B A S M A A

Alameda Countywide
Clean Water Program

Contra Costa
Clean Water Program

Fairfield-Suisun
Urban Runoff
Management Program

Marin County
Stormwater Pollution
Prevention Program

Napa County
Stormwater Pollution
Prevention Program

San Mateo Countywide
Water Pollution
Prevention Program

Santa Clara Valley
Urban Runoff Pollution
Prevention Program

Sonoma County
Water Agency

Vallejo Sanitation
and Flood
Control District

November 27, 2013

Bruce Wolfe, Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Status Report on the Application of Feasibility/Infeasibility Criteria for Low Impact Development–MRP Provisions C.3.c.i.(2)(v) and C.3.c.iii.(2)

Dear Mr. Wolfe:

This letter and attachment are submitted on behalf of all 76 municipalities subject to the requirements of the Municipal Regional Stormwater NPDES Permit (MRP).

MRP Provision C.3.c describes the Low Impact Development (LID) source control, site design, and treatment measure requirements for Regulated Projects, which took effect December 1, 2011. With regard to LID treatment, Provision C.3.c.i.(2)(b) states that Permittees must require each Regulated Project to treat 100% of the amount of runoff identified in Provision C.3.d. for the Regulated Project's drainage area with LID treatment measures onsite or with LID treatment measures at a joint treatment facility. Provision C.3.d. includes options for determining this amount of runoff and for sizing facilities accordingly.

Provision C.3.c.i.(2)(b) goes on to state that LID treatment measures are harvesting and re-use, infiltration, evapotranspiration, or biotreatment. A properly engineered and maintained biotreatment system may be considered only if it is infeasible to implement harvesting and re-use, infiltration, or evapotranspiration at a project site.

On May 1, 2011, as required by Provision C.3.ci.(2)(iv), BASMAA submitted on behalf of the Permittees a "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report" (Criteria Report), which presented the results of technical analyses to develop criteria and procedures for Permittees to follow to determine whether harvesting and use, infiltration, or evapotranspiration are feasible or infeasible at a Regulated Project site and when biotreatment may be used. The Permittees subsequently incorporated the criteria in the report into guidance that has been used by applicants for development approvals and by municipal staff when reviewing those applications since December 1, 2011.

MRP Provision C.3.c.i.(2)(v) requires that by December 1, 2013, the Permittees, collaboratively or individually, shall submit a report on their experience with determining infeasibility of harvesting and re-use, infiltration, or evapotranspiration at Regulated Project sites. The report shall, at a minimum, contain the information required in Provision C.3.c.iii.(2).

Bay Area

Stormwater Management

Agencies Association

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This Status Report fulfills Provisions C.3.c.i.(2)(v) and C.3.c.iii.(2) and describes the experience of the Permittees during Fiscal Years 2011-2012 and 2012-2013 in implementing the LID requirements. Consistent with the direction in Provision C.3.c.iii.(2), this report discusses proposed changes to the criteria, presents a rationale for those changes, and outlines corresponding changes to the Permittees' guidance for development projects.

We look forward to discussing with you and your staff the Status Report and BASMAA's recommendations for the current and future permit terms.

We certify under penalty of law that this document was prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Scanlin

James Scanlin, Alameda Countywide Clean Water Program

Tom Dalziel, Contra Costa Clean Water Program

Kevin A. Cullen

Kevin Cullen, Fairfield-Suisun Urban Runoff Management Program

Matthew Fabry

Matt Fabry, San Mateo Countywide Water Pollution Prevention Program

Adam Olivieri, Santa Clara Valley Urban Runoff Pollution Prevention Program

Lance Barnett, Vallejo Sanitation and Flood Control District

Attachment: Status Report on the Application of Feasibility/Infeasibility Criteria for Low Impact Development

cc: Tom Mumley, Regional Water Board
Shin-Roei Lee, Regional Water Board
Dale Bowyer, Regional Water Board
Sue Ma, Regional Water Board
BASMAA Board of Directors

Status Report on the Application of Feasibility/Infeasibility Criteria for Low Impact Development

Provision C.3.c.iii.(2)

B A S M A A

Bay Area Stormwater Management Agencies Association

Submitted to the

California Regional Water Quality Control Board

San Francisco Bay Region

1 December 2013

Bay Area
Stormwater Management
Agencies Association

Status Report on the Application of Feasibility/Infeasibility Criteria for Low Impact Development

Provision C.3.c.iii.(2)

Submitted to the

California Regional Water Quality Control Board

San Francisco Bay Region

1 December 2013

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Executive Summary

Provision C.3.c. in the San Francisco Bay Municipal Regional Stormwater Permit (MRP) describes the Low Impact Development (LID) source control, site design and treatment measure requirements for Regulated Projects. The requirements took effect December 1, 2011. With regard to LID treatment, Provision C.3.c.i.(2)(b) states that Permittees must require each Regulated Project to treat 100% of the amount of runoff identified in Provision C.3.d. for the Regulated Project's drainage area with LID treatment measures onsite or with LID treatment measures at a joint treatment facility. Provision C.3.d. includes options for determining this amount of runoff—and for sizing facilities accordingly.

Provision C.3.c.i.(2)(b) goes on to state that LID treatment measures are harvesting and re-use, infiltration, evapotranspiration or biotreatment. A properly engineered and maintained biotreatment system may be considered only if it is infeasible to implement harvesting and re-use, infiltration, or evapotranspiration at a project site.

MRP Provision C.3.c.i.(2)(v) states:

> By December 1, 2013, the Permittees, collaboratively or individually, shall submit a report on their experience with determining infeasibility of harvesting and re-use, infiltration, or evapotranspiration at Regulated Project sites. The report shall, at a minimum, contain the information required in Provision C.3.c.iii.(2).

Provision C.3.c.iii.(2) further stipulates this report contain the following information:

- Discussion of the most common feasibility and infeasibility criteria employed since implementation of the Provision C.3.c. requirements, including site-specific examples;
- Discussion of barriers, including institutional and technical site-specific constraints, to implementation of harvesting and reuse, infiltration, or evapotranspiration, and proposed strategies for removing these identified barriers;
- If applicable, discussion of proposed changes to feasibility and infeasibility criteria and rationale for these changes; and
- Guidance for the Permittees to make a consistent and appropriate determination of the feasibility of harvesting

and reuse, infiltration, or evapotranspiration for each Regulated Project.

This Status Report fulfills Provisions C.3.c.i.(2)(v) and C.3.c.iii.(2) and describes the experience of the Permittees during Fiscal Years (FYs) 2011-2012 and 2012-2013 in implementing the LID requirements.

On May 1, 2011, BASMAA submitted the "Harvest and Use, Infiltration and Evapotranspiration Feasibility/ Infeasibility Criteria Report" (Criteria Report), which presented the results of technical analyses to develop criteria and procedures for Permittees to follow to determine whether harvesting and use, infiltration, or evapotranspiration are feasible or infeasible at a Regulated Project site and when biotreatment may be used. The Permittees subsequently incorporated the criteria in the report into guidance which has been used by applicants for development approvals and by municipal staff when reviewing those applications since December 1, 2011.

Based on a review of Permittee Annual Reports submitted for Fiscal Years 2011-2012 and 2012-2013, the majority of projects required to implement LID treatment measures used variations of bioretention facilities (identified as "bioretention", "bioinfiltration", flow-through planters, etc.) as the selected treatment measure. Of the 554 regulated development projects approved during the last two fiscal years, there were approximately 22 projects that reported the use of infiltration treatment facilities. There may also be other projects for which it was feasible to infiltrate the water quality design volume but chose to design a biotreatment facility to accomplish infiltration of that volume, and reported the treatment as "bioretention". In addition, there were 256 projects (46% of the total) that reported using infiltration-based site design measures, 69 projects that reported using pervious paving, and many projects using biotreatment facilities that infiltrated a significant portion, if not all, of the water quality design volume.[1]

There were no regulated projects that used rainwater harvesting as a means to achieve compliance with Provision C.3.c.i.(2)(b). There are, however, a number of projects constructed in the past several years that are using rainwater harvesting to meet non-potable water demands on-site—for reasons other than

[1] The proportion of biotreatment facilities proposed to be unlined vs. lined, and the amount of infiltration achieved in the unlined facilities, is unknown. However, countywide program guidance manuals require that, where infiltration is allowed on-site, bioretention areas be unlined and that underdrains be placed near the top of the gravel layer in order to maximize infiltration from bioretention facilities.

stormwater permit compliance. Some of these projects are described in case studies in the Criteria Report and the Status Report.

Based on the information presented in this Status Report, the Permittees conclude the following:

Infiltration of some runoff is feasible on most projects. In the clay soils typical of our Region, the amount of runoff that can be infiltrated is unpredictable and highly variable. On most sites, it is not practical or feasible to design facilities that can reliably and dependably infiltrate the Provision C.3.d.i.(3) amount of runoff (that is, 80% of the total quantity of runoff over a period of 30 years or more).

Very few development projects create the quantity and timing of non-potable-water demand required to feasibly harvest and use the amount of runoff specified in MRP Provision C.3.d.i.(3). Harvesting and use of a smaller quantity of runoff is technically feasible on some projects. In particular, proponents of some development projects are willing and able to incorporate harvesting and use systems when those systems are sized and designed for cost-effective augmentation of water supply, which requires considerably less storage than would be required to meet current MRP requirements. However, the complexity and operation and maintenance requirements for harvesting and use systems make it inadvisable to require those systems on developments where it cannot be assured that a qualified maintenance staff will be employed on-site at all times during the life of the project.

Bioretention facilities, when designed according to the criteria in current Permittee guidance, could infiltrate between 40% and 80% or more of total runoff, depending on rainfall patterns and facility size. However, the amount of runoff that would be infiltrated over the life of a particular project is variable and unpredictable because of uncertainty in the near-term and long-term infiltration performance of underlying soils. Infiltration can be maximized by ensuring project designs adhere to current design criteria and by ensuring facilities are constructed as designed.

Bioretention is, on balance, equal in water-quality effectiveness to harvesting/use or infiltration. It has the following advantages over harvesting/use and infiltration:

- Applicable to nearly all development sites;
- Proven to be practical, affordable, and acceptable to applicants;

- Robust and very low maintenance;
- Provides ancillary benefits of heat island mitigation, evapotranspiration of some runoff, aesthetics, air quality, and habitat.

Based on these conclusions, the Permittees believe the maximum water-quality benefit would be obtained by adopting policies that allow project proponents to choose among effective options, so that they can effectively integrate LID treatment with other project objectives and features. Accordingly, the Permittees propose eliminating the feasibility/infeasibility criteria. Although this is a change in process, the outcomes are the same as current policy. The application of current feasibility/infeasibility criteria has resulted in widespread installation of bioretention facilities that are effectively treating water quality design runoff volumes and are retaining a significant portion of total runoff. The Permittees propose to continue to promote infiltration to the degree achievable on each development site via site design and bioretention. This is the best way to achieve the maximum practical amount of infiltration collectively over all development sites on a watershed scale.

Consistent with the Water Board's direction that this document should discuss "…proposed changes to feasibility and infeasibility criteria and rationale for these changes" and to guide Permittees to "…make a consistent and appropriate determination of the feasibility of harvesting and reuse, infiltration, or evapotranspiration," the Permittees reviewed their experience and developed the following recommendations.

BASMAA recommends that, beginning now, Permittees take the following actions relevant to the LID Feasibility Evaluation Process identified beginning on page 12 of the May 1, 2011 Criteria Report (BASMAA 2011a):

1. Recognize the use of bioretention facilities incorporating the raised-underdrain design as an equivalently acceptable LID option.
2. Adopt procedures that require applicants to first minimize runoff using site design measures and runoff reduction measures—such as those described in MRP Provisions C.3.c.i.(2)(a)—and then use infiltration, harvesting/use, and/or bioretention facilities that meet the hydraulic sizing requirements of Provision C.3.d. to manage runoff from remaining Drainage Management Areas.

3. Prepare a regional compilation of references and resources for harvesting/use and make this available to applicants for development approvals issued by the Permittees.

4. Review existing Permittee guidance for runoff reduction features and bioretention, and also review current implementation of that guidance, and make any changes or improvements needed to ensure facilities are consistently constructed to design criteria.

BASMAA further recommends the following activities be considered for Permittee implementation in a time frame corresponding to the term of the forthcoming reissued MRP:

1. Continue review and ongoing improvement of standards for design and construction of runoff reduction measures and bioretention facilities.

2. Seek grant funding for *in situ* monitoring and evaluation of the hydrologic performance of bioretention facilities.

3. Revise and re-orient operation and maintenance verification programs to optimize the long-term performance of runoff reduction measures and LID treatment facilities (most commonly bioretention).

4. Develop protocols for delineation and signage for pervious pavements and other runoff reduction measures, and for bioretention.

5. Include notation of pervious paving condition as part of O&M verification inspections on regulated projects, and include requirements for maintaining pervious paving in maintenance agreements or equivalent mechanisms.

1 · Introduction and Background

1.1 MRP Low Impact Development Requirements

Provision C.3.c. in the San Francisco Bay Municipal Regional Stormwater Permit (MRP), titled Low Impact Development (LID), begins as follows:

> The goal of LID is to reduce runoff and mimic a site's predevelopment hydrology by minimizing disturbed areas and impervious cover and then infiltrating, storing, detaining, evapotranspiring, and/or biotreating stormwater runoff close to its source. LID employs principles such as preserving and recreating natural landscape features and minimizing imperviousness to create functional and appealing site drainage that treats stormwater as a resource, rather than a waste product. Practices used to adhere to these LID principles include measures such as rain barrels and cisterns, green roofs, permeable pavement, preserving undeveloped open space, and biotreatment through rain gardens, bioretention units, bioswales, and planter/tree boxes.

Provision C.3.c describes the LID source control, site design and treatment measure requirements for Regulated Projects. With regard to LID treatment, Provision C.3.c.i.(2)(b) states that permittees must:

> Require each Regulated Project to treat 100% of the amount of runoff identified in Provision C.3.d. for the Regulated Project's drainage area with LID treatment measures onsite or with LID treatment measures at a joint treatment facility.

Provision C.3.d. includes options for determining this amount of runoff and for sizing facilities accordingly.

