THOUGHTS FOR WASHINGTON DEPARTMENT OF ECOLOGY'S CONSIDERATION OF LOW IMPACT DEVELOPMENT

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Clarity in Definitions

Analysis

State-of-the-art methods are what most call low impact development (LID) techniques and the National Research Council's (2008) report termed aquatic resources conservation design (ARCD). Mechanistically, these methods embrace infiltration, evapotranspiration (ET), and harvesting precipitation for a beneficial use.

From a process standpoint the methods include an array of practices: (1) preservation of existing vegetation and soils; (2) numerous site design strategies intended to reduce creation of impervious surfaces, such as clustering buildings and related developed features; narrowing streets, driveways, and parking areas; and covering parking; (3) bioretention cells, channels, and filter strips (retention indicates that precipitation is prevented from being converted to surface runoff through the previously listed mechanisms); (4) stormwater planters of various designs, which essentially are small-scale bioretention cells; (5) permeable paving; (6) green roofs; (7) water-storage cisterns and tanks; and (8) roof runoff subsurface drain systems and other applications of infiltration trenches.

The best strategy for choosing among and implementing these practices is an integrated one making maximum possible use of the first two listed and then selecting among the remaining ones in relation to the localized and overall site conditions. Preservation of existing vegetation and soils obviously avoids post-development runoff quantity and pollutant increases from any portion of the site that can be so treated. Among all strategies, this one best maintains pre-development hydrology (infiltration and ET patterns) and yield of materials flowing from the site. This preventive strategy is supplemented by the minimization one of creating as little impervious cover as possible. The remaining practices then contend with the excess runoff and pollutants over pre-development levels generated by the development. In specifying these practices equal attention should be given to all three LID mechanisms, without over-reliance on infiltration, for several reasons. First, in a natural landscape retention is somewhat balanced between infiltration and ET; maintaining a semblance of that balance best replicates pre-development hydrology. Second, there are legitimate circumstances where infiltration potential is limited (e.g., heavy clay soils, very high water table or bedrock) or should not be induced beyond what would occur in the natural landscape (e.g., where percolating water could mobilize subsurface contaminants). Then ET and, especially, harvesting mechanisms still provide opportunities to retain water under such circumstances.

In their fullest development soil- and vegetative-based practices have such attributes as: (1) soils amended, usually with organic compost, if necessary to maximize water storage and subsequent infiltration and ET; (2) vegetation in several canopy layers (e.g., small herbaceous growth, bushes, trees) to promote diverse quantity and quality management mechanisms, such as ET,

infiltration (enhanced by the well developed root structures of larger plants), particle filtering, and surface-based pollutant reduction processes like biodegradation, adsorption, absorption, and ion exchange; (3) absence of an impermeable liner, for maximum infiltration opportunity; and (4) absence of an underdrain connected to a storm sewer, which creates surface runoff that might otherwise be retained on-site.

Recommendation

The outcome should reflect the ideas in the above paragraphs, including the distinction between mechanisms and practices, the integrated, hierarchical strategy set forth, and the attributes to gain the best retention of runoff and pollutants.

Maximizing Use of State-of-the-Art Methods

Analysis

Thorough and effective use ARCD methods can usually prevent discharge of the whole water quality volume. These methods can often or even usually prevent the discharge of the differential between the pre- and post-development peak flow rate and volume for channel protection. They can sometimes or even often prevent the discharge of the differential between the pre- and post-development peak flow rates and volume for overbank flood protection and extreme flood protection. The capabilities have been demonstrated in field and theoretical studies to which this reviewer has contributed (Horner 2006; Horner 2007a, b, c; Chapman and Horner in press; Horner and Chapman 2007; Horner, Lim, and Burges 2004).

