. The BMP sizing and cost results are developed to provide a practical example to evaluate the draft permit requirements.

Estimates of runoff volume in pre-development and post-development conditions were developed using the NRCS Curve Number Method for both design storm scenarios. The differences or "delta" of these volumes are shown in Table 7 below.

Table 7: Runoff Estimates from Kmart Site[1]

Permit Interpretation	Design Storm (inches per 24-hour)	Pre-Development[2] Runoff (Ac-Ft[3])	Post-development Runoff (Ac-Ft)	Delta Volume: BMP Criteria (Ac-Ft)
High Volume	3.1	0.41	2.38	1.97
Low Volume	0.75	0.00	0.32	0.32

Notes:

1. Total site area equal 12.4 acres.
2. Pre-development = native vegetation and soils that existed prior to the first development
3. Ac-Ft = Acre-feet

LID BMPs were selected to treat the "delta" volume in both design storm scenarios assuming the LID BMP would control the draft permit hydromodification volume in a treatment train approach: vegetated filter strips followed by aggregate-filled infiltration trenches. For the low volume interpretation, it was assumed that a 1-foot wide filter strip would be provided prior to water entering the ribbon drains. For the high volume interpretation of LID requirements, it was assumed that filter strips would be sized to 5 percent of the tributary impervious area, yielding filter strips approximately 25 feet wide, collecting runoff prior to flowing into the infiltration trenches. It was assumed for this case study that infiltration trenches would be designed to drain in 72 hours into Ventura County Soil Type 3 (NRCS Category C) soils with a Ventura County standard infiltration rate of 0.5 inches per hour. This infiltration rate is the minimum for infiltration trenches. Assuming an aggregate porosity of 0.35, a trench depth of 8 feet, for the high volume interpretation, two basins were sized, one 600 feet long and 42 feet wide, the other 290 feet long and 18.5 feet wide. The low volume interpretation required an 8 foot deep basin 900 feet long and 5.5 feet wide. The project could also comply with LID criteria by using a variety of BMPs such as tree boxes, bioretention, pervious pavement, and other LID BMPs, however, the filter strip/infiltration trench treatment train was assumed based on its simplicity and suitability for a constrained commercial site.

The present worth cost estimates for the two volume retention scenarios ranged from approximately $17,000 per acre to $100,000 per acre for the 12.4 acre site (Table 8). For the high volume interpretation, 1.9 watershed inches (1.97 Ac-Ft) of water would need to be infiltrated. The LID BMPs for this scenario occupied 10 percent of the site; the filter strips covered approximately 5 percent of the site and the infiltration trenches covered approximately 5 percent of the site. Under the low volume interpretation of LID requirements, 0.3 watershed inches (0.32 Ac-Ft) would need to be infiltrated. The LID BMPs for this scenario included an approximately one-foot wide vegetated filter strip placed along the drainage collection features of the site and infiltration trenches covering approximately 1 percent of the project site. The cost results presented in Table 8 are approximate and should be considered as an order-of-magnitude, relative comparison based on engineering experience and limited field data.

Table 8: Present Worth Cost Comparison of Kmart Case Study

Case Study	Proposed Permit Costs[1]	% of Total Redevelopment Cost[2]
High volume interpretation (2-year storm)	$1,290,000	4 – 22%
Low volume interpretation (0.75-inch storm)	$208,000	1 – 3%

[1] LID BMP Costs are developed as 20-year present worth (lifecycle) costs using a 4 percent interest rate.
[2] Assuming other present worth costs of redevelopment range from $6 million to $32 million

Case Studies Conclusions

The following conclusions can be drawn from the case studies:

- In all of the case studies, it was possible to achieve less than 5% EIA based on the criteria provided in the draft Ventura Countywide permit that defines under what conditions imperviousness may be assumed to be disconnected. It is important to note that such conditions do not define engineering sizing criteria.
- The lack of a sizing criteria in the definition of EIA in the draft Ventura Countywide permit resulted in a wide range of possible interpretations, effectiveness (measured as retained runoff volume), and costs. In fact, the first case study (Table 1) showed that a site with an EIA of 18% could be designed to retain more runoff than a site with an EIA of 0%.
- An EIA criterion coupled with a volumetric matching requirement is a much more difficult performance standard to meet as it requires a focused effort to design retention BMPs for a large portion of the project area.
- The same or better hydrologic effectiveness (reduction in runoff volume) may be achieved through more intensive application of LID BMPs where opportunities exist, compared to a scenario in which LID features are spread more extensively throughout the project site, but with less emphasis on volumetric retention. For example, the first case study (Table 1) showed that 6 inch retention over all the active landscape area with 76% EIA provided the same runoff volume retention as 1 inch retention over all the active landscape area with 0% EIA. Therefore, if reduction in runoff volume is the desired outcome, a volumetric reduction standard would be more constructive than a % EIA standard.
- The feasibility of retaining the delta runoff volume on site in landscaped areas is highly dependent on the site-specific infiltration rate.

- Retention of the delta WQ storm volume is more feasible than the delta 2-year volume.
- The 60 California case study showed that it was possible to achieve less than 5% EIA in a downtown redevelopment scenario, but required use of LID BMPs such as green roofs and large volume cisterns due to typical high density downtown redevelopment site constraints. However, this case study did not consider cost implications.
- It is clear from the Kmart case study cost estimates that the proposed draft permit requirements would significantly increase the drainage costs of urban redevelopment projects. The LID BMP costs of the high volume interpretation would challenge the feasibility of the project, being as much as 22% of the total cost. The low volume interpretation could be as much as 3% of the total cost although this estimate does not include the cost for complying with the treatment and hydromodification controls.
- It is also clear from the Kmart case study that the ability to implement LID BMPs on the site without substantially reducing the developable area is dependent on the volumetric criterion that is selected. In the high volume scenario, a significant amount of area (approximately 10 percent of the site) was required for LID BMPs, while in the low volume scenario, the area requirements were less.

IV. Alternative Metrics Currently Used in Other Jurisdictions for LID Implementation

Representative MS4 permits within California and other key states were reviewed for alternative approaches to regulating low impact design and hydromodification. In addition, LID implementation and hydromodification control metrics that have been adopted by jurisdictions via ordinance, guidance, or technical manuals were reviewed. The discussion below summarizes the findings of this review.

Example LID and Hydromodification Performance Standards

In the course of our research, many MS4 permit language examples were obtained. A summary of the LID and hydromodification control performance standards from these various MS4 permits is provided in Table 9 below. A summary of example LID implementation and hydromodification control requirements that have been adopted by jurisdictions via ordinance, guidance, or technical manuals is provided in Table 10 below.

Additional details are provided in Attachment B.

Table 9: Comparison of LID and Hydromodification Performance Standards in Various Stormwater Permits

Regulatory Program	LID Performance Standard	Hydromodification Control Performance Standard	Type of Performance Standard	
			LID	Hydromodification
Washington State Phase I and Phase II Permits (Stormwater Management Manual for Western WA) (February 2005)	1. Infiltrate, disperse, and retain stormwater runoff onsite to the maximum extent feasible without causing flooding or erosion impacts. 2. Roof downspout control BMPs, dispersion, and soil quality BMPs required.	1. Match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. 2. Standard requirement is waived for sites that will reliably infiltrate all the runoff from impervious surfaces and converted pervious surfaces.	Narrative and prescriptive site design/LID BMP requirements with no LID metric	Flow duration control
San Diego MS4 Permit (January 2007) and Interim HMP Standard (October 2007)	1. Drain a portion of impervious areas into pervious areas prior to discharge to the MS4. The amount of runoff from impervious areas that is to drain to pervious areas shall correspond with the total capacity of the project's pervious areas to infiltrate or treat runoff, taking into consideration the pervious areas' soil conditions, slope, and other pertinent factors. 2. Properly design and construct the pervious areas to effectively receive and infiltrate or treat runoff from impervious areas, taking into consideration the pervious areas' soil conditions, slope, and other pertinent factors. 3. Construct a portion of walkways,	1. For flow rates from 20% of the pre-project 5-year runoff event (0.2Q5) to the pre-project 10-year runoff event (Q10), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10% over more than 10% of the length of the flow duration curve. 2. For flow rates from 0.2Q5 to Q5, the post-project peak flows shall not exceed pre-project peak flows. For flow rates from Q5 to Q10, post-project peak flows may exceed pre-project flows by up to 10% for a 1-year frequency interval. For example, post-project flows could exceed pre-project flows by up to 10% for the interval	Prescriptive site design/LID BMP requirements with no LID metric	Flow duration control

Regulatory Program	LID Performance Standard	Hydromodification Control Performance Standard	Type of Performance Standard	
			LID	Hydromodification
	trails, overflow parking lots, alleys, or other low-traffic areas with permeable surfaces, such as pervious concrete, porous asphalt, unit pavers, and granular materials.	from Q9 to Q10 or from Q5.5 to Q6.5, but not from Q8 to Q10. 3. LID may be implemented to manage hydromodification impacts, using design procedures, criteria, and sizing factors (ratios of LID BMP volume or area to tributary area) specified by the Co-permittees. The Co-permittees' LID BMP designs and sizing factors shall be determined using continuous simulation of runoff from a long-term rainfall record.		
Draft San Francisco Bay Area Municipal Regional NPDES Permit (December 2007)	1. Drain a portion of impervious areas into pervious areas prior to discharge to the MS4. The amount of runoff from impervious areas that is to drain to pervious areas shall correspond with the total capacity of the project's pervious areas to infiltrate or treat runoff, taking into consideration the pervious-areas' soil conditions, slope, and other pertinent factors. 2. Properly design and construct the pervious areas to effectively receive and infiltrate or treat runoff from impervious areas, taking into consideration the pervious areas' soil conditions, slope, and other pertinent factors.	1. Ep = 1.0. Match flow rates and durations from a critical low flow of 10% of Q2 up to the pre-project 10-yr peak flow.	Prescriptive site design/LID BMP requirements with no LID metric	Erosion Potential and Flow duration control

Regulatory Program	LID Performance Standard	Hydromodification Control Performance Standard	Type of Performance Standard	
			LID	Hydromodification
	3. Construct a portion of walkways, trails, overflow parking lots, alleys, or other low-traffic areas with permeable surfaces, such as pervious concrete, porous asphalt, unit pavers, and granular materials.			
Sacramento MS4 Permit (September 2008)	1. Consider and incorporate all appropriate and applicable LID components and measures that have been successfully and effectively implemented in other municipal areas.	1. Hydromodification Management Plan shall require controls to manage the increases in the magnitude (e.g., flow control), frequency, volume and duration of runoff.	Narrative	Narrative. No numeric requirements
Central Coast Regional Board Phase II Permit SWMP Notification Letter (February 2008)	1. Minimum 30-ft buffer zone for riparian areas and wetlands. 2. Watershed-based Hydromodification Management Plans should incorporate LID strategies to achieve an EIA of 3% - 10% of watershed area.	1. All projects: ≤5% EIA. 2. Projects that add and/or replace 5,000 sf impervious area: match post-construction hydrograph to the undeveloped hydrograph within 1% for a range of events with return periods from 1-yr to 10-yrs. 3. Project > 2 acres: preserve pre-construction drainage density (miles of stream length/square miles of watershed) for all drainage areas serving a 1st order stream[16] or larger and post-project time of concentration ≥ pre-project time of concentration.	Prescriptive site design/LID BMP requirements and EIA limit	EIA limit, match hydrograph, and match drainage density and time of concentration.

[16] A first order stream is defined as a stream with no tributaries.

Regulatory Program	LID Performance Standard	Hydromodification Control Performance Standard	Type of Performance Standard	
			LID	Hydromodification
Draft West Virginia Phase II Permit (August 2008)	1. Develop quantifiable objectives, with a time frame for achieving them, for eight watershed elements. 2. Infiltrate, evapotranspirate, and reuse the first 1 in of rainfall from a 24-hr storm preceded by 48 hrs of no measurable precipitation. This first 1 in of rainfall must be 100% managed with no discharge to surface waters. 3. A reduction of 0.1 in from the 1 in infiltration/ evapotranspiration/ reuse standard may be applied to any of the following types of development. Reductions are additive such that a maximum reduction of 0.5 inch is possible for a project that meets all five criteria: a) Redevelopment b) Brownfield redevelopment c) High density (>7 units per acre) d) Vertical Density, (Floor to Area Ratio (FAR) of 2 or >18 units per acre) e) Mixed use and Transit Oriented Development (within ½ mile of transit)	1. "Hydromodification" is included in the definitions, but no specific performance standard is included in the draft permit.	Prescriptive site design/LID BMP requirements and volume retention standard. Allowance for reduction in volume retention standard for infill/ redevelopment/ Smart Growth	N/A

Regulatory Program	LID Performance Standard	Hydromodification Control Performance Standard	Type of Performance Standard	
			LID	Hydromodification
	4. For projects that cannot meet 100% of the infiltration/ evapotranspiration/reuse requirement on-site, two alternatives are available: off-site mitigation and payment in lieu. 5. These alternatives are only available, in combination or alone, for up to 0.4 in of the original obligation at a 1:1.5 ratio, i.e., mitigation or payment in lieu must be for 1.5 times the amount of stormwater not managed on site.			
Draft SWRCB Construction General Permit (March 2008)	1. Runoff volume from 85th percentile storm event ≤ pre-project runoff volume.	1. Post-project time of concentration ≥ pre-project time of concentration. 2. Preserve pre-project drainage density.	Match runoff volume	Match drainage density and time of concentration

Table 10: Comparison of LID and Hydromodification Requirements Adopted by Jurisdictions

Jurisdiction	LID Requirements	Hydromodification Control Requirements	Type of Performance Standard	
			LID	Hydromodification
Pierce County, WA Stormwater Management & Site Development Manual (2005)	1. Retain 65% of the site in open space or natural resource protection areas where feasible. 2. Within the County's Urban Growth Area, when retention of 65% native vegetation cannot be achieved, residential LID projects shall retain a minimum of 50% native soil/vegetation protection areas and provide specified BMPs. 3. Commercial and industrial LID projects shall retain a minimum of 25% native soil/vegetation protection areas and provide specified BMPs. 4. The required order of preference for LID BMP selection: • Infiltrate where Type A and B soil exists. • Bioretention areas (rain gardens) or vegetated channels designed with detention (Type C and D soils). • Dispersion techniques for roof runoff to rain gardens. • Dispersion of road runoff into natural resource protection areas down gradient of the road.	1. Match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. 2. The definition of the pre-developed condition is the native vegetation and soils that existed on the site prior to 1800 A.D.	Volume reduction with sizing metric related to site design and water quality storm. Sliding scale for maximum impervious area based on project type	Flow duration control

Jurisdiction	LID Requirements	Hydromodification Control Requirements	Type of Performance Standard	
			LID	Hydromodification
	• Pervious pavements outside the traveled lane, within driveways, and within parking stalls. • More conventional collection, conveyance, and detention methods.			
Draft Etowah Aquatic Habitat Conservation Plan (December 2007)	1. Priority 1: Runoff volume from 2-yr/24-hr event ≤ pre-development (forested) runoff volume for 2 – yr/24-hr event 2. Priority 2: Runoff volume from 2-yr/24-hr event ≤ pre-development 95% forested + 5% impervious runoff volume for 2 –yr/24-hr event 3. Development nodes: Runoff volume ≤ volume from project site with 50% less impervious area.	1. Preservation, restoration and/or reforestation (with native vegetation) of any stream buffers protected through other regulations; and 2. Erosion prevention measures such as energy dissipation and velocity control; and 3. 24-hour extended detention storage of the 1-year, 24-hour return frequency storm event. This requirement may be reduced or waived through the use of other structural and nonstructural measures that allow for infiltration of runoff. The storage volume may be reduced by the volume that is infiltrated.	Match runoff volume with a sliding scale based on protection of endangered species (i.e. Priority 1 – most sensitive species present to Priority 3 – no endangered species present).	Match peak flow
City of Santa Barbara (June 2008)	Small Projects: 1. Voluntary use of basic LID options. Medium Projects: 2. Mandatory use of basic LID options.	Large Projects: 1. Post-project peak flow rate ≤ pre-development peak flow rate for 2, 5, 10, and 25-yr/24-hr events	Prescriptive site design/LID BMP requirements and volume retention standard.	Match peak flow

Jurisdiction	LID Requirements	Hydromodification Control Requirements	Type of Performance Standard	
			LID	Hydromodification
	Large Projects: 1. Runoff volume from 25-yr/24-hr event ≤ pre-development runoff volume for 25-yr/24-hr event, or 2. Runoff volume from one-inch/24-hr storm event, whichever is larger			
County of Los Angeles Department of Public Works Draft Low Impact Development Standards Manual (December 2008)	Single Family Residential <5 Units: 1. Install a minimum of 2 LID BMPs from a list provided in the manual. Non-Residential or Residential ≥ 5 units: 1. First preference is to infiltrate the difference in the post-project SUSMP design storm runoff volume and the undeveloped SUSMP design storm runoff (ΔV). 2. Second preference is to store and reuse ΔV. 3. Third preference is to treat ΔV and release slowly (detention). 4. If the Director of Public Works determines that compliance with the above 3 LID requirements is technically infeasible, the applicant shall submit a proposal for approval by the Director that incorporates design features	1. Match the flow velocity, flow volume, and depth/width of flow for the SUSMP, LID, 2, 5, 10, 25, and 50-year storm events. 2. Conduct sediment transport analysis to determine long-term impacts of streambed accretion and degradation for major drainages.	Prescriptive site design/LID BMP requirements and volume retention or detention standard.	Match peak flow, volume, and depth/width of flow, consider reduction in sediment supply

Jurisdiction	LID Requirements	Hydromodification Control Requirements	Type of Performance Standard	
			LID	Hydromodification
	demonstrating compliance with the LID requirements to the maximum extent practicable.			
Contra Costa County Clean Water Program C.3. Guidebook (September 2008)	1. The CCCWP's LID design guidance (Chapter 4 of the Guidebook) was crafted to ensure LID facilities comply with the NPDES permit's hydraulic sizing requirements for stormwater treatment facilities and flow control facilities. 2. Self-retaining areas are designed to retain the first one inch of rainfall without producing any runoff. 3. Drainage from roofs and paving can be directed to self-retaining areas. The maximum ratios are 2 parts impervious: 1 pervious (treatment only) or 1 part impervious: 1 pervious (treatment and flow control).	1. Show no increase in impervious area and no increase in efficiency of drainage collection and conveyance. 2. Use the design procedures and design criteria in the Guidebook, and the Program's sizing tool, to select and size BMPs for flow control (also meets treatment requirements). 3. Use a continuous-simulation model and 30 years or more of hourly rainfall data to simulate pre-project and post-project runoff, including the effect of proposed control facilities to show that post-project runoff does not exceed pre-project rates and durations. 4. Show that all downstream channels between the project site and the Bay/Delta are enclosed pipes, are engineered hardened channels, are subject to tidal action, or are aggrading. 5. Propose and implement appropriate in-stream restoration projects to fully mitigate potential risk.	Sizing metric for BMPs included in manual to meet water quality and/or hydromodification control standard. Volume retention standard for self-retaining areas.	Flow duration control

The example LID performance standards listed in Table 9 and Table 10 above generally fall into one (or a combination) of the following two general categories:

1. *Prescriptive site design and LID BMP requirements with no metric.* Examples of this approach include the Stormwater Management Manual for Western Washington, San Diego MS4 Permit, and Draft San Francisco Bay Area Municipal Regional NPDES Permit. Narrative site design and LID BMP performance standards are included, with some specific BMPs required, typically to the "maximum extent practicable."

2. *Site design and LID BMP requirements with metrics.* The Pierce County Stormwater Management & Site Development Manual provides an example of a sizing metric related to site design (e.g., retain 65% of the site in open space or natural resource protection areas where feasible). Several of the examples incorporate metrics based on volume reduction (e.g., infiltrate, evapotranspire, or reuse the first one inch of rainfall). The Central Coast Regional Board Phase II Permit SWMP Notification Letter incorporates an LID performance standard based on limiting effective impervious area at the watershed scale related to hydromodification control.

Note that none of the example LID performance standards listed in Table 9 and Table 10 included a requirement for 5% EIA at the project level. Also note, the following statement from the State Water Resources Control Board[17]:

> "... existing development exerts a tremendous pollution impact largely due to the resulting, developed landscape and its associated runoff characteristics. Addressing it by matching pre-development hydrology may not always be possible because many urban areas lack land for stormwater control and natural hydrology has been altered so significantly. **In these instances, the urban stormwater regulations in Portland and Washington, D.C. that require volume retention can serve as appropriate models. (emphasis added)"**

A feature that is common to several of the example performance standards and requirements are recognition of site conditions that limit the feasibility of implementing infiltration (e.g., the San Diego MS4 Permit, the Draft San Francisco Bay Area Municipal Regional NPDES Permit, and the County of Los Angeles Department of Public Works Low Impact Development Standards Manual). These standards and requirements generally allow for use of other types of site design and LID BMPs in these circumstances.

One of the more interesting approaches is the draft West Virginia Phase II Permit LID performance standard, which incorporates a metric that allows for a credit in the volumetric reduction standard for redevelopment projects, brownfield redevelopment,

[17] *A Review of Low Impact Development Policies: Removing Institutional Barriers To Adoption.* Commissioned and sponsored by the California State Water Resources Control Board Stormwater Program and The Water Board Academy. December 2007.

high density projects, mixed use projects, and transit oriented development (within ½ mile of transit). Also, two alternatives are available for projects that cannot meet the onsite infiltration/evapotranspiration/reuse volumetric requirement: 1) off-site mitigation, and 2) payment in lieu. Both of these off-site options require a ratio of 1:1.5 of the original volumetric obligation to the off-site mitigation, and cap the total amount of off-site mitigation that is allowable to a fraction of the total obligation.