Provision C.3.c.i.(2)(b) goes on to state:

- LID treatment measures are harvesting and re-use, infiltration, evapotranspiration or biotreatment.
- A properly engineered and maintained biotreatment system may be considered only if it is infeasible to implement harvesting and re-use, infiltration, or evapotranspiration at a project site.
- Infeasibility to implement harvesting and re-use, infiltration, or evapotranspiration at a project site may result from conditions including the following:

- Locations where seasonal high groundwater would be within 10 feet of the base of the LID treatment measures.
- Locations within 100 feet of a groundwater well used for drinking water.
- Development sites where pollutant mobilization in the soil or groundwater is a documented concern.
- Locations with potential geotechnical hazards.
- Smart growth and infill or redevelopment sites where the density and/or nature of the project would create significant difficulty for compliance with the onsite volume retention requirement.
- Locations with tight clay soils that significantly limit the infiltration of stormwater.

Permittees were required to fully implement the LID source control, site design and treatment requirements on private projects by December 1, 2011, and on public projects by December 1, 2012, per Provision C.3.c.ii.

1.2 Feasibility/Infeasibility Criteria Report

MRP Provision C.3.c.i.(2)(b)(iv) requires that by May 1, 2011, the Permittees, collaboratively or individually, submit a report on the criteria and procedures the Permittees shall employ to determine when harvesting and re-use, infiltration, or evapotranspiration is feasible and infeasible at a Regulated Project site. This requirement is reiterated in Provision C.3.c.iii.(1).

The "Harvest and Use, Infiltration and Evapotranspiration Feasibility/ Infeasibility Criteria Report" ("Criteria Report") was prepared by Geosyntec Consultants and submitted by BASMAA (2011a) on behalf of the Permittees as required. The Criteria Report presented the results of technical analyses to develop criteria and procedures for Permittees to follow to determine whether harvesting and use, infiltration, or evapotranspiration are feasible or infeasible at a Regulated Project site and when biotreatment may be used. The Criteria Report also provided a literature review and a description of documented cases/sites in the Bay Area and California where harvesting and use, infiltration, and evapotranspiration have been demonstrated to be feasible or infeasible.

The Permittees subsequently incorporated the criteria in the report into guidance which has been used by applicants for development approvals and by municipal staff when reviewing those applications since December 1, 2011. The criteria are summarized in Section 2.1.1.

1.3 Status Report on Application of Feasibility/Infeasibility Criteria

MRP Provision C.3.c.i.(2)(v) states:

> By December 1, 2013, the Permittees, collaboratively or individually, shall submit a report on their experience with determining infeasibility of harvesting and re-use, infiltration, or evapotranspiration at Regulated Project sites. The report shall, at a minimum, contain the information required in Provision C.3.c.iii.(2).

Provision C.3.c.iii.(2) further stipulates that this report to the Water Board ("Status Report") contain the following information:

- Discussion of the most common feasibility and infeasibility criteria employed since implementation of the Provision C.3.c. requirements, including site-specific examples;
- Discussion of barriers, including institutional and technical site-specific constraints, to implementation of harvesting and reuse, infiltration, or evapotranspiration, and proposed strategies for removing these identified barriers;
- If applicable, discussion of proposed changes to feasibility and infeasibility criteria and rationale for these changes; and
- Guidance for the Permittees to make a consistent and appropriate determination of the feasibility of harvesting and reuse, infiltration, or evapotranspiration for each Regulated Project.

This Status Report fulfills Provisions C.3.c.i.(2)(v) and C.3.c.iii.(2) and describes the experience of the Permittees during Fiscal Years (FYs) 2011-2012 and 2012-2013 in implementing the LID requirements.

1.4 Discussion and Correspondence with Water Board Staff

Staff from the California Regional Water Quality Control Board for the San Francisco Bay Region (Water Board) elected to distribute the May 1, 2011 "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report" via the Water Board website and to solicit comments with a deadline for comments of June 10, 2011. A number of commenters responded, including USEPA Region IX, the Natural Resources

Defense Council, the Bay Planning Coalition, and local developers and design professionals.

Water Board staff also elected to prepare their own comments on the May 1, 2011 report and transmitted these comments to BASMAA in a July 12, 2011 letter.

Following discussions between Water Board staff and Permittee representatives, BASMAA submitted an April 30, 2012 letter that responded to Water Board staff issues and committed to analyzing and/or addressing the following issues further:

1. Maximize stormwater retention on-site before using biotreatment;
2. Analyze increased footprint and depth of infiltration facilities;
3. Analyze rainwater harvest and use versus recycled water use; and
4. Maintenance of self-retaining and self-treating areas, especially pervious pavement.

These and other issues are addressed in this Status Report.

2 · LID Implementation

2.1 Application of Current Feasibility and Infeasibility Criteria

2.1.1 Methods of Feasibility/Infeasibility Analysis

To assist Permittees in applying the feasibility/infeasibility criteria and procedures established in the Criteria Report to Regulated Projects by the required date of December 1, 2011, a work group of the BASMAA Development Committee met during September-November 2011 to develop worksheets and supporting materials that have now been incorporated into local and/or countywide guidance documents. The Development Committee work group products are provided in Appendix A. All Permittees began using tools and guidance for applying LID requirements on private Regulated Projects by December 1, 2011 and on public Regulated Projects by December 1, 2012. This section describes the methods being used to apply the feasibility/infeasibility criteria.

Infiltration/Evapotranspiration Criteria

Consistent with Provision C.3.c.i.(2)(b), criteria in the May 1, 2011 Criteria Report were based on determining if 80% of runoff over a long period (the amount of runoff established in Provision C.3.d) can be infiltrated on-site. A continuous-simulation hydrologic model analysis was conducted to determine the minimum subsurface-soil infiltration rate (expressed as saturated hydraulic conductivity) that would be required for a bioretention facility to infiltrate and evapotranspirate 80% of runoff. The bioretention facility investigated was sized to have a surface area of 4% of tributary equivalent impervious area, and had a 6" deep surface reservoir, an 18" deep biotreatment soil layer (with an infiltration rate of 5 inches per hour), and a 12" deep gravel layer. The modeled bioretention facility also had an underdrain with a discharge point at the top of the gravel layer. See Figure 2-1.

Results showed that a minimum saturated hydraulic conductivity of 1.6 inches per hour, or more depending on location and rainfall patterns, was required for the modeled facility to retain 80% of runoff through infiltration and evapotranspiration.

Implementation Tools

The Permittes use the following tools to implement this criterion:

- Santa Clara, Alameda, and San Mateo county-wide program Permittees and the Cities of Fairfield, Suisun City[2], and Vallejo[3] require the applicant to complete an "Infiltration/Harvesting and Use Feasibility Screening Worksheet." This worksheet uses saturated hydraulic conductivity as a screening criterion. If the applicant

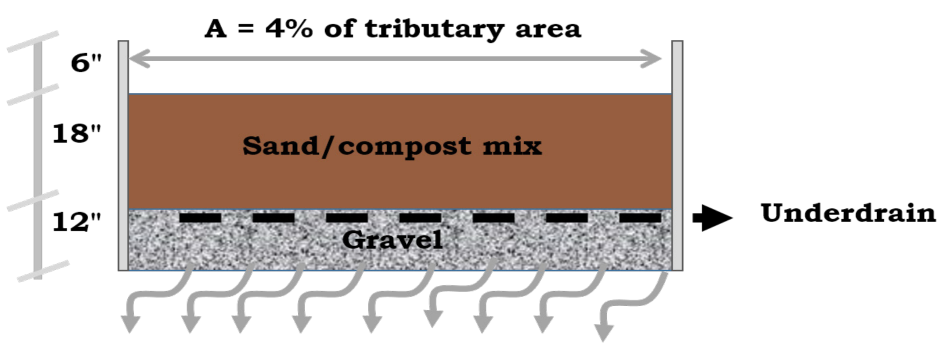

Figure 2-1. Bioretention Facility Cross-Section

[2] The City of Suisun City has not had any development project submittals since the implementation of LID requirements began, but staff plan to use the Screening Worksheet beginning with the first project submittal (John Kearns, pers. comm., 10-1-13).
[3] The City of Vallejo has not had any development project submittals since the implementation of LID requirements began, but staff plan to use the Screening Worksheet beginning with the first project submittal (Jill Mercurio, pers. comm., 10-8-13).

provides evidence that site soils have a saturated hydraulic conductivity less than 1.6 inches per hour, or are classified as Hydrologic Soil Group C or D soils, infiltration is determined to be infeasible[4]. If the applicant states that site soils have a saturated hydraulic conductivity of 1.6 inches per hour or more, then the applicant must also complete an "Infiltration Feasibility Worksheet" to determine if infiltration is infeasible due to other site-specific conditions listed in the Criteria Report.

- Contra Costa Permittees require the use of a bioretention facility with design criteria the same as the criteria featured in the May 1, 2011 Criteria Report. When implemented on sites with soils that have a saturated hydraulic conductivity of 1.6 inches per hour or more, these facilities operate as infiltration facilities meeting the requirements of Provision C.3.c.i.(2)(b). When implemented on sites with soils that have a saturated hydraulic conductivity of less than 1.6 inches per hour, these facilities operate as bioretention facilities meeting the requirements of Provision C.3.c.i.(2)(b)(vi).

In addition, all four countywide program guidance manuals have been updated to require that, where infiltration is allowed on-site, bioretention areas be unlined and that underdrains be placed near the top of the gravel layer. These design features maximize infiltration from bioretention facilities.

Harvesting and Use Criteria

Consistent with Provision C.3.c.i.(2)(b), criteria in the May 1, 2011 Criteria Report were based on determining if the planned uses of a proposed development project would create sufficient consistent and reliable on-site non-potable water demand to ensure 80% of runoff (over a long period of time) can be harvested and used. Using continuous simulation hydrologic modeling, a series of sizing curves was generated for each of 11 rain gages indicating the required storage volumes to achieve a certain percent capture of runoff at different drawdown times (see Appendix F of the Criteria Report). From a given combination of storage volume and drawdown time, the required daily non-potable water demand can be computed. The larger the storage facility and the longer the drawdown times, the lower the daily demand needs to be to drain the facility. The minimum

[4] Some Permittees have adjusted this screening criterion to reflect local rainfall patterns based on model results for the closest rain gage, presented in Appendix E of the Criteria Report

demands are tabulated in the Criteria Report by rain gage (Table 9 in that report) and varies from 2,400 to 9,000 gallons per day per acre of tributary impervious surface, assuming 50,000 gallons of storage per acre of tributary impervious surface is available.

Toilet Flushing

The Criteria Report includes estimates of the daily volume of water required for toilet flushing for each resident and employee of a facility. The estimates are based on literature values.

Subsequent to submittal of the Criteria Report, Permittees identified factors to be used to estimate the number of facility residents based on the number of proposed dwelling units (2.7-2.9 residents per dwelling unit, depending on the county) or employees (for example, one employee per 200 square feet of commercial office interior floor space). These factors facilitate estimation of demand (and checking of estimated demand) using conceptual or preliminary project plans. Applicants may propose their own estimates of the number of residents or employees for a facility based on project-specific data.

Irrigation

The Criteria Report includes an analysis of water demand per irrigated acre based on the methods in the Model Water Efficient Landscape Ordinance (California Assembly Bill 1881). Based on this demand and the required demand to meet the criteria in Provision C.3.c.i.(2)(b), the report identifies a simple ratio of Effective Irrigated Area to Tributary Impervious Area (EIATIA) for the location of each rain gauge used in the analysis. The ratios ranged from 2.6 to 21.4 (that is, a minimum of 2.6 acres of landscape per acre of impervious area is needed to create sufficient irrigation demand to use 80% of total runoff). At these ratios, it would be simpler and easier to allow runoff from impervious areas to disperse into adjacent pervious areas, than to collect and use the runoff for irrigation.

Other Uses

As described above, Table 9 in the Criteria Report provides the minimum daily demand per impervious acre to meet the 80% runoff capture requirement in each rain gage area. Non-potable water demand for other uses, such as for washing or industrial process water, is compared to this calculated minimum demand per impervious acre to determine the feasibility of rainwater harvesting for the identified use.

Use of Recycled Water

Stormwater harvesting and use is considered infeasible for development and redevelopment projects where recycled water is available. This policy has a net environmental benefit because water recycling helps achieve regional water conservation goals and—in the South Bay—use of recycled water helps POTWs meet wastewater discharge limits by reducing fresh water discharges to the Bay.

Municipalities and water/wastewater agencies have made major investments in recycled water treatment and distribution facilities.

Recycled water has the following additional advantages over stormwater harvesting and use:

- It provides a constant, reliable, year-round supply.
- No on-site treatment system is required.
- No on-site storage is required.
- Plumbing codes are well established.

Implementation Tools

The Permittees use the following tools to implement this criterion:

The “Infiltration/Harvesting and Use Feasibility Worksheet” used by the Santa Clara, Alameda, and San Mateo county-wide program Permittees and the Cities of Fairfield, Suisun City, and Vallejo first checks whether recycled water will be used for on-site non-potable demand. If the answer is no, the next step in the worksheet is to apply threshold densities for residential projects (100 dwelling units per impervious acre), commercial projects (70,000 square feet per impervious acre), and schools (21,000 square feet per impervious acre) to screen for the feasibility of toilet flushing uses for harvested runoff. These thresholds represent the minimum daily toilet flushing demand per impervious acre to meet the 80% runoff capture requirement for the San Jose rain gage (the lowest mean annual precipitation among the 11 Bay Area rain gages analyzed)[5]. The feasibility of rainwater harvesting for toilet flushing is evaluated both for the impervious area of the entire site (compared to demand for the entire project), and for each building roof area of more than 10,000 square feet (compared to the toilet flushing demand

[5] Some Permittees have adjusted these screening thresholds to reflect local rainfall patterns based on model results for the closest rain gage.

within that building only). Feasibility of landscape uses is assessed using the EIATIA ratio. If the responses to the worksheet indicate that there may be sufficient demand on-site to use harvested rainwater, then the applicant must also complete a "Rainwater Harvesting and Use Feasibility Worksheet" to determine if harvesting/use is infeasible due to other factors listed in the Criteria Report.

Contra Costa's *Stormwater C.3 Guidebook,* 6th Edition requires permittees to calculate on-site demand for toilet flushing based on number of toilet users. The number of users can be calculated by using default densities of users per dwelling unit or commercial square footage, or by using project-specific information. Feasibility of landscape uses is assessed using the EIATIA ratio.