Recommendation

An improved, mandatory approach would have the following features:

1. A requirement to prevent, to the maximum possible extent, discharge from the site, on the surface or in a storm drain system, any quantity of runoff equivalent to the designated water quality volume or any quantity that would exceed the designated channel protection requirements;

2. If requirement 1 cannot be met, a requirement to demonstrate and justify convincingly, according to specific criteria, why it is not achievable; and

3. If such a convincing demonstration and justification can be made, a requirement to make up any shortfall in meeting requirement 1 by performing or contributing to a project off the site but within the same watershed to prevent discharge equivalent to the on-site shortfall (the project can initiated by the developer or involve a payment to support a regional installation established for the purpose by a public jurisdiction).

Example Relevant Provisions from Elsewhere

From **Orange County, CA municipal stormwater permit** paragraph L.61 (subject: prioritization of strategies):

> This order requires the project proponents to first consider preventative and conservation techniques (e.g., preserve and protect natural features to the maximum extent practicable) prior to considering mitigative techniques (structural treatment, such as infiltration systems). The mitigative measures should be prioritized with the highest priority for BMPs that remove storm water pollutants and reduce runoff volume, such as infiltration, then other BMPs, such as harvesting and re-use, evapotranspiration and bio-treatment should be considered. These LID BMPs must be implemented at the project site in a manner consistent with the maximum extent practicable standard. Where LID BMPs are not feasible at the project site, more traditional, but equally effective control measures should be implemented.

From **Orange County, CA municipal stormwater permit** paragraph XII.C.2 (subject: requirement to manage water quality volume on-site using LID mechanisms):

> The permittees shall reflect in the WQMP and otherwise require that each priority development project infiltrate, harvest and re-use, evapotranspire, or bio-treat the 85th percentile storm event ("design capture volume"), as specified in Section XII.B.4.A.1, above. Any portion of the design capture volume that is not infiltrated, harvested and re-used, evapotranspired or bio-treated onsite by LID BMPs shall be treated and discharged in accordance with the requirements set forth in Section XII.C.7 and/or Section XII.E, below.

From **Orange County, CA municipal stormwater permit** paragraph XII.C.3 (subject: requirement to replicate pre-development hydrology through LID mechanisms and practices):

> The permittees shall incorporate LID site design principles to reduce runoff to a level consistent with the maximum extent practicable standard during each phase of priority development projects. The permittees shall require that each priority development project include site design BMPs during development of the preliminary and final WQMPs. The design goal shall be to maintain or replicate the pre-development hydrologic regime through the use of design techniques that create a functionally equivalent post-development hydrologic regime through site preservation techniques and the use of integrated and distributed micro-scale storm water infiltration, retention, detention, evapotranspiration, filtration and treatment systems as close as feasible to the source of runoff.

From **Orange County, CA municipal stormwater permit** paragraph XII.C.4 (subject: hierarchy of strategies):

> The selection of LID principles shall be prioritized in the following manner (from highest to the lowest priority): (1) Preventative measures (these are mostly non-structural

measures, e.g., preservation of natural features to a level consistent with the maximum extent practicable standard; minimization of runoff through clustering, reducing impervious areas, etc.) and (2) Mitigation (these are structural measures, such as, infiltration, harvesting and reuse, bio-treatment, etc. The mitigation or structural site design BMPs shall also be prioritized (from highest to lowest priority): (1) Infiltration (examples include permeable pavement with infiltration beds, dry wells, infiltration trenches, surface and sub-surface infiltration basins.

From **Orange County, CA municipal stormwater permit** paragraph XII.C.7 (subject: compensation if requirements cannot be met on-site):