The draft Etowah Aquatic Habitat Conservation Plan (HCP) is an example of a watershed specific study that was prepared by a group of jurisdictions to mitigate take of three species listed under the Endangered Species Act. The stormwater management policy of the Etowah Aquatic HCP is centered around a stormwater ordinance that includes performance standards for water quality protection, stream channel protection, and flood protection. In addition, the Etowah Aquatic HCP stormwater ordinance includes a performance standard that limits the volume of runoff in areas most critical to the survival of the fish species covered under the Etowah Aquatic HCP. The areas where the Runoff Limits apply are known as Priority Area 1 and Priority Area 2. Priority Area 1 is home to the most sensitive species protected by the HCP and so has the most restrictive standard. Priority Area 2 supports species that are less sensitive and has a less restrictive standard. Parts of the Upper Etowah that do not currently provide essential habitat to any imperiled fish are classified as Priority Area 3 and are not subject to the Runoff Limits.

V. Land Development Performance Standard

Overview of Use of EIA as a Metric

Effective impervious area as a metric for LID BMP implementation has serious limitations, however, the use of EIA as a planning principle may be relevant to overall watershed protection goals. In 2003, the Water Environment Research Foundation published a report entitled "Physical Effects of Wet Weather Flows on Aquatic Habitats: Present Knowledge and Research Needs"[18]. This report emphasized the limitations of current attempts to link stream impacts to gross measures of development such as imperviousness, observing that these measures provide little meaningful information to understand key processes and to create practical strategies for mitigation. The authors contended that conveyance and storage facilities in urban drainage systems exert a strong influence on runoff hydrology, but this fact is not recognized in studies that attempt to relate stream impacts to gross imperviousness only. They stressed that predictive models of reach-scale habitat changes must account for the connectivity and conveyance of the drainage system and relevant stormwater controls. Moreover, more recent research on the effects of development on aquatic habitat indicate that the preferred metrics rely on hydrologic measures that reflect the watershed response to not only changes in imperviousness, but effects of the drainage infrastructure and stream conditions.[19]

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[18] Roesner, L.A., and Bledsoe, B.P., 2003. Physical Effects of Wet Weather Flows on Aquatic Habitats: Present Knowledge and Research Needs, Water Environment Research Foundation, 00-WSM-4.
[19] Protocols for Studying Wet Weather Impacts and Urbanization Patterns. Water Environment Research Foundation 03WSM3, 2008.

Per Schueler's *Cautionary Note*[20], while the research on impervious cover and stream quality is compelling, it is doubtful whether it can serve as the sole foundation for legally defensible regulatory actions at this time. Key reasons include: 1) the research has not been standardized, so different investigators have used different methods to define and measure/estimate imperviousness; 2) researchers have employed a wide number of techniques to measure stream quality characteristics that are not always comparable to each other; 3) most of the studies have been confined to a few ecoregions, and few studies have been conducted in California; 4) the absolute measure of watershed imperviousness that could cause stream instability depends on many factors, including watershed area, land cover, vegetative cover, topography, and soil type; development impervious area and connectedness; longitudinal slope of the river; channel geometry; and local boundary materials, such as bed and bank material properties and vegetation characteristics; and 5) none of the studies has yet examined the effect of widespread application of stormwater treatment, LID controls and/or hydromodification control practices on impervious cover/stream quality relationships.

Proposed Land Development Performance Standard

LID Controls

The following approach to establishing a reasonable, quantitative LID metric is suggested based on our case study analysis and review of alternative LID MS4 performance standards and requirements for new development and redevelopment.

STEP 1 – SITE DESIGN PLANNING PRINCIPLES. Technical literature and policy studies conducted to date unanimously conclude that to effectively implement site design and LID BMP techniques, regulatory and management strategies must be developed for, and integrated into, project planning, design and environmental review phases and processes. Planning principles for controlling the adverse effects of new development and significant redevelopment emphasize the need to address potential impacts in the earliest stages of the development planning process, namely during the site assessment, site planning and layout, vegetation planning, and grading planning stages.

Preliminary and final project plan submittals prepared for priority projects should integrate site design strategies and LID BMPs into project design to infiltrate, disperse, and retain runoff onsite to the extent technically feasible and appropriate. In determining the degree to which site design strategies and LID BMPs must be implemented, it is appropriate for projects to consider the scale of development, site planning BMPs employed, and volume and flow controls achieved by other BMPs and measures implemented for a project area, including, without limitation, regional, subregional and site-specific treatment control, hydromodification, and LID measures and BMPs. Permittees should incorporate a site design planning principle to achieve an effective impervious area of no more than 5% of watershed area, depending on local conditions. Local conditions are particularly important in highly urbanized areas with improved

[20] Schueler, Thomas R. and Heather K. Holland, 2000. The Practice of Watershed Protection, Article 1, "The Importance of Imperviousness", pp. 7 – 18.

drainage channels, in which case the use of EIA as a site design planning principle is less effective and relevant.

The following site design planning principles should be implemented for each project at the applicable project planning scale (Master Planned Community/Tract Map or Project Site) unless shown to be infeasible or inappropriate given applicable goals and constraints:

1. Master Planned Community/Tract Map Site Design Measures

   (a) Cluster development to preserve open space.

   (b) Provide riparian buffers.

   (c) Preserve and/or restore and enhance natural slopes and native vegetation on slopes adjacent to natural drainage systems.

   (d) Minimize impervious areas by incorporating open space and/or parks.

   (e) Locate development on least infiltrative soils.

   (f) Utilize infiltration properties of sandy soils for groundwater recharge when migrating pollutants or groundwater levels are not a problem.

   (g) In areas not subject to mass grading, delineate and flag the smallest site disturbance area possible and restrict temporary storage of construction equipment in these areas to minimize soil compaction.

   (h) Use vegetated or infiltration-based treatment control and/or hydromodification control BMPs.

   (i) Construct streets, sidewalks, and parking lot aisles to the minimum widths specified in the land use code and in compliance with regulations for the Americans with Disabilities Act (ADA) and safety requirements for fire and emergency vehicle access.

   (j) Construct trails with open-jointed paving materials, granular materials, or other pervious materials, in compliance with regulations for ADA and safety requirements for fire and emergency vehicle access.

   (k) Use native and/or non-native/non-invasive, climate-appropriate landscaping vegetation that requires less watering and chemical application.

   (l) Use efficient irrigation technologies and centralized irrigation controls for landscape watering in common areas, commercial areas, multiple family residential areas, and parks.

   (m) Identify potential water reuse options.

2. Project-level Site Design Measures

   (a) Drain impervious areas into pervious areas prior to discharge to the MS4. The amount of runoff from impervious areas that is to drain to pervious areas shall correspond with the total capacity of the project's pervious areas to infiltrate or treat runoff, taking into consideration the pervious areas' soil conditions, slope, and other pertinent factors.

(b) Properly design and construct the pervious areas to effectively receive and infiltrate or treat runoff from impervious areas, taking into consideration the pervious areas' soil conditions, slope, and other pertinent factors..

(c) Use vegetated or infiltration-based treatment control and/or hydromodification control BMPs.

(d) Use efficient irrigation technologies for landscape watering.

(e) Do not use copper or zinc building materials for roof gutters and downspouts.

STEP 2 – LID BMP PERFORMANCE STANDARD. Priority projects should prioritize the selection of LID BMPs to remove stormwater pollutants, reduce stormwater runoff volume, and promote groundwater infiltration and stormwater reuse in an integrated approach to protecting water quality and managing water resources. One or a combination of the three LID BMP options listed below should be implemented. The order of preference is for options 1 and 2 first (with equivalent preference), and option 3 second.

LID BMP options include:

1. BMPs that promote infiltration.
2. BMPs that store and reuse stormwater runoff.
3. BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs which percolate runoff through engineered soil and allow it to discharge downstream slowly.

The LID BMP(s) should be sized, at a minimum, to infiltrate, evapotranspire, reuse, or collect and detain the LID design runoff volume, which is defined as the excess runoff[21] from the water quality design storm event. It is recognized that LID BMPs may be sized to provide treatment control and/or hydromodification control in addition to meeting the LID performance standard, as applicable and feasible.

If a priority project is not able to implement one of the above three LID BMP requirements due to technically infeasibility, in whole or in part, the priority project should incorporate design features demonstrating compliance with the LID BMP requirements to the maximum extent practicable.

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[21] Excess storm water runoff = volume of post-development runoff minus pre-development runoff for the 85th percentile storm event (or equivalent water quality design event).

LID BMP Options

LID BMP Option 1: BMPs that Promote Infiltration and Groundwater Recharge. Infiltrate stormwater runoff throughout the project site where possible. This can be accomplished on a lot-by-lot, subregional, and/or regional scale.

Infiltration may not be possible in all development scenarios. Exceptions may include, but are not limited to, the following:

- Locations where seasonal high groundwater is within 10 feet of the surface.
- Within 100 feet of a water supply well.
- Brownfield development sites or other locations where pollutant mobilization is a documented concern.
- Locations with potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations with soil infiltration rates that do not support infiltration-based BMPs.[22]
- Locations where excessive infiltration to groundwater could cause adverse biological impacts to hydraulically connected ephemeral or intermittent natural drainage courses.
- Development projects in which the use of infiltration BMPs would conflict with local ordinances and building codes.
- Locations where excessive infiltration could cause health and safety concerns.

LID BMP Option 2: BMPs that Store and Reuse Stormwater Runoff. Store and reuse stormwater runoff. Storage and reuse of the LID design volume may not be possible in all development scenarios. Exceptions may include but are not limited to the following:

- Projects that would not provide sufficient irrigation demand or (where permitted) domestic grey water demand for use of stored runoff due to limited landscaping or extensive use of low water use plant palettes in landscaped areas.
- Projects that are required to use reclaimed water for irrigation of landscaping.
- Development projects in which the storage and reuse of stormwater runoff would conflict with local, state or federal ordinances or building codes.
- Locations where storage facilities would cause potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations where storage and reuse could cause health and safety concerns.

LID BMP Option 3: BMPs that Incorporate Vegetation. LID BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction, integrate multiple

[22] Infiltration should be regarded with caution in soils with an infiltration rate less than 0.5 inches per hour.

uses and/or BMPs which percolate runoff through engineered soil and allow it to discharge downstream slowly shall be implemented. These LID BMPs shall be sized to collect and detain the LID design. These LID BMPs include, but are not limited to. bioretention with underdrains, dry extended detention basins, constructed wetlands, green roofs, planter boxes, sand filters, vegetated buffers, vegetated swales, and wetponds.

Redevelopment and Infill Projects

To promote redevelopment and infill projects, it is recommended that a credit system be established such as a reduction of 0.15 inch from the LID design runoff volume that would be applied to any of the following types of projects. Reductions are additive such that a maximum reduction of 0.65 inch is possible for a project that meets all five criteria:

a) Redevelopment
b) Brownfield redevelopment
c) High density (>7 units per acre)
d) Vertical Density, (Floor to Area Ratio (FAR) of 2 or >18 units per acre)
e) Mixed use and Transit Oriented Development (within ½ mile of transit)

LID Implementation

Compliance with the LID BMP requirements may not be feasible in all development scenarios. In these situations, the priority project shall demonstrate the infeasibility of compliance with the LID requirements in the project report submittal to the satisfaction of the permittee. The LID goal of mimicking natural hydrology by increasing groundwater recharge, enhancing water quality, and preventing degradation to downstream natural drainage courses should be used in the evaluation, approval, and implementation of alternative BMPs, as well as any determination of infeasibility.

Priority projects that cannot meet the LID BMP performance standard onsite shall incorporate design features demonstrating compliance with the LID BMP requirements to the maximum extent practicable.

Priority projects that infiltrate, evapotranspire, reuse, or collect and detain less than the LID design runoff volume onsite (even after the application of redevelopment credits) should mitigate the remaining LID design runoff volume either with off-site mitigation or via payment in lieu. The permittee must develop and fairly apply criteria for determining the circumstances under which these alternatives would be available. A determination that standards cannot be met on site may not be based solely on the difficulty or cost of implementing measures, but must include multiple criteria that would rule out an adequate combination of infiltration, evapotranspiration, reuse, and detention.

Off-site mitigation or payment in lieu, in combination or alone, should meet the original obligation. For either of these options to be available, the permittee must create an inventory of appropriate mitigation projects, and develop appropriate institutional standards and management systems to value, evaluate and track transactions.

Off-site mitigation. LID BMPs may be implemented at another location in the same or equivalent sewershed/watershed as the original project, approved by the permittee. The permittee should identify priority areas within the sewershed/watershed in which mitigation projects can be completed. Mitigation must be for retrofit or redevelopment projects, and cannot be applied to new development.

Payment in lieu. Payment in lieu may be made to the permittee, who will apply the funds to a public stormwater project.

Treatment Control

Consistent with the current draft permit requirements, it is recommended that treatment control BMPs be designed and implemented for the remaining water quality volume or flow not already addressed by LID BMPs.

Hydromodification Control

Until such time that the Southern California Storm Water Monitoring Coalition (SMC) completes the Hydromodification Control Study, an interim hydromodification control criterion to protect natural drainage systems[23] is suggested as follows:

- Projects disturbing land area of less than fifty acres should include LID BMP(s) such that, at a minimum, the 2-year 24-hour storm event post-development runoff volume is less than the 2-year 24-hour storm event pre-development runoff volume. Alternatively, hydromodification controls should control runoff by matching the pre-development flows and durations for the continuous range of return periods from 10 percent of the two year to the 10-year, based on long-term rainfall records. Within this range, the post-project flow duration curve should not deviate above the pre-project flow duration curve flows by more than 10 percent, and shall not deviate above the pre-project flow duration curve flows over more than 10 percent of the length of the curve. A site specific critical flow may substitute for the lower return period (10 percent of the two year) if available.
- For projects disturbing more than 50 acres, the project should develop and implement a Hydromodification Analysis Study that demonstrates that the pre-project sediment transport capacity (erosion potential) in the receiving channel is maintained to within an identified tolerance based on local or regional data. The analysis shall be based on a continuous simulation of the long-term, local rainfall record, with acceptable hydrologic models and assumptions.

VI. Conclusions

[23] Projects that discharge to non-susceptible stream channels are exempt; see hydromodification control exemptions.

This white paper was prepared to facilitate discussion among the regulatory agencies. regulated communities, and environmental groups as to appropriate metrics for ensuring reasonable implementation of LID and an integrated strategy for water quality protection for discharges from new development and redevelopment projects.

Case studies of three redevelopment projects were presented that showed that using effective impervious area as a metric with no size requirement can result in a wide range of possible hydrologic effects and costs. The same or greater reduction in runoff volume may be achieved through more intensive application of LID BMPs where opportunities exist, compared to a scenario in which LID features are spread more extensively throughout the project site, but with less emphasis on volumetric retention. For example, the first case study showed that 6 inch retention over all the active landscape area with 76% EIA provided the same runoff volume retention as 1 inch retention over all the active landscape area with 0% EIA. Therefore, if reduction in runoff volume is the desired outcome, a volumetric reduction standard would be more constructive than a % EIA standard. Although retention of the delta water quality storm volume appears to be a more reasonable standard than the delta 2-year storm volume, the feasibility of retaining the delta runoff volume on site in landscaped areas is highly dependent on the site-specific infiltration rate. The second case study showed that it was possible to achieve less than 5% EIA without consideration of cost in a downtown redevelopment scenario, but LID BMPs such as green roofs and large volume cisterns were necessitated by site constraints.

The Kmart case study cost estimates showed that the proposed draft permit requirements would significantly increase the drainage costs of urban redevelopment projects. The cost to infiltrate the change in runoff in the 2-year, 24-hour storm event would challenge the feasibility of the redevelopment project, estimated to cost approximately 22% of the total project cost. On the other hand the cost to infiltrate the change in runoff from the water quality design storm is estimated to cost 3% of the total project cost. It is also clear from the Kmart case study that the ability to implement LID BMPs on the site without substantially reducing the developable area is dependent on the volumetric criterion that is selected. In the high volume scenario, a significant amount of the project area (approximately 10 percent of the site) was required for LID BMPs, while in the low volume scenario, the area requirements were much less.

Representative MS4 permits within California and other key states and LID implementation and hydromodification control metrics that have been adopted by jurisdictions via ordinance, guidance, or technical manuals were reviewed and summarized to illustrate alternative approaches to regulating low impact design and hydromodification. These example performance standards and requirements were shown to vary widely, but generally fell into two categories. Some standards relied on prescriptive site design and LID BMP requirements but included no sizing metric. Narrative site design and LID BMP performance standards were also included, with some specific BMPs required, typically to the "maximum extent practicable." Other standards and requirements incorporated sizing metrics. Sizing metrics include metrics related to site design and metrics based on volume reduction. The Ventura Countywide and Orange

Countywide draft MS4 permits currently appear to be unique in prescribing metrics based primarily on effective impervious area.

EIA as a planning goal may be a reasonable metric for watershed protection, but as an LID BMP implementation metric it has serious limitations. Effective impervious area at the watershed scale may be used at the project planning stage. An approach to establishing a reasonable, quantitative LID metric is suggested based on our case study analysis and review of alternative LID MS4 performance standards and requirements for new development and redevelopment.

VII. Recommendations

The suggested approach begins with site design planning principles that should be implemented for each project at the applicable project planning scale (Master Planned Community/Tract Map or Project Site) unless shown to be infeasible or inappropriate given applicable goals and constraints. A LID BMP performance standard is suggested that requires priority projects to implement one or a combination of three types of LID BMPs, with priority placed on option 1 and option 2 equally:

1. BMPs that promote infiltration.
2. BMPs that store and reuse stormwater runoff.
3. BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs which percolate runoff through engineered soil and allow it to discharge downstream slowly.

The LID BMP(s) should be sized, at a minimum, to infiltrate, evapotranspire, beneficially use, or collect and detain the LID design runoff volume, which is defined as the excess runoff from the water quality (SUSMP) design storm event. The LID BMPs can be sized to provide treatment control and/or hydromodification control in addition to meeting the LID performance standard, as applicable and feasible. A reduction (i.e., credit) in the LID design runoff volume would be allowed to promote redevelopment, infill, and smart growth projects. Finally, projects that cannot meet the LID BMP performance standard onsite would be required to incorporate design features demonstrating compliance with the LID BMP requirements to the maximum extent practicable. Projects that infiltrate, evapotranspire, reuse, or collect and detain less than the LID design runoff volume onsite after proving infeasibility would be required to mitigate the remaining LID design runoff volume either in off-site mitigation or via payment in lieu.

The proposed hydromodification performance standard, if incorporated into the revised MS4 Permits, would ensure a reasonable level of interim LID implementation by new development and redevelopment projects until the SCCWRP studies are completed and their recommendations are considered.

ATTACHMENT A - LID Case Studies

Walnut Village

60 California

Ventura Kmart Site

Case Study: Walnut Village

Project Description

Walnut Village is a proposed multi-family redevelopment project in the City of Anaheim. The site encompasses 7.6 acres at the corner of Walnut Street and Ball Road. Proposed development consists of a main building with interior courtyards and two sets of smaller structures along Walnut Street. Primary parking is provided below the grade of the large central building with some parking at the surface. The site is bordered on the west and north by a fire access road.

Landscaping is generally present as narrow strips along some building edges and around the perimeter of the sites. Except for the vegetated filter strip, the landscaping does not accept runoff from adjacent impervious area. Key project characteristics are provided in Table 1 below.

The site can be divided into three drainage areas based on the BMP that provides treatment. Stormwater runoff from the site, as proposed, is treated by a StormFilter® vault, Aqua-Guardian® catch basin inserts, and a vegetated filter strip. A site plan with proposed land cover, drainage areas, and stormwater BMPs is shown in Figure 1 below.

Table 1: Project Characteristics

Characteristic	Value	Source
Area, ac	7.6	Project WQMP, submitted to City of Anaheim, August, 2007
Total Imperviousness, %	84%	Delineation of project land uses
Effective Impervious Area, %	76%	Project WQMP, submitted to City of Anaheim, August, 2007
Soil Type/Description	Soils at the site are characterized as B soils	Orange County Hydrology Manual Soils Maps (1986)
Approximate slope of site and surrounding land, ft/ft	Approximately 0.005	Google Earth
Water Quality Storm Depth, in	0.7	OC DAMP, 2003
2-yr Storm Depth, in	2.05	OC Hydrology, 1986

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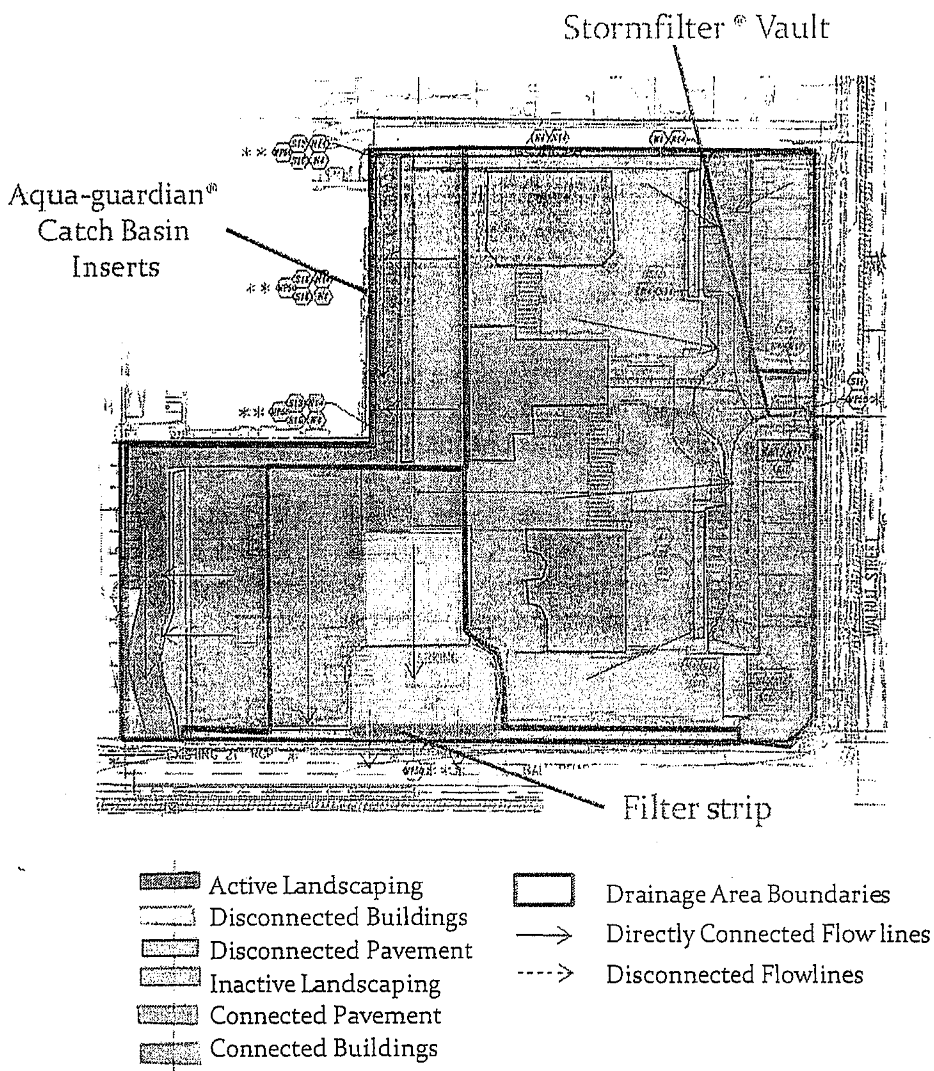

Figure 1: Site land cover and drainage areas

Case Study Assumptions

This case study was completed with the underlying philosophy that for the proposed LID requirements to be feasible they must not necessitate changes to the fundamental character of the project. The follow assumptions were made:

6) Site boundaries are fixed and LID requirements cannot be fulfilled on adjacent parcels of land.
7) Building and parking footprints are fixed in size.