2.1.2 Application of Feasibility Criteria

BASMAA obtained and analyzed the data submitted by Permittees in the FY 2011-2012 and 2012-2013 Annual Reports submitted to the Water Board. Data were obtained from the C.3.b.v.(1) Regulated Project Tables of each annual report, in which Permittees report the site design and treatment measures that have been approved for use in regulated projects approved during the reporting period. Those Permittees reporting a project that included infiltration treatment measures were asked to complete a survey requesting more information about the infiltration measures. Because no rainwater harvesting systems were used to comply with LID treatment requirements on regulated projects during FYs 2011-2012 and 2012-2013, surveys were also sent to selected Permittees to obtain information on planned or constructed rainwater harvesting systems on non-regulated projects. From the surveys, projects using infiltration or rainwater harvesting were selected as case studies for this report.

Summaries of the data collected on LID implementation over the last two fiscal years are presented in Tables 2-1 and 2-2.

Table 2-1 provides information on regulated projects approved during FY 2011-2012, the year in which the LID requirements took effect for private projects on December 1, 2011, and LID treatment was not required in projects approved before that date. In that year, 117 projects (42% of the 279 total projects reported) were required to implement LID treatment. However, 205 projects (73% of the 279 total projects) reported using biotreatment. Only six projects reported using infiltration as the method of stormwater treatment; however, 113 projects (41%)

reported using self-retaining areas and/or impervious pavement draining to landscaping as site design measures, and 34 projects (12%) reported using pervious paving. All of these site design measures accomplish infiltration and retention of runoff onsite.

Table 2-1. Fiscal Year 2011-2012 Approved Projects.

	Alameda County	Contra Costa County	San Mateo County	Santa Clara County	Sonoma County	**Totals**
Total Number of Reported Projects (excluding Special Projects not yet approved)	103	36	32	106	2	**279**
Number of Private Projects requiring LID (approved on or after 12/1/11)	29	13	17	47	2	**108**
Number of Public Projects requiring LID (construction starts on or after 12/1/12)	6	0	0	3	0	**9**
Number of Private and Public Projects requiring LID	35	13	17	50	2	**117**
Number of Reported Projects that include treatment with biotreatment	72	30	21	80	2	**205**
Number of Reported Projects that include treatment with infiltration	0	0	0	6	0	**6**
Number of Reported Projects that include self-retaining areas and/or impervious pavement draining to landscaping	14	8	14	77	0	**113**
Number of Reported Projects that include pervious pavement	3	9	8	14	0	**34**

Table 2-2 provides information on regulated projects approved during FY 2012-2013. In this fiscal year, all private projects (except some Special Projects) were required to implement LID treatment, but LID treatment was not required for public projects that began construction before December 1, 2012.

In FY 2012-2013, 266 projects (97%) of the 275 total projects reported) were required to implement LID treatment. Of the projects implementing LID treatment, 251 (94%) reported using biotreatment and 16 (6%) reported using infiltration for treatment[6]. Approximately 143 projects (52% of the total) reported using self-retaining areas and/or impervious pavement draining to landscaping as site design measures, and 35 projects (13% of the total) reported using pervious paving.

Table 2-2. Fiscal Year 2012-2013 Approved Projects

	Alameda County	Contra Costa County	San Mateo County	Santa Clara County	Sonoma County	**Totals**
Total Number of Reported Projects (excluding Special Projects not yet approved)	77	37	39	119	3	**275**
Number of Private Projects requiring LID (approved on or after 12/1/11)	61	32	38	112	3	**246**
Number of Public Projects requiring LID (construction starts on or after 12/1/12)	10	4	1	5	0	**20**
Number of Private and Public Projects requiring LID	71	36	39	117	3	**266**
Number of Reported Projects that include treatment with biotreatment	75	34	35	104	3	**251**
Number of Reported Projects that include treatment with infiltration	3	1	1	11	0	**16**(5)
Number of Reported Projects that include self-retaining areas and/or impervious pavement draining to landscaping	51	10	29	53	0	**143**
Number of Reported Projects that include pervious pavement	5	5	9	16	0	**35**

[6] With the FY 2011-2012 data set, reported use of "infiltration" was confirmed with Permittees and it was determined that the actual number of infiltration treatment measures was less than that reported. This confirmation step has not been performed for the FY 2012-2013 data.

2.1.3 Results of Feasibility Criteria Implementation

In summary, during the last two fiscal years, the majority of projects required to implement LID treatment measures used variations of bioretention facilities (identified as "bioretention", "bioinfiltration", flow-through planters, etc.) as the selected treatment measure.

There were approximately 22 approved regulated projects that reported the use of infiltration treatment facilities[7]. There may also be other projects for which it was feasible to infiltrate the water quality design volume but chose to design a biotreatment facility to accomplish infiltration of that volume, and reported the treatment as "bioretention". In addition, there were 256 projects (46% of the total) that reported using infiltration-based site design measures, 69 projects that reported using pervious paving, and many projects using biotreatment facilities that infiltrated a significant portion, if not all, of the water quality design volume.[8]

There were no regulated projects that used rainwater harvesting as a means to achieve compliance with Provision C.3.c.i.(2)(b). There are, however, a number of projects constructed in the past several years that are using rainwater harvesting to meet non-potable water demands on-site—for reasons other than stormwater permit compliance. Some of the projects were described in the Criteria Report, and others are presented as case study projects in Section 2.1.5 and Appendix C of this report.

2.1.4 <u>Use of Feasibility Criteria</u>

A lack of soil infiltration capacity was the most common criterion used to determine the infeasibility of infiltration. The criterion for a saturated hydraulic conductivity of 1.6"/hour was met on a very small percentage of development sites.

A lack of on-site demand for non-potable water was the most common criterion used to determine the infeasibility of harvesting/use. To provide sufficient toilet flushing demand for the water quality design volume of harvested rainwater, a project must include a very large number of dwelling units or

[7] See footnote 5.

[8] The proportion of biotreatment facilities proposed to be unlined vs. lined, and the amount of infiltration achieved in the unlined facilities, is unknown. However, as mentioned in Section 2.1.1.1, all four countywide program guidance manuals require that, where infiltration is allowed on-site, bioretention areas be unlined and that underdrains be placed near the top of the gravel layer in order to maximize infiltration from bioretention facilities.

commercial office space per impervious acre. Furthermore, the use of 80% of runoff for outdoor irrigation is not feasible anywhere in the MRP permit area due to the large amounts of landscaped area required per impervious acre.

For the small percentage of projects that may have had sufficient toilet flushing demand to use the design runoff volume from a building roof, the second most common criterion used to determine infeasibility was the lack of plumbing codes and treatment standards for rainwater harvesting systems. Many municipalities determined that they did not have the legal authority to require a developer to construct a non-potable water collection, treatment and plumbing system for which plumbing codes and treatment standards do not exist.[9]

2.1.5 Examples of Infiltration Treatment Measures

Case studies of projects using infiltration treatment measures were selected from the approved projects reported in FY 2011-2012 Permittee annual reports. During this period, only six approved projects included infiltration treatment measures[10]. The majority of the projects were located in the West Valley area of Santa Clara County (Los Gatos and Campbell) where soils tend to have higher infiltration rates. Of these six projects, the four projects in Table 2-3 below are described as case studies in Appendix B.

2.1.6 Examples of Rainwater Harvesting Systems

The review of Regulated Projects Tables in the FY 2011-2012 and 2012-2013 annual reports revealed that there were no approved projects that incorporated rainwater harvesting and use to meet the LID treatment requirements. However, a number of rainwater harvesting systems have been built or are being planned for other purposes. BASMAA surveyed Permittees to obtain information on rainwater harvesting systems built or planned in their jurisdictions. Some of these systems were featured as case

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[9] In the case studies presented in Section 2.1.5 of this report, developers typically submitted an Alternate Methods and Materials Request (AMMR), prepared on a voluntary basis, for approval of the local building official. The AMMR must show how the proposed rainwater harvesting systems are equivalent with current plumbing code.

[10] Other projects used the word “infiltration” when describing treatment measures to be implemented at an approved project, but upon further investigation, it was determined that the infiltration was accomplished as part of another treatment measure (e.g., bioretention) or a site design measure.

studies in the Criteria Report. The four projects in Table 2-4 below were selected as case studies in this Status Report.

Table 2-3. Case Studies: Infiltration

Project Address	Development Type	Site Area (acres)	Treatment Measures
125 S. San Tomas Aquino Rd., Campbell	25 single family home subdivision	2.0	Infiltration, evapotranspir-ation
16213 Los Gatos Blvd, Los Gatos	22 single family home subdivision	1.9	Infiltration trench
14251 Winchester Blvd, Los Gatos	Medical office building	1.0	Infiltration trench, bioinfiltration
Creekside Sports Park, Los Gatos	Recreational facility	2.8	Permeable paving and artificial turf, infiltration trench

Table 2-4. Case Studies: Harvesting and Use

Project Address	Development Type	Cistern Size (gal)	Use of Harvested Rainwater
43917 Pacific Commons, Fremont	Commercial (Century Theaters)	10,000	Toilet flushing
150 Valparaiso Ave, Atherton	Sacred Heart School	10,000	Toilet flushing
343 Second St, Los Altos	Packard Foundation	20,000	Irrigation and toilet flushing
Oakland Rain Barrel Program	Residential (290 homes)	Varies	Varies

2.2 Barriers to Infiltration and Harvesting/Use

MRP Provision C.3.c.iii.(2) requires this Status Report to include a discussion of barriers to implementation of harvesting/use, infiltration, and evapotranspiration, and proposed strategies for removing these barriers.

2.2.1 Barriers to Stormwater Infiltration

Low Permeability of Bay Area Soils

With a few exceptions, soils on Bay Area development sites are not sufficiently permeable to reliably infiltrate the amount of runoff specified in the MRP.

Figures 2-2 and 2-3 were prepared by Geosyntec Consultants for BASMAA. The figures present the results of continuous simulation of infiltration achieved by bioretention facilities using

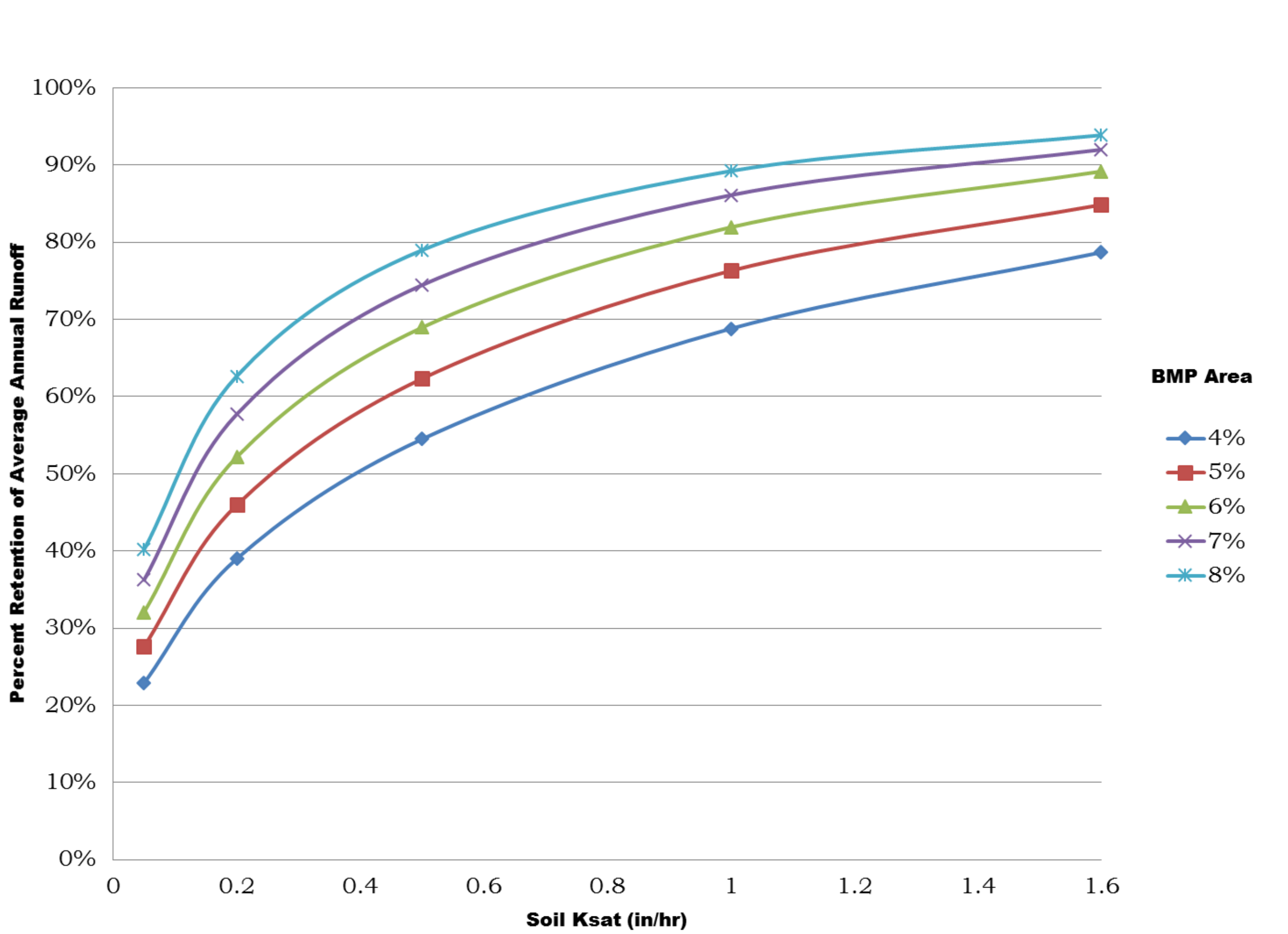

Figure 2-2. Plot of percent capture vs. soil permeability (Martinez Gauge)

long-term hourly data from rain gauges in Martinez and San Jose, respectively.

The simulation was based on facilities with the same design as described in the Criteria Report: a 6-inch-deep surface reservoir, 18 inches of engineered soil mix, and a 12-inch-deep gravel layer (see Figure 2-1). For each rain gauge, simulations were run for facilities with a sizing factor (percentage of tributary impervious area) of 4%, 5%, 6%, 7%, and 8%.