> If site conditions do not permit infiltration, harvesting and re-use, and/or evapotranspiration, and/or bio-treatment of the design capture volume at the project site as close to the source as possible, the alternatives discussed below should be considered and the credits and in-lieu programs discussed under Section E, below, may be considered:
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> a. Implement LID principles at the project site. This is the preferred approach. For example, in a single family residential development: connect roof drains to a landscaped area, divert driveway runoff to a vegetated strip and minimize any excess runoff generated from the development. The pervious areas to which the runoff from the impervious areas are connected should have the capacity to infiltrate, harvest, evapotranspire and/or bio-treat and re-use at least the design capture volume.
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> b. Implement as many LID principles as possible at the project site close to the point of storm water generation and infiltrate and/or harvest and re-use at least the design capture volume through designated infiltration/treatment areas elsewhere within the project site. For example, at a condominium development: connect the roof drains to landscaped areas, construct common parking areas with pervious asphalt with a sub-base of rocks or other materials to facilitate percolation of storm water, direct road runoff to curbless, vegetated sidewalks. The pervious areas which receive runoff from impervious areas should have the capacity to infiltrate, harvest and re-use, evapotranspire and/or bio-treat at least the design capture volume.
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> c. Implement LID on a sub-regional basis. For example, at a 100 unit high density housing unit with a small strip mall and a school: connect all roof drains to vegetated areas (if there are any vegetated areas, otherwise storm water storage and reuse may be considered or else divert to the local storm water conveyance system, to be conveyed to the local treatment system), construct a storm water infiltration gallery below the school playground to infiltrate and/or harvest and re-use the design capture volume. The pervious areas to which the runoff from the impervious areas are connected should have the capacity to infiltrate, harvest and re-use, evapotranspire and/or bio-treat at least the design capture volume. (Also see discussion on hydrologic conditions of concern, below.)

d. Implement LID on a regional basis. For example, several developments could propose a regional system to address storm water runoff from all the participating developments. The pervious areas to which the runoff from the impervious areas are connected should have the capacity to infiltrate, harvest and re-use, evapotranspire and/or bio-treat at least the design capture volume from the entire tributary area. (Also see discussion on hydrologic conditions of concern, below.)

From **Orange County, CA municipal stormwater permit** paragraph XII.E (subject: compensation if requirements cannot be met on-site):

1. Within 12 months of adoption of this order, the principal permittee, in collaboration with the co-permittees, shall develop technically-based feasibility criteria for project evaluation to determine the feasibility of implementing LID BMPs (feasibility to be based in part, on the issues identified in Section XII.C). This plan shall be submitted to the Executive Officer for approval. Only those projects that have completed a vigorous feasibility analysis as per the criteria developed by the permittees and approved by the Executive Officer should be considered for alternatives and in-lieu programs. If a particular BMP is not technically feasible, other BMPs should be implemented to achieve the same level of compliance, or if the cost of BMP implementation greatly outweighs the pollution control benefits, a waiver of the BMPs may be granted. All requests for waivers, along with feasibility analysis including waiver justification documentation, must be submitted to the Executive Officer in writing, 30 days prior to permittee approval.

2. The permittees may collectively or individually propose to establish an urban runoff fund to be used for urban water quality improvement projects within the same watershed that is funded by contributions from developers granted waivers. The contributions should be at least equivalent to the cost savings for waived projects and the urban runoff fund shall be expended for water quality improvement or other related projects approved by the Executive Officer within two years of receipt of the funds.

From **Ventura County, CA municipal stormwater permit** paragraph 4.E.III. (subject: requirement to manage water quality volume on-site using LID mechanisms):

1. Integrated Water Quality/Flow Reduction/Resources Management Criteria

   (a) Except as provided in subpart 5.E.III.1.(c) below, Permittees shall require all New Development and Redevelopment projects identified in subpart 4.E.II to control pollutants, pollutant loads, and runoff volume emanating from impervious surfaces through infiltration, storage for reuse, evapo-transpiration, or bioretention/biofiltration by reducing the percentage of Effective Impervious Area (EIA) to 5 percent or less of the total project area.

   (b) Impervious surfaces may be rendered “ineffective,” and thus not count toward the 5 percent EIA limitation, if the stormwater runoff from those

surfaces is fully retained onsite for the design storm event specified in provision (c), below. To satisfy the EIA limitation and low-impact development requirements, the permittees must require stormwater runoff to be infiltrated, reused, or evapotranspired onsite through a stormwater management technique allowed under the terms of this permit and implementing documents.