8) Limited modifications to site design may be considered feasible if conditions 1 and 2 are met.
9) Pervious pavement constitutes disconnection of that area, but cannot be used in high-traffic areas.
10) Proprietary BMPs do not constitute disconnection of impervious areas unless they incorporate substantial volume-reduction mechanisms.

Case Study Methodology

This case study considered the feasibility and effectiveness of three design goals, as derived from the Ventura Countywide and Orange Countywide draft MS4 permit requirements described in the main body of this white paper:

3) Reduction of effective impervious area[24] to less than 5%,
11) Retention[25] of the difference between pre-development and post-development runoff volume for the water quality storm event (i.e., the "delta" WQ volume), and
12) Retention of the difference between pre-development and post-development runoff volume for the 2-yr storm event (i.e. the "delta" 2-year volume).

The case study effort first identified the project land cover and proposed drainage patterns. It then identified opportunities for "disconnection" of impervious area through conversion of passive landscaped areas (those that do not accept runoff from adjacent impervious areas) to active landscaped areas (those that do accept runoff from adjacent impervious areas). It also identified minor site design modifications that would allow for addition of more active landscaping or conversion of additional passive landscaping to active landscaping. The practicability of meeting the first goal (<5% EIA) was evaluated based on what could be achieved on the site in this manner without changing the fundamental character of the site. It was important to consider that since routing water through a small strip of landscaping does not fulfill water quality treatment requirements, the disconnection had to be achieved in a way such that water overflowing the active landscaping would be routed to a downstream BMP (in this case, StormFilters or Aqua-Guardian CBIs).

The second part of the case study considered the depth of runoff that must be retained over landscaped areas to achieve the retention goals (#2 and #3). While the first goal, consistent with the draft Ventura Countywide Permit, does not specify a volume of runoff that must be retained as a result of disconnection, the draft Orange Countywide Permit requires that the difference in pre-development and post-development runoff for the 2-yr storm be retained as a result of

[24] As defined by the Ventura County Draft Permit, impervious surfaces may be rendered "ineffective" if the stormwater runoff is: (1) drained into a vegetated cell, over a vegetated surface, or through a vegetated swale, having soil characteristics either as native material or amended medium using approved soil engineering techniques; (2) collected and stored for reuse such as irrigation, or other reuse purpose; or (3) discharged into an infiltration trench. The draft Ventura Permit does not include sizing criteria for these three options.
[25] Retention is defined as the capture and elimination of stormwater through percolation, evapotranspiration, or use.

disconnection. This represents Goal 3, while Goal 2 represents an intermediate level of control between #1 and #3 that has been incorporated into the draft County of Los Angeles Department of Public Works Low Impact Development Standards Manual.

To determine the depth that actively landscaped areas would need to retain, the "delta" water quality and "delta" 2-year storm volumes were computed. In one case it was assumed that all of the delta volume would be stored in active landscaping. In another, it was assumed that driveways and parking areas would be mitigated by pervious pavement up to the water quality depth. The remaining volume required to be retained onsite would be spread over the actively landscaped area to determine the required depth.

Limitations

Two major limitations are acknowledged:

- This case study, as is the case with most investigations of feasibility, relied on subjective assumptions and interpretations which were based on professional judgment; and
- Computational methods used to evaluate effectiveness were simplified, as incorporation of complex methods reduces transparency while increasing the required level of effort.

Thus, the investigations contained herein are not promoted as defensible against all points of view, nor are they promoted as precise. Rather, they are intended to illustrate concepts in a way that does not intentionally introduce bias, while providing planning level results that are open to the scrutiny of the reader.

Case Study Results and Discussion

Effective Impervious Area

Modifications to stormwater routing and site design were identified in an attempt to meet the goal of reducing effective impervious area (EIA) to less than 5%. In this effort, it was critical to understand which areas of the site could be made available for infiltration. Based on site plans, the courtyard areas located over the underground parking structure could not be assumed to accept runoff from adjacent impervious areas because water could not be infiltrated over the parking structures. Perimeter landscaping was deemed potentially appropriate for infiltration, thus disconnection of impervious area was achieved by routing runoff through these areas. Parking areas, driveways, and fire roads were routed to drain to landscaping where possible. It was assumed that entry driveways represented high traffic areas that would not be suitable for pervious pavement.

The project as proposed has 76% EIA. Two degrees of disconnection were achieved in this study, illustrated in Figures 2 and 3 below. Figure 2 shows a reduction to 18% EIA simply by converting passive landscape to active landscape and purposefully routing rooftop drainage over this area. Figure 3 shows a reduction to 0% EIA achieved through adding active landscaping where non-essential hardscape had existed previously.

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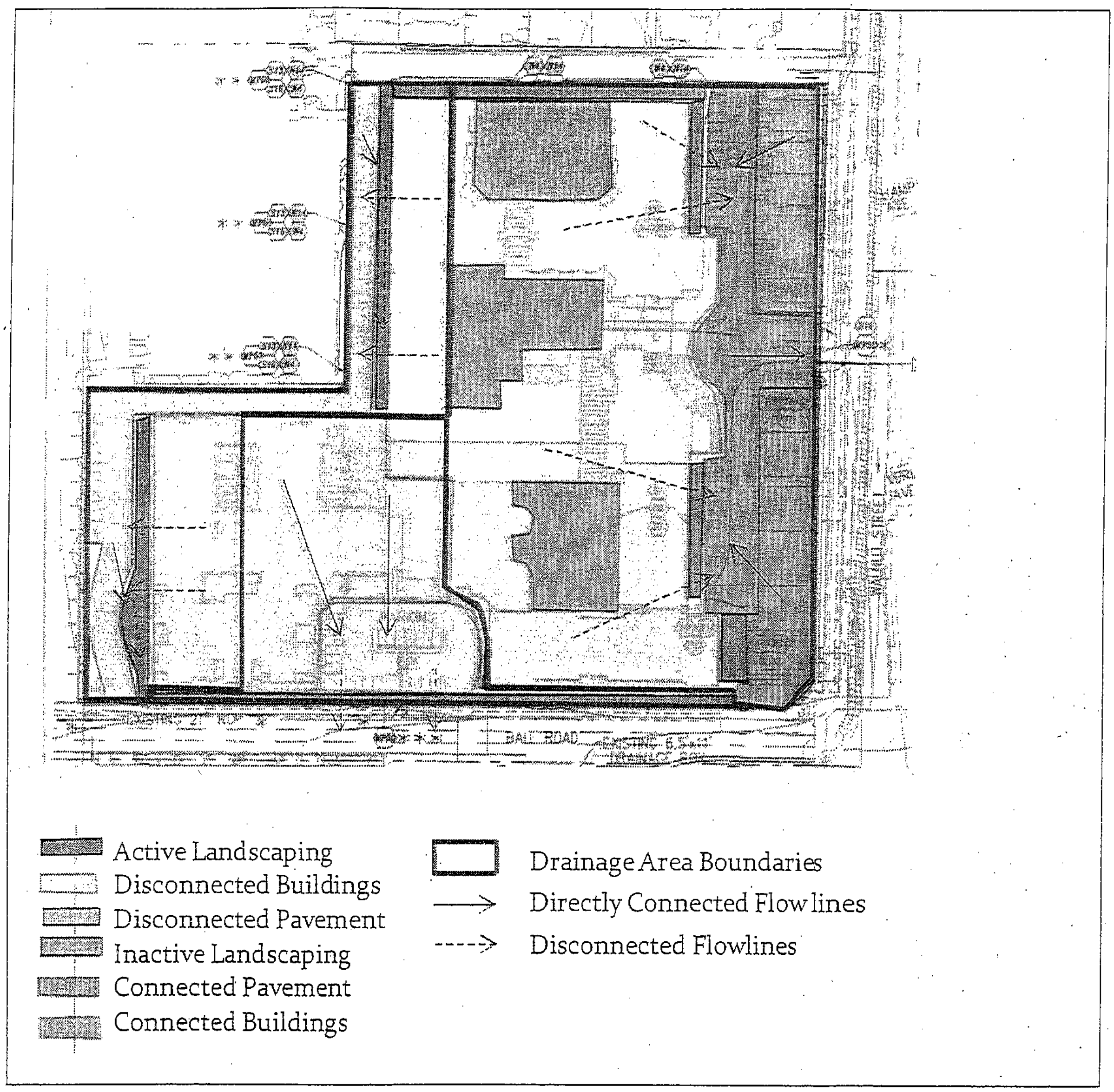

Figure 2: Disconnection scenario resulting in 18% EIA

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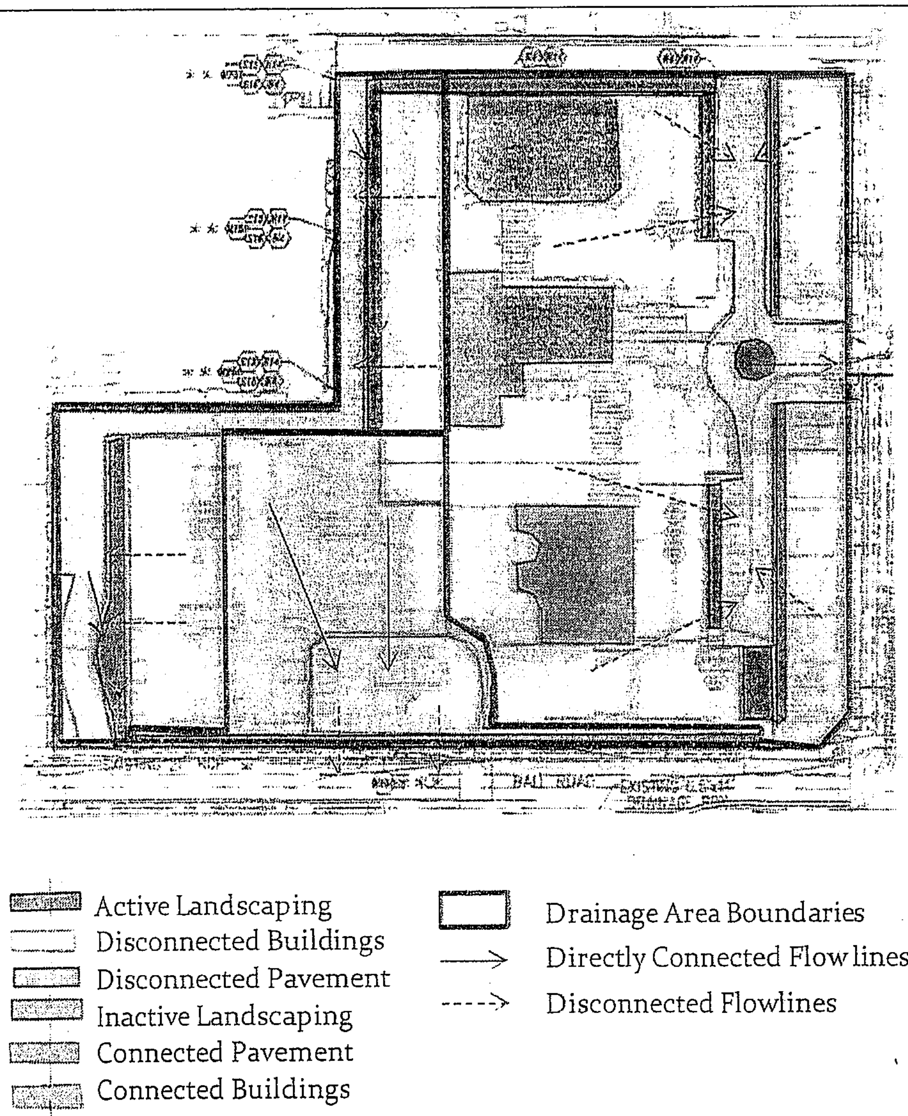

Figure 3: Disconnection scenario resulting in 0% EIA

Table 2 below summarizes the land cover of each disconnection scenario and the runoff coefficients assume for calculation of runoff volumes from each.

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Table 2: Land Cover Distribution for Various Disconnection Scenarios

Project Land Cover	Assumed RC	Project Scenarios (areas in acres) 76% EIA	18% EIA	0% EIA
Disconnected				
Parking, Sidewalks and Roads	0.9	0.30	1.13	1.70
Building	1.0	0.30	3.93	4.59
Inactive Landscape	0.1	1.10	0.71	0.71
Active Landscape	0.0	0.10	0.49	0.60
Directly Connected				
Parking, Sidewalks and Roads	0.9	1.44	0.63	0.00
Building	1.0	4.36	0.71	0.00
Total Project Area		7.60	7.60	7.60
% Impervious		84%	84%	83%
% EIA		**76%**	**18%**	**0%**

To estimate the approximate effectiveness of the disconnection scenarios in retaining stormwater, simple exploratory calculations were used for three levels of implementation:

A. Baseline turf landscaping over all actively landscaped areas assumed to retain and infiltrate or evapotranspire one inch of water over its surface,
B. Enhanced landscaping over half of the actively landscaped areas assumed to retain and infiltrate or evapotranspire six inches of water over its surface,
C. Enhanced landscaping over all of the actively landscaped areas assumed to retain and infiltrate or evapotranspire six inches of water over its surface,

Runoff volumes were generated using the runoff coefficients and acreages shown in Table 2, and were reduced as a function of the type of disconnection implemented and the area of active landscaping in each scenario. Results are presented as the amount of runoff retained in a given storm event, expressed as watershed inches (Table 3).

Table 3: Approximate Retention Depth for Various Disconnection Scenarios and Types of Active Landscaping Employed

Disconnection Scenarios		Effective Retention Depth (Watershed Inches) 76% EIA	18% EIA	0% EIA
A	1" retention over all active landscape	0.01	0.06	0.08
B	6" retention over half of active landscape	0.04	0.19	0.24
C	6" retention over all active landscape	0.08	0.39	0.47

Reduction of effective impervious area to less than 5% of the project area appears to be feasible if the definition of EIA does not include a volumetric retention requirement to render an area ineffective. In order to achieve <5% EIA, additional active landscaping was created. It is important to note that this conclusion is based on limited available information of site constraints that may not have been evident from project documentation.

From Table 3, it is noted that the depth retained on the site due to LID measures was both a function of the reduction in EIA and the increase in depth retained in actively landscaped areas. It can be seen that an increase from 1 watershed-inch retained to 6 watershed-inches retained over active landscaping (moving down the columns in Table 3) had a more pronounced effect than reducing the EIA from a easily achieve value (18%) to a more difficult to achieve value (0%) (moving left to right in Table 3). Certainly this result is a function of the cases that were selected, but nonetheless illustrates that LID benefits can be achieved by both extensive implementation and more intensive design of active landscaping (i.e., greater retention depth) where opportunities exist. A fixed % EIA LID metric promotes only the former option.

Retention Scenarios

Storage volumes required to retain the delta water quality and delta 2-year events were calculated using methodology contained in the Orange County Drainage Area Management Plan (DAMP). The DAMP method is based on the Rational Method using a constant runoff coefficient. This method may not be the most appropriate method to use for larger storms (such as the 2-yr storm), but it was employed as a simple and easily-understood method. Assumptions and resulting volumes are provided in Table 4 below.

Table 4: Differential Volume of Runoff in WQ and 2-year Storm Event

Storm	Storm Depth (inches)	Imperviousness	Runoff Coefficient[1]	Runoff Depth (watershed inches)	ΔV (watershed inches)
WQ	0.70	0	0.15	0.11	0.45
	0.70	84	0.79	0.55	
2-year	2.05	0	0.15	0.31	1.31
	2.05	84	0.79	1.62	

[1] Table A-1 of OC DAMP, page 7-II-46

To help understand the nature of active landscaping or BMPs that would be required to retain the delta volumes, the following scenarios were explored:

X. Distribution of required retention volume over all active landscaping under the 0% EIA scenario.

Y. Assumed use of pervious pavement to mitigate up to 0.70 inches over all paved area with remaining volume retention spread over actively landscaped area in the 0% EIA scenario.

The required retention depth over all active landscaping was computed using simplified volumetric routing assumptions and is show in Table 5 for Scenarios X and Y. An infiltration rate representative of compacted B soils (0.2 inches per hour) was assumed to explore the range of drawdown times that could be expected for the required retention depths.

Table 5: Required Depth of Retention in Active Landscaping to Achieve Volumetric Retention Requirements and Range of Approximate Drawdown Times

Disconnection Scenarios		Required Retention Depth in All Active Landscaping (inches)		Time to Drain at 0.2 inches per hour [2] (hours)
		Delta WQ (0.45 inches)	Delta 2-yr (1.31 inches)	
X	Retention over all Active Landscaping	5.7	16.6	28 – 83
Y	Retention of 0.70 inches over all pavement[1], with remaining volume retained in active landscaping	3.7	14.6	18 – 73

[1] Based on assumption that all paved areas can be designed to be self-mitigating for entire WQ storm; however, pavement does not accept building runoff.
[2] 0.2 inches per hour is at the high end of typically assumed saturated hydraulic conductivity for compacted B soils under long-term operation. Actual infiltration rates must be based on site-specific testing which was not available for this site. The low end of the reported range is for the Delta WQ volume and the high end is for the Delta 2-yr volume.

The range of required retention depths over the active landscaping is not unreasonable, however, would require priority to be placed on converting all active landscaping to an LID BMP designed and maintained specifically as a retention facility. In the range of 14-17 inches of retention, as required to capture the delta 2-year volume, this would require a combination of fairly deep amended soils and significant surface storage. The drawdown time for such a depth is at or above the upper limit of what would typically be allowed for a surface storage facility to avoid vector concerns (72 hrs), which could be mitigated by the storage of some volume in soil pores but indicates that performance would be substantially reduced in sequential storm events. From this calculation, it is also apparent that feasibility is strongly dependent on site-specific infiltration rates.

The retention of the lesser delta volume (i.e., Delta WQ) appears to be more feasible, but is also dependent on the ability to make use of all active landscaping for intensive BMPs and the site-specific infiltration rates.

Conclusions

The following conclusions can be drawn from this case study:

- In the case study considered, it was possible to achieve less than 5% EIA with no sizing metric.
- The lack of a sizing metric in the definition of EIA resulted in a wide range of possible effectiveness (measured as retained runoff volume).
- The same or better effectiveness in reducing runoff volume may be achieved through more intensive application of LID features where opportunities exist, compared to a scenario in which LID features are spread more extensively throughout the project site, but with less emphasis on volumetric retention. In other words, this case study showed that 6 inch retention over all the active landscape area with 76% EIA provided the same

runoff volume retention as 1 inch retention over all the active landscape area with 0% EIA.

- An EIA criterion coupled with a volumetric retention metric is a much more difficult performance standard as it requires a focused effort to design and maintain active landscaping as retention BMPs for a large portion of the project area.
- The feasibility of retaining the delta runoff volume on site is highly dependent on the site-specific infiltration rate.
- Retention of the delta WQ storm volume appears to be more feasible than the delta 2-yr volume. To retain the delta 2-year volume would require a combination of fairly deep amended soils and significant surface storage. The drawdown time for such a depth is at or above the upper limit of what would typically be allowed for a surface storage facility to avoid vector concerns.

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Case Study: 60 California

Project Description

60 California Street is a proposed four-story, multi-use commercial/retail redevelopment project in the City of Ventura. The site occupies 0.14 acres between East Santa Clara and East Main Street on South California Street. While miscellaneous uses exist on site, nearly the entire lot is covered by the building roof, with only a negligible buffer around the edges. The site is bordered by restaurants and shops to the north and south. Parking does not appear to be provided onsite unless it is below grade. A four-story city parking lot is adjacent to the site and presumably provides parking for the site.

The surrounding area is highly urbanized and no vegetation exists directly on the site with the exception of two palm trees in planters on the sidewalk. These planters do not accept runoff from the site or the adjacent road. Key project characteristics are provided in Table 1 below. Under the proposed conditions, stormwater is conveyed from the roof in four downspouts that presumably tie directly to the off-site storm drain. These downspouts divide the site into four drainage areas. A site plan with proposed stormwater drainage system is shown in Figure 1 below.