The curves in Figures 2-2 and 2-3 show the percent of total runoff retained during the simulation period for facilities with the five different sizing factors and for different soil infiltration rates (represented as saturated hydraulic conductivity, or K_{sat}).

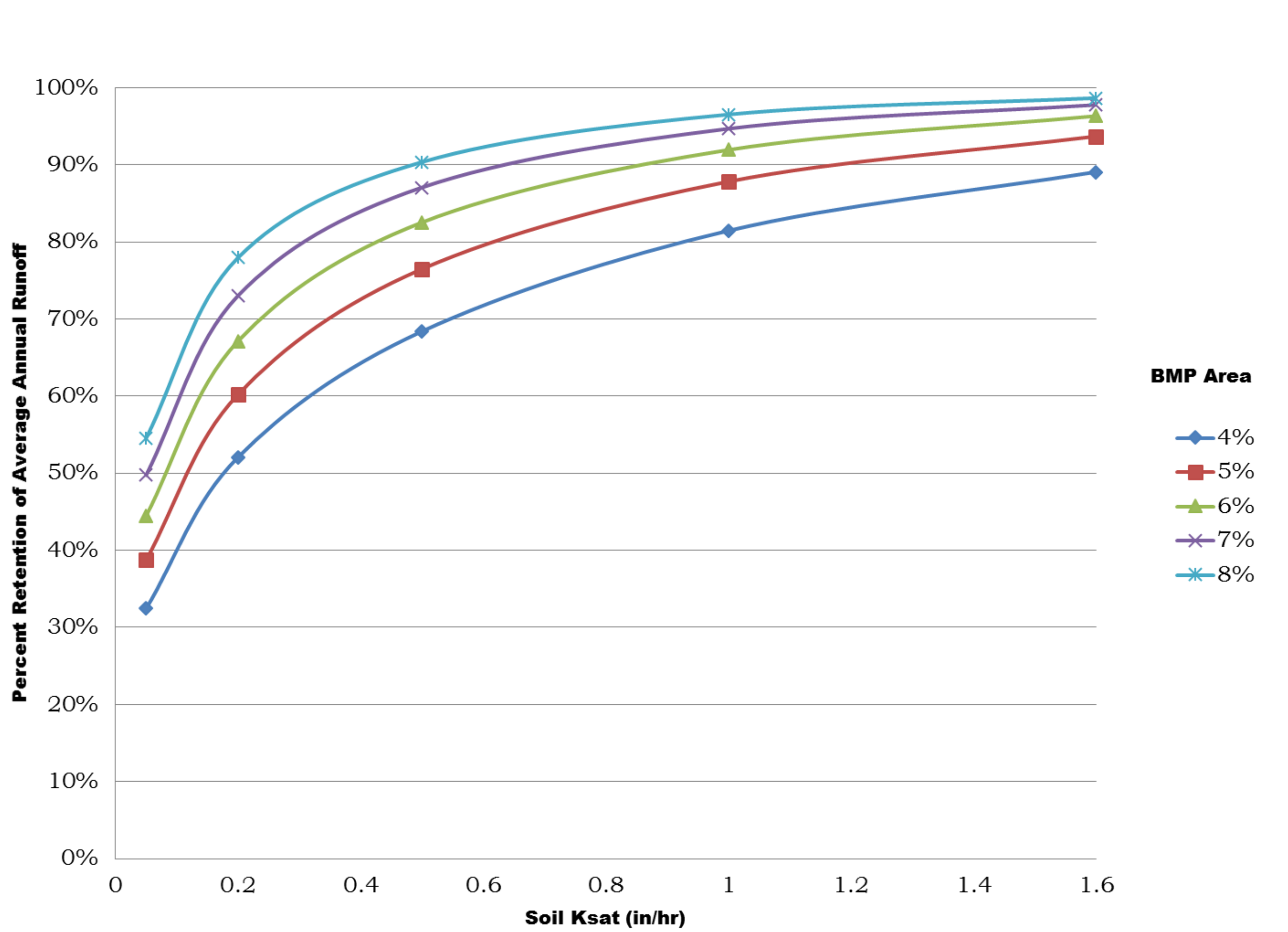

Figure 2-3. Plot of percent capture vs. soil permeability (San Jose Gauge)

The simulated results demonstrate the following:

- At low infiltration rates, the 80% criterion is not achieved with any of the facility sizing factors.
- At high infiltration rates the 80% criterion can be met with all facility sizes.
- There is a narrow range of soil infiltration rates over which percent retention of annual runoff can be improved by increasing facility size.

At the low infiltration rates typical of the Hydrologic Soil Group C and D soils commonly occurring throughout the Bay area, even a very large facility (8% of tributary impervious area) does not come close to achieving the 80% of total runoff specified by Provision C.3.d. At this 8% sizing factor for stormwater facilities, the usability, layout, and economic value of development sites is strongly affected, and a less-dense, sprawl-inducing type of development is favored. Not only does the cost of the treatment facility increase over that of a standard 4% sizing factor facility, but there is also the loss of opportunity to achieve desirably high urban density. Given these factors, and the variability of soil infiltration rates on a site (as demonstrated in the infiltration case studies), it is difficult to justify the increase in facility size for a small gain in percent retention.

Impacts on Foundations and Stability of Slopes

Soil strength and stability declines with increasing moisture content; this is particularly true for the expansive clays typical of Bay Area development sites. Stormwater infiltration can increase the likelihood of settlement, overturning, or other foundation failures, the potential for structural damage due to foundation movement from swelling clay soils, and the risk of slope failures on steep slopes. Increasing soil moisture can also reduce the useful life of pavements.

In many cases, these risks can be mitigated by incorporating cutoff walls into the design of bioretention facilities or direct infiltration facilities. The cutoff walls limit groundwater movement toward the potentially affected slope, foundation, or pavement section. Also, the design of foundations and pavement sections can be augmented to offset the risk posed by infiltration.

For any particular development project, the assessment of risks posed by stormwater infiltration, and design of appropriate measures to mitigate those risks, are typically conducted by one or more engineers retained by the project proponent. Municipal staff responsible for C.3 implementation have noted that engineers differ in how they assess and respond to risk. For example, in some projects, engineers have designed bioretention facilities with liners that prevent infiltration entirely; in other, similar projects, other engineers have designed similarly situated bioretention facilities, in similar soils, to maximize infiltration.

Other Technical Issues Related to Infiltration

It is difficult to predict the infiltration rate for a stormwater facility at any given time following construction. The results of soil sampling and testing in the laboratory, or *in-situ* testing, are imprecise and can be misleading. Typically, measured infiltration rates are multiplied by a safety factor of 0.5 or less to account for this uncertainty.

Once in operation, the rate of infiltration may increase by up to an order of magnitude, a phenomenon which has been attributed to the development of macropores within natural soils (Ferguson, 1994). Or the rate of infiltration may decrease by an order magnitude or more, due to the formation of an inhibiting soil crust, or by geochemical changes caused by water constituents (Ferguson, 1994).

The loss of infiltration capacity is of special concern with regard to underground infiltration galleries or other structures. For most underground infiltration structures, renewal of the soil interface can only be accomplished by destruction and rebuilding of the facility.

2.2.2 Barriers to Rainwater Harvesting and Use

Harvesting and use of runoff is implemented on a regional scale in some Bay Area locations, where surface waters are in proximity to aquifers that can be managed for conjunctive use. Alameda County Water District and the Santa Clara Valley Water District operate surface water diversions and groundwater infiltration basins. Regional-scale harvesting and use, and particularly use of diversions from municipal storm drains, is more widespread in Southern California, which has more locations where the geology is favorable for groundwater storage.

Regional-scale harvesting and use is similar in concept, but very different in practice, than on-site harvesting and use.

On-site Supply, Demand, and Storage

On-site rainwater harvesting has two potential benefits: runoff reduction and water supply augmentation. Systems designed to achieve runoff reduction objectives have high demand relative to the catchment size, or they have large storage volumes, or both. The systems are in use a small proportion of the time. In contrast, systems designed to achieve water supply augmentation objectives may have lower demand relative to catchment size, have smaller amounts of storage, and are in use a larger proportion of the time.

Consider the following two scenarios:

1. A site with a continuous, high demand for non-potable water and small impervious area that generates runoff.
2. A more typical site with limited demand for non-potable water, and a proportionately large impervious area generating runoff.

In the first scenario, the objective of using 80% of total runoff (over a long period) may be achievable. Storage will be quickly drained following storms, creating capacity to store successive storms.

The first scenario can be "created" on a development site by limiting runoff collection to a small Drainage Management Area (small DMA, e.g., a small portion of a building roof) and applying demand for toilet flushing from a much larger area (e.g., the whole building, or many buildings).

In this scenario, runoff fulfills a very small portion of the total demand for water. Most of the time—including all summer—demand is met by other sources such as the municipal potable water supply.

The system works well to manage runoff from the small DMA, but is very inefficient with regard to water supply. The storage and piping must be maintained year-round, but remain idle most of the time.

In the second scenario, there is a relatively large tributary area, and relatively low demand. Under this scenario, the storage stays full more of the time, and non-potable water is available more of the time that it is needed. However, only a small portion of the total amount of runoff is harvested and used. The rest overflows the storage. The system makes more efficient use of storage and piping, but contributes little to stormwater management—and does not come close to meeting the criterion to harvest and use 80% of runoff.

These two scenarios illustrate the fundamental barrier to harvesting and use as a strategy to manage the amount of runoff specified in Provision C.3. Although harvesting and use is an increasingly popular means of supplementing water supply, efficient water-supply-driven design requires that storage stay full most of the time, and overflow frequently.

This is underscored by examination of actual water harvesting systems in the Bay Area. Where both water harvesting and stormwater management are implemented, the water harvesting and stormwater management facilities (typically bioretention) must be in series. The Packard Foundation case study presented in Appendix C is an example of a rainwater harvesting system sized to meet non-potable water demands of the project that overflows into a stormwater management facility. A similar configuration was constructed at the City of El Cerrito's Recycling Center in 2011.

In these cases, and generally, the upstream rainwater harvesting system is not considered when calculating the required size of the downstream bioretention facilities.

Hypothetically, a continuous simulation model could be constructed to represent the hourly inflows and hourly drawdown (use) for a rainwater harvesting facility, and iterations to the cistern volume and downstream bioretention facility area could be made, until a combination (or combinations) of cistern volume and bioretention area were found that would achieve the criterion to retain 80% of runoff. However, it is relatively easy to predict that, taking the harvesting and use system into account in this manner, the downstream bioretention facility area could be reduced, at most, by a fraction of 1% of the tributary area. Because such a small reduction in bioretention size would have little incremental impact on site layout or project costs, the modeling would likely not be worth the effort.

Furthermore, bioretention facilities are generally sized to accommodate the flow rates specified in Provision C.3.d.i.(2)(c)—which is the basis of the commonly used 4% sizing factor—rather than to achieve retention of a target volume. From a practical point of view, for a harvesting and use facility that overflows to a bioretention facility, the sizing calculations for each facility are made separately and without consideration that the facilities are in series.

System Complexity and Maintenance Requirements

Rainwater harvesting systems range from small, distributed systems, such as rain barrels, to large above-ground or below-ground cisterns. Small systems supplying water for gravity-fed irrigation systems can be relatively simple, but larger systems supplying water for indoor use in multi-story buildings are much more complex. These systems typically include the following components:

- Storage tank (e.g., pre-cast or pre-fabricated cistern);
- Pretreatment (filtration);
- Pump(s), piping and valves;
- Piping for makeup water and overflow;
- Treatment (filtration and disinfection systems); and
- Separate indoor plumbing system.

These systems, especially the treatment components, require frequent inspection and maintenance by trained personnel over the life of the system.

Recently adopted plumbing codes for rainwater harvesting systems (see description later in this section) require rainwater to be distributed for non-potable use via a separate indoor plumbing system. The code states that "rainwater catchment systems shall have no unprotected connection to a potable water supply or alternate water source system", and that potable or recycled water is permitted to be used as makeup water for a rainwater catchment system provided there is an air gap or backflow preventer[11].

The likelihood that complex systems will be successfully managed over the life of a development project is dependent on the size and characteristics of that development. In general, successful management of complex mechanical systems, such as HVAC systems and elevators, requires a management structure that includes qualified maintenance staff, relationships with specialty contractors, and a dedicated financing mechanism.

Water Rights

In general, the issue of water rights should not be a barrier to stormwater harvesting and use in California. AB 1750, the Rainwater Capture Act of 2012, clarifies that use of rainwater collected from rooftops does not require a water right permit from the SWRCB. The law also authorizes landscaped contractors to, under certain conditions, design and install exterior components of a rainwater capture system that are not part of or attached to a structure.

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[11] 2013 California Plumbing Code, Chapter 17, Nonpotable Rainwater Catchment Systems, Section 1702.4. Adopted July 1, 2013.

Plumbing Codes

As mentioned in Section 2.1.4, the second most common criterion used to determine infeasibility of rainwater harvesting systems (after lack of demand) was the lack of plumbing codes and treatment standards for rainwater harvesting systems. At the time the LID treatment requirements took effect, there were no State plumbing codes in place, and developers who wanted to construct rainwater harvesting systems typically were required to submit an Alternative Methods and Materials Request (AMMR) based on consistency with potable water codes for approval by building officials.

Since that time, codes for “rainwater capture systems”, including treatment standards, have been developed at the national level by the International Association of Plumbing and Mechanical Officials (IAPMO) and published in Chapter 17 of the 2012 Uniform Plumbing Code. The California Building Standards Commission (CBSC) then conducted a process to adopt the 2012 UPC with amendments. The amended Chapter 17 was incorporated into the California Codes and Regulations Title 24 Part 5, and published as the California 2013 Plumbing Code on July 1, 2013. There is a six-month period for public review and local amendment adoption process, and the effective date for the new codes is January 1, 2014.

Chapter 17, Nonpotable Rainwater Capture Systems, includes requirements for construction and installation of system components, and minimum treatment and water quality standards. Appendix K of the 2013 Plumbing Code provides additional details, including minimum system testing, inspection and maintenance requirements for potable systems.