(c) The permittees shall require all features constructed or otherwise utilized to render impervious surfaces "ineffective," as described in provision (b), above, to be properly sized to infiltrate, store for reuse, or evapotranspire, without any runoff, at least the volume of water that results from:

(1) The 85th percentile 24-hour runoff event determined as the maximized capture stormwater volume for the area using a 48 to 72-hour draw down time, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998);

(2) The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in the Ventura County Technical Guidance Manual for Storm Water Quality Control Measures (July 2002 and its revisions); or

(3) The volume of runoff produced from a 0.75 inch storm event.

(d) To address any impervious surfaces that may not be rendered "ineffective," surface discharge of stormwater runoff, if any, that results from New Development and Redevelopment projects identified in subpart 4.E.II which have complied with subparts 4.E.III.1(a)-(c), above, shall be mitigated in accordance with subpart 4.E.III.1.(c).

From **Ventura County, CA municipal stormwater permit** paragraph 4.E.III (subject: criteria for alternative compliance):

2. Alternative Compliance for Technical Infeasibility

(a) To encourage smart growth and infill development of existing urban centers where onsite compliance with post-construction requirements may be technically infeasible, the permittees may allow projects that are unable to meet the Integrated Water Quality/Flow Reduction/Resources Management Criteria in subpart 4.E.III.1, above, to comply with this permit through the alternative compliance measures described in subpart 4.E.III.2, below.

(b) To utilize alternative compliance measures, the project applicant must demonstrate that compliance with the applicable post-construction requirements would be technically infeasible by submitting a site-specific hydrologic and/or design analysis conducted and endorsed by a registered professional engineer, geologist, architect, and/or landscape architect. Technical infeasibility may result from conditions including the following:

(1) Locations where seasonal high groundwater is within 5 feet of the surface;

(2) Locations within 100 feet of a groundwater well used for drinking water;

(3) Brownfield development sites or other locations where pollutant mobilization is a documented concern;

(4) Locations with potential geotechnical hazards;

(5) Smart growth and infill or redevelopment locations where the density and/or nature of the project would create significant difficulty for compliance with the onsite volume retention requirement; and

(6) Other site or implementation constraints identified in the LID Technical Guidance document required by subpart 4.E.IV.5.

From **Ventura County, CA municipal stormwater permit** paragraph 4.E.III.2 (subject: compensation if requirements cannot be met on-site):

(c) Alternative Compliance Measures. When a permittee finds that a project applicant has demonstrated technical infeasibility, the permittee shall identify alternative compliance measures that the project will need to comply with as a substitute for the otherwise applicable post-construction requirements listed in subparts 4.E.III.1(a)-(c) of this permit. The Ventura County Technical Guidance Manual shall be revised to identify the alternative compliance measures and shall include the following requirements:

(1) Minimum onsite requirement. The project must reduce the percentage of Effective Impervious Area to no more than 30 percent of the total project area and treat all remaining runoff, pursuant to the design and sizing requirements of subparts 4.E.III.1(b)-(d).

(2) Offsite mitigation volume. The difference in volume between the amount of stormwater infiltrated, reused, and/or evapotranspired

by the project onsite and the otherwise applicable requirements of subparts 4.E.III.1(a)-(c) (the "offsite mitigation volume"), above, must be mitigated by the project applicant either by performing offsite mitigation that is approved by the permittee or by providing sufficient funding for public or private offsite mitigation to achieve equivalent stormwater volume and pollutant load reduction through infiltration, reuse, and/or evapotranspiration.

(3) Location of offsite mitigation. Offsite mitigation projects must be located in the same sub-watershed (defined as draining to the same hydrologic area in the Basin Plan) as the new development or redevelopment project. A list of eligible public and private offsite mitigation projects available for funding shall be identified by the Permittees and provided to the project applicant. Offsite mitigation projects include green streets projects, parking lot retrofits, other site specific LID BMPs, and regional BMPs. Project applicants seeking to utilize these alternative compliance provisions may propose other offsite mitigation projects, which the Permittees may approve if they meet the requirements of this subpart.