Table 1: Project Characteristics

Characteristic	Value	Source
Area, ac	0.14	Project Site Plans, submitted to City of Ventura, Sep-Oct 2007
Imperviousness, %	>95%	Delineation of project land uses; primarily roof; minor planter boxes
Effective Impervious Area, %	100%	Project Site Plans, submitted to City of Ventura, Sep-Oct 2007
Soil Type/Description	Soils at the site are characterized as C soils	Ventura County Hydrology Manual (2006)
Approximate slope of site and surrounding land, ft/ft	Approximately 0.02	DesignARC Grading and Utility Plan (2007)
Water Quality Storm Depth, in	0.75	Volume-based criteria #3, p 57 of 115, in Draft Ventura Co Permit
2-yr Storm Depth, in	2.7	Ventura County Hydrology Manual, 2006. Adjusted from 50 yr depth per multipliers from 1993 manual

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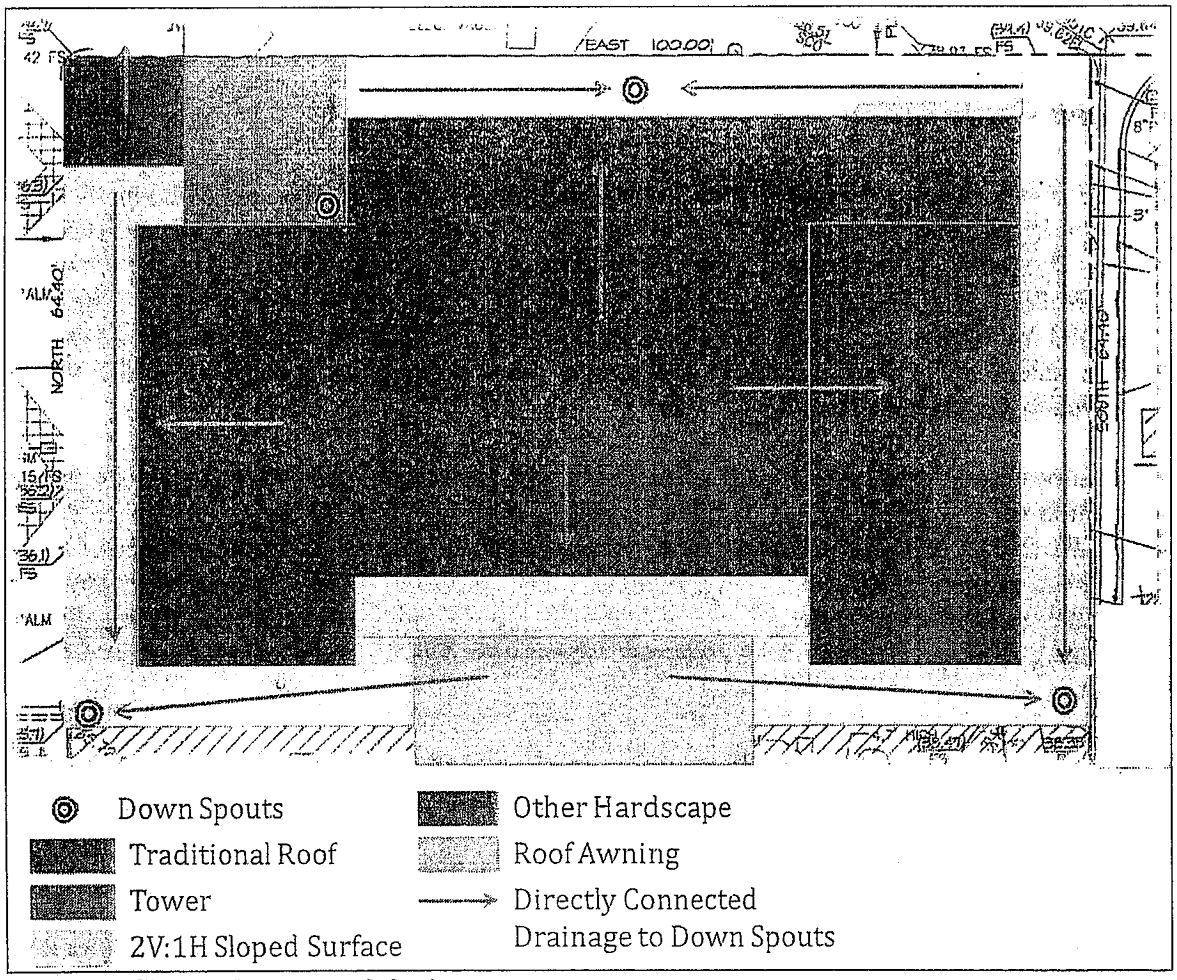

Figure 1: Site land cover and drainage areas

Case Study Assumptions

This case study was completed with the underlying philosophy that for the proposed LID requirements to be feasible they must not necessitate changes to the fundamental character of the project. The follow assumptions were made:

1) Site boundaries are fixed and LID requirements cannot be fulfilled on adjacent parcels of land.
2) Building and parking footprints are fixed in size.
3) Limited modifications to site design may be considered feasible if conditions 1 and 2 are met.
4) Pervious pavement and/or green roofs constitute disconnection of that area, but pervious pavement cannot be used in high-traffic areas and green roofs cannot be used on steeply sloped roofs.

5) Proprietary BMPs do not constitute disconnection unless they incorporate substantial volume-reduction mechanisms.

Case Study Methodology

This case study considered the feasibility and effectiveness of three design goals, as derived from the Ventura Countywide and Orange Countywide Draft MS4 permit requirements described in the main body of this white paper:

1) Reduction of effective impervious area[26] to less than 5%,
2) Retention[27] of the difference between pre-development and post-development runoff volume for the water quality storm event (i.e. the "delta" WQ volume), and
3) Retention of the difference between pre-development and post-development runoff volume for the 2-yr storm event (i.e. the "delta" 2-year volume).

The case study first identified the project land cover and proposed drainage patterns. It then identified opportunities for "disconnection" of impervious area through the use of green roofs and cisterns for reuse. The practicability of meeting the first goal (<5% EIA) was evaluated based on what could be achieved on the site in this manner without changing the fundamental character of the site. Because the nature of the project is that of a multi-story building built to the lot lines, there is no opportunity to create vegetated areas for infiltration.
The second part of the case study considered the infrastructure required to achieve the retention goals (#2 and #3). While the first goal, consistent with the draft Ventura Countywide Permit, does not specify a volume of runoff that must be retained as a result of disconnection, the draft Orange Countywide Permit requires that the difference in pre-development and post-development runoff for the 2-yr storm be retained as a result of disconnection. This represents Goal 3, while Goal 2 represents an intermediate level of control between #1 and #3 that has been incorporated into the draft County of Los Angeles Department of Public Works Low Impact Development Standards Manual.

The volume of cistern storage and effective retention depth of green roofs were computed and evaluated for their reasonableness and probable effectiveness.

Limitations

Two important limitations are acknowledged:

[26] As defined by the Ventura County Draft Permit, impervious surfaces may be rendered "ineffective" if the storm water runoff is: (1) drained into a vegetated cell, over a vegetated surface, or through a vegetated swale, having soil characteristics either as native material or amended medium using approved soil engineering techniques; (2) collected and stored for reuse such as irrigation, or other reuse purpose; or (3) discharged into an infiltration trench. The draft Ventura Permit does not include sizing criteria for these three options.
[27] Retention is defined as the capture and elimination of stormwater through percolation, evapotranspiration, or reuse.

- This case study, as is the case with most investigations of feasibility, relied on subjective assumptions and interpretations which were based on professional judgment; and
- Computational methods used to evaluate effectiveness were simplified, as incorporation of complex methods reduces transparency while increasing the required level of effort.

Thus, the investigations contained herein are not promoted as defensible against all points of view, nor are they promoted as precise. Rather, they are intended to illustrate concepts in a way that does not intentionally introduce bias, while providing planning level results that are open to the scrutiny of the reader.

Case Study Results and Discussion

Effective Impervious Area

Modifications to the baseline design configuration were identified in an attempt to reduce the impervious area to less than 5 percent. Due to the site's small size and highly urban setting, few options were available. Little to no space is available on the site at the ground level for retaining stormwater. The use of a green or vegetated roof was considered as a means of reducing the runoff from the primary impervious surface on the site: the roof of the building. Green roofs rely on highly porous media and moisture retention layers to store intercepted precipitation and to support vegetation that can reduce the volume of stormwater runoff via evapotranspiration. As proposed, the building's roof contains several features that limit the spatial applicability of a green roof (e.g., a tower, 2V:1H sloped perimeter). Thus, approximately 1,900 ft^2 of the total 6,200 ft^2 roof is unavailable to support vegetated cover.

Runoff from roof area that cannot be covered in green roof could be captured through the use of a cistern for reuse in flushing toilets and irrigating indoor plants in the building. Per the draft Ventura Countywide Permit requirements, the capture of runoff in cisterns constitutes disconnection of that impervious area. No minimum cistern volume is required per the draft permit.

Dry wells are also included as an acceptable means to disconnect impervious area in the draft permit, but were not considered to be feasible given the high density of development (dry wells are generally located away from building foundations) and the indication of poor soil infiltration rates (C soils) at the project site.

Based on this discussion, a reduction in EIA to less than 5% can be achieved, but only by means of a combination of green roof and cisterns for reuse of stormwater.

Figures 2 and 3 below illustrate disconnection scenarios. Table 2 below summarizes the land cover of each disconnection scenario.

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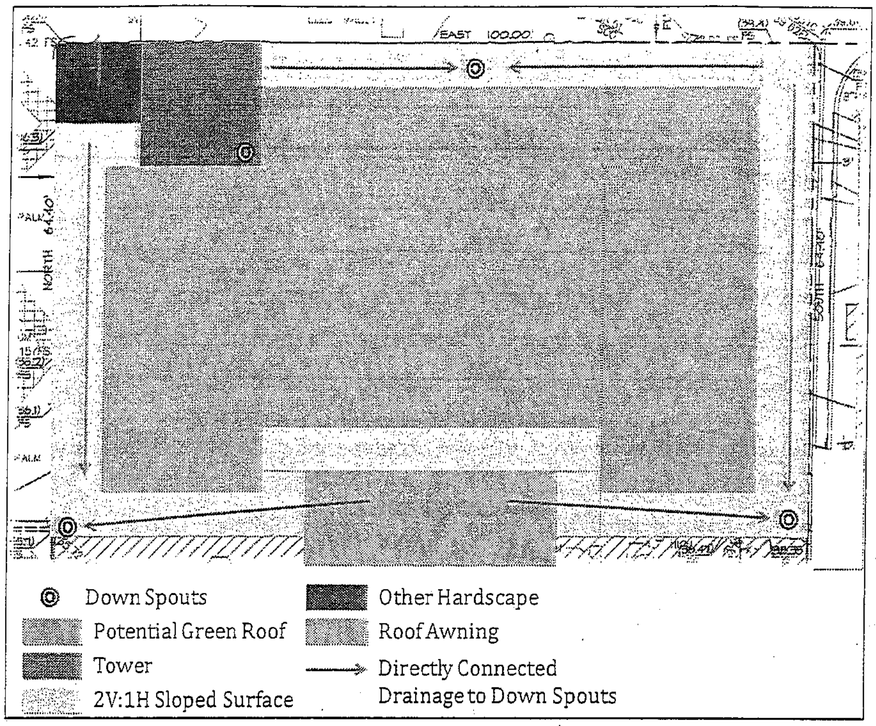

Figure 2: Disconnection scenario resulting in 31% EIA

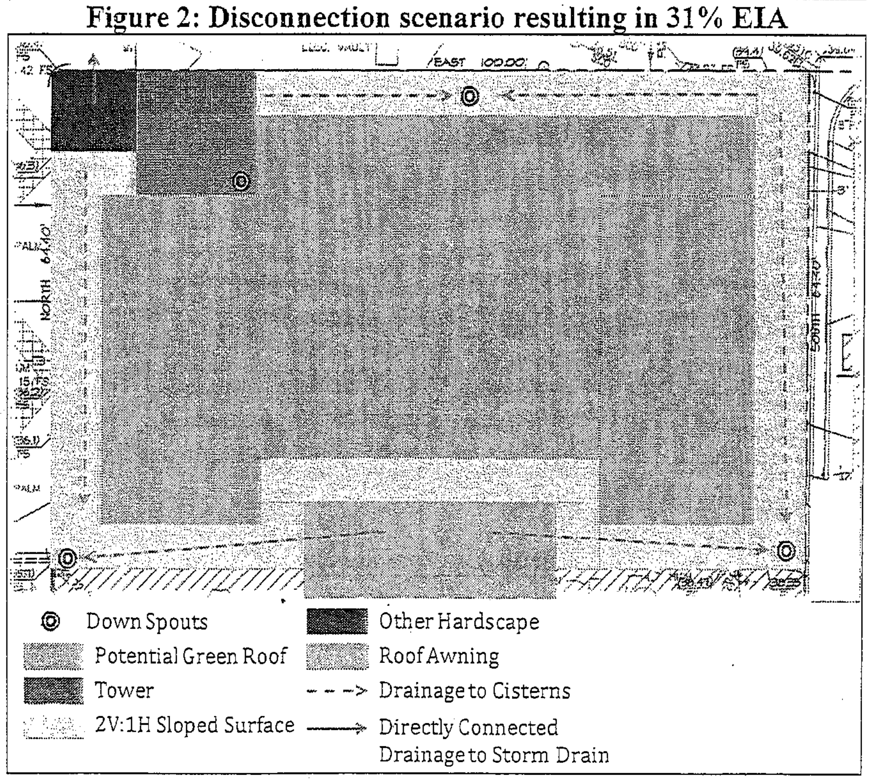

Figure 3: Disconnection scenario resulting in 3% EIA

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Table 2: Land Cover Distribution for Various Disconnection Scenarios

Project Land Cover	Project Scenarios (areas in sf)		
	100% EIA	**31% EIA**	**<5% EIA**
Miscellaneous hardscape (directly connected)[1]	200	200	200
Building (directly connected)	6,200	1,900	0
Disconnected via green roof	0	4,300	4,300
Disconnected via cistern	0	0	1,900
Total Project Area	6,400	6,400	6,400
% EIA	**100%**	**31%**	**3%**

[1] Miscellaneous hardscape consists primarily of entryway areas that cannot feasibly be converted to vegetation.

Green roofs can be engineered to store a range of precipitation depths through the use of different design features. It is important to note that green roofs do not eliminate volume through infiltration; only through evapotranspiration. Regeneration of storage by means of ET is generally slower than by means of infiltration, indicating that antecedent conditions may be more important for performance of green roofs than for infiltration-based BMPs.

Similarly, cisterns may be designed in any volume, and also do not infiltrate water; rather water is held for reuse, the rate of which may be the limiting factor in how much water should be stored.

To estimate the approximate effectiveness of the disconnection scenarios in retaining stormwater, simple exploratory calculations were used for two arbitrary levels of implementation:

A. 0.5" of retention over green roof and 1-1,000 gallon cistern,
B. 2" of retention over green roof and 1-2,000 gallon cistern,

Runoff volumes were generated by assuming that all rainfall on rooftops would run off. and were reduced as a function of the type of disconnection implemented. Results are presented as the amount of runoff retained in a given storm event, expressed as watershed inches (Table 3), assuming dry antecedent conditions.

Table 3: Approximate Retention Depth for Various Disconnection Scenarios

Disconnection Scenarios		Effective Retention Depth (Watershed Inches)		
		100% EIA	**31% EIA (no cistern)**	**3% EIA (Green roof and cistern)**
A	0.5 in of retention over green roof and 1-500 gallon cistern	NA – No retention BMPs	0.15	0.27
B	2 in of retention over green roof and 1-2000 gallon cistern		0.58	1.08

Reduction of effective impervious area to less than 5% of the project area appears to be feasible if the definition of EIA does not include a volumetric retention requirement to render an area ineffective. The effectiveness values shown in Table 3 are based on typical design parameters for green roofs and cisterns, which are BMPs that are generally beyond the typical level of BMP implementation in common practice at this time (although not unheard of). In order to achieve <5% EIA, rainwater collection and reuse or re-engineering of the building roof to eliminate areas of steep slope would be required. It is important to note that this conclusion is based on limited available information of site constraints that may not have been evident from project documentation.

Table 3 shows that the depth retained on the site due to LID BMPs was highly dependent on the design criteria selected for green roofs and cisterns. It was generally possible to achieve fairly high retention depths within typical ranges of design criteria for these BMPs.

Retention Scenarios

Storage volumes required to retain the delta water quality and delta 2-year events were calculated using methodology contained in the Orange County Drainage Area Management Plan (DAMP). The DAMP method is based on the Rational Method using a constant runoff coefficient. This method may not be the most appropriate method to use for larger storms (such as the 2-yr storm), but it was employed as a simple and easily-understood method. Assumptions and resulting volumes are provided in Table 4 below.

Table 4: Differential volume of runoff in WQ and 2-year storm event

Storm	Storm Depth (inches)	% Imperv	Runoff Coefficient[1]	Runoff Depth (watershed inches)	ΔV (watershed inches)	ΔV (gallons)
WQ	0.75	0	0.15	0.11	0.64	2,550
	0.75	100	1.0	0.75		
2-year	2.7	0	0.15	0.31	2.39	9,530
	2.7	100	1.0	2.7		

[1] Table A-1 of OC DAMP, page 7-II-46; all rainfall on rooftops assumed to run off

To help understand the quantity of storage that would be required to retain the delta volumes, the following scenarios were explored:

X. Green roof retaining 0.5 inches of water and remainder captured by cistern.
Y. Green roof retaining 2 inches of water and remainder captured by cistern.

The required cistern volume is show in Table 5 for Scenarios X and Y.

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Table 5: Required cistern storage volume to achieve volumetric retention requirements

Disconnection Scenarios		Required Cistern Volume (gal)	
		Delta WQ (2,550 gal)	Delta 2-yr (9,530 gal)
X	Green roof retaining 0.5 in of water and remainder captured by cistern.	1,210	8,200
Y	Green roof retaining 2 in of water and remainder captured by cistern.	Cistern not required	4,170

It is noted that the range of required storage volumes is not unreasonable but would require that a viable and sufficient demand exists for the stored water and that use of stormwater as grey water within the buildings would be permittable. An exception is noted for Scenario Y, in which the volume of water stored by the green roof is sufficient to mitigate the delta of the water quality-sized storm and does not rely on storage and reuse.

It is important to note that suitability of both green roofs and storage and reuse systems for southern California is not well understood. Generally, during the rainiest times of the year in southern California, the potential evapotranspiration is the lowest, meaning that the ability to regenerate storage capacity between storms is low. During the summer, green roofs would likely need to be irrigated to sustain healthy vegetation and to reduce fire danger. Likewise, irrigation demand for stormwater stored in a cistern is generally highest over the long summer months when limited rainfall is likely to occur. This is not meant to say that the solutions would not work, but that they are possibly not the most climate-appropriate technologies. In addition, their use may conflict with existing building and health codes.

Conclusions

The following conclusions can be drawn from this case study:

- In the case study considered, it was not exceedingly difficult to achieve less than 5% EIA, but innovative LID BMPs such as green roofs and cisterns were necessitated by site constraints.

Case Study: Kmart Site

Project Description

This case study site is of a former Kmart center located within the City of Ventura. The 12.4 acre site is in a highly urbanized area along South Victoria Avenue and includes a department store, a grocery store, and two restaurants. Currently, the site is covered by building roof and parking lot, with some inactive vegetation (curbed off trees) within the main parking lot.

Key project characteristics are provided in Table 1 below. In the existing condition, stormwater is conveyed from the northeast corner of the site along two main ribbon drains and discharges at the southwest corner (based on limited field data, Google Earth elevations, and previous site visits). A site plan with existing stormwater drainage system is shown in Figure 1 below. It is assumed that the general use of the site would not change with redevelopment, but that redevelopment activities would exceed thresholds triggering the draft permit requirements associated with LID, water quality, and hydromodification.

Table 1: Kmart Site Project Characteristics

Characteristic	Value	Source
Area, ac	12.4	Photomapper, 2005
Pre-development Impervious area, percent	0 percent	Assumed based on definition of pre-development in Draft Permit
Current Imperviousness coverage, percent	93 percent	Aerial Photography
Current Effective Impervious Area, percent	93 percent	Aerial Photography
Approximate slope of site and surrounding land, ft/ft	Approximately 0.02	Aerial Photography
Soil Type/Description	Soils characterized as NRCS Category B or Ventura County soil Type 3	Ventura County Hydrology Manual (2006)
Water Quality Storm Depth, in	0.75	Volume-based criteria #3, p 57 of 115, in Draft Ventura Co Permit
2-yr Storm Depth, in	3.1	Ventura County Hydrology Manual, 2006

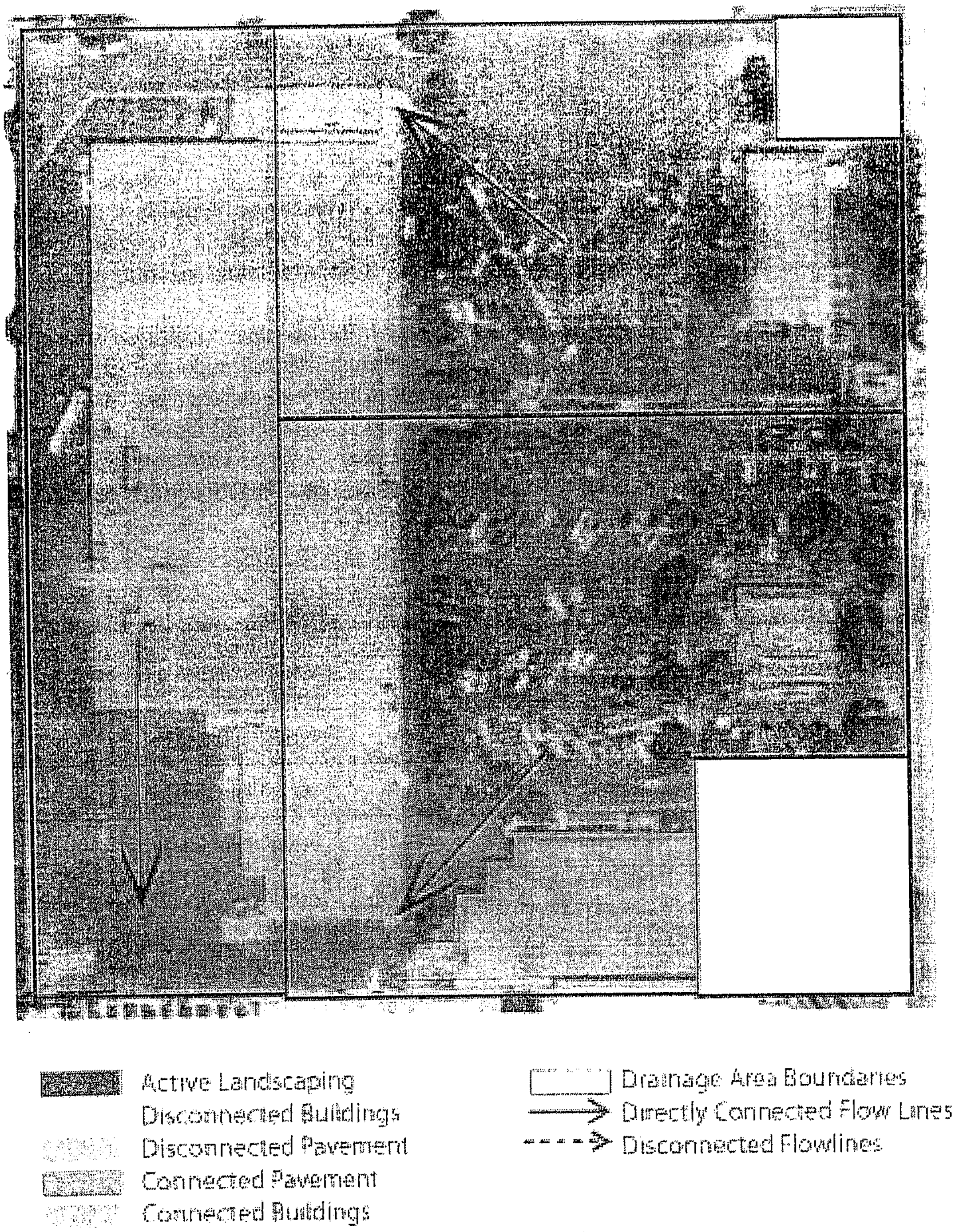

Figure 1: Kmart Site - Land Cover and Drainage Pattern
(Background image from Google Earth™ 2008)

Case Study Assumptions

The draft Ventura County permit does not include volumetric criteria for the disconnection of impervious area nor does it define a design storm type. Because the intent of this case study was to evaluate the cost of complying with the draft Ventura permit requirement, and because the type of facilities requiring compliance with the draft Ventura permit would operate through capture and retention of runoff volume, it was necessary to assume a range of volumetric criteria to render impervious area "ineffective."