Key components of the new codes for rainwater capture systems include the following:

- Rainwater collected is limited to water captured from building roofs, consistent with AB 1750 (Rainwater Capture Act);
- Minimum treatment standards consist of:
- Debris excluder and 100 micron filtration for most uses;
- Water quality requirements of E. coli less than 100 CFU/100 ml and turbidity less than 10 NTU for the following uses: spray irrigation, toilet flushing, fountains, and cooling tower makeup water;

- Potable or recycled water may be used as makeup water as long as connections to those systems are protected with a backflow preventer;
- No permits or treatment is required for small systems (i.e., systems with less than 5,000 gallons of storage that use rainwater for non-spray irrigation).

Use of Recycled Water

As mentioned in Section 2.1.1, rainwater harvesting and use is considered infeasible for development and redevelopment projects where recycled water is available. Municipalities and water/wastewater agencies have made major investments in recycled water treatment and distribution facilities, and in locations near distribution pipelines, commercial and institutional buildings are required or strongly encouraged to use recycled water as a non-potable water source. Adding harvested rainwater as a source would require a third water supply plumbing system within buildings (in addition to potable water and recycled water systems) which is not economically feasible for most developments.

3 · Future LID Implementation Efforts

3.1 Feasibility of Infiltration and Harvesting/Use

Based on the information presented in this report, the Permittees conclude the following:

3.1.1 Infiltration for Stormwater Management.

Infiltration of some runoff is feasible on most projects. In the clay soils typical of our Region, the amount of runoff that can be infiltrated is unpredictable and highly variable. On most sites, it is not practical or feasible to design facilities that can reliably and dependably infiltrate the Provision C.3.d.i.(3) amount of runoff (that is, 80% of the total quantity of runoff over a period of 30 years or more).

3.1.2 Harvesting and Use for Stormwater Management

Very few development projects create the quantity and timing of non-potable-water demand required to feasibly harvest and use the amount of runoff specified in MRP Provision C.3.d.i.(3).

Harvesting and use of a smaller quantity of runoff is technically feasible on some projects. In particular, proponents of some development projects are willing and able to incorporate harvesting and use systems when those systems are sized and designed for cost-effective augmentation of water supply, which requires considerably less storage than would be required to meet current MRP requirements.

The complexity and operation and maintenance requirements for harvesting and use systems make it inadvisable to require those systems on developments where it cannot be assured that a qualified maintenance staff will be employed on-site at all times during the life of the project.

3.1.3 Bioretention for Stormwater Management

The results of the Contra Costa Clean Water Program's Model Calibration and Validation Project (CCCWP, 2013) indicate that bioretention facilities can infiltrate runoff substantially faster than is typically assumed. As described in the report for that project, the bioretention IMPs in HSG "D" soils at the Pittsburg site consistently infiltrated runoff at 0.24 inches per hour. Referring to Figures 2-2 and 2-3 above, at this rate bioretention facilities, when designed according to the criteria in current Permittee guidance, could infiltrate between 40% and 80% of total runoff, depending on rainfall patterns and facility size.

However, the amount of runoff that would be infiltrated over the life of a particular project is variable and unpredictable because of uncertainty in the near-term and long-term infiltration performance of underlying soils.

Infiltration can be maximized by ensuring project designs adhere to current design criteria and by ensuring facilities are constructed as designed.

Bioretention is, on balance, equal in water-quality effectiveness to harvesting/use or infiltration. It has the following advantages over harvesting/use and infiltration:

- Applicable to nearly all development sites
- Proven to be practical, affordable, and acceptable to applicants
- Robust and very low maintenance
- Provides ancillary benefits of heat island mitigation, evapotranspiration of some runoff, aesthetics, air quality, and habitat

3.2 Proposed Changes to Feasibility and Infeasibility Criteria

Based on these conclusions, the Permittees believe the maximum water-quality benefit would be obtained by adopting policies that allow project proponents to choose among effective options, so that they can effectively integrate LID treatment with other project objectives and features.

Accordingly, the Permittees propose eliminating the feasibility/infeasibility criteria. Although this is a change in process, the outcomes are the same as current policy: The application of current feasibility/infeasibility criteria has resulted in widespread installation of bioretention facilities that are effectively treating water quality design runoff volumes and are retaining a significant portion of total runoff.

The Permittees propose to continue to promote infiltration to the degree achievable on each development site via site design and bioretention. This is the best way to achieve the maximum practical amount of infiltration collectively over all development sites on a watershed scale.

This approach is similar to, and is codified in, Provision E.12 of the Phase II municipal stormwater NPDES permit adopted by the State Water Resources Control Board on February 5, 2013. Provision E.12. requires Regulated Projects to implement site design measures to reduce the amount of runoff to the extent technically feasible.

Next, Provision E.12 requires that each Regulated Project provide "a map or diagram dividing the developed portions of the project site into discrete Drainage Management Areas (DMAs), and to manage runoff from each DMA." This requirement facilitates development of drainage designs, and Permittees' review of drainage designs, to ensure site design measures are used to the extent feasible. (Bay Area Permittees' guidance for new developments also require applicants to submit such a map or diagram.)

Finally, Provision E.12 requires that remaining runoff must be routed to facilities at least as effective as a bioretention facility with specified dimensions and design. The design criteria include features—such as locating the underdrain at the top of a gravel storage layer and no compaction of soils beneath the facility, or ripping/loosening of soils if compacted—that promote infiltration. Criteria in the MRP Permittees' current guidance are similar.

3.3 Addressing Barriers to LID

3.3.1 Addressing Barriers to Harvesting and Use

Harvesting and use of the Provision C.3.d.i.(3) amount of runoff is not feasible on most developments. Noted barriers to harvesting and use of a smaller amount of runoff have been:

- Lack of plumbing codes and standards
- Questions about water rights
- Mechanical complexity, reliability, and maintenance requirements

The first two issues have been largely addressed in the time since the MRP was adopted.

The issue of mechanical complexity of harvesting systems is best addressed by encouraging use of technologies that are appropriate to the development—including the development's scale and future uses—and the capacity of on-site staff to manage mechanical systems.

Where recycled water is available to a development site, its use is strongly preferred over rainfall harvesting and use. Recycled water is a year-round, continuously available non-potable source and does not require on-site storage. Some Permittees have made substantial investments in recycled water distribution. Use of both non-potable sources would require a separate plumbing systems for each. Since the water-quality benefit of using more of one source would be offset by the reduced benefit of using less of the other source, construction of the two separate systems would not be cost-effective.

3.3.2 Addressing Barriers to Infiltration

Infiltrating the Provision C.3.d.i.(3) amount of runoff is not feasible on most developments due to the low permeability of the region's predominantly clay soils. Where soils are sufficiently permeable for facilities such as dry wells, infiltration basins, or infiltration trenches to be feasible, and groundwater protection guidelines are followed, there are few technical or institutional barriers to design and construction of infiltration systems.

However, even in these cases, bioretention may be a better option, as bioretention facilities effectively intercept non-stormwater discharges and allow for easier detection and clean-up. Bioretention facilities also filter fine sediments prior to infiltration, maintain soil permeability by encouraging the formation of soil macropores, provide aesthetic and habitat benefits, reduce heat island effects, improve air quality, and provide opportunities for education.

3.4 Guidance for Permittees and LID Education and Outreach

Bay Area development sites use a variety of methods to implement LID, including site design, landscape dispersion, green roofs, permeable pavements, harvesting/use, infiltration, and bioretention. Bioretention is by far the most common method used, and the great majority of impervious area which drains to LID treatment drains to bioretention facilities. This trend is expected to continue because bioretention is more widely applicable to different locations and conditions, and—as documented above—has many inherent advantages over other LID options.

3.4.1 Guidance for Design of LID Facilities

Permittees' experience and current use of design guidance can be summarized as follows:

- For *site design*, to supplement Permittee manuals, there are many suitable guides, including BASMAA's *Start at the Source* (1999) and *Slow It, Spread It, Sink It!* (Southern Sonoma County Resource Conservation District, 2010). However, successful use of LID site design on a particular development project depends on the motivation and creativity of the designer.
- For *landscape dispersion,* the principles are simple. Guidance is available and incorporated in Permittee guidance manuals. Success depends on attention to detail during design and construction.
- For *green roofs,* as documented in BASMAA's Green Roofs Minimum Specifications Report (BASMAA 2011b), Permittees have incorporated the stated minimum specifications in their guidance. For detailed design assistance, Permittees have found it effective to refer applicants who might consider a green roof to the industry association, Green Roofs for Healthy Cities.
- For *permeable pavements,* Permittees have created suitable guidance and incorporated it into their manuals. Design assistance for specific applications of permeable concrete and porous asphalt is available from industry associations.

- For *harvesting and use,* design guidance and training is available from the American Rainwater Catchment Systems Association (ARCSA).
- For *infiltration* and *bioretention* design, Permittees have drawn from various sources nationally, including USEPA publications and websites. However, the best and most complete design guidance for bioretention has been developed by Bay Area Permittees; this includes guidance on bioretention soils (BASMAA, 2010) and the Permittees' guidance manuals, which are emulated statewide.

In summary, the BASMAA Permittees' guidance for design and construction of LID features and facilities is the most complete and detailed of any California municipalities. Based on the experience of Permittees and countywide program managers, the quality and attention to detail in constructed projects has greatly improved in the past few years; however, errors in implementation continue to occur. Some errors relate to the succession of permit requirements and design guidance over the past decade. For large development projects, several years can elapse between conceptual design and construction. Applicants and applicants' engineers occasionally rely on outdated information or guidance when preparing construction documents.

3.4.2 Maintenance Verification for LID Features and Facilities

MRP Provision C.3.h. contains requirements for Permittee programs to verify the operation and maintenance of stormwater management facilities. The current requirements were carried over, with few changes or updates, from previous stormwater permits.

The language and requirements were developed in the context of non-LID treatment. At the time the requirements were developed, stormwater treatment methods leaned toward extended detention basins, sand filters, and proprietary devices such as continuous deflection separators and vault-based media filters. Much emphasis was placed on the need for these facilities to be regularly maintained to be effective. Required maintenance activities for these facilities include regular removal of accumulated sediment and debris, changing of proprietary filter media or raking of sand filters, and removal of debris that may have clogged orifices.

In comparison, bioretention facilities require much less maintenance and are less prone to failure. Further, because bioretention facilities are designed as aesthetic features, they are regularly seen and maintenance problems are readily apparent.

Experience has shown the problems with bioretention facilities tend to result from errors during design and construction and include the following:

- Runoff doesn't enter the facility because of faulty grading or inlet construction.
- Facility surface reservoir does not fill because it the top of soil layer was not installed level and/or because the overflow elevation was set too low.
- Facility subsurface reservoir does not fill because top of gravel layer was not installed level and/or because underdrain elevation was not set at top of gravel layer.
- Runoff does not enter facility because inlets are transverse to curb flow line, and curb flow velocity is too high.

In addition, the following noted issues relate to maintenance as well as to design and construction (including plant selection and installation).

- Facility surface reservoir does not fill because mulch, topsoil, or other material was added after construction.
- Runoff does not enter facility because vegetation has grown in too densely and is blocking inlets.
- Entire surface of facility is covered with tree roots.
- Limits of facility are not delineated in the field; unclear where landscaping ends and facility begins.
- Potentially erodible landscape is tributary to the facility.
- Vegetation has died because of lack of irrigation.
- Mulch has biodegraded and has not been replaced.
- Trash has collected in the facility and has not been removed.

Although not generally noted in field observations, there are also some concerns regarding the use of fertilizers and pesticides in bioretention facilities and potential effects on water quality.

Maintenance of Permeable Pavements

Permeable pavements and other runoff reduction measures, including self-retaining and self-treating areas, are not stormwater treatment systems as referenced and defined in the

MRP. The MRP is unambiguous in excluding pervious pavement and landscape dispersion from the definition of stormwater treatment system in the glossary, and also excludes these features from its many references to stormwater treatment systems. Accordingly, the requirements of Provision C.3.h., "Operation and Maintenance of Stormwater Treatment Systems," do not apply to pervious pavement or landscape dispersion.

With regard to maintenance requirements for permeable pavements, there is a paucity of documented field experience. On the one hand, there have been general recommendations that permeable pavements should be regularly vacuumed to remove accumulated fine sediments from near-surface pores; on the other, some industry representatives have noted that, when properly installed, permeable pavement has a surfeit of pores that can pass through water—even an 80% reduction in permeability from the initial condition would still leave sufficient porosity to prevent runoff during an intense storm.

Based on discussions among Permittee staff, the most significant concerns related to long-term performance of pervious pavements include:

- Quality of installation, specifically noting the specialized methods and skills required to install pervious concrete.
- Potential for pavement repair, overlay, or replacement with an impermeable treatment—actions that would typically not require a permit from a municipality.
- Potential for sources of sediment, such use of the pavement for storage and handling of soils or other bulk materials.

Maintenance of Self-Treating and Self-Retaining Areas

These features are generally regarded to be maintenance-free; however, there is the potential for the effectiveness of these features to be reduced by minor changes to site grading or drainage; these actions would not ordinarily require a permit from the municipality.

Summary of Maintenance Issues Pertaining to LID

In summary, maintenance issues for LID runoff-reduction features and LID stormwater treatment facilities are considerably different than the maintenance issues for non-LID stormwater treatment facilities. LID facilities are, in the main, less prone to failure; however, they are more likely to installed or built less than optimally, and they are more likely to be altered—sometimes unintentionally—by property owners.

The Provision C.3.h. operation and maintenance verification requirements for stormwater facilities should be reviewed in this context. A shift in emphasis may be warranted—a shift away from maintenance plans and regular inspections and toward better construction standards and signage that identifies bioretention facilities and LID features and provides information regarding their care.

3.5 Summary of Recommendations

As detailed in Section 2, nearly 400 Bay Area development projects have been subject to the requirement to evaluate the feasibility of harvesting and use, infiltration, and evapotranspiration. The Permittees have reviewed and considered this substantial body of experience. The project-by-project evaluation process nearly always results in the conclusion that harvesting and use, infiltration, and evapotranspiration cannot feasibly treat the amount of runoff identified in Provision C.3.d. and that bioretention should be used to implement LID on-site.

Consistent with the Water Board's direction that this document should discuss "…proposed changes to feasibility and infeasibility criteria and rationale for these changes" and to guide Permittees to "…make a consistent and appropriate determination of the feasibility of harvesting and reuse, infiltration, or evapotranspiration," the Permittees reviewed their experience and developed the following recommendations.

