CALIFORNIA COASTKEEPER ALLIANCE

Heal the Bay

California Sportfishing Protection Alliance
"An Advocate for Fisheries, Habitat and Water Quality"

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10-22-12
SWRCB Clerk

October 22, 2012

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
1001 I Street, 24th Floor
Sacramento, CA 95814
Sent via email to commentletters@waterboards.ca.gov

RE: Comment Letter – Industrial General Permit

Dear Chair Hoppin and Board Members:

On behalf of California Coastkeeper Alliance ("CCKA"), representing 12 California Waterkeeper groups spanning the coast of California, Heal The Bay, and California Sportfishing Protection Alliance ("CSPA"), we appreciate the opportunity to provide comments on the State Water Resources Control Board's ("State Water Board") 2012 draft permit for storm water discharges associated with industrial activities.[1] We incorporate by reference the comments submitted by CCKA and CSPA on April 29, 2011 ("2011 Comment Letter"), and offer additional comments below on the changes reflected in the July 16, 2012 draft of the Permit ("Draft Permit").[2]

As demonstrated by the **1,432 letters** submitted to the State Water Board (*see* Attachment 1), California residents are deeply concerned about industrial storm water pollution, and are counting on the State Water Board to develop a permit that serves the greater public interest.[3] Despite the 15-year timeframe since this permit's last reissuance, many facilities still have not implemented storm water controls necessary to protect human health and the environment. As shown in Attachment 1, the (now deferred) cost of compliance for many facilities can be quite low; yet, Californians continually bear the costs of the loss of use of our state waters as a result of the 7,294 documented impaired water body statewide.[4]

We therefore greatly appreciate the State Water Board's work on the provisions of the Draft Permit and efforts to improve the 1997 Permit. For example, we strongly support the State Water Board's elimination of group monitoring.[5] In addition, we strongly support the State Water Board's step forward

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[1] National Pollutant Discharge Elimination System, General Permit for Storm Water Discharges Associated With Industrial Activities, Order No. _____, NPDES No. CAS000001.
[2] There are three elements to the Draft Permit: (1) the Order, (2) the Findings, and (3) the Fact Sheet. CCKA's comments refer to the Draft Permit generally, or to each of these elements within the Draft Permit with citation to the specific section and page number.
[3] *See* Attachment 1, a statement of support for a strong, clear, enforceable Industrial Storm Water Permit submitted to the State Water Board by 1,432 Californians.
[4] *See* California 2010, 303(d) list, available at: http://maps.waterboards.ca.gov/webmap/303d/files/2010_USEPA_approv_303d_List_Final_122311wsrcs.xls.
[5] *See* Fact Sheet Section I.D.12., at 12; *see also* Page 2, Finding #14, at 2.

to require all data and reports, including each facility's Storm Water Pollution Prevention Plan, to be filed electronically with the State Water Board, and electronically available for public review. This measure will reduce State Water Board's resources needed to administer the program, and shine a brighter light on each facility's storm water discharges. We urge the State Water Board to resist industry pressure to roll back even these modest advancements.

Unfortunately, in most ways, the Draft Permit is a step backwards—both from the 1997 Permit, and from the 2011 draft permit. Most notably, the Draft Permit does not provide a sampling scheme that will elicit better quantitative and qualitative data—an integral component of this permit revision identified by the Blue Ribbon Panel,[6] State Water Board staff and members, and environmental stakeholders. Additionally, the Draft Permit will be extremely resource-intensive for State Water Board and Regional Boards to enforce. The California Environmental Protection Agency found that "one of the greatest difficulties faced by enforcement staff is complicated, ambiguous and/or poorly written permits or multiple, conflicting and confusing regulatory requirements that are unenforceable."[7] The Draft Permit's complex monitoring and reporting scheme threatens to undermine the implementation and enforcement of the Draft Permit, drain limited agency resources, and divert Permittees' resources from pollution controls, to generating reports.

Ultimately, the Draft Permit should ensure the collection of more and better data, achieve water quality objectives, and improve the use of pollution control technology, in a clear and objective way for all parties to determine compliance with the permit. In order to accomplish these goals, we urge the State Water Board to address the problems with the Draft Permit, summarized here and described in detail below:

- **The Draft Permit impermissibly allows Permittees to self-regulate.**
- **The Draft Permit limits the scope of protection afforded under Porter-Cologne and the Clean Water Act.**
- **The Draft Permit's sampling scheme is inadequate to determine Permittee compliance.**
- **The State Water Board has not complied with its mandatory duties when establishing the Draft Permit's technology-based effluent limitations.**
- **The Draft Permit does not clearly delineate that a Permittee is required to strictly comply with water quality standards.**
- **The Draft Permit is inconsistent with existing, applicable Total Maximum Daily Loads and fails to incorporate Waste Load Allocations as water quality-based effluent limits.**

CCKA provides proposed language for all the suggested revisions of the Draft Permit discussed below. *See* Attachment 2.