To facilitate this study, many possible interpretations of the draft permit requirements were considered. In one high volume interpretation, to achieve 5% EIA could mean infiltrating 95% of the volume of runoff from the site. This would be greater than what is required for hydromodification control, and would likely preclude the need for separate treatment control BMPs. This interpretation was considered possible but beyond the probable intent of the draft permit. Thus, the following two interpretations were considered for analysis:

- High volume interpretation - interim hydromodification control requires detaining the difference between pre-development[28] and post-development runoff for a 3.1-inch storm (2-year, 24-hour rainfall event). On top of this, to achieve 5% EIA for the site, a vegetated filter strip was added.
- Low volume interpretation – Detain the difference between pre-development and post-development runoff for a 0.75-inch storm (approximate 85th percentile (SUSMP) rainfall event). A vegetated filter strip was added to achieve 10% EIA for the site (LA County LID Manual goal).

It is recognized that the draft stormwater permit hydrologic controls are related to other drainage controls set by county or cities for the rarer, but larger runoff and flood events. For this case study, drainage/flood control and water quality BMPs were assumed to be the same for both scenarios and no cost was assigned to them. This assumption means that the cost developed for the low volume retention scenario would need to be increased to account for appropriately sized treatment BMPs, and potentially hydromodification controls, whereas the high volume retention scenario would have already fulfilled treatment requirements and potential hydromodification requirements.

The focus of this analysis was on the LID criteria and the costs associated with the range of possible interpretations in the two scenarios above.

Case Study Methodology

The case study included estimating required detention volume, selecting and sizing LID BMPs, and estimating the order of magnitude lifecycle costs. These costs are also compared to a range of potential site redevelopment costs to provide prospective on the total cost of redevelopment. The BMP sizing and cost results are developed to provide a practical example to evaluate the draft permit requirements.

Estimates of runoff volume in pre-development and post-development conditions were developed using the NRCS Curve Number Method for both design storm scenarios. The differences or "delta" of these volumes are shown in Table 2.

[28] Consistent with Draft Ventura County permit language, "pre-development conditions" were assumed to refer to the site condition prior to any development.

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Table 2: Runoff Estimates from Kmart Site

Permit Interpretation	Design Storm (inches per 24-hour)	Pre-Development Runoff (Ac-Ft)	Post-development Runoff (Ac-Ft)	Delta Volume: BMP Criteria (Ac-Ft)
High Volume	3.1	0.41	2.38	1.97
Low Volume	0.75	0.00	0.32	0.32

Notes:
Pre-development = native vegetation and soils that existed prior to the first development
Ac-Ft = Acre-feet

LID BMPs were selected to treat the "delta" volume in both design storm scenarios assuming the LID BMP would control the draft permit hydromodification volume in a treatment train approach: vegetated filter strips followed by aggregate-filled infiltration trenches.

Filter strips operate by collecting runoff into shallow sheet flow through dense vegetation, slowing the velocity of runoff and promoting filtering, sediment deposition, and some volume reduction due to infiltration. The CASQA BMP Handbook (2003) recommends that filter strips be sized at a 1:1 ratio with contributing impervious area in order to provide full water quality treatment; however, because filter strips were assumed to be followed by downstream infiltration trenches, they were only intended to provide pre-treatment and this requirement was reduced. It is clear that providing an area of filter strip equivalent to the tributary pervious area would constitute a very large impact to other uses on this case study site. For the low volume interpretation, it was assumed that a 1-foot wide filter strip would be provided prior to water entering the ribbon drains. This is quite small for filter strips by typical standards, but is not outside of the potential interpretation of LID requirements contained in the draft permit. For the high volume interpretation of LID requirements, it was assumed that filter strips would be sized to 5 percent of the tributary impervious area, yielding filter strips approximately 25 feet wide, collecting runoff prior to flowing into the infiltration trenches. This width is more consistent with typical guidance for water quality treatment.

Infiltration trenches are designed to capture runoff, filling during a storm event and emptying slowly via infiltration following the event. It was assumed for this case study that infiltration trenches would be designed to drain in 72 hours into Ventura County Soil Type 3 (NRCS Category C) soils with a Ventura County standard infiltration rate of 0.5 inches per hour. This infiltration rate is the minimum for infiltration trenches. Assuming an aggregate porosity of 0.35, a trench depth of 8 feet, for the high volume interpretation, two basins were sized, one 600 feet long and 42 feet wide, the other 290 feet long and 18.5 feet wide. The low volume interpretation required an 8 foot deep basin 900 feet long and 5.5 feet wide.

The project could also comply with LID criteria by using a variety of BMPs such as tree boxes, bioretention, pervious pavement, and other LID BMPs, however, the typical treatment train described above was assumed for its simplicity and based on its suitability for a constrained commercial site.

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Costs

Anticipated capital and operation/maintenance costs were developed using information from the California Stormwater Quality Association data (CASQA, 2003) along with supplemental information from the Environmental Protection Agency data (EPA, 2007) for infiltration trenches and vegetated filter strips.

Capital cost estimates for vegetated filter strips included the removal of impervious surface at \$0.30 per square foot and revegetation at about \$0.70 per square foot for a total of \$1 per square foot. Operation and maintenance costs for the vegetated filter strips were assumed to be \$350 per acre per year. Capital costs estimates for infiltration trenches were developed by assuming that the rock matrix would have a porosity of 35 percent and cost \$5 per cubic foot of volume. Operation and maintenance costs for the infiltration trench option were assumed to be 10 percent of construction costs per year. These simple cost assumptions for the selected BMPs could be further developed, but were used herein to show the magnitude of potential costs. It is important to note that impacts to usable land area resulting from LID implementation were not factored into this analysis.

Plans to redevelop the site could range from simply remodeling the interior of the Kmart building to demolishing the Kmart building and constructing a new shopping mall or business park. The footprint of the Kmart building is approximately 130,000 ft^2. Order-of-magnitude costs for the redevelopment plans can range from about \$50/ft^2 for remodeling to \$250/ ft^2 for new commercial construction, which result in a total cost estimate for this site of \$6 million to \$32 million.

Limitations

Two major limitations are acknowledged:

- This case study analysis was based on professional judgment and limited field data;
- Simplified BMP selection and computational methods were used for this order-of-magnitude cost evaluation of the scenarios. Incorporation of complex analytical methods would reduce transparency while increasing the required level of effort.

Thus, the investigations contained herein are not promoted as being an ideal case study that evaluates all the issues of the draft permit. Rather, they are intended to illustrate concepts in a way that does not intentionally introduce bias, while providing planning level results and order-of-magnitude cost estimates that are open to the scrutiny of the reader.

Case Study Results and Discussion

The two scenarios produced vastly different cost estimates.

For the high volume interpretation of the draft permit language, 1.9 watershed inches or 85,800 cubic feet (1.97 Ac-Ft) of water would need to be infiltrated. The LID BMPs for this scenario used 10 percent of the site for LID BMPs included filter strips covering approximately 5 percent of the site. and infiltration trenches covering approximately 5 percent of the site. (See Figure 2). The capital and O&M costs for this interpretation of the permit requirements are provided in Table 3.

Under the low volume interpretation of LID requirements, the delta (or difference) in volume from the pre-development condition to the proposed condition would need to be infiltrated making up 0.3 watershed inches or 13,900 cubic feet (0.32 Ac-Ft). LID BMPs for this scenario would include an approximately one-foot wide vegetated filter strip placed along the drainage collection features of the facility and infiltration trenches covering approximately 1.0 percent of the project site (Figure 3). The capital and O&M costs associated with this scenario are provided in Table 3.

The cost results of the case studies presented in Table 3 are approximate and should be considered as an order-of-magnitude, relative comparison based on engineering experience and limited field data.

Table 3: Present Worth Cost Comparison of Kmart Case Study

Case Study	Proposed Permit Costs[1]	% of Total Redevelopment Cost[2]
High volume interpretation (2-year storm)	$1,290,000	4 – 22%
Low volume interpretation (0.75-inch storm)	$208,000	1 – 3%

[1] LID BMP Costs are developed as 20-year present worth (lifecycle) costs using a 4 percent interest rate.
[2] Assuming other present worth costs of redevelopment range from $6 million to $32 million

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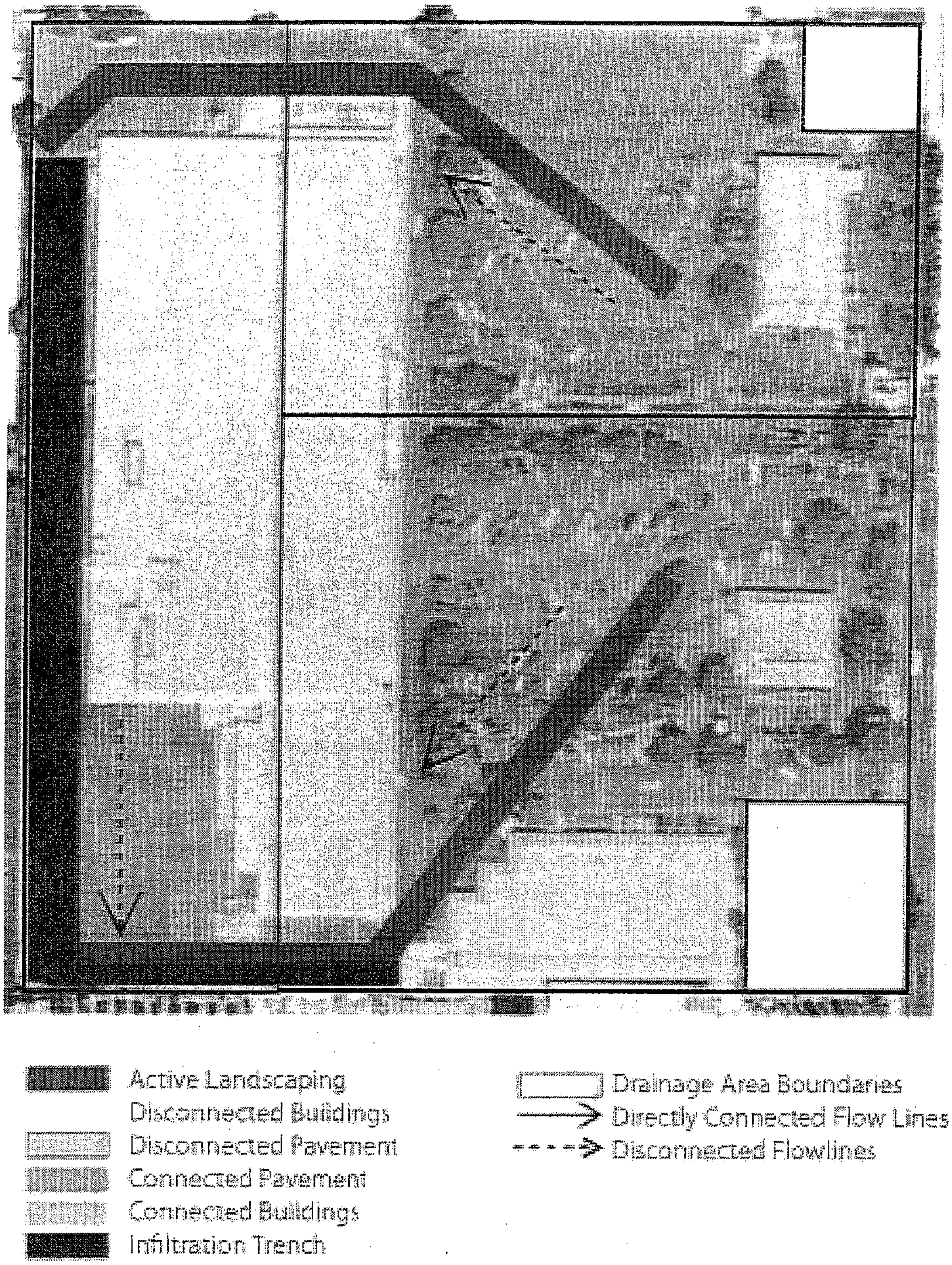

Figure 2: Illustration of LID BMPs to meet the high volume interpretation of draft permit requirements
(Background image from Google Earth™ 2008)

From Figure 2, it can be seen that substantial impacts to the site may result from the implementation of LID BMPs if the high volume interpretation is used.

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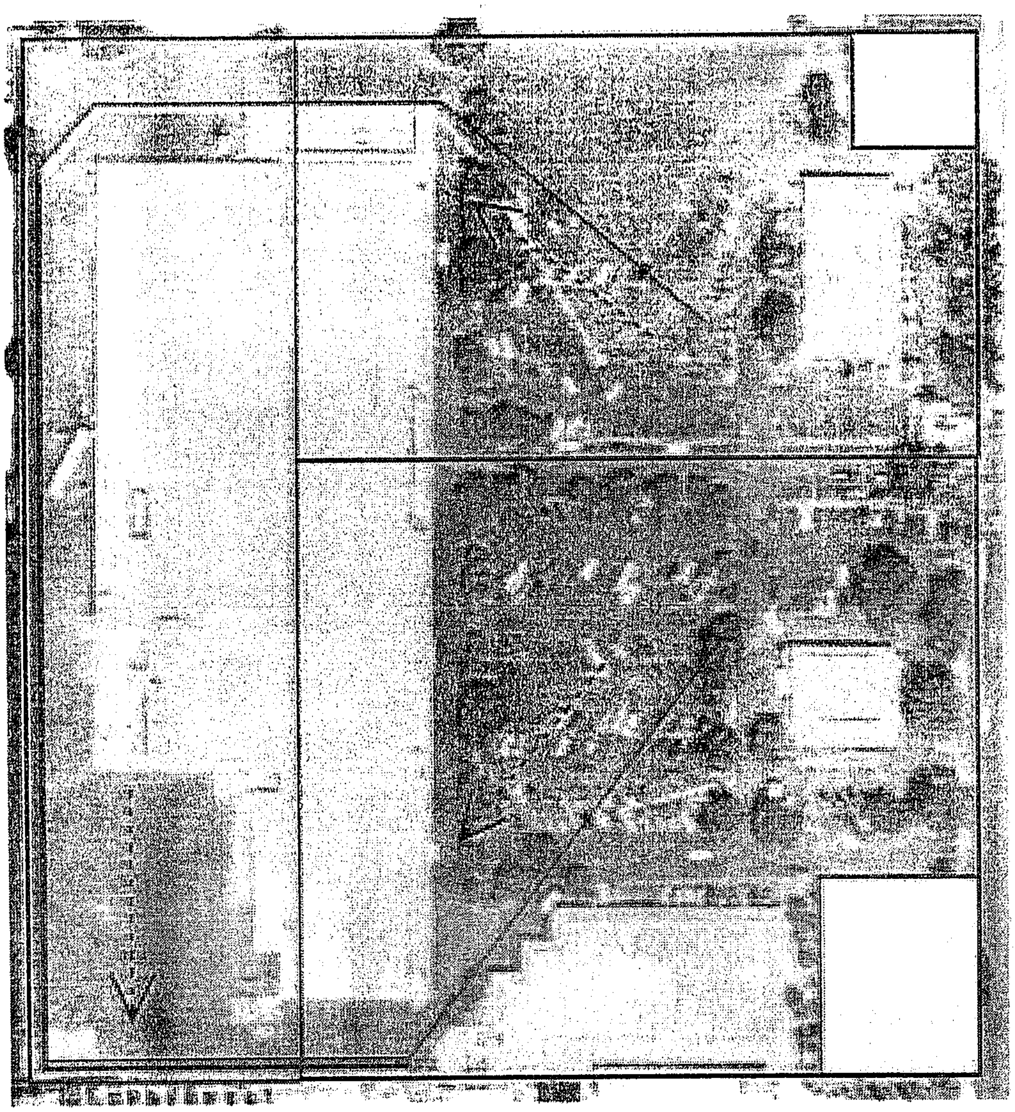

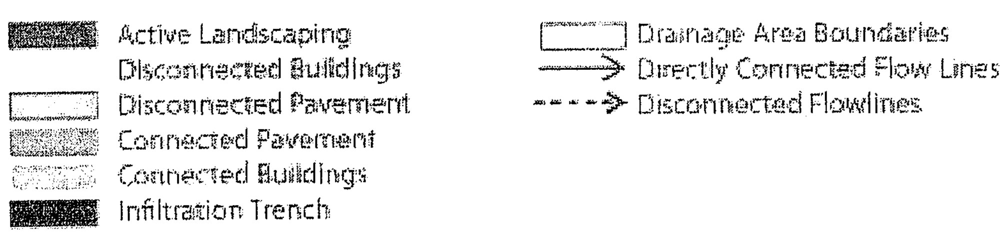

Figure 3: Illustration of LID BMPs to meet the low volume interpretation of draft permit requirements
(Background image from Google Earth™ 2008)

From Figure 3, it can be seen that much less impact results from implementing LID BMPs commensurate with the low volume interpretation of the draft permit requirements.

Conclusions

It is clear from the cost estimates in Table 3, that the proposed permit will significantly increase the drainage costs of urban redevelopment projects. These costs will vary widely, from approximately $0.2 million to $1.3 million in this case, based on interpretation of draft permit requirements.

The LID BMP costs of the high volume interpretation would challenge the feasibility of the total redevelopment, being as much as 22% of the total cost. The low volume interpretation can also be significant, being as much as 3% of the total cost.

It is also clear from Figure 2 and 3 that the ability to implement LID BMPs on the site without substantially reducing the developable area is dependent on the volumetric criterion that is selected. In the high volume scenario, the amount of area (approximately 10 percent of the site) is required for LID BMPs, while in the low volume scenario the area requirements are much less (approximately 1 percent of the site).

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ATTACHMENT B - Example LID and Hydromodification Metrics

ATTACHMENT B

Example LID and Hydromodification Metrics

Stormwater Management Manual for Western Washington

The Stormwater Management Manual for Western Washington establishes minimum requirements for new development and redevelopment projects of all sizes and provides guidance concerning how to prepare and implement stormwater site plans. The Department of Ecology updated the 2001 Stormwater Management Manual for Western Washington in 2005 to correct errors, clarify statements, update design criteria and procedures, and apply recent research. The Manual is intended to provide project proponents, regulatory agencies, and others with technically sound stormwater management practices which are presumed to protect water quality and instream habitat and to meet the stated environmental objectives of the applicable regulations. The following minimum requirements establish LID and hydromodification control performance standards:

Minimum Requirement #5: On-site Stormwater Management. Projects shall employ On-site Stormwater Management BMPs to infiltrate, disperse, and retain stormwater runoff onsite to the maximum extent feasible without causing flooding or erosion impacts. Roof Downspout Control BMPs, functionally equivalent to those described in Chapter 3 of Volume III, and Dispersion and Soil Quality BMPs, functionally equivalent to those in Chapter 5 of Volume V, shall be required to reduce the hydrologic disruption of developed sites.

The objective of this requirement is to use inexpensive LID practices on individual properties to reduce the amount of disruption of the natural hydrologic characteristics of the site. "Flooding and erosion impacts" include impacts such as flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks and roadways; earth movement/settlement, increased landslide potential; erosion, and other potential damage. Based upon gross level applications of continuous runoff modeling and assumptions concerning minimum flows needed to maintain beneficial uses, watersheds must retain the majority of their natural vegetation cover and soils, and development projects must meet the Flow Control Minimum Requirement (see Minimum Requirement #7 summarized below), in order to avoid significant natural resource degradation in lowland streams. The Roof Downspout Control BMPs and the Dispersion and Soil Quality BMPs are insufficient to prevent significant hydrologic disruptions and impacts to streams and their natural resources. Therefore, local governments should look for opportunities to encourage and require additional LID BMPs through updates to their site development standards, critical areas ordinances, and land use plans.

Minimum Requirement #7: Flow Control. Projects must provide flow control to reduce the impacts of stormwater runoff from impervious surfaces and land cover conversions. This requirement applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a river or stream, except for projects that discharge to a large river (Flow Control-Exempt Receiving Waters named in an appendix) in accordance with the following restrictions:

- Direct discharge to the exempt receiving water does not result in the diversion of drainage from any perennial stream classified as Types 1, 2, 3, or 4 in the State of Washington Interim Water Typing System, or Types "S", "F", or "Np" in the Permanent Water Typing System, or from any category I, II, or III wetland; and

- Flow splitting devices or drainage BMPs are applied to route natural runoff volumes from the project site to any downstream Type 5 stream or category IV wetland:

  - Design of flow splitting devices or drainage BMPs will be based on continuous hydrologic modeling analysis. The design will assure that flows delivered to Type 5 stream reaches will approximate, but in no case exceed, durations ranging from 50% of the 2-year to the 50-year peak flow.