BASMAA recommends that, beginning now, Permittees take the following actions relevant to the LID Feasibility Evaluation Process identified beginning on page 12 of the May 1, 2011 Criteria Report (BASMAA 2011a):

1. Recognize the use of bioretention facilities incorporating the raised-underdrain design as an equivalently acceptable LID option.
2. Adopt procedures that require applicants to first minimize runoff using site design measures and runoff reduction measures—such as those described in MRP Provisions C.3.c.i.(2)(a)—and then use infiltration, harvesting/use, and/or bioretention facilities that meet the hydraulic sizing requirements of Provision C.3.d. to manage runoff from remaining Drainage Management Areas.

3. Prepare a regional compilation of references and resources for harvesting/use and make this available to applicants for development approvals issued by the Permittees.

4. Review existing Permittee guidance for runoff reduction features and bioretention, and also review current implementation of that guidance, and make any changes or improvements needed to ensure facilities are consistently constructed to design criteria.

BASMAA further recommends the following activities be considered for Permittee implementation in a time frame corresponding to the term of the forthcoming reissued MRP:

1. Continue review and ongoing improvement of standards for design and construction of runoff reduction measures and bioretention facilities.

2. Seek grant funding for *in situ* monitoring and evaluation of the hydrologic performance of bioretention facilities.

3. Revise and re-orient operation and maintenance verification programs to optimize the long-term performance of runoff reduction measures and LID treatment facilities (most commonly bioretention).

4. Develop protocols for delineation and signage for pervious pavements and other runoff reduction measures, and for bioretention.

5. Include notation of pervious paving condition as part of O&M verification inspections on regulated projects, and include requirements for maintaining pervious paving in maintenance agreements or equivalent mechanisms.

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APPENDIX A

Feasibility/Infeasibility Work Sheets

Infiltration/Harvesting and Use Feasibility Screening Worksheet

Apply these screening criteria for C.3 Regulated Projects required to implement Provision C.3 stormwater treatment requirements. See the Glossary (Attachment 1) for definitions of terms marked with an asterisk (*). Contact municipal staff to determine whether the project meets Special Project* criteria. If the project meets Special Project criteria, it may receive LID treatment reduction credits.*

1. Applicant Info

Site Address: ________________________________, CA APN:__________________

Applicant Name:______________________________ Phone No.:__________________

Mailing Address: ____

2. Feasibility Screening for Infiltration

Do site soils either (a) have a saturated hydraulic conductivity* (Ksat) that will NOT allow infiltration of 80% of the annual runoff (that is, the Ksat is LESS than 1.6 inches/hour), or, if the Ksat rate is not available, (b) consist of Type C or D soils?[1]

☐ Yes (continue) ☐ No – complete the Infiltration Feasibility Worksheet. If infiltration of the C.3.d amount of runoff is found to be feasible, there is no need to complete the rest of this screening worksheet.

3. Recycled Water Use

Check the box if the project is installing and using a recycled water plumbing system for non-potable water use.

☐ The project is installing a recycled water plumbing system, and installation of a second non-potable water system for harvested rainwater is impractical, and considered infeasible due to cost considerations. Skip to Section 6.

4. Calculate the Potential Rainwater Capture Area* for Screening of Harvesting and Use

Complete this section for the entire project area. If rainwater harvesting and use is infeasible for the entire site, and the project includes one or more buildings that each have an individual roof area of 10,000 sq. ft. or more, then complete Sections 4 and 5 of this form for each of these buildings.

4.1 Table 1 for (check one): ☐ The whole project ☐ Area of 1 building roof (10,000 sq.ft. min.)

Table 1: Calculation of the Potential Rainwater Capture Area*

The Potential Rainwater Capture Area may consist of either the entire project area or one building with a roof area of 10,000 sq. ft. or more.

	1	2	3	4
	Pre-Project Impervious surface[2] (sq.ft.), if applicable	Proposed Impervious Surface[2] (IS), in sq. ft.		Post-project landscaping (sq.ft.), if applicable
		Replaced[3] IS	Created[4] IS	
a. Enter the totals for the area to be evaluated:				
b. Sum of replaced and created impervious surface:	N/A			N/A
c. Area of existing impervious surface that will NOT be replaced by the project.		N/A		N/A

[1] Base this response on the site-specific soil report, if available. If this is not available, consult soil hydraulic conductivity maps in Attachment 3.

[2], Enter the total of all impervious surfaces, including the building footprint, driveway(s), patio(s), impervious deck(s), unroofed porch(es), uncovered parking lot (including top deck of parking structure), impervious trails, miscellaneous paving or structures, and off-lot impervious surface (new, contiguous impervious surface created from road projects, including sidewalks and/or bike lanes built as part of new street). Impervious surfaces do NOT include vegetated roofs or pervious pavement that stores and infiltrates rainfall at a rate equal to immediately surrounding, unpaved landscaped areas, or that stores and infiltrates the C.3.d amount of runoff*.

[3] "Replaced" means that the project will install impervious surface where existing impervious surface is removed.

[4] "Created" means the project will install new impervious surface where there is currently no impervious surface.

* For definitions, see Glossary (Attachment 1).

4.2 Answer this question ONLY if you are completing this section for the entire project area. If existing impervious surface will be replaced by the project, does the area to be replaced equal 50% or more of the existing area of impervious surface? *(Refer to Table 1, Row "a". Is the area in Column 2 > 50% of Column 1?)*

- ☐ Yes, C.3. stormwater treatment requirements apply to areas of impervious surface that will remain in place as well as the area created and/or replaced. This is known as the 50% rule.
- ☐ No, C.3. requirements apply only to the impervious area created and/or replaced.

4.3 Enter the square footage of the Potential Rainwater Capture Area*. If you are evaluating only the roof area of a building, or you answered "no" to Question 4.2, this amount is from Row "b" in Table 1. If you answered "yes" to Question 4.2, this amount is the sum of Rows "b" and "c" in Table 1.:

______________________________________ square feet.

4.4 Convert the measurement of the Potential Rainwater Capture Area* from square feet to acres (divide the amount in Item 4.3 by 43,560):

______________________________________ acres.

5. Feasibility Screening for Rainwater Harvesting and Use

5.1 Use of harvested rainwater for landscape irrigation:

Is the onsite landscaping LESS than 2.5 times the size of the Potential Rainwater Capture Area* (Item 4.3)? (Note that the landscape area(s) would have to be contiguous and within the same Drainage Management Area to use harvested rainwater for irrigation via gravity flow.)

☐ Yes (continue) ☐ No – Direct runoff from impervious areas to self-retaining areas* OR refer to Table 11 and the curves in Appendix F of the LID Feasibility Report to evaluate feasibility of harvesting and using the C.3.d amount of runoff for irrigation.

5.2 Use of harvested rainwater for toilet flushing or non-potable industrial use:

a. Residential Projects: Proposed number of dwelling units:________________________________

Calculate the dwelling units per impervious acre by dividing the number of dwelling units by the acres of the Potential Rainwater Capture Area* in Item 4.4. Enter the result here:

________________)

Is the number of dwelling units per impervious acre LESS than 100 (assuming 2.7 occupants/unit)?

☐ Yes (continue) ☐ No – complete the Harvest/Use Feasibility Worksheet.

b. Commercial/Industrial Projects: Proposed interior floor area:___________________________ (sq. ft.)

Calculate the proposed interior floor area (sq.ft.) per acre of impervious surface by *dividing the interior floor area (sq.ft.) by the acres of the Potential Rainwater Capture Area* in Item 4.4. Enter the result here:*

____

Is the square footage of the interior floor space per impervious acre LESS than 70,000 sq. ft.?

☐ Yes (continue) ☐ No – complete the Harvest/Use Feasibility Worksheet

c. School Projects: Proposed interior floor area:____ (sq. ft.)

Calculate the proposed interior floor area per acre of impervious surface by *dividing the interior floor area (sq.ft.) by the acres of the Potential Rainwater Capture Area* in Item 4.4 . Enter the result here:*

_________________.

Is the square footage of the interior floor space per impervious acre LESS than 21,000 sq. ft.?

☐ Yes (continue) ☐ No – complete the Harvest/Use Feasibility Worksheet

* For definitions, see Glossary (Attachment 1).

d. Mixed Commercial and Residential Use Projects

- Evaluate the residential toilet flushing demand based on the dwelling units per impervious acre for the residential portion of the project, following the instructions in Item 5.2.a, except you will use a prorated acreage of impervious surface, based on the percentage of the project dedicated to residential use.
- Evaluate the commercial toilet flushing demand per impervious acre for the commercial portion of the project, following the instructions in Item 5.2.a, except you will use a prorated acreage of impervious surface, based on the percentage of the project dedicated to commercial use.

e. Industrial Projects: Estimated non-potable water demand (gal/day): ____________________________

Is the non-potable demand LESS than 2,400 gal/day per acre of the Potential Rainwater Capture Area?

☐ Yes (continue) ☐ No – refer to the curves in Appendix F of the LID Feasibility Report to evaluate feasibility of harvesting and using the C.3.d amount of runoff for industrial use.

6. Use of Biotreatment

If only the "Yes" boxes were checked for all questions in Sections 2 and 5, or the project will have a recycled water system for non-potable use (Section 3), then the applicant may use appropriately designed bioretention facilities for compliance with C.3 treatment requirements. The applicant is encouraged to maximize infiltration of stormwater if site conditions allow.

7. Results of Screening Analysis

Based on this screening analysis, the following steps will be taken for the project (check all that apply):

☐ Implement biotreatment measures (such as an appropriately designed bioretention area).

☐ Conduct further analysis of infiltration feasibility by completing the Infiltration Feasibility Worksheet.

☐ Conduct further analysis of rainwater harvesting and use (check one):

- ☐ Complete the Rainwater Harvesting and Use Feasibility Worksheet for:
  - ☐ The entire project
  - ☐ Individual building(s), if applicable, describe:___________________________________
- ☐ Evaluate the feasibility of harvesting and using the C.3.d amount of runoff for irrigation, based on Table 11 and the curves in Appendix F of the LID Feasibility Report
- ☐ Evaluate the feasibility of harvesting and using the C.3.d amount of runoff for non-potable industrial use, based on the curves in Appendix F of the LID Feasibility Report.

* For definitions, see Glossary (Attachment 1).

Infiltration Feasibility Worksheet

Municipal Regional Stormwater Permit (MRP)
Stormwater Controls for Development Projects

Complete this worksheet for C.3 Regulated Projects* *for which the soil hydraulic conductivity (Ksat) exceeds 1.6. Use this checklist to determine the feasibility of treating the* C.3.d *amount of runoff** *with infiltration. Where it is infeasible to treat the C.3.d amount of runoff* with infiltration or rainwater harvesting and use, stormwater may be treated with* biotreatment* *measures. See Glossary (Attachment 1) for definitions of terms marked with an asterisk (*).*

1. Enter Project Data.

1.1 Project Name: ____________________

1.2 Project Address: ____________________

1.3 Applicant/Agent Name: ____________________

1.4 Applicant/Agent Address: ____________________

1.5 Applicant/Agent Email: ____________________ Applicant / Agent Phone: ____________________

2. Evaluate infiltration feasibility.

Check "Yes" or "No" to indicate whether the following conditions apply to the project. If "Yes" is checked for any question, then infiltration is infeasible, and you can continue to Item 3.1 without answering any further questions in Section 2. If all of the answers in Section 2 are "No," then infiltration is feasible, and you may design *infiltration facilities** *for the area from which runoff must be treated. Items 2.1 through 2.3 address the feasibility of using* *infiltration facilities**, *as well as the potential need to line bioretention areas.*

		Yes	No
2.1	Would infiltration facilities at this site conflict with the location of existing or proposed underground utilities or easements, or would the siting of infiltration facilities at this site result in their placement on top of underground utilities, or otherwise oriented to underground utilities, such that they would discharge to the utility trench, restrict access, or cause stability concerns? (If yes, attach evidence documenting this condition.)	☐	☐
2.2	Is there a documented concern that there is a potential on the site for soil or groundwater pollutants to be mobilized? (If yes, attach documentation of mobilization concerns.)	☐	☐
2.3	Are geotechnical hazards present, such as steep slopes, areas with landslide potential, soils subject to liquefaction, or would an infiltration facility need to be built less than 10 feet from a building foundation or other improvements subject to undermining by saturated soils? (If yes, attach documentation of geotechnical hazard.)	☐	☐

Respond to Questions 2.4 through 2.8 only if the project proposes to use an infiltration device*.

2.4	Do local water district or other agency's policies or guidelines regarding the locations where infiltration may occur, the separation from seasonal high groundwater, or setbacks from potential sources of pollution prevent infiltration devices from being implemented at this site? (If yes, attach evidence documenting this condition.)	☐	☐

		Yes	No
2.5	Would construction of an infiltration device require that it be located less than 100 feet away from a septic tank, underground storage tank with hazardous materials, or other potential underground source of pollution? (If yes, attach evidence documenting this claim.)	☐	☐

Infiltration Feasibility Worksheet

		Yes	No
2.6	Is there a seasonal high groundwater table or mounded groundwater that would be within 10 feet of the base of an infiltration device* constructed on the site? (If yes, attach documentation of high groundwater.)	☐	☐
2.7	Are there land uses that pose a high threat to water quality – including but not limited to industrial and light industrial activities, high vehicular traffic (i.e., 25,000 or greater average daily traffic on a main roadway or 15,000 or more average daily traffic on any intersecting roadway), automotive repair shops, car washes, fleet storage areas, or nurseries? (If yes, attach evidence documenting this claim.)	☐	☐
2.8	Is there a groundwater production well within 100 feet of the location where an infiltration device would be constructed? (If yes, attach map showing the well.)	☐	☐

3. Results of Feasibility Determination

		Infeasible	Feasible
3.1	Based on the results of the Section 2 feasibility analysis, infiltration is (check one):	☐	☐

→ *If "FEASIBLE" is indicated for Item 3.1, then the amount of stormwater requiring treatment must be treated with infiltration (or rainwater harvest and use, if feasible).* ***Infiltration facilities**** *may be designed for the area from which runoff must be treated.*

→ *If "INFEASIBLE" is checked for item 3.1, then the applicant may use appropriately designed* ***biotreatment facilities**** *for compliance with C.3 treatment requirements. The applicant is encouraged to maximize infiltration of stormwater if site conditions allow.*

Name of Applicant (Print)

Name of Applicant (Sign)

Date

* See Glossary (Attachment 1) for definitions.