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[6] Fact Sheet Section II.K.2.b., at 45.
[7] Memorandum from Terry Tamminen, Secretary, Cal/EPA to BDOs, p. 8 (November 30, 2004) ("Cal EPA Enforcement Initiative").

I. THE DRAFT PERMIT IMPERMISSIBLY ALLOWS PERMITTEES TO SELF-REGULATE.

The Draft Permit's allowance of self-regulation is contrary to sound public policy, violates fundamental provisions of the Clean Water Act, and has been expressly invalidated by the Ninth Circuit Court of Appeals.[8] The State Water Board acknowledges that Permittees may not self-regulate, as the Ninth Circuit ruled in *Environmental Defense Center* and the Second Circuit ruled in *Waterkeeper Alliance*.[9, 10] As such, the State Water Board is required to write permit terms and establish effluent limitations governing the level of pollutants, including any determinations of best available technology economically achievable/best conventional pollutant control technology ("BAT/BCT") for a facility, discharged from industrial facilities prior to extending permit coverage.[11]

CCKA proposes language in Attachment 2 to remedy the Draft Permit's illegal scheme by clarifying that Permittees' cannot write their own permit terms.[12] Absent CCKA's proposed revisions, each element of the Draft Permit that purports to allow Permittees to write and re-write permit terms must be subject to full NPDES permitting process.

A. The Draft Permit Authorizes Self-Regulation Because it Does Not Require Permittees to Implement Specific BMPs Nor Meet NALs.

In an effort to defend the Draft Permit's "flexible" approach to regulating Permittees' storm water discharges, the State Water Board claims that the Draft Permit does not run afoul of the Clean Water Act's prohibition on self-regulation because: "By requiring Dischargers to implement [ ] specific BMPs and meet NALs, this General Permit ensures that Dischargers do not write their own permit terms."[13] However, the Draft Permit neither requires Permittees to implement minimum best management practices ("BMPs"), nor meet numeric action levels ("NALs"). Even if it were true that Permittees were not themselves establishing the generic, minimum BMPs, the fact that they are free to write their own BAT/BCT requirements through various off-ramps and reports is fatal to the Draft Permit's proposed scheme.

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[8] *Environmental Defense Center v. EPA*, 344 F.3d 832, 854-56 (9th Cir. 2003) (programs that are designed by regulated parties must, in every instance, be subject to meaningful review by an appropriate regulating entity to ensure that each such program reduces the discharge of pollutants to the level required by the Clean Water Act); *see also Waterkeeper Alliance, Inc. v. EPA*, 399 F.3d 486, 498-504 (2d Cir. 2005) (failing to provide for permitting authority review and public participation of effluent limitations developed by permitted dischargers is a violation of the Clean Water Act).

[9] *See* Fact Sheet Section I.C., at 8-9.

[10] The Fact Sheet is incorporated as Findings of the Order. *See* Finding #8, at 2. To avoid potential inconsistencies between the Draft Permit and the Fact Sheet, CCKA proposes that the Fact Sheet not be incorporated as Findings of the Order, and that Finding #8 be deleted. As such, CCKA has not provided proposed language for the Fact Sheet because the Fact Sheet need not be part of the Draft Permit. By not providing proposed language revising the Fact Sheet, CCKA in no way intends to approve of the language of the Fact Sheet. The State Water Board should ensure that the Fact Sheet is consistent with CCKA's proposed revisions to the Findings and the Order.

[11] *See* 33 U.S.C. §§ 1311(b)(1), 1314(b); *see also Waterkeeper Alliance, Inc.*, 399 F.3d at 498-504.

[12] *See* Attachment 2.

[13] Fact Sheet Section I.C., at 9.

1. The Draft Permit Authorizes Permittees to Unilaterally Determine What, if Any, BMPs Will Be Implemented at their Facility.