(4) Timing and Reporting Requirements for Offsite Mitigation Projects. The Permittee(s) shall develop a schedule for the completion of offsite mitigation projects, including milestone dates to identify, fund, design, and construct the projects. Offsite mitigation projects shall be completed as soon as possible, and at the latest, within 4 years of the issuance of the certificate of occupancy for the first project that contributed funds toward the construction of the offsite mitigation project, unless a longer period is otherwise authorized by the Executive Officer. For public offsite mitigation projects, the permittees must provide in their annual reports a summary of total offsite mitigation funds raised to date and a description (including location, general design concept, volume of water expected to be retained, and total estimated budget) of all pending public offsite mitigation projects. Funding sufficient to address the offsite mitigation volume must be transferred to the permittee (for public offsite mitigation projects) or to an escrow account (for private offsite mitigation projects) within one year of the initiation of construction.

(5) The project applicant must demonstrate that the EIA achieved onsite is as close to 5 percent EIA as technically feasible, given the site's constraints.

(d) Watershed equivalence. Regardless of the methods through which permittees allow project applicants to implement alternative compliance

measures, the sub-watershed -wide (defined as draining to the same hydrologic area in the Basin Plan) result of all development must be at least the same level of water quality protection as would have been achieved if all projects utilizing these alternative compliance provisions had complied with subparts 4.E.III.1(a)-(d) of the permit. The permittees shall provide in their annual report to the Regional Board a list of mitigation project descriptions and pollutant and flow reduction analyses (compiled from design specifications submitted by project applicants and approved by the permittee(s)) comparing the expected aggregate results of alternative compliance projects to the results that would otherwise have been achieved by meeting the 5 percent EIA requirement onsite.

From **West Virginia General National Pollution Discharge Elimination System Water Pollution Control Permit** paragraph II.C.b.5.ii.A (subject: requirement to manage water quality volume on-site using LID mechanisms and practices):

> *Performance Standards.* 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 keep and manage on site the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. Runoff volume reduction can be achieved by canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration and/or evapotranspiration and any combination of the aforementioned practices. This first one inch of rainfall must be 100% managed with no discharge to surface waters, except when the permittee chooses to implement the conditions in paragraph 4 below. This can be achieved through on site utilization of practices to include dry swales, bioretention, rain tanks and cisterns, soil amendments, roof top disconnections, permeable pavement, porous concrete, permeable pavers, reforestation, grass channels, green roofs and other practices that alone or combined will capture the first one inch of rainfall runoff volume. Extended filtration practices that are designed to capture and retain up to one inch of rainfall may discharge volume in excess of the first inch through an under drain system. An Underground Injection Control permit may be required when certain conditions are met.

From **West Virginia General National Pollution Discharge Elimination System Water Pollution Control Permit** paragraph II.C.b.5.ii.A.4 (subject: compensation if requirements cannot be met on-site):

> For projects that cannot meet 100% of the runoff reduction requirement on site, two alternatives are available: off-site mitigation and payment in lieu. If these alternatives are chosen, then 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 the practices set forth in section 1, above, such as: too small a lot outside of the building footprint to create the necessary infiltrative capacity even with amended soils; soil instability as documented by a thorough geotechnical analysis; 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. In instances where alternatives to complete on site management of the first inch of rainfall are chosen, technical justification as to the infeasibility of on site management is required to be documented.

These alternatives are available, in combination or alone, for up to 0.6 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. If, as demonstrated to the permittee, it is technically infeasible to manage on site a portion of all of the remaining 0.4 inches, off site mitigation or payment in lieu will be applied at a 1:2 ratio for that portion. For any 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. Runoff reduction practices 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. The permittee shall determine who will be responsible for long term maintenance on mitigation projects.

Payment in lieu. Payment in lieu may be made to the permittee, who will apply the funds to a public stormwater project. MS4s shall maintain a publically accessible database of approved in lieu projects.

Exploiting Redevelopment to Optimize Opportunities for Environmental Benefits

Recommendation

The outcome should:

1. Require that already developed but unaltered portions of a site undergoing some redevelopment become subject to the full requirements applying to new development, above specific thresholds (see, for example, the provision from the Orange County, CA municipal stormwater permit below);

2. Require the same water quantity and quality management of both new development and redevelopment, either on-site or equivalently compensated off-site if warranted according to set criteria, except as provided for under incentives; and

3. Devise a simple and straightforward incentive system to stimulate redevelopment while simultaneously ensuring achievement of water quality standards and beneficial uses (see, for example, the provision from the West Virginia stormwater permit below).