Rainwater Harvesting and Use Feasibility Worksheet

Municipal Regional Stormwater Permit (MRP)

Stormwater Controls for Development Projects

Complete this worksheet for all C.3 Regulated Projects* for which the project density exceeds the screening density* provided by municipal staff. Use this worksheet to determine the feasibility of treating the C.3.d amount of runoff* with rainwater harvesting and use for indoor, non-potable water uses. Where it is infeasible to treat the C.3d amount of runoff with either harvesting and use or infiltration, stormwater may be treated with biotreatment* measures. See Glossary (Attachment 1) for definitions of terms marked with an asterisk.

Complete this worksheet for the entire project area. If the project includes one or more buildings that each individually has a roof area of 10,000 square feet or more, complete a separate copy of this form for each of these buildings.

1. Enter Project Data.

1.1	Project Name:		
1.2	Project Address:		
1.3	Applicant/Agent Name:		
1.4	Applicant/Agent Address:		

(For projects with a potential non-potable water use other than toilet flushing, skip to Question 5.1)

1.5	Project Type:	If residential or mixed use, enter # of dwelling units:	
1.6		Enter square footage of non-residential interior floor area.:	
1.7	**Potential rainwater capture area*:**		sq.ft.
1.8	If it is a Special Project*, indicate the percentage of LID treatment* reduction: *(Item 1.8 applies only to entire project evaluations, not individual roof area evaluations.)*		percent
1.9	Total potential rainwater capture area that will require LID treatment: *(This is the total rain capture area remaining after any Special Project LID treatment reduction is applied.)*	0	sq.ft.

2. Calculate Area of Self-Treating Areas, Self-Retaining Areas, and Areas Contributing to Self-Retaining Areas.

(For areas within the Potential Rain Capture Area only)

2.1	Enter square footage of any self-treating areas* in the area that is being evaluated:		sq.ft.
2.2	Enter square footage of any self-retaining areas* in the area that is being evaluated:		sq.ft.
2.3	Enter the square footage of areas contributing runoff to self-retaining area*:		sq.ft.
2.4	TOTAL of Items 2.1, 2.2, and 2.3:	-	sq.ft.

3. Subtract credit for self-treating/self-retaining areas from area requiring treatment.

3.1	Subtract the TOTAL in Item 2.4 from the potential rainwater capture area in Item 1.9:	-	sq.ft.
3.2	Convert the remaining area required for treatment in Item 3.1 from square feet to acres:	0.00	acres

4. Determine feasibility of use for toilet flushing based on demand

4.1	Project's dwelling units per acre of adjusted potential rain capture area (Divide the number in 1.5 by the number in 3.2)		dwelling units/acre
4.2	Non-residential interior floor area per acre of adjusted potential rain capture area (Divide the number in 1.6 by the number in 3.2)		Int. non-res. floor area/acre

Note: formulas in Items 4.1 and 4.2 are set up, respectively, for a residential or a non-residential project. Do not use these pre-set formulas for mixed use projects. ***For mixed use projects****, evaluate the residential toilet flushing demand based on the dwelling units per acre for the residential portion of the project (use a prorated acreage, based on the percentage of the project dedicated to residential use). Then evaluate the commercial toilet flushing demand per acre for the commercial portion of the project (use a prorated acreage, based on the percentage of the project dedicated to commercial use).*

4.3	Refer to the applicable countywide table in Attachment 2. Identify the number of dwelling units per impervious acre needed in your Rain Gauge Area to provide the toilet flushing demand required for rainwater harvest feasibility.	____ dwelling units/acre
4.4	Refer to the applicable countywide table in Attachment 2. Identify the square feet of non-residential interior floor area per impervious acre needed in your Rain Gauge Area to provide the toilet flushing demand required for rainwater harvest feasibility.	____ int. non-res. floor area/acre

Check "Yes" or "No" to indicate whether the following conditions apply. If "Yes" is checked for any question, then rainwater harvesting and use is infeasible. As soon as you answer "Yes", you can skip to Item 6.1. If "No" is checked for all items, then rainwater harvesting and use is feasible and you must harvest and use the C.3.d amount of stormwater, unless you infiltrate the C.3.d amount of stormwater.*

4.5	Is the project's number of dwelling units per acre of adjusted area requiring treatment (listed in Item 4.1) LESS than the number identified in Item 4.3?	☐ Yes	☐ No
4.6	Is the project's square footage of non-residential interior floor area per acre of adjusted area requiring treatment (listed in Item 4.2) LESS than the number identified in Item 4.4?	☐ Yes	☐ No

5. Determine feasibility of rainwater harvesting and use based on factors other than demand.

5.1	Does the requirement for rainwater harvesting and use at the project conflict with local, state, or federal ordinances or building codes?	☐ Yes	☐ No
5.2	Would the technical requirements cause the harvesting system to exceed 2% of the Total Project Cost, or has the applicant documented economic hardship in relation to maintenance costs? (If so, attach an explanation.)	☐ Yes	☐ No
5.3	Do constraints, such as a slope above 10% or lack of available space at the site, make it infeasible to locate on the site a cistern of adequate size to harvest and use the C.3.d amount of water? (If so, attach an explanation.)	☐ Yes	☐ No
5.4	Are there geotechnical/stability concerns related to the surface (roof or ground) where a cistern would be located that make the use of rainwater harvesting infeasible? (If so, attach an explanation.)	☐ Yes	☐ No
5.5	Does the location of utilities, a septic system and/or **heritage trees*** limit the placement of a cistern on the site to the extent that rainwater harvesting is infeasible? (If so, attach an explanation.)	☐ Yes	☐ No

Note 1: It is assumed that projects with significant amounts of landscaping will either treat runoff with landscape dispersal (self-treating and self-retaining areas) or will evaluate the feasibility of havesting and using rainwater for irrigation using the curves in Appendix F of the LID Feasibility Report.

6. Results of Feasibility Determination

		Infeasible	Feasible
6.1	Based on the results of the feasibility analysis in Item 4.4 and Section 5, rainwater harvesting/use is (check one):	☐	☐

➔ If "FEASIBLE" is indicated for Item 6.1 the amount of stormwater requiring treatment must be treated with harvesting/use, unless it is infiltrated into the soil.

➔ If "INFEASIBLE" is checked for Item 6.1, then the applicant may use appropriately designed bioretention,[1] facilities for compliance with C.3 treatment requirements. If Ksat > 1.6 in./hr., and infiltration is unimpeded by subsurface conditions, then the bioretention facilities are predicted to infiltrate 80% or more average annual runoff. If Ksat < 1.6, maximize infiltration of stormwater by using bioretention if site conditions allow, and remaining runoff will be discharged to storm drains via facility underdrains. If site conditions preclude infiltration, a lined bioretention area or flow-through planter may be used.*

Applicant (Print) ____________________

Applicant (Sign) ____________________ Date ____________________

* See definitions in Glossary (Attachment 1)

LID Feasibility Worksheet
Attachment 1: Glossary

Biotreatment

A type of low impact development treatment allowed under Provision C.3.c of the *MRP**, if infiltration, evapotranspiration and rain water harvesting and use are infeasible. As required by Provision C.3.c.i(2)(vi), biotreatment systems shall be designed to have a surface area no smaller than what is required to accommodate a 5 inches/hour stormwater runoff surface loading rate and shall use biotreatment soil as specified in the biotreatment soil specifications submitted by the MRP co-permittees to the Regional Water Quality Control Board on April 29, 2011, or equivalent.

C.3 Regulated Projects:

Development projects as defined by Provision C.3.b.ii of the *MRP**. This includes public and private projects that create and/or replace 10,000 square feet or more of impervious surface, and it includes restaurants, retail gasoline outlets, auto service facilities, and uncovered parking lots (stand-alone or part of another use) that create and/or replace 5,000 square feet or more of impervious surface. Single family homes that are not part of a larger plan of development are specifically excluded.

C.3.d Amount of Runoff

The amount of stormwater runoff from C.3 Regulated Projects that must receive stormwater treatment, as described by hydraulic sizing design criteria in Provision C.3.d of the *MRP**.

Diameter at Breast Height (DBH)

The trunk diameter of a tree measured at breast height, 4.5 feet above the ground.

Heritage Tree

An individual tree of any size or species given the ‘heritage tree’ designation as defined by the municipality’s tree ordinance or other section of the municipal code.

Infiltration Devices

Infiltration facilities that are deeper that they are wide and designed to infiltrate stormwater runoff into the subsurface and, as designed, bypass the natural groundwater protection afforded by surface soil. These devices include dry wells, injection wells and infiltration trenches (includes French drains).

Infiltration Facilities

A term that refers to both infiltration devices and measures.

Infiltration Measures

Infiltration facilities that are wider than they are deep (e.g., bioinfiltration, infiltration basins and shallow wide infiltration trenches and dry wells).

Low Impact Development (LID) Treatment

Removal of pollutants from stormwater runoff using the following types of stormwater treatment measures: rainwater harvesting and use, infiltration, evapotranspiration, or, where these are infeasible, biotreatment may be used.

Municipal Regional Stormwater Permit (MRP)

The municipal stormwater NPDES permit under which discharges are permitted from municipal separate storm sewer systems throughout the NPDES Phase I jurisdictions within the San Francisco Bay Region.

Potential Rain Capture Area

The area defined as the C.3 site area, if the rainwater harvesting and use evaluation considers the entire site; or, if the rainwater harvesting and use evaluation considers only the roof area, the Potential Rain Capture Area consists only of the roof area of the project.

Screening Density

A threshold of density per acre of impervious surface, set by a municipality, for C.3 regulated projects. If the screening density is met or exceeded, the Rainwater Harvesting and Use Feasibility Worksheet must be completed for the project.

Self-Retaining Area

A portion of a development site designed to retain the first one inch of rainfall (by ponding and infiltration and/or evapotranspiration) without producing stormwater runoff. Self-retaining areas must have at least a 2:1 ratio of contributing area to a self-retaining area and a 3" ponding depth. Self-retaining areas may include graded depressions with landscaping or pervious pavement. **Areas that Contribute Runoff to Self-Retaining Areas** are impervious or partially pervious areas that drain to self-retaining areas.

Self-Treating Area

A portion of a development site in which infiltration, evapotranspiration and other natural processes remove pollutants from stormwater. Self-treating areas may include conserved natural open areas, areas of landscaping, green roofs and pervious pavement. Self-treating areas treat only the rain falling on them and do not receive stormwater runoff from other areas.

Special Projects

Certain types of smart growth, high density and transit oriented development projects that are allowed, under Provision C.3.e.ii of the MRP, to receive LID treatment reductions. The specific development project types will be described in an amendment to the MRP, anticipated in Fall 2011.

Total Project Cost

Total project cost includes the construction (labor) and materials cost of the physical improvements proposed; however, it does not include land, transactions, financing, permitting, demolition, or off-site mitigation costs.

LID Feasibility Worksheet
Attachment 2: Toilet-Flushing Demand Required for Rainwater Harvesting Feasibility per Impervious Acre (IA) [1,2]

Table 1 - Alameda County:

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]		Schools[6]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]	Employees[11] per IA	Interior Floor Area (sq.ft./IA)[12]
Berkeley	5,900	690	255	860	172,000	170	51,000
Dublin	4,100	480	177	590	118,000	120	36,000
Hayward	4,800	560	207	700	140,000	140	42,000
Palo Alto	2,900	340	125	420	84,000	90	27,000
San Jose	2,400	280	103	350	70,000	70	21,000

Table 2 - Santa Clara County:

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]		Schools[6]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]	Employees[11] per IA	Interior Floor Area (sq.ft./IA)[12]
Morgan Hill	6,500	760	260	940	188,000	190	57,000
Palo Alto	2,900	340	116	420	84,000	90	27,000
San Jose	2,400	280	96	350	70,000	70	21,000

Table 3 – San Mateo County:

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]		Schools[6]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]	Employees[11] per IA	Interior Floor Area (sq.ft./IA)[12]
Palo Alto	2,900	340	124	420	84,000	90	27,000
San Francisco	4,600	530	193	670	134,000	140	42,000
SF Oceanside	4,300	500	182	620	124,000	130	39,000

Table 4 – Contra Costa County:

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]		Schools[6]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]	Employees[11] per IA	Interior Floor Area (sq.ft./IA)[12]
Berkeley	5,900	690	254	860	172,000	170	51,000
Brentwood	4,200	490	180	610	122,000	120	36,000
Dublin	4,100	480	176	590	118,000	120	36,000
Martinez	5,900	690	254	860	172,000	170	51,000

Table 5 – Solano County:

Rain Gauge[3]	Required Demand (gal/day/IA)[4]	Residential		Office/Retail[5]		Schools[6]	
		No. of residents per IA[7]	Dwelling Units per IA[8]	Employees per IA[9]	Interior Floor Area (sq.ft./IA)[10]	Employees[11] per IA	Interior Floor Area (sq.ft./IA)[12]
Lake Solano	9,000	1,050	362	1,300	260,000	270	81,000
Martinez	5,900	690	238	860	172,000	170	51,000

Notes:

1. Demand thresholds obtained from the "Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report" (LID Feasibility Report) submitted to the Regional Water Board on May 1, 2011.
2. Toilet flushing demands assume use of low flow toilets per the California Green Building Code.
3. See Attachment 3 to identify the rain gauge that corresponds to the project site.
4. Required demand per acre of impervious area to achieve 80% capture of the C.3.d runoff volume with the maximum allowable drawdown time for cistern of 50,000 gallons or less, from Table 9 of the LID Feasibility Report.
5. "Office/Retail" includes the following land uses: office or public buildings, hospitals, health care facilities, retail or wholesale stores, and congregate residences.
6. "Schools" includes day care, elementary and secondary schools, colleges, universities, and adult centers.
7. Residential toilet flushing demand identified in Table 10 of the LID Feasibility Report.
8. Residential toilet flushing demand divided by the countywide average number of persons per household (US Census data reported on www.abag.org), as follows: Alameda County: 2.71 persons per household; Santa Clara County: 2.92; San Mateo County: 2.74; Contra Costa County: 2.72; Solano County: 2.90.
9. Office/retail employee toilet flushing demand identified in Table 10 of the LID Feasibility Report.
10. Interior floor area required for rainwater harvest and use feasibility per acre of impervious area is based on the number of employees in Column 5 multiplied by an occupant load factor of 200 square feet per employee (reference: 2010 California Plumbing Code, Chapter 4, Plumbing Fixtures and Fitting Fixtures, Table A, page 62.)
11. School employee toilet flushing demand identified in Table 10 of the LID Feasibility Report. Each school employee represents 1 employee and 5 "visitors" (students and others).
12. Interior floor area required for rainwater harvest and use feasibility per acre of impervious area is based on the number of employees in Column 7 multiplied by 6 to account for visitors, then multiplied by an occupant load factor of 50 square feet per employee (reference: 2010 California Plumbing Code).