Section X.H.2. of the Draft Permit authorizes Permittees to exclude implementation of any BMP on the list of "Minimum BMPs" if the Permittee makes a unilateral determination that a BMP(s) is "inapplicable, infeasible, or inappropriate."[14] This is the same flawed scheme used in the 1997 Permit.[15] Permittees may also revise BMPs based on this same unilateral analysis.[16] Thus, the Draft Permit does not require Permittees to implement "specific BMPs" as the State Water Board claims. The Ninth Circuit has held that BMPs reduce or restrict discharges of pollutants and thus are effluent limitations.[17] Accordingly, by not making the Minimum BMPs mandatory, but instead allowing Dischargers to unilaterally decide whether to implement them, the Draft Permit allows Permittees to illegally self-regulate by establishing their own effluent limitations.[18]

The State Water Board has no basis to not require Permittees to implement a "minimum" set of BMPs, while allowing them the ability to implement more site-specific BMPs as necessary. For example, in addition to basic housekeeping BMPs that all dischargers can conduct, the Draft Permit should require Permittees to implement BMPs that reduce discharge points, while giving them the flexibility to determine which BMPs would accomplish this but not interfere with the site's operations.[19] Thus, the six (6) Minimum BMPs set forth at Section X.H.2. of the Draft Permit must be mandatory, and must be established by the State Water Board. CCKA has provided proposed language in Attachment 2, which eliminates the illegal self-regulation from Section X.H.2.

2. The Draft Permit Does Not Require Permittees To Meet NALs.

Despite the above-referenced language in Fact Sheet Section I.D.1 which states that Permittees are required to meet NALs, the Draft Permit makes clear in several other places that compliance with NALs is not required.[20] For example, the NALs established at Table 5 are not effluent limitations.[21] An exceedance of an NAL does not constitute a violation of the permit terms.[22] Further, as explained below in section I.B.1, a Permittee is not required to implement any pollution control measures even after an exceedance of an NAL.[23] Permittees are not even required to compare sampling results to the NALs until 2014.[24] And instantaneous NALs were only set for three pollutants: pH, TSS, and Oil & Grease.[25]

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[14] Order Section X.H.2., at 30; *see also* Fact Sheet Section I.D.1., at 9 ("This General Permit requires Dischargers to implement a specific set of minimum BMPs unless they are determined to be inapplicable, infeasible, or inappropriate."); Finding #32, at 4.
[15] *See* 1997 Permit, Section A.8., at 19. Thus the Draft Permit does not improve the 1997 Permit and the State Water Board is incorrect when it claims that the Draft Permit fixes the 1997 Permit's approach to allowing Permittees to simply "consider" which BMPs to implement by now requiring Minimum BMPs be implemented. *See* Fact Sheet Section I.D.1., at 9.
[16] *See* Order Section X.H.2, at 30.
[17] *See Environmental Defense Center*, 344 F.3d at 854-56.
[18] *See Environmental Defense Center*, 344 F.3d at 854-56; *Waterkeeper Alliance, Inc.*, 399 F.3d at 498-504.
[19] CCKA's proposed Draft Permit revision to require BMPs to reduce discharge locations will also save Permittees costs as they will have fewer discharge locations to sample.
[20] *See* Finding #64-73, at 10-12; *see also* Fact Sheet Section II.K., at 44-48.
[21] Finding #64-73, at 10-12.
[22] Fact Sheet Section II.K., at 44-52
[23] *See* Order Section XII.E., at 48-51.
[24] Order Section XII.A.2., at 46.

Moreover, Permittees are allowed to develop self-imposed Alternate NALs.[26] As such, the Draft Permit nowhere requires Permittees to "meet NALs" as the State Water Board claims in the Fact Sheet.

Given that neither of the reasons provided by the State Water Board for asserting the Draft Permit does not allow self-regulation are true, and because many provisions of the Draft Permit expressly allow dischargers to write and re-write their own permit terms,[27] the State Water Board authorizes Permittees to self-regulate in violation of the Clean Water Act.

B. The Draft Permit's Reporting Scheme Allows Permittees to Write Their Own Permit Terms and Exempt Storm Water Discharges from Permit Terms.

The Draft Permit provides that Permittees may develop "Demonstration Technical Reports" to unilaterally claim that the Permittee is in compliance with the permit terms, that additional BMPs are not required, and that pollutants in the Permittees' discharges are exempt from permit terms.[28] While the State Water Board has suggested that these reports are not designed to irrefutably determine compliance with the Permit, the plain language of the Draft Permit allows a contrary interpretation, and must be revised to ensure that no self-regulation occurs. There are three types of Demonstration Technical Reports that a Permittee could submit: (1) BAT/BCT Compliance Demonstration Technical Report, (2) Non-Industrial Source Pollutant Demonstration Technical Report, and (3) Natural Background Demonstration Technical Report.[29] To ensure the Draft Permit complies with the Clean Water Act, any and all provisions in these Demonstration Technical Reports allowing Permittees to self-regulate must be deleted from the Draft Permit, as well as the corresponding sections of the Findings and Fact Sheet.

1. The Draft Permit's "BAT/BCT Compliance Demonstration Technical Report" Provision Will Be Interpreted By Dischargers As Authorizing Each Individual Permittee to Establish a BAT/BCT Effluent Limitation.