  - Flow splitting devices or drainage BMP's that deliver flow to category IV wetlands will also be designed using continuous hydrologic modeling to preserve pre-project wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction; and

- The project site must be drained by a conveyance system that is comprised entirely of manmade conveyance elements (e.g., pipes, ditches, outfall protection, etc.) and extends to the ordinary high water line of the exempt receiving water; and
- The conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions (under current zoning) of the site, and the existing condition from non-project areas from which runoff is or will be collected; and
- Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under the conditions noted above.

The following require construction of flow control facilities and/or land use management BMPs that will achieve the standard requirement for western Washington:

- Projects in which the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area, or

- Projects that convert ¾ acres or more of native vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site, or
- Projects that through a combination of effective impervious surfaces and converted pervious surfaces cause a 0.1 cubic feet per second increase in the 100-year flow frequency from a threshold discharge area as estimated using the Western Washington Hydrology Model or other approved model.

That portion of any development project in which the above thresholds are not exceeded in a threshold discharge area shall apply Onsite Stormwater Management BMPs in accordance with Minimum Requirement #5.

State Water Board Construction General Permit

The State Water Resource Control Board's most recent draft of the Construction General Permit (CGP), released in March 2008, contains new development and redevelopment stormwater performance standards for regulated[29] construction projects located outside of a Phase I or Phase II jurisdiction that address water quality and hydromodification control.[30]

The CGP's performance standard related to water quality protection requires regulated projects to replicate the pre-project runoff volume for the 85th percentile storm event (or the smallest storm event that generates runoff, whichever is larger). The CGP emphasizes runoff reduction through onsite storm water reuse, interception, evapotranspiration, and infiltration through non-structural controls and conservation design measures. Dischargers are given the option of using an excel spreadsheet (provided in an appendix) to calculate the required runoff volume or a watershed process-based, continuous simulation model such as the EPA's Storm Water Management Model (SWMMM) or Hydrologic Simulation Program Fortran (HSPF).

The CGP's performance standard related to hydromodification control requires regulated projects to maintain predevelopment drainage densities and times of concentration in order to protect channels and encourages projects to implement setbacks to reduce channel slope and velocity changes that can lead to aquatic habitat degradation. The CGP also requires regulated projects to predict post-construction average annual soil loss using the RUSLE. Rather than prescribe a specific one-size-fits all modeling method in the CGP, the State Water Board staff intend to develop a stream power and channel evolution model-based framework to assess channels and to develop a hierarchy of suitable analysis methods and management strategies.

West Virginia Draft Phase II Permit

The draft West Virginia Phase II permit incorporates watershed protection elements and site and neighborhood design elements. The purpose of watershed protection elements is to manage the impacts of stormwater on receiving waters that occur because of regional or watershed-scale management decisions. The primary purpose of site and neighborhood design elements is to manage the impacts of stormwater on receiving waters that occur because of site and neighborhood design management decisions. The technical principles of these management practices have many complementary similarities, and must be implemented in tandem.

Watershed Protection Elements. The watershed protection elements must be incorporated into the subdivision ordinance or an equivalent document and into all relevant policy documents as they come up for regular review. Planning documents include comprehensive or master plans,

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[29] Construction activity subject to the General Permit includes any construction or demolition activity, clearing, grading, grubbing, or excavation or any other activity that results in a land disturbance if more than one acre is disturbed, is part of a larger plan, if the activity is part of more activities in a municipality's Capital Improvement Project Plan.

[30] Fact Sheet for Water Quality Order 2008-XX-DWQ State Water Resources Control Board (State Water Board) National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity (General Permit).

subdivision ordinances, general land use plans, zoning codes, transportation master plans, specific area plans, or unified development ordinances. The permit does not stipulate specific baselines or standards for these elements in order that the permittees may develop criteria that meet the characteristics of their watershed(s).

The permittees must develop quantifiable objectives, with a time frame for achieving them, for the following eight watershed elements:

(1) Minimize the amount of impervious surfaces (roads, parking lots, roofs, etc.) within each watershed, by minimizing the creation, extension and widening of parking lots, roads, and associated development.

(2) Preserve, protect, create and restore ecologically sensitive areas that provide water quality benefits and serve critical watershed functions. These areas may include, but are not limited to; riparian corridors, headwaters, floodplains and wetlands.

(3) Implement management practices that prevent or reduce thermal impacts to streams, including requiring vegetated buffers along waterways, and disconnecting discharges to surface waters from impervious surfaces such as parking lots.

(4) Prevent disturbances of natural water bodies and natural drainage systems caused by development, including roads, highways, and bridges.

(5) Avoid development in areas that are particularly susceptible to erosion and sediment loss.

(6) Implement standards to protect trees, and other vegetation with important evapotranspirative qualities.

(7) Implement policies to protect native soils, prevent topsoil stripping, and prevent compaction of soils.

(8) Implement water conservation policies that will reduce both stormwater and non- stormwater discharges via storm sewer systems.

Site and Neighborhood Design. The permittees must develop a program to protect water resources by requiring all new and redevelopment projects to control stormwater discharge rates, volumes, velocities, durations and temperatures. The permittee must implement and enforce via ordinance and/or other enforceable mechanism(s) the following requirements for new and redevelopment:

1. Site design standards for all new and redevelopment that require, in combination or alone, management measures that infiltrate, evapotranspirate, and reuse of, at a minimum, the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. This first one inch of rainfall must be 100% managed with no discharge to surface waters. An Underground Injection Control permit may be required when certain conditions are met.

2. The following additional water quality requirements, as applicable:

   a) A project with reasonable potential for pollutant loading(s) must provide water quality treatment for pollutants of concern (e.g., petroleum hydrocarbons at a vehicle fueling facility) before infiltration.

b) A project that cannot implement adequate preventive or treatment measures to ensure compliance with groundwater and/or surface water quality standards, must properly convey stormwater to a NPDES-permitted wastewater treatment facility or via a licensed waste hauler to a permitted treatment and disposal facility.

c) A project that discharges or proposes to discharge to any surface water or ground water that is used as a source of drinking water must comply with all applicable source water protection policies and plans.

3. When considered at the watershed scale, certain types of development can either reduce existing impervious surfaces, or at least create less 'accessory' impervious. Incentive standards may be applied to these types of projects. A reduction of 0.1 inches from the one inch infiltration/evapotranspiration/reuse standard may be applied to any of the following types of development. Reductions are additive such that a maximum reduction of 0.5 inch is possible for a project that meets all five criteria.

   a) Redevelopment
   b) Brownfield redevelopment
   c) High density (>7 units per acre)
   d) Vertical Density, (Floor to Area Ratio (FAR) of 2 or >18 units per acre)
   e) Mixed use and Transit Oriented Development (within ½ mile of transit)

4. For projects that cannot meet 100% of the infiltration/evapotranspiration/reuse requirement on-site, two alternatives are available: off-site mitigation and payment in lieu. The permittee must develop and fairly apply criteria for determining the circumstances under which these alternatives will be available. A determination that standards cannot be met on site may not be based solely on the difficulty or cost of implementing measures, but must include multiple criteria that would rule out an adequate combination of infiltration, evapotranspiration and reuse such as: too small a lot outside of the building footprint to create the necessary infiltrative capacity even with amended soils; a site use that is inconsistent with capture and reuse of stormwater; too much shade or other physical conditions that preclude adequate use of plants.

   These alternatives are only available, in combination or alone, for up to 0.4 inches of the original obligation at a 1:1.5 ratio, i.e., mitigation or payment in lieu must be for 1.5 times the amount of stormwater not managed on site. For either of these options to be available, the permittee must create an inventory of appropriate mitigation projects, and develop appropriate institutional standards and management systems to value, evaluate and track transactions.

   Off-site mitigation. Infiltration/evapotranspiration/reuse measures may be implemented at another location in the same sewershed/watershed as the original project, approved by the permittee. The permittee shall identify priority areas within the sewershed/watershed in which mitigation projects can be completed. Mitigation must be for retrofit or redevelopment projects, and cannot be applied to new development.

   Payment in lieu. Payment in lieu may be made to the permittee, who will apply the funds to a public stormwater project.

5. When public streets or parking lots are repaired, modified or reconstructed opportunities to improve stormwater management using infiltration and evapotranspiration measures shall be

included in the design work. During the next permit term formal design standards for streets and parking lots will be required per the street and parking design assessment undertaken this permit term.

Draft Etowah Aquatic Habitat Conservation Plan

The draft Habitat Conservation Plan (HCP) for the issuance of an Endangered Species Act Section 10(a)(1)(B) permit for Incidental Take in the Etowah watershed was prepared by a group of jurisdictions to mitigate take of the amber darter (Percina antesella), Etowah darter (Etheostoma etowahae) and Cherokee darter (Etheostoma scotti) and to assure their survival and recovery.[31] The Etowah River is a major headwater tributary of the Coosa River system in northern Georgia. The basin is exceptional for its aquatic biodiversity, with 76 extant native fish species, including three species listed under the Endangered Species Act (ESA) and six others that are considered imperiled but not currently listed. Five Federally listed mussel species were once found in the Etowah, though all but one are now considered extirpated. A species of brachycentrid caddisfly also is considered imperiled because it is believed to exist only in the Etowah and Hiawassee Rivers.

The Etowah Aquatic HCP Stormwater Management Policy was developed by a technical committee of professionals and local government staff from the Etowah watershed through several meetings from 2004 to 2006. It was the intent of the HCP Steering Committee that the Stormwater Management Policy be adopted by all jurisdictions participating in the HCP prior to receiving an Incidental Take Permit from US Fish and Wildlife Service and that, once implemented, the policy would help minimize and mitigate the take of imperiled aquatic species in the Etowah Watershed.

The stormwater management policy of the Etowah Aquatic HCP is centered around a stormwater ordinance adapted from the Metropolitan North Georgia Water Planning District ("Metro District") ordinance. The two ordinances are identical in many important respects so that jurisdictions within the Metro District can meet both requirements in a single set of regulations. Both ordinances include performance standards for water quality protection, stream channel protection, and flood protection. In addition, the Etowah Aquatic HCP stormwater ordinance includes a performance standard that limits the volume of runoff in areas most critical to the survival of fish species covered under the Etowah Aquatic HCP. This "Runoff Limit" standard is critical to protecting imperiled species of the Etowah.

The areas where the Runoff Limits apply are known as Priority Area 1 and Priority Area 2. Priority Area 1 is home to the most sensitive species protected by the HCP and so has the most restrictive standard. Priority Area 2 supports species that are less sensitive and has a less restrictive standard. Parts of the Upper Etowah that do not currently provide essential habitat to any imperiled fish are classified as Priority Area 3 and are not subject to the Runoff Limits. The Runoff Limit for a site in a Priority 1 area is equal to that of an undeveloped, forested site for the two-year design storm. That is, the volume of runoff for the site must not exceed the volume of

[31] Draft Etowah Aquatic Habitat Conservation Plan, December 14, 2007. http://www.etowahhcp.org/background/documents/2007_12_14_draft_etowah_hcp_sections_1-9.pdf.

runoff that would occur under a forested condition, for small storms, given the soils present. The Runoff Limit for a site in a Priority 2 area is set at the equivalent of 5% impervious cover. Therefore, new development and major redevelopment must employ stormwater management practices that make the site act as if it had no more than 5% impervious cover (and the remainder forested). In both Priority Areas 1 and 2, local governments can designate some locations as "development nodes," where Runoff Limits are significantly relaxed. The Runoff Limit for a development node is set at 50% of the actual impervious cover for the site. For example, a site with 60% impervious cover must reduce the runoff to the amount expected from the site if it had only 30% impervious cover (and the remainder forested).

To meet the Runoff Limits, developers can use "Better Site Design" techniques to reduce the amount of impervious cover, as well as various stormwater infiltration best management practices to return runoff to the soil. Use of these practices is supported by an engineering manual and by a training program. An optional Better Site Design checklist has been developed to assist local governments in working with developers in pre-construction meetings to use these practices. Jurisdictions are also encouraged to amend regulations to allow the use of all Better Site Design techniques, although this is not required.

County of Los Angeles Department of Public Works Low Impact Development Standards Manual

All new development and redevelopment under the jurisdiction of the County of Los Angeles is required to meet LID requirements. The goals of LID are to increase groundwater recharge, enhance water quality, and prevent degradation to downstream natural drainage courses.

Requirements for Small Scale Residential Projects

Residential development and redevelopment of 4 units or less, or remodels affecting more than 50 percent of the original home footprint are not required to complete hydrologic analysis for the project site, but must include at least 2 of the following items into the site design:

- Porous pavement: Install porous pavement that allows rainwater to infiltrate through it. Porous pavement includes, but is not limited to: porous asphalt, porous concrete, ungrouted paving blocks, and gravel. At least 50% of the pavement on the lot shall be porous.

- Downspout routing: Each roof downspout shall be directed to one of the following BMPs. The sum of the capacity of the downspout BMPs shall be at least 200 gallons.

    a. Cistern/rain barrel. Direct roof downspouts to a rain barrels or cisterns. The stored stormwater can then be used for irrigation or other nonpotable uses.

    b. Rain garden/planter box. Direct roof downspouts to rain gardens or planter boxes that provide retention and treatment of stormwater.

- Disconnect impervious surfaces. Slope driveways and other impervious surfaces to drain toward pervious surfaces. If possible, runoff should be directed toward vegetated areas or water quality BMPs. Limit the total area not directed toward vegetated areas or water quality BMPs to 10% or less of the area of the lot.

- Dry well. Install a dry well to infiltrate stormwater. The dry well shall be sized to hold at least 200 gallons of stormwater.

- Landscaping and landscape irrigation. Plant trees near impervious surfaces to intercept rainfall in their leaves. Trees planted adjacent to impervious surfaces can intercept water that otherwise would have become runoff. Two trees shall be planted on each parcel so that they overhang impervious surfaces. Install irrigation systems that minimize water usage and eliminate dry-weather urban runoff.

- Green roof. Install a green roof to retain and treat stormwater on the rooftop. A green roof shall cover at least 50% of the total rooftop area.

<u>Requirements For Large Scale Development</u>

All residential developments of 5 units or greater and all nonresidential developments shall follow the LID Hydrologic Analysis techniques outlined in the Hydrologic Analysis Section of this manual.

LID Requirements

Large scale residential and nonresidential development projects shall prioritize the selection of BMPs to treat stormwater pollutants, reduce stormwater runoff volume, and promote groundwater infiltration and stormwater reuse in an integrated approach to protecting water quality and managing water resources.

BMPs shall be implemented in the following order of preference:

1. BMPs that promote infiltration,
2. BMPs that store and beneficially use stormwater runoff,
3. BMPs that utilize the runoff for other water conservation uses including but not limited to BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs which percolate runoff through engineered soil and allow it to discharge downstream slowly.

If the Director of Public Works determines that compliance with the above 3 LID requirements is technically infeasible, in whole or in part, in response to an applicant's submittal, the Director shall require the applicant to submit a proposal for approval by the Director that incorporates design features demonstrating compliance with the LID requirements to the maximum extent practicable.

The LID goals of increasing groundwater recharge, enhancing water quality, and preventing degradation to downstream natural drainage courses shall be used in the evaluation, approval, and implementation of LID BMPs, as well as any determination of infeasibility.

Onsite Infiltration Requirements

The excess volume (ΔV) determined by the hydrologic analysis in Chapter 4 shall be infiltrated throughout the project site whenever possible. This can be accomplished on a lot-by-lot or on a sub-regional scale provided that equivalent benefit can be demonstrated. The following requirements apply:

- Infiltrate the ΔV from each lot at the lot level, or
- Infiltrate the ΔV from the entire project site, including streets and public right-of-way, in sub-regional facilities. The tributary area of a sub-regional facility shall generally be limited to 5 acres, but may be exceeded per the Director of Public Works.

Infiltration may not be possible in all development scenarios. Exceptions may include but are not limited to the following technical feasibility and implementation parameters:

- Locations where seasonal high groundwater is within 10 feet of the surface.
- Within 100 feet of a groundwater well used for drinking water.
- Brownfield development sites or other locations where pollutant mobilization is a documented concern.
- Locations with potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations with natural, undisturbed soil infiltration rates of less than 0.5 inches per hour that do not support infiltration-based BMPs.
- Locations where infiltration could cause adverse impacts to biological resources.
- Development projects in which the use of infiltration BMPs would conflict with local, state or federal ordinances or building codes.
- Health and Safety concerns

Onsite Storage and Reuse Requirements

When infiltration is not possible, on-site storage and reuse of the ΔV is the next preferred LID BMP option. Storage and reuse of the ΔV may not be possible in all development scenarios. Exceptions may include but are not limited to the following technical feasibility and implementation parameters:

- Projects that would not provide sufficient irrigation or (where permitted) domestic grey water demand for use of stored runoff due to limited landscaping or extensive use of low water use plant palettes in landscaped areas.

- Projects that are required to use reclaimed water for irrigation of landscaping.
- Development projects in which the storage and reuse of stormwater runoff would conflict with local, state or federal ordinances or building codes.
- Locations where storage facilities would cause potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer
- Health and Safety concerns

Water Conservation Requirements

When infiltration or storage and reuse of the ΔV is not possible, LID BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction, integrate multiple uses and/or BMPs which percolate runoff through engineered soil and allow it to discharge downstream slowly shall be implemented. These LID BMPs shall be sized to detain and treat the ΔV.

Infeasibility

Compliance with the LID requirements in this manual in whole or in part may not be feasible in all development scenarios. In these situations, the applicant shall demonstrate the infeasibility of compliance with the LID requirements and submit a proposal for approval by the Director that incorporates design features demonstrating compliance with the LID requirements to the maximum extent practicable.

Water Quality Treatment Requirements

The runoff from the water quality design storm event associated with the developed site hydrology described in Chapter 4 must be treated before discharge in compliance with the National Pollutant Discharge Elimination System Municipal Stormwater Permit for the County of Los Angeles.

Hydromodification Requirements

California Drainage Law is a complicated and complex area with respect to the rights of upper and lower landowners. Therefore, it is in everyone's best interest to require developments to analyze all the factors that may contribute to changed drainage characteristics, which may contribute to downstream drainage impacts (increased flooding and erosion). Below is an outline of the procedure required to analyze drainage impacts on off-site property.

1. All projects are required to conduct hydrology and hydraulic analysis for SUSMP, LID, 2, 5, 10, 25, and 50-year storm events per the LACDPW Hydraulic and Hydrology manuals.

2. HEC-RAS is required as the standard for analyzing changes in flow velocity. flow volume, and depth/width of flow for all natural drainage courses.
3. Sediment transport analysis using HEC-RAS, SAMS, and HEC-6 is required to determine long-term impacts of streambed accretion and degradation for major drainage courses with Capital Storm flow rates (Q) greater than 5,000 cubic feet per second.
3. All projects are required to fully mitigate off-site drainage impacts caused by hydromodification and changes in water quality, flow velocity, flow volume, and depth/width of flow under all 7 hydrologic scenarios above.
4. If not fully mitigated, the developer is required to obtain Drainage Acceptance letters from impacted downstream property owners. If Drainage Acceptance letters cannot be obtained and mitigation is not feasible, the developer must recommend to Regional Planning that a Statement of Overriding Consideration be included in the California Environmental Quality Act document to disclose that there will be significant unmitigated downstream drainage impacts.

Hydromodification Exemptions

All projects which comply with one or more of the following conditions are exempt from conducting a full analysis for hydromodification impacts. Applicants must still demonstrate that the project mitigates for hydromodification impacts to the satisfaction of the Director of Public Works.

- Projects that disturb less than one acre and add less than 10,000 square feet of new impervious area.
- Projects that do not increase impervious area or decrease the infiltration capacity of pervious areas compared to pre-project conditions.
- Projects that are replacement, maintenance, or repair of an existing permitted flood control facility.
- Projects within a watershed or sub-watershed where a geomorphically-based watershed study has been prepared that establishes that the potential for hydromodification impacts is not present based on appropriate assessment and evaluation of relevant factors, including: runoff characteristics, soils conditions, watershed size and conditions, channel conditions, and proposed levels of development within the watershed.
- Projects that discharge directly or via a storm drain into concrete or significantly hardened channels, which, in turn, discharge into a sump area under tidal influence, or other receiving water that is not susceptible to hydromodification impacts.
- Projects for which have hydrologic control measures that include sufficient sub-regional, regional, in-stream control measures, or a combination thereof such that hydromodification will not occur.

Geosyntec consultants

LARRY WALKER ASSOCIATES

Memorandum

Date: 9 April 2009

To: Mary Anne Skorpanich, Director, OC Watersheds Program

cc: Jeff Pratt, Public Works Director, County of Ventura

From: Eric Strecker, P.E. and Aaron Poresky, E.I.T Geosyntec Consultants
Malcolm Walker, P.E. Larry Walker and Associates

Subject: Response to Critical Comments on "Low Impact Development Metrics in Stormwater Permitting"

This document contains Geosyntec response to elements of "Critique of Certain Elements of 'Low Impact Development Metrics in Stormwater Permitting'" (Dr. Richard Horner, February 2009 (paper not dated))

Dr. Horner's paper is referenced in a subsequent memorandum from the Natural Resources Defense Council (NRDC) to Ms. Carolyn Beswick and Members of the Santa Ana RWQCB titled: *Draft NPDES Stormwater Permit for the County of Orange, Tentative Order R8-2008-0030.* Comments on Dr. Horner's critique expressed herein apply to the NRDC memorandum by extension.

1 Overview

1.1 Dr. Horner's paper critiques elements of "Low Impact Development Metrics in Stormwater Permitting" prepared by Geosyntec Consultants and Larry Walker Associates (Geosyntec and LWA, 2009). The critique questions several assumptions and assertions made in the case studies contained therein, disagrees with the recommendations of the study, and selects elements from the study that support the assertion that a 5% effective impervious area (EIA) standard is both widely feasible and effective.