Example Relevant Provisions from Elsewhere

From **Orange County, CA municipal stormwater permit** paragraph XII.B.2:

a. All significant redevelopment projects, where significant redevelopment is defined as projects that include the addition or replacement of 5,000 square feet or more of impervious surface on a developed site. Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of the facility, or emergency redevelopment activity required to protect public health and safety. Where redevelopment results in the addition or replacement of less than fifty percent of the impervious surfaces of a previously existing developed site, and the existing development was not subject to WQMP requirements, the numeric sizing criteria discussed below applies only to the addition or replacement, and not to the entire developed site. Where redevelopment results in the addition or replacement of more than fifty percent of the impervious surfaces of a previously existing developed site, the numeric sizing criteria applies to the entire development.

Notes: This provision of the Orange County permit makes significant redevelopment, as defined, equivalent with respect to stormwater management requirements to new development projects that create 10,000 square feet or more of impervious surface. The **Ventura County, CA municipal stormwater permit** has an essentially identical provision at paragraph 4.E.II.2.

From **West Virginia General National Pollution Discharge Elimination System Water Pollution Control Permit** paragraph II.C.b.5.ii:

> The permittee shall develop a program to protect water resources by requiring all new and redevelopment projects to control stormwater discharge rates, volumes, velocities, durations and temperatures. These standards shall apply at a minimum to all new development and redevelopment disturbing one acre or greater, including projects less than one acre that are part of a larger common plan of development or sale.

Notes: This provision of the West Virginia permit makes redevelopment equivalent with respect to stormwater management requirements to new development, except that the permit (at paragraph II.C.b.5.ii.A.3) allows specified reductions in the runoff volume management requirement for several types of development that can either reduce existing impervious surfaces, or at least create less 'accessory' impervious surface, including redevelopment.

Site-Specific Soils and Hydrogeologic Determinations

<u>Recommendation</u>

The best, and an eminently reasonable, way to introduce better soils information in stormwater management facility analysis and design is to require all building permit applicants should to determine soil characteristics and infiltration rates around their sites through direct observations and measurements. Excavating shallow pits, analyzing basic soil characteristics, and performing percolation tests are not expensive tasks. As illustrated by the example below, other jurisdictions already have this requirement.

Example Relevant Provisions from Elsewhere

From **City of Santa Barbara Storm Water BMP Guidance Manual** (2008):

> **3 SITE SOIL AND INFILTRATION ASSESSMENT**
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> The purpose of the site soil assessment and infiltration testing is to determine where BMPs should be located on the site and if infiltration BMPs are feasible on the site. This chapter is intended to apply to Tier 3 projects. Refer to Section 5-2 in Chapter 5 for soil assessment methodologies for Tier 1 and Tier 2 projects. Site soil assessment and infiltration testing should be conducted early in the design process to facilitate LID site design principles and practices. When sites are designed without initially assessing the site's soil characteristics or considering LID site design principles and practices in the initial design process, often times the chance to preserve the site's natural hydrology, distribute post-construction storm water BMPs appropriately across a site, and preserve the site's soil infiltration capacity in areas where at appropriate BMP locations is limited. However, if the site soil assessment and infiltration testing occurs early in the design process, potential infiltration sites may be identified and measures can be taken to preserve the infiltration capability of the site and reduce implementation costs.
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> **3.1 Who Should Conduct the Assessment?**
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> A qualified soil scientist or geotechnical professional should conduct the test pit investigation and infiltration tests. The professional should be experienced with not only the testing procedures themselves but also the requirements of the potential BMPs to ensure that additional information regarding the siting of BMPs is acquired during the test pit investigations.

Note: This chapter of the Santa Barbara manual continues with detailed guidance on performing the assessment.

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