LID Feasibility Worksheet

Attachment 3:

Countywide Maps with
Rain Gauge Areas
And
Soil Hydraulic Conductivity (Ksat)

APPENDIX B

Infiltration Case Studies

<u>Infiltration Case Study 1</u>

Single Family Home Subdivision
125 South San Tomas Aquino Road, Campbell

Introduction to Project

The redevelopment project consists of a 25-lot, detached single family home subdivision on a 2.03-acre site. The existing site is currently occupied by three single-story buildings being used as auto repair shops and has 76,146 square feet of existing impervious surface; the project will create/replace 65,079 square feet of impervious surface. The site drains to the hardened portion of San Tomas Aquino Creek. The project was approved in FY 11-12 and is currently in plan check review for building permit.

According to the soils report, groundwater levels are on the order of 50 feet or more below grade. Soil borings indicated clayey surface soils to depths of 8 to 13 feet, underlain by clayey sands and gravels with infiltration rates ranging from 5-7 inches per hour to more than 20 inches per hour on one corner of the site.

Description of Site Design and Treatment Measures

Approximately 80,921 square feet of the site will drain to an underground infiltration facility below a common area in the center of the subdivision. The remaining areas of the site (7,530 square feet) are self-treating landscaped areas.

For the underground infiltration facility, a product called "EcoRain" consisting of modular storage cells will be installed. The modules are made of 100% recycled polypropylene and have 95% void space. The water quality design volume is 4,250 cubic feet; the EcoRain modules will provide 4,423 cubic feet of storage. The modules will have a surface area of 1,083 square feet and a height of 5.7 feet (with an overflow outlet at 1.5 feet below the top, the usable storage is 4.2 feet high). The modules will be installed such that the bottom of the facility is in contact with the higher permeability soils. A hydrodynamic separator will be installed upstream of the facility for pretreatment.

Lessons Learned

None at this stage of the project.

Contact

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Brandon Steiber, P.E., Design Engineer, Ruth and Going, Inc. bstieber@ruthandgoing.com

<u>Infiltration Case Study 2</u>

Single Family Home Subdivision
16213 Los Gatos Boulevard, Los Gatos

Introduction to Project

The project consisted of redevelopment of a former car dealership at 16213 Los Gatos Boulevard into a s subdivision consisting of 23 lots with detached single family homes and a new private street servicing the lots. The existing 1.9-acre site was approximately 90% impervious; after redevelopment, the site is approximately 54% impervious. The project replaced 44,930 square feet of impervious surface and converted about 30,000 square feet to pervious surface. The site is relatively flat and drains to the municipal storm drain system and ultimately to Los Gatos Creek. Groundwater levels on the site are greater than 20 feet below grade. The geotechnical report indicated infiltration rates may exceed 8 inches per hour. The project was approved in FY 11-12 and is currently under construction.

Description of Site Design and Treatment Measures

The treatment measure constructed for the project consisted of an infiltration trench along the east side of the private street, consisting of permeable pavers underlain by bedding gravel, pervious concrete, and drain rock. Site design measures included roof downspouts draining to landscaping on each individual lot and pervious paving driveways on some of the lots.

The infiltration trench was sized to accept runoff from an area of about 38,913 square feet, which contained about 24,380 square feet of impervious surface including the private street. Runoff from the remaining impervious areas is dispersed and infiltrated into landscaping (i.e., self-retaining areas in which the impervious to pervious area ratio does not exceed 2:1.)

The C.3.d stormwater treatment volume for the infiltration trench was determined to be 2,007 cubic feet. The infiltration trench was designed to infiltrate this volume into the underlying soil layer assuming a 48-hour drawdown time and an infiltration rate of the site soils equal to 0.5 inches per hour. (The geotechnical report later confirmed that the actual infiltration rate greatly exceeded this assumption.) The trench has a surface area of 1,510 square feet and is 4.5 feet deep. A 6-inch underdrain was installed 3.8 feet (46 inches) above the bottom of the trench, to provide for storage and infiltration of the design volume. The infiltration trench meets the Santa Clara Valley Water District and the Santa Clara Valley Urban Runoff Program guidelines for stormwater infiltration devices in residential subdivisions[1].

Lessons Learned

None at this stage of the project.

Contact

Andrew Turner, Civil Engineering Associates <Aturner@ceainc.net>
Trang Tu-Nguyen, Town of Los Gatos <ttunguyen@losgatosca.gov>

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[1] Infiltration guidelines can be found in the SCVURPPP C.3 Stormwater Handbook (2012), Appendix A.

Infiltration Case Study 3

Medical Office Building
14251 Winchester Blvd, Los Gatos

Introduction to Project

The project consisted of removal of an existing building and parking lot, and construction of a new medical office building, parking lot and landscaping. The existing 1-acre site contains 24,521 square feet of impervious surface. The project replaced all of the existing impervious surface and added about 10,715 square feet of impervious surface, for a total of 35,236 square feet (0.81 acres). The site is relatively flat; however, the finished grade is about four feet above street level on the north and east sides. The site drains ultimately to Los Gatos Creek. Groundwater levels on the site are 30-50 feet below grade, based on regional maps. The results of two percolation tests performed on the site showed percolation rates of 2.5 and 48 inches per hour. The project was approved in FY 11-12 and is currently under construction.

Description of Site Design and Treatment Measures

One linear bioinfiltration area along the south edge of the property treats runoff from the southern portion of the parking lot (0.3 acres). There are two infiltration trenches, one along Knowles Drive (north side of site) and one along Winchester Boulevard (east side). The Knowles trench receives roof and parking lot runoff from a 0.34-acre area, and the Winchester trench receives roof runoff from a 0.18-acre area. Site design measures include microdetention in landscaping and disconnected downspouts.

Runoff is conveyed to the infiltration trenches via 24-inch pipes that run just below the top of each trench and are perforated over the length of the trench. The trenches are buried and wrapped in filter fabric. The trench dimensions are below:

Trench	Design Volume (cu. ft.)	Actual Volume* (cu. ft.)	Length (ft.)	Width (ft.)	Depth (ft.)
Knowles	959	963	95	3.5	5.0
Winchester	523	526	52	3.5	5.0

*Includes volume in pipe.

At an infiltration rate of 2.5 inches per hour, the trenches will empty within 24 hours.

Lessons Learned

Later in the design phase, it was determined that the infiltration trench on the east side was too close to the building and the slope down to the street, so it was moved to the south along the parking lot.

Contact

Maziar Bozorginia, Town of Los Gatos <MBozorginia@losgatosca.gov>

<u>Infiltration Case Study 4</u>

Creekside Sports Park
930 University Avenue, Los Gatos

Introduction to Project

Creekside Sports Park is a project constructed by the Town of Los Gatos on the site of a former Verizon corporation yard. The project consists of a synthetic turf soccer field, a 41-space parking area, and a restroom/concession building. The site is 2.8 acres in size and located adjacent to Los Gatos Creek. The depth to groundwater ranges from 13 to 23 feet below ground surface, based on soil borings at various locations onsite. Three percolation tests conducted onsite indicated an average percolation rate of 3 inches per hour (a rate of 1 inch per hour was recommended for design). The project was completed in October 2012 (prior to the LID requirements for public projects).

Description of Site Design and Treatment Measures

The playing field and practice area consist of synthetic turf underlain with 6 inches of drain rock designed to store and infiltrate the water quality design volume of rainfall on the surface of the field. This area qualifies as a pervious, self-treating area and does not require additional treatment. The playing field and practice area also serve as a “self-retaining areas” that receive, store, and infiltrate runoff from adjacent sidewalks (there is sufficient storage in the drain rock to store this additional runoff).

The parking lot consists of permeable asphalt paving underlain with 16 inches of drain rock designed to store and infiltration the water quality design volume of rainfall. This area qualifies as a pervious, self-treating area and does not require additional treatment. Another smaller area of pervious pavers is provided next to the concession building. The parking lot and the area near the restroom/concession building also serve as “self retaining areas” that will receive, store and infiltrate runoff from adjacent sidewalks and other impervious areas. Runoff from several small impervious areas will disperse into adjacent landscaping or drain to one of two biofiltration swales.

The water quality design volume expressed as a depth over the site (also known as the “unit basin storage volume”) was calculated to be 0.57 inches. Percolation tests on site soils concluded that this volume could infiltrate into the compacted subgrade soil at a rate of approximately 1 inch/day.

The parking lot will contain three diagonal infiltration trenches below the pervious paving subbase to intercept lateral flow in the drain rock and keep it from undermining the creek bank. The trenches will be 18 inches deep below the paving subbase, for a total depth of about 38 inches below grade. Given the data on groundwater levels on the site, this design meets the MRP and Santa Clara Water District requirements for a 10-foot separation between the base of the trench and groundwater levels**.**

Lessons Learned

The geotechnical engineer recommended the diagonal “cut-off” trenches to protect the creek bank. The City had planned to install pervious pavers in the parking lot and switched to pervious asphalt to reduce costs.

Contact

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APPENDIX C

Rainwater Harvesting System Case Studies

Appendix C

RAINWATER HARVESTING SYSTEMS

Rainwater Harvesting Case Study 1

Century Theaters in Pacific Commons Planning Area 5
43917 Pacific Commons Boulevard, Fremont

Introduction to Project

The project consists of construction of a commercial movie theater on a 27.6-acre site. The building has a roof area of 64,040 square feet. It is a private project that was subject to Provision C.3 prior to the December 1, 2011, start date for Provision C.3.c requirements for LID. Construction was completed in 2012.

Rainwater Harvesting System

The applicant chose to install a 10,000 gallon cistern to harvest rainwater for toilet flushing. The motivation for including rainwater harvesting in the project was to build an environmentally sustainable building and obtain LEED certification. Rainwater is harvested only from the 64,040 square-foot roof area of the theater. Bioretention areas and mechanical treatment devices were included in the project to treat runoff from non-roof impervious surfaces. The storage and use of water counted toward meeting C.3 requirements.

Cost of Rainwater Harvesting System

No cost information is available.

Lessons Learned

This was the first rainwater harvesting project reviewed by City staff, and therefore staff needed to become familiar with the technology as part of the review process.

Information Provided by

Shannan Young, City of Fremont Environmental Services Division, syoung@fremont.gov, 510.494.4584

Rainwater Harvesting Case Study 2

Sacred Heart Schools
150 Valparaiso Ave., Atherton

Introduction to Project

The project consists of construction of a new building on the existing 8.5-acre campus of a private school, which resulted in the creation of 191,644 square feet of new impervious surface. It is a private project that was subject to Provision C.3 prior to the December 1, 2011, start date for the Provision C.3.c requirements for LID.

Rainwater Harvesting System

The applicant chose to install a 10,000 gallon cistern to harvest rainwater for toilet flushing. The motivation for including rainwater harvesting in the project was the school's interest in environmental sustainability.

Cost of Rainwater Harvesting System

No cost information is available.

Lessons Learned

No lessons were identified.

Information Provided by

David Huynh, City of Atherton, 650.752.0555, dhuynh@ci.atherton.ca.us

Rainwater Harvesting Case Study 3

David and Lucille Packard Foundation Headquarters
343 Second Street, Los Altos, CA 94022

Introduction to Project

The project consisted of construction of a new office building on a 2.2-acre site. Prior to redevelopment, the site consisted of asphalt parking lots and vacant buildings. The redevelopment resulted in the total impervious surface area decreasing from 97% to 37%. It is a private project that was subject to Provision C.3 prior to the December 1, 2011, start date for Provision C.3.c requirements for LID. Construction was completed in 2012.

Rainwater Harvesting System

The applicant chose to install two 10,000 gallon cisterns to capture runoff from 29,000 sq. ft. of roof area. The motivation for including rainwater harvesting in the project was the Packard Foundation's interest in environmental sustainability. The first cistern provides water for toilet flushing. It overflows into the second cistern which provides water for irrigation use. The second cistern overflows to a landscaped detention basin. The system includes pre-treatment filters and UV disinfection for toilet flushing water. Approximately 34% of the harvested rainwater collected annually is used for toilet flushing and meets an estimated 90% of the demand (326 gallons per day). Approximately 20% of the harvested rainwater is used for irrigation and meets an estimated 64% of the annual irrigation demand.

Cost of Rainwater Harvesting System

No cost information is available.

Lessons Learned

Filters installed near the roof level initially clogged due to pollen on the roof. A different filter system was then installed at the bottom of each downspout.

Information Provided by

Shauna Dunton, Sherwood Engineers
Linda Rhodes, Packard Foundation representative

Rainwater Harvesting Case Study 4

City of Oakland Rain Barrel Program

In 2009, the City of Oakland initiated a Rain Barrel Program, which provided rain barrels and cisterns to over 290 properties in the City, creating the capacity to harvest and use over 300,000 gallons of rainwater. The program operated from 2009 to 2013, with $1.3 million of funding provided by the ARRA, administered by the State Water Resources Control Board.

The program was conceived as an innovative approach to address hydromodification and erosion of creeks in the Oakland hills. Low-cost, subsidized rain barrels and cisterns were marketed through newspaper ads, editorials, neighborhood list serves, workshops, press events, garbage bill inserts, a program website, Facebook page, a marketing brochure and post card announcement. Later in the program, rain barrels were provided at no cost and homeowners were charged only for tax and delivery. Rain barrels and cisterns provided by the program ranged in size from 64 gallons to as large as two 2,825 gallon tanks installed at Skyline High School.

As of this writing, all rain barrels and cisterns have been distributed, and the program is in the evaluation phase. Modeling of the program's effectiveness in managing hydromodification is being conducted, and a participant survey is being administered. Among other data, the survey will identify the participants' uses of harvested water.

The City is considering the use of sanitary sewer funds to continue the program, in order to investigate the effect of cistern systems in preventing sanitary sewer over flows during storm events.