2 General Responses

2.1 It appears that all parties are in agreement that an appropriate LID standard must be linked to a volumetric standard. One of the objectives of the Metric paper was to determine the practicality and environmental outcomes of the LID metrics proposed in the draft April 2008 Ventura Countywide permit and the November 2008 Orange Countywide permit. The Metrics paper addressed the lack of such a volumetric standard in the Draft Ventura County permit. Without a volumetric standard the EIA metric may be abused. It is acknowledged that a volumetric standard is included in the Draft Orange County permit.

2.2 Geosyntec and LWA do not agree with, nor does the Metrics paper support, the validity or effectiveness of a 5% EIA limit. While values in the range of 5% EIA have been found to correspond to a "threshold" for channel degradation in some studies, the use of these findings to support a 5% EIA standard for new development and redevlopment projects relies on two tenuous links. First, the definition of EIA contained in the two draft permits does not necessarily correspond to the definition employed by studies of the impacts of EIA. Second, the studies finding approximate thresholds of 5% EIA were based on watershed averages, not individual projects or parcels. The Metrics paper states that a volumetric criterion for LID implementation does not need to be linked to a specific spatial extent of disconnection and/or compliance on a lot-by-lot basis to be protective, and that establishing a lot-by-lot criterion could inadvertently cause adverse impacts to receiving water quality (e.g., could lead to sprawl or preclude infill/redevelopment projects from occurring).

2.3 From the arguments provided in the critique, it appears that Dr. Horner misinterpreted the context in which the LID provisions of the draft MS4 permits are proposed. The critique argues against a "delta volume" approach and for a "full volume approach" to LID sizing. We fully support the component of the draft permits that require <u>treatment</u> of the entire "water quality volume." The critique's apparent misunderstanding is to confuse the LID design standard with the water quality design standard. The bulk of the argument against a delta-volume as a LID sizing metric is based on this apparent misunderstanding and the resulting assumption that any volume above the delta volume would be allowed to discharge without treatment or hydrologic control. This is not the case for either the Ventura or Orange Countywide draft permits. Both the water quality treatment and hydromodification elements of the draft permits would prohibit this from occurring. This item is discussed further in Section 3.1 below.

2.4 Geosyntec and LWA do not agree with, nor does the Metrics paper support, the critique's assertion that infiltration and reuse are feasible in all densities and types of development. A variety of limitations can prevent infiltration on a project site which are typical in southern California. Dr. Horner's study "Investigation of the Feasibility and Benefits for Low-Impact Site Design Practices ("LID") for Ventura County" (Horner, 2007) does not consider site specific infiltration rates and other limitations on infiltration; rather, it relies on a modeling study that assumed rather high infiltration rates based on San Fernando Valley soil types and applied those results in a rather simplified way to different case studies for example projects from San Diego County. Geosyntec has previously prepared a critique of this study (Geosyntec, 2008) that found various misrepresentations of findings and problematic assumptions that tended to result in uncertainty about claims of feasibility and effectiveness of an EIA standard at all project densities.

2.5 Horner (2007) relies on capture and reuse as a fall-back strategy where infiltration is not feasible. Stormwater reuse for the purpose of stormwater management requires a sufficient demand during the wet season to replenish the capacity of storage units to be effective as a stormwater management device. Horner (2007) does not attempt to demonstrate the effectiveness of capture and reuse. It is well understood that if sufficient water demand does not exist during the rainy season, the volume of storage that can be made available for subsequent storms is minimized. This would result in overall poor performance of capture and reuse to achieve stormwater management goals. Furthermore the Metric paper would be remised if it did not acknowledge the "practicality" challenges that are associated with the implementation of capture and reuse options, such as building and health code compliance.

2.6 We appreciate the detailed comments the critique offers on the case studies contained in the Metrics paper. Several were well-founded and could be used to make the case studies more robust. However, it is apparent that several others were made without consideration for the stated purposed of the case studies and thus unfairly misrepresent the findings of these studies. The findings of the Metrics paper do not support a lot-by-lot EIA criterion. In fact, the case studies demonstrate that lot-by-lot EIA limits are not the only, nor necessarily the best, way to realize the benefits of LID. The scope of the studies is not broad enough to dismiss the feasibility of this criterion nor did it attempt to do so. The critique takes this lack of dismissal as support for a lot-by-lot EIA limit and labels important constraints identified by the case studies as simply "negative". The critique's detailed comments on specific assumptions are tangential to the underlying discussion of whether a lot-by-lot EIA limit is superior to more appropriate watershed-scale metrics that may be better linked to the resources they are attempting to protect, as well as supported by the research on the impacts of impervious area on riparian ecology.

3 Specific Responses to the Critique

3.1 **Selection of an LID Design Storm.** On pages 1 through 3, the critique references a variety of studies that have found that the "full water quality volume" (calculated in a variety of ways across the country) represents the "point of diminishing returns" for water quality improvement. While we believe that this assumption should always be confirmed through analysis of site-specific rainfall patterns, we are in general agreement. The recommendations of the Metrics paper are not to replace the established water quality treatment criteria with the LID criteria. Rather, the Metrics paper recommends that the LID criteria should be less than the full water quality criteria and allow for natural condition runoff potential to be factored into calculations.

It appears that Dr. Horner erroneously treats the LID and water quality provisions of the draft permits interchangeably. Among the various regulatory standards that the critique cites (Georgia, Washington, Maine, Pennsylvania, North Carolina), only one standard appears to require retention of a specific design storm (Pennsylvania). This standard requires <u>treatment</u> of the first 2" of runoff from all impervious surfaces and permanent removal (i.e., infiltration, ET, or reuse) of 1" of runoff from <u>new</u> impervious surfaces. This does not seem to represent a "full volume" standard, nor does it seem to be consistent with the logic that the critique uses to support a full retention standard. Note that this "standard" is in a guidance document that is a draft form and has not been adopted to date. The other standards that were mentioned only require <u>treatment</u> of the design storm. It is not clear how these example regulations support a standard that would require capture and infiltration or reuse of the entire water quality volume. .

3.2 **Performance of LID vs. WQ Design Storm.** The critique relies on an event-based methodology to illustrate the difference between a "delta volume" and "full volume" approach, which inherently over-states the difference between these two standards. The critique claims that a "delta volume" design storm would result in significant impacts while a full volume design storm would result in none. (P 2)

> *"When managing water quality, in contrast, any untreated volume (in the delta volume scenario, this would be the amount that originally flowed from the undeveloped land) would deliver to the receiving water the many pollutants characteristic of urban runoff. There, these pollutants would create negative physical, chemical, and biological effects. On the other hand, if the appropriate water quality volume is used (i.e. no less than the 85th percentile event)* ***the LID-based stormwater management BMPs should deliver no pollutants to the receiving water****, since the retention and reuse or infiltration of that volume is practicable and achievable, as I have demonstrated separately by analyzing a range of development scenarios in southern California."* [Emphasis added]

This excerpt shows an apparent misunderstanding of BMP performance factors. BMPs are not designed to capture all of the runoff volume from every storm, but only that volume up to the design storm volume (e.g., 0.75 inches). Thus, the argument above applies only to a specific storm depth for which the difference in performance for "full volume" BMPs and for "delta volume" BMP would be greatest. Long term performance of a BMP depends on the patterns of rainfall and the drawdown rate of the BMP in addition to the storage volume provided. All other factors equal, the use of a "delta volume" approach (i.e., a smaller storage volume) would indeed infiltrate a lower portion of the overall runoff than a "full volume" approach, but the difference may be something on the order of capturing 70% versus 80% of the average annual runoff volume, not an "all or nothing" outcome. As the critique points out, the difference between the "delta volume" and the "full volume" is small for the cases considered. The runoff that is between the difference of the "delta volume" and the "full volume" would still require treatment to remove pollutants before discharge, which is not considered in the critique.

3.3 **Use of Horner, 2007 as a Basis for Assumption of Feasibility**. Dr. Horner's critique refers to his study entitled "Investigation of the Feasibility and Benefits for Low-Impact Site Design Practices ("LID") for Ventura County" as evidence of the benefits and feasibility of LID implementation at all densities. Geosyntec has already provided a critique of this study (Geosyntec, 2008) in which we found:

- Three of the six case studies assumed a lower imperviousness than typical of their land use category. For example, the restaurant case study assumed an imperviousness of 49%, although the Ventura County Hydrology Manual lists an average imperviousness of 85% for this land use. Lower imperviousness yields less runoff-generating surface and more area available for infiltration.

- The study assumed that all of the pervious area would be available for infiltration; no reduction was made to account for necessary building setbacks or to account for scenarios in which some pervious area is upgradient of impervious area or otherwise not suitable for infiltration.

- Dr. Horner's study made questionable use of a study of the benefit of infiltration basins in the San Fernando Valley. Geosyntec's critique identifies issues with this study as well as issues in the applicability of this study to Dr. Horner's findings for Ventura County. For example, the San Fernando Valley study assumed infiltration rates of 0.5 to 2 inches per hour and made use of daily rainfall totals from a San Fernando gage. The 2007 study did not attempt to validate or adjust these assumptions for the range of rainfall and soil conditions present in Ventura County.

- In higher density development and in areas of Ventura County that experience larger rainfall events, the conclusions of Dr. Horner's study were not supported by his calculations. The 2007 study relied on a fall-back strategy of capture and reuse where infiltration would not be sufficient to mitigate stormwater runoff; however, the study did not evaluate the effectiveness or feasibility of this concept.

Overall, the findings of the Horner (2007) study do not appear to fully support the stated conclusions related to volume reduction and feasibility of meeting an EIA standard. Considering the simplifications that the study relied upon, we believe that there should be more qualifications of, or limitations on, the findings.

3.4 **Benefits of LID in Case Studies**. Dr. Horner's critique asserts that the case studies contained in the Metrics paper do not address the benefits of LID. First, the stated intent of the studies was to evaluate the feasibility of implementation of a variety of interpretations of an EIA standard for LID implementation. It was not to perform a cost-benefit analysis. The primary benefits of LID lie in the volume reduction it can achieve on suitable sites. In fact, each scenario was linked to the volume retained on-site, thereby implicitly describing the benefits of implementation. The studies identified different ways in which equivalent benefit could be achieved.

3.5 **Walnut Village assumption of infiltration rate**. The critique contends that an assumption of 0.2 inches per hour for B soils is too low, and that the study ignores a basic tenant of LID: that soils should not be compacted during development. This case study was of an actual redevelopment project in Anaheim that included underground parking under the majority of the site and landscaped areas typically measuring 4-8 feet in width between the adjacent roadways and building foundations. We would like to make several comments related to this contention:

- In redevelopment projects, the condition of underlying soils may be out of the control of the site design engineer. While it is considered a "best practice" to recondition soil through soil amendments, this practice can only be feasibly implemented to a certain depth. If a low permeability soil layer lies below this depth, whether due to prior site compaction or natural site conditions, then reconditioning the surface, while increasing moisture storage capacity, would not necessarily increase the rate at which moisture storage capacity can be regenerated by infiltration.

- Both roadways and building foundations require compaction of underlying soils for structural stability. In an ideal scenario, the soil underlying the thin strips of landscaping would not be compacted, however it may very well be within the practical influence area of adjacent compacted areas.

- In cases where the landscaped area is proximate to the foundation of the underlying garage, compaction may be required for structural purposes, and in fact, infiltration may be prohibited for structural reasons.

- Typical guidance in the design of infiltrative BMPs suggests a factor of safety to account for long-term degradation of infiltration rates. For example, the Stormwater Management Manual of Western Washington (WADOE, 2005) recommends a factor of safety of 4 for BMPs relying primarily on infiltration in soils with unadjusted infiltration rates from 0.5 to 8.0 inches per hour. Such guidance seems prudent where the result of failure is the discharge of greater volumes of runoff to receiving waters and/or long durations of standing water potentially leading to public health concerns. The critique cites a range from 0.57 in/hr to 1.4 in/hr for B soils from the NRCS soil survey, a source which generally considers soils in their natural state (NRCS, 2007). Quoting from this source (Section 630.0702):

  "As a result of construction or other disturbances, the soil profile can be altered from its natural state and the listed group assignments generally no longer apply, nor can any supposition based on natural soils be made that will accurately describe the hydrologic properties of the disturbed soil. In these circumstances, an onsite investigation should be made to determine the hydrologic soil group."

Factoring the effects of incidental compaction in the urban environment and a prudent factor of safety, the assumption of 0.2 inches per hour as a design infiltration rate for B soils is consistent with the critique's citations. While the critique accurately points out that a slightly higher assumption would indeed reduce the drawdown time to less than 72 hours, this does not negate the fact that with relatively deep BMPs over soils with low infiltration rates, limited storage capacity would be regenerated for sequential storms. Such sequential storm sets are responsible for a large fraction of total precipitation in Southern California.

3.6 **Walnut Village – "non-essential hardscape".** Geosyntec and LWA agree that in some cases more hardscape is used in development than necessary. However, it should not be taken as a given that landscaping is less expensive. The statement in the case study should have been "apparently non-essential hardscape". The case studies explicitly state that not all site-specific constraints could be evaluated. It is likely that some of the hardscape that was removed for the 0% EIA case could have been needed for ADA access or to meet parking standards, if the case study were to be evaluated more closely.

3.7 **60 California – appropriateness of greenroofs and cisterns.** We appreciate the critiques's perspective on the trend of BMPs towards greenroofs and reuse. We fully embrace these technologies in places where they can be demonstrated to have a good chance of success. However, the critique does not demonstrate that the use of greenroofs and stormwater reuse are commonplace. Currently, greenroofs have been implemented primarily in a few large cities and primarily on public buildings.

The critique refers to an established program of rainwater harvesting and reuse in Texas. While eastern Texas receives greater rainfall than Southern California, the critique states that western Texas "has rainfall conditions very much like southern California's". A detailed review of the Texas Rainwater Harvesting Guidelines (TWDB, 2005) showed that this program is primarily targeted toward using harvesting to meet water demands, not to control stormwater. It should also be noted that large parts of Texas receive summer rainfall in the form of thunderstorms which rarely, if ever, occur during the summer in Southern California. Figure 1 provides a summary comparison between precipitation and evapotranspiration patterns in western Texas versus southern California.

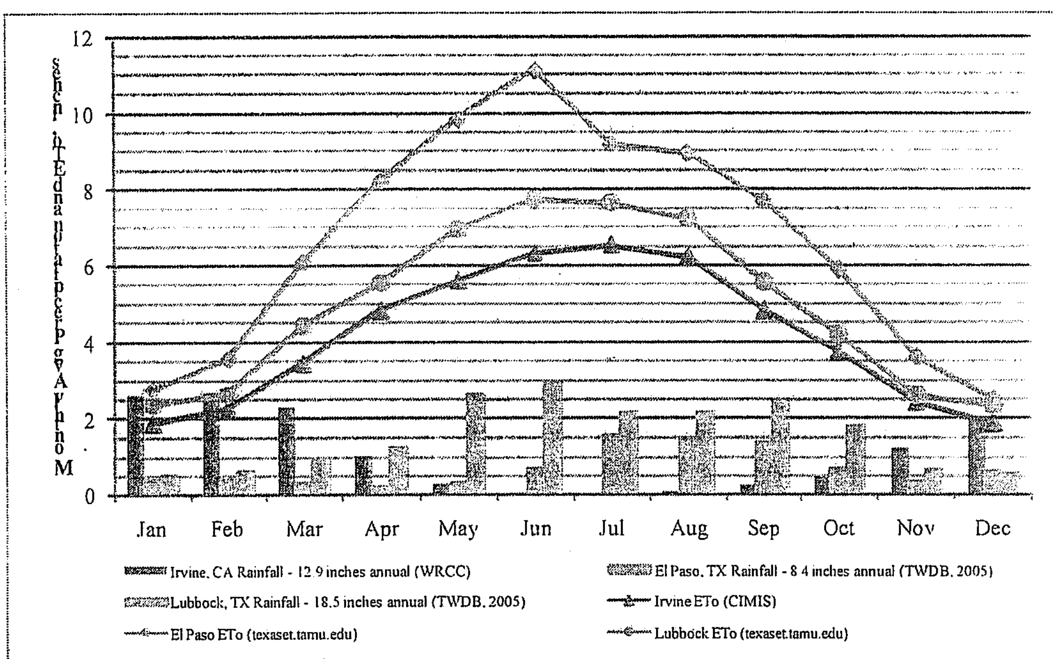

Figure 1: Comparison of precipitation and ET patterns between western Texas and southern California

Based on this preliminary comparison, western Texas appears to be a more favorable location than southern California for rainwater harvesting to manage stormwater impacts and meeting water demands. First, periods of higher rainfall are coincident with periods of higher ETo in west Texas, while the opposite is true in southern California. Second, rainfall occurs more steadily throughout the year in west Texas compared to the normally dry spring, summer and fall months of southern California.

3.8 **60 California – anticipated performance of greenroofs and cisterns.** The critique provides a somewhat vague defense for the performance of greenroofs in Southern California. One cited study found that a greenroof in Pennsylvania could reduce average annual runoff volumes by 50 percent. This study was compared to Southern California by saying that pan evaporation rates are between 3.3 and 4.2 inches per month in Pennsylvania from June to September (presumably a wet season in that locale) while November – February pan evaporation ranges from 3.5 to 4.0 in Los Angeles. A review of local ET data in Los Angeles County showed that this comparison is not valid. Monthly ET rates in Southern California range from about 1.5 to 2.5 from November through February. Also, rainfall is more seasonally concentrated in Southern California than in the mid-Atlantic region. Figures 2 and 3 below provide a comparison between Irvine, CA and the Washington, DC vicinity, for example.

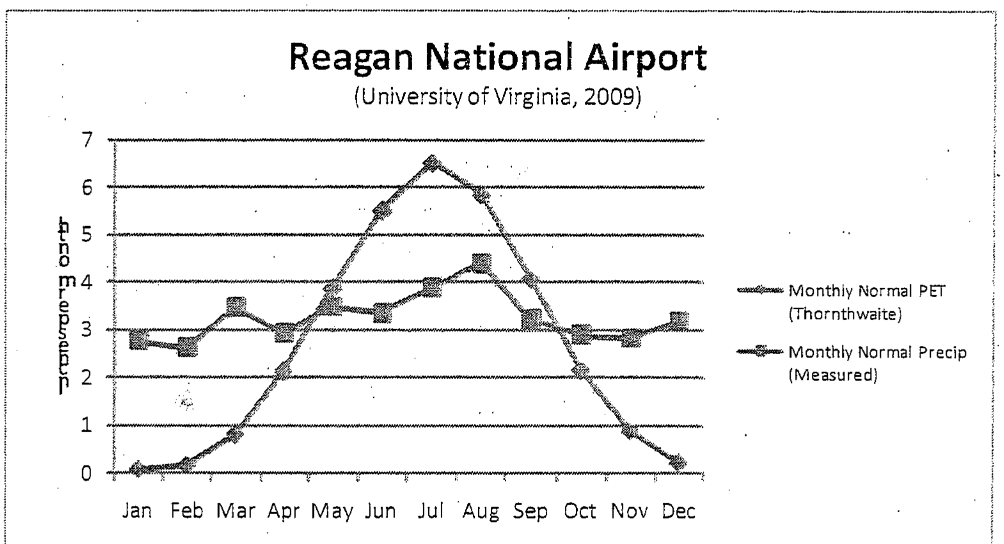

Figure 2: Monthly normal patterns of ET and precipitation at Reagan National Airport

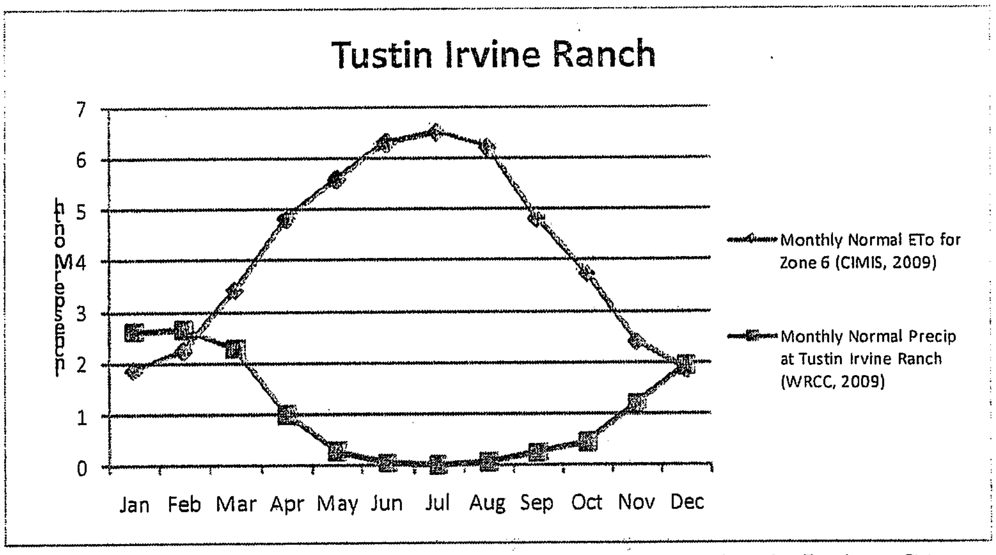

Figure 3: Monthly normal patterns of ET and precipitation in Irvine, CA

Dr. Horner states: "Therefore, Los Angeles has as much evaporation potential in the months when it most needs that potential as locations with successful green roofs elsewhere." Figure 2 shows that ET rates in December, January, and February are lower than the average precipitation. As precipitation is rarely average, on frequent occasions rainfall rates will significantly exceed ET rates. Thus Dr. Horner's conclusion does not seem to be supported by the examples provided.

Dr. Horner's critique does not address anticipated performance and feasibility of capture and reuse systems.

3.9 **60 California – regulatory barriers to indoor reuse**. We agree that codes should not be regarded as unbending. However, we feel it would not be responsible to discuss indoor reuse and its current feasibility without mentioning the current limitations and considering the time that may be needed to get code changes in place. We do not state that this should be basis for dismissing this approach.

3.10 **Ventura K-mart – scope of study**. We agree that the scope of this case study was too narrow to draw wide-ranging conclusions about cost. Likewise, the study did not "reject" tree boxes, bioretention, pervious pavement, green roofs, or water harvesting as the critique indicates. The study simply stated that two typical BMPs were chosen for evaluation. This is an issue of scope, not logic.

Dr. Horner himself took a simplified approach to costs by relying on the EPA report entitled: *Reducing Stormwater Costs through LID Strategies and Practices* (EPA 841-F-07-006, December 2007 - available for download at www.epa.gov/nps/lid). This report generally found that LID could result in cost savings. It is well understood that design criteria play a large factor in the cost of BMPs, however only two of 17 case studies contained in the EPA 2007 reported design criteria. Likewise, only three of 17 estimated performance. It is not clear whether these sites were designed to similar standards. It is also unclear whether these sites represent opportunistic examples (i.e., sites that had a natural fit for LID-type BMPs) or whether they are a true cross-section of development sites with the various inherent constraints.

Some of the studies contained in EPA (2007) relied on BMPs, such as narrowing street width and downspout disconnection, which would not be widely applicable to many high-density redevelopment projects. Of the BMPs contained in the case studies that would likely be used for higher-density projects (bioretention, permeable pavement, green roofs, and cisterns), permeable pavement was considered in only two of 17 case studies, and green roofs were considered in only one of the 17 studies (cost-benefit analysis showed substantially greater costs than benefits for this study). Cisterns with reuse were not considered in any of the 17 studies. Considering these factors, this source should not be relied upon solely in evaluating the costs of implementing the proposed permit requirements.

3.11 **Ventura K-mart – method of runoff estimation**. We agree that the NRCS curve number is not the best method to use for small storms, however the critique of this method is tangential to overall results, and use of the NRCS curve number method would actually tend to under-predict infrastructure requirements (i.e., cost). We appreciate this comment. It is noted that in Dr. Horner's previous evaluation of feasibility and effectiveness (Horner, 2007), the curve number method was used to establish the volume that would need to be infiltrated on-site.

3.12 **Ventura K-mart – assumption of infiltration rate**. We appreciate this correction. It appears that an adjustment factor was not applied as described in Section 3.5 to account for long-term decline in infiltration rate. Correction of this error would result in substantially increased infrastructure requirements (i.e., cost).

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ATTACHMENT C
LEGAL AND POLICY COMMENTS
FEBRUAY 24, 2009 TENTATIVE ORDER
VENTURA COUNTY MUNICIPAL SEPARATE STORM SEWER
SYSTEM PERMIT (NPDES NO. CAS004002)
FOR THE VENTURA COUNTY WATERSHED PROTECTION DISTRICT,
COUNTY OF VENTURA, AND INCORPORATED CITIES

I. Findings E.7 and E.25 – E.28 Exert Many Conclusions Of Law That Are Not Appropriate

In general, findings are required to "bridge the analytical gap between the raw evidence and ultimate decision or order." (*Topanga Assn. for a Scenic Community v. County of Los Angeles* (1974) 11 Cal.3d 506, 515 (*Topanga*); see also *In Re Petition of the City and County of San Francisco, et al.*, SWRCB Order 95-4 (Sept. 21, 1995) 1995 WL 576920 (*San Francisco Petition*) at pp. 4-5.) The findings at issue here fail to meet this essential test as they read more like a legal brief than regulatory finding that bridge the Los Angeles Regional Water Quality Control Board's (Regional Water Board) evidence to the permit provisions contained within the Tentative Order.

Under federal law, municipal storm water discharges must comply with section 402(p) of the Clean Water Act (CWA), which requires that cities reduce storm water to the maximum extent practicable (MEP). (33 U.S.C. § 1342(p)(3)(B)(iii).) "Congress did not require municipal storm-sewer discharges to comply strictly with [water quality standards]." (*Defenders of Wildlife v. Browner* (1999) 191 F.3d 1159, 1166.) Whenever a Regional Water Board imposes pollutant restrictions in a wastewater discharge permit *more stringent* than what federal law requires, California law requires the Regional Water Board to take into account the public interest factors of Water Code section 13241, which includes economic factors and the cost of compliance. (*City of Burbank v. State Water Resources Control Bd.* (2005) 35 Cal.4th 613, 627.) Thus, if the Regional Water Board seeks to impose any requirements that go beyond those set forth in section 402(p), the Regional Water Board must evaluate the public interest factors in Water Code section 13241 prior to permit adoption.

The Tentative Order attempts to disregard this important legal requirement by making findings that all provisions contained in the Tentative Order are part of a federal mandate. (Tentative Order at pp. 11, 21.) Through these findings, the Tentative Order tries to conclude that because the requirements are federally mandated, the Tentative Order does not require consideration of section 13241 factors, or constitute an unfunded local government mandate. As indicated above, findings are required to "bridge the analytical gap between the raw evidence and ultimate decision or order." (*Topanga, supra,* 11 Cal.3d at p. 515; see also *San Francisco Petition,* SWRCB Order 95-4, *supra,* at pp. 4-5.) The blanket statements made in the Tentative Order's findings fail to rise to a level necessary to serve as a bridge between evidence and the conclusion.

In general, municipal storm water programs are typically a combination of source controls and management practices that address targeted sources within a municipality's jurisdictional area.

(See National Pollutant Discharge Elimination System (NPDES) Permit Writers' Manual at p. 164.) Also, permit writers are instructed to rely on application requirements and management programs as proposed by the applicants when developing appropriate permit conditions. (See *id.* at p. 165.) Recent court decisions have also declared that the Regional Water Board may adopt water pollution controls in addition to those that come from MEP in order to meet water quality standards. (See *Building Industry Assn. of San Diego v. State Water Resources Control Bd.* (2004) 124 Cal.App.4th 866, 883.) Notwithstanding the recent court decisions that allow for additional discretion, many of the provisions contained in the Tentative Order may in fact exceed requirements associated with implementation of MEP and exceed requirements necessary to meet water quality standards. At the very least, the Tentative Order fails to properly connect the provisions as contained in the Tentative Order to federal requirements from the CWA through its findings. Our specific comments on the various elements of the findings in question are provided here.

A. Because Many Provisions In The Tentative Order May Exceed MS4 Storm Water Provisions As Mandated By Federal Law, Some Of The Provisions May Be Considered An Unfunded State Mandate

Finding E.7, in conjunction with Findings E.26 - E.27, assert that the Tentative Order "does not constitute an unfunded local government mandate subject to subvention under Article XIIIB, Section (6) of the California Constitution" because the Tentative Order implements "federally mandated requirements" under section 402 of the CWA. (Tentative Order at p. 11.) The Permittees object to these assertions on several grounds.

First, the Regional Water Board's jurisdiction does not include decisions or determinations regarding what is, or what is not an unfunded mandate subject to subvention under the California Constitution. The Regional Water Board's jurisdiction is limited to water quality and related functions. Decisions regarding what constitutes, or does not constitute, an unfunded mandate is for the Commission on State Mandates. (Gov. Code, §§ 17551 and 17552; see also *Lucia Mar Unified School Dist. v. Honig* (1988) 44 Cal.3d 830, 837 [the question must be decided by the Commission on State Mandates "in the first instance"].) "Whether a particular cost incurred by a local government arises from carrying out a state mandate for which subvention is required under *article XIII B, section 6*, is a matter for the Commission to determine in the first instance." (*County of Los Angeles v. Commission on State Mandates* (2007) 150 Cal.App.4th 898, 907 (*County of Los Angeles*), emphasis added.)

Second, the Permittees question the purpose and intent of this finding. As discussed above, findings are required to "bridge the analytical gap between the raw evidence and ultimate decision or order." (*Topanga, supra,* 11 Cal.3d at p. 515.) The Regional Water Board staff's purpose for including this finding is suspect as it raises an issue that has recently been unsuccessfully litigated in the recent *County of Los Angeles* case. (*County of Los Angeles*, *supra*, 150 Cal.App.4th 898.) In that case, the Court held that whether the permit obligation(s) in question constitutes a state or federal mandate is a question of fact which must be first addressed by the Commission on State Mandates. (*Id.* at pp. 917-918.) Thus, it is not appropriate for the Regional Water Board staff to propose a finding that attempts to make a conclusion of fact for the Commission on State Mandates.

Furthermore, even if a program is required in response to a federal mandate, a subvention of state funds may be in order. Government Code section 17556(c) provides that if a requirement was mandated by federal law or regulation, but the state "statute or executive order mandates costs that exceed the mandate in that federal law or regulation," a subvention of funds is authorized. Also, even if the costs were mandated to implement a federal program, if the "state freely chose to impose the costs upon the local agency as a means of implementing" that federal program, "the costs are the result of a reimbursable state mandate regardless whether the costs were imposed upon the state by the federal government." (*Hayes v. Commission on State Mandates* (1992) 11 Cal.App.4th 1564, 1594.) For example, the Tentative Order proposes to shift to the Permittees the state's responsibility to inspect and enforce its general industrial and construction storm water permits. Although municipal stormwater programs are required to include industrial and construction programs, the provisions in the Tentative Order relate to the state's general permits and are arguably an unfunded state mandate. (See Tentative Order at pp. 49-52, 71-73.)

Finally, the findings in question assert that provisions in the Tentative Order to implement total maximum daily loads (TMDLs) are also federal mandates. While it is true that waste load allocations (WLAs) in TMDLs must be reflected in NPDES permits as applicable, the manner in which the TMDL is implemented in the NPDES permit is not a federal mandate, but is left up to the state. (See *Pronsolino v. Nastri* (2002) 291 F.3d 1123, 1140.) Thus, as with the other aspects of the Tentative Order, implementation of applicable TMDL WLAs is not necessarily a federal mandate, immune from subvention of state funds. In summary, because this language is inappropriate for inclusion in the Tentative Order, we recommend that all findings and language related to this issue be removed from the Tentative Order.

B. Finding 7 Inappropriately Asserts That " 'Costs Incurred By Local Agencies To Protect Water Quality Reflect An Overarching Regulatory Scheme That Places Similar Requirements On Governmental And Nongovernmental Dischargers" (Tentative Order at p. 12)

The purpose of this language appears to be to hinder future test claims to the Commission on State Mandates regarding specific provisions contained in the Tentative Order. Under the logic contained in this paragraph, the Regional Water Board would find that as long as the requirements are placed on both government and nongovernmental dischargers, regardless of their legality, there is an over-aching regulatory scheme, and therefore no cost subject to state subvention. However, this is an overbroad view regarding the over-arching regulatory scheme. In this case, the regulatory scheme is the application of municipal storm water permit requirements, which are not equally applicable to governmental and nongovernmental dischargers. Thus, the assertion as contained in the finding is misplaced and should be removed.

C. Finding 7 Inappropriately Characterizes The Regulation Of Municipal Storm Water As Being More Lenient Than The Discharge Of Waste From Nongovernmental Sources (Tentative Order at p. 12)

The paragraph that characterizes the regulation of municipal storm water as being more lenient (i.e., "less stringent") than the regulation of discharges from nongovernmental sources is inappropriate. Municipal storm water is regulated pursuant to different standards, but simply because the standards are different does not necessarily mean that they are more lenient. Furthermore, the purpose for including this finding is vague and again fails to bridge the gap between evidence and provisions in the Order. Thus, this paragraph should be removed in its entirety.

D. Finding 7 Inappropriately Asserts That "Local Agency Permittees Have The Authority To Levy Service Charges, Fees, Or Assessments Sufficient To Pay For Compliance With This Order," And That "[L]ocal Agencies Can Levy Service Charges, Fees, Or Assessments On These Activities, Independent Of Real Property Ownership" (Tentative Order at p. 12)

The language contained in this finding is misleading as it fails to completely explain or characterize the overlay of Proposition 218 to assessments related to storm water drainage fees. First of all, storm water drainage fees are typically applicable to developed parcels of land within a municipality's jurisdiction and are not usually assessed based on business ownership. Thus, reliance on the California Supreme Court's decision in *Apartment Assn. of Los Angeles County, Inc. v. City of Los Angeles* is misplaced as that case hinges on the Court's finding that the relationship between the inspection fee at issue and property ownership was indirect. (*Apartment Assn. of Los Angeles County, Inc. v. City of Los Angeles* (2001) 24 Cal.4th 830, 843.)

Furthermore, it has subsequently been determined that storm water drainage fees are not subject to the exceptions for "sewer" and "water" service provided in article XIII D, section 6(c) of Proposition 218, and thus, such fees are subject to vote by either property owners in the affected area or voting residents. (See *Howard Jarvis Taxpayers Assn. v. City of Salinas* (2002) 98 Cal.App.4th 1351, 1358-1359 ["We conclude that article XIII D required the City to subject the proposed storm drainage fee to a vote by the property owners or the voting residents of the affected area."].) Thus, it goes without saying that a local agency's ability to levy storm drainage fees on its residents is restricted by the overlay of Proposition 218, which would require the agency to propose the assessment for approval by its voters before it could be assessed. The likelihood of success on such an assessment is unknown.

Because of the uncertainty associated with the Permittees' ability to levy new or increased fees for storm water, this paragraph should be deleted from the permit. At a minimum, Paragraph 5 of this finding should be revised to read as follows:

> Third, the ability of a local agency to defray the cost of a program without raising taxes is relevant to the question of whether a particular cost is subject to subvention. *(County of Fresno v. State of California* (1991) 53 Cal.3d 482, 487-488.) The local agency permittees have limited authority to levy service charges, fees, or assessments sufficient to pay for compliance with this Order. The fact sheet demonstrates that numerous activities contribute to the pollutant loading in the municipal separate storm sewer system. Local agencies can levy service charges, fees, or assessments on these activities, independent of real property ownership. (See, e.g., *Apartment Ass'n of Los Angeles County, Inc. v. City of Los Angeles* (2001) 24 Cal.4th 830, 842 [upholding inspection fees associated with renting property].) These fees may not exceed the reasonable cost of

providing service to the payer. (*Sinclair Paint Co. v. State Bd. of Equalization* (1997) 15 Cal.4th 866.) However, Proposition 218 prohibits a local government from imposing or increasing a fee for storm water related services without a vote of the electorate. (Cal. Const. Art. XIIID, § 6.c; *Howard Jarvis Taxpayers Assn. v. City of Salinas* (2002) 98 Cal.App.4th 1351.)

E. Finding 7 Inappropriately Asserts That Because The Permittees Have Requested BMPs In Lieu Of A Discharge Prohibition Or Numeric Restrictions It Has Voluntarily Availed Itself Of The Tentative Order And That The Program Is Not A State Mandate (Tentative Order at pp. 12-13)

The Tentative Order attempts to argue that because the Permittees "voluntarily" chose the type of permit that is being proposed, implementation of the provisions therein are not subject to state subvention. This logic is flawed. First, as discussed above, determinations regarding state subventions are properly made by the Commission on State Mandates, not the Regional Water Board. Second, the application of state subventions is a question of fact for the Commission on State Mandates. The Regional Water Board cannot pre-determine the Commission's findings under a proper test claim by claiming that the Permittees voluntarily chose the permit in question. Thus, the assertion contained in this paragraph should be deleted.

F. Finding 7 Inappropriately Asserts That The Permittees' Responsibility For Preventing Discharges Predates The Enactment Of Article XIII B, Section (6) Of The California Constitution (Tentative Order at p. 13)

This assertion attempts to put forward an argument that permit provisions as contained in this Tentative Order, and any other Order that may be issued to the Permittees in the future, are not subject to the state's constitutional provisions regarding state subvention because the Permittees had a responsibility to control discharges under state law before the constitutional provisions were adopted. We disagree with this conclusion; the Regional Water Board's adoption of each and every permit is a discrete action that may or may not include provisions that are appropriately subject to state subventions. Furthermore, such an argument is better left in a legal brief before a court. The Order is supposed to contain provisions related to the regulation of municipal storm water, not the state's legal arguments to challenges that may or may not occur on the provisions as contained in the Order. Thus, this paragraph should be removed in its entirety.

II. Total Maximum Daily Loads

The Tentative Order's approach to implement the WLAs in the TMDLs[1] is lawful and otherwise appropriate. Specifically, the use of BMPs in lieu of numeric effluent limits is consistent with the CWA, federal regulations and guidance, and case law. Further, the TMDLs call for the use of BMPs to implement the WLAs in permits issued under the NPDES program. Finally, the approach avoids potentially unreasonable and unintended policy-based consequences.

[1] The Tentative Order lists the relevant TMDLs adopted for water bodies in Ventura County at pages 15 to 17.

A. The Tentative Order's Use Of BMPs To Implement The WLAs In The TMDLs Is Consistent With Federal And State Law And Guidance

An NPDES permit typically must include water quality based effluent limits (WQBELs) where a discharge will cause, have the reasonable potential to cause or contribute to an excursion above a water quality standard. (40 C.F.R. § 122.44(d)(1).) When a TMDL is at issue, the WQBELs must be consistent with the assumptions and requirements of the WLAs for the discharge. (40 C.F.R. § 122.44(d)(1)(vii)(b).) Under federal and state law and guidance, WQBELs in NPDES municipal storm water permits may be—and generally should be—BMPs instead of numeric effluent limits.

Section 402(p) of the CWA authorizes the use of BMPs as WQBELs to control storm water discharges from MS4s. (33 U.S.C. § 1342(p)(3)(B)(iii); *Divers' Environmental Conservation Organization v. State Water Resources Control Bd.* (2006) 145 Cal.App.4th 246, 260 (*Divers'*).) In particular, NPDES storm water permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable, *including management practices*, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants."[2] (33 U.S.C. § 1342(p)(3)(B)(iii), emphasis added.) Accordingly, Congress intended to provide permitting authorities such as the Regional Water Board broad discretion to regulate storm water discharges—including the use of BMPs. (*Divers'* at p. 261.)

Moreover, the federal regulations direct NPDES permits to include BMPs as WQBELs to control pollutants in storm water discharges authorized under CWA section 402(p). (40 C.F.R. § 122.44(k)(2); *Divers', supra,* 145 Cal.App.4th at pp. 256-58.) Federal NPDES permitting guidance also expresses a preference to regulate storm water discharges by way of BMPs instead of numeric effluent limits. For example, the United States Environmental Protection Agency (USEPA) issued a policy in 1996 that recognized BMPs as the effluent limits typically most appropriate for NPDES storm water permits. (61 Fed.Reg. 43761 (Aug. 26, 1996).) USEPA confirmed this policy in 2002:

> EPA's policy recognizes that because storm water discharges are due to storm events that are highly variable in frequency and duration and are not easily characterized, only in rare cases will it be feasible or appropriate to establish numeric limits for municipal and small construction storm water discharges. The variability in the system and minimal data generally available make it difficult to determine with precision or certainty actual and projected loadings for individual dischargers or groups of dischargers. *Therefore, EPA believes that in these situations, permit limits typically can be expressed as BMPs, and that numeric limits will be used only in rare instances.* (Memorandum from R.H. Wayland, III,

[2] While this CWA provision expressly mentions management practices, it does not expressly mention "numeric" effluent limits. "Numeric" also does not appear in the CWA or federal regulations that broadly define "effluent limitation" to include BMPs as WQBELs. (33 U.S.C. § 1362(11); 40 C.F.R. § 122.2.) This further evinces that WQBELs may be BMPs instead of numeric. (See *Divers', supra,* 145 Cal.App.4th at p. 259; *Communities for a Better Environment v. State Water Resources Control Bd.* (2003) 109 Cal.App.4th 1089, 1104.)

and J.A. Hanlon to Water Division Directors (Nov. 22, 2002) re: *Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on those WLAs* at p. 4.)

Accordingly, neither federal law nor USEPA's long-standing policy supports the use of numeric effluent limits rather than BMPs.

B. The TMDLs Direct The Regional Water Board To Implement The WLAs In NPDES Permits By Way Of BMPs

The Tentative Order's BMP-based approach is also consistent with the applicable TMDLs. The TMDLs call for WQBELs in the form of BMPs instead of numeric effluent limits to implement the WLAs in NPDES permits. For example, the Calleguas Creek TMDLs for Toxicity, Organochlorine Pesticides and PCB and Metals and Selenium include similar language that states that NPDES should express storm water WLAs as BMPs:

> Storm water WLAs will be incorporated into the NPDES permit as receiving water limits measured at the downstream points of each subwatershed and will be achieved through the implementation of BMPs as outlined in the implementation plan. (Calleguas Creek TMDL for Toxicity at p. 7; Calleguas Creek TMDL for Organochlorine Pesticides & PCB at p. 10; Calleguas Creek TMDL for Metals and Selenium at p. 17.)

In addition, the Santa Clara River Nitrogen TMDL requires holders of MS4 permits to achieve reductions through BMPs. "Ammonia, nitrite, and nitrate reductions will be regulated through effluent limits prescribed in POTW and minor point source NPDES Permits, *Best Management Practices required in NPDES MS4 Permits* … ." (Santa Clara River Nitrogen TMDL at p. 8, emphasis added.)

Further, each TMDL implementation plan discusses BMPs appropriate to meet the MS4 allocation requirements. The purpose of each TMDL is to achieve the applicable receiving water objectives. The TMDL analyses indicate the assimilative capacity of the streams and loads each source may discharge to meet the objectives. The analyses recognize that discharges from a single storm water outfall could exceed water quality objectives but not cause the receiving water to exceed the objectives. As a result, the TMDLs assign WLAs to MS4 dischargers as a group and do not require WLAs or numeric WQBELs for individual outfall discharges. "In accordance with current practice, a group concentration-based WLA has been developed for all permitted storm water discharges, including municipal separate storm sewer systems (MS4s)." (Calleguas Creek Metals and Selenium TMDL at p. 17.) Accordingly, the intent of the TMDLs is to assign receiving water limits implemented through BMPs in the NPDES permit. The intent is not to assign the WLAs at the end of each major outfall and require whatever controls are necessary to achieve the limits.

C. The Use Of Numeric Effluent Limits In Lieu Of BMPs May Unreasonably Subject The Permittees To Certain Enforcement Provisions

The Tentative Order's use of BMPs instead of numeric effluent limits is a sound policy approach that avoids potentially unreasonable and unintended consequences. The use of numeric effluents to implement the TMDL WLAs may subject the Permittees to mandatory minimum penalties where deemed a "serious violation" under the Water Code or where there are four or more violations in any six-month period. Further, the violation of numeric effluent limits could subject the Permittees to additional enforcement through administrative civil liability and/or third party lawsuits. The threat or potential jeopardy of such liability is unreasonable particularly since the TMDL implementation plans and applicable law provide for BMP-based effluent limits to implement the WLAs.