As the name "BAT/BCT Compliance Demonstration Technical Report" suggests, a Permittee may file the report and in the process claim to unilaterally re-write Effluent Limitation V.A and demonstrate compliance for that Permittees' facility.[30] However, it is the State Water Board's mandatory duty to define BAT/BCT – and corresponding effluent limitations – prior to the issuance of the permit.[31] The Ninth Circuit, as well as other circuits, have unambiguously held that an NPDES permit that allows a discharger to write its own permit terms, including effluent limitations, violates the Clean Water Act.[32] The State Water Board acknowledges that it is illegal for Permittees to write their own effluent limitations.[33] In *Environmental Defense Center v. EPA*, the Ninth Circuit held that storm water management plans written by Permittees constituted effluent limitations because those plans restricted the

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[25] Order Table 5, at 42.
[26] *See* Order Section XII.E.3.g, at 49 and Section XIV.B.5.b, at 56; *see also* section I.B.1., below.
[27] *See e.g.,* Order Section XII.E.3., at 48-49 (allowing dischargers to define the BMPs for their site as BAT/BCT).
[28] *See* Order Section XII.E.2, at 48; *see also* Order Section XII.D.b.iv, at 47 (a Permittee can submit a Demonstration Technical Report in lieu of implementing BMPs).
[29] *See* Order Section XII.E.3.-5., at 48-50.
[30] Fact Sheet Section II.K.4.a., at 49-50; *see also* Order Section XII.E.3.c., at 49; Finding #72, at 12.
[31] *See* 33 U.S.C. §§ 1311(b)(1), 1314(b); *see also* section IV., below.
[32] *See Environmental Defense Center,* 344 F.3d at 854-56; *see also Waterkeeper Alliance, Inc.*, 498-504.
[33] *See* Fact Sheet Section I.C., at 8-9.

quantities, rates, and concentrations of pollutants in Permittees' discharges.[34] In the same way, as explained below, a BAT/BCT Compliance Demonstration Technical Report authorizes a Permittee to establish BAT/BCT, which constitutes an effluent limitation.

First, as set forth in Sections XII.E.3.c., XII.E.3.f., and XII.E.3.g. of the Draft Permit,[35] Permittees submitting a BAT/BCT Compliance Demonstration Technical Report set forth the BMPs they are currently implementing, and unilaterally define those BMPs as BAT/BCT for their own industrial facility. By defining which BMPs are BAT/BCT for their facility, Permittees are impermissibly writing their own effluent limitations.[36,37]

Second, the Draft Permit goes further in allowing Permittees to illegally self-regulate because it authorizes a Permittee submitting a BAT/BCT Compliance Demonstration Technical Report to set its own NALs, which *replace* the NALs set by the State Water Board.[38] The Permittee's individual NALs then become applicable to discharges from the site and no other action is required.[39] The Permittee continues to remain in compliance with Effluent Limitation V.A. as long as the Permittee meets its own self-imposed NALs.[40]

Finally, Section X.H.7.c.[41] authorizes Permittees to submit a BAT/BCT Compliance Demonstration Technical Report in lieu of complying with the design storm standards for treatment control BMPs established in the Draft Permit. Thus Permittees are again allowed to exempt themselves from implementing BMPs by simply submitting a BAT/BCT Compliance Demonstration Technical Report.[42]

As explained in detail above, the Draft Permit appears to allow Permittees to rewrite vast and critical sections of the permit. To remedy these illegal provisions, CCKA provides proposed revisions to Sections XII.E.2., XII.E.3., XII.E.3.c., XII.E.3.f., XII.E.3.g., and X.H.7.c. as set forth in Attachment 2.

2. *The Draft Permit's "Non-Industrial Source Pollutant Demonstration Technical Report" Provision Improperly Excludes Pollutants in Discharges from BMP Requirements.*

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[34] *Environmental Defense Center*, 344 F.3d at 854-56.
[35] Order, at 49.
[36] *See Environmental Defense Center*, 344 F.3d at 854-56.
[37] The State Water Board asserts that it will obtain information relevant to its analysis of BAT/BCT through the BAT/BCT Compliance Demonstration Technical Reports. However, only the worst performing Permittees will submit these reports. Yet, the State Water Board may only consider the "best performers" when conducting its BAT/BCT analysis. *See* section VI., below.
[38] *See* Order Section XII.E.3.g., at 49.
[39] *See* Order Section XII.E.2., at 48.
[40] *Id*.
[41] Order, at 35.
[42] No provision of the Draft Permit requires Permittees submitting a BAT/BCT Compliance Demonstration Technical Report to revisit their BAT/BCT analysis. The 1997 Permit has been in effect for the past 15 years. It is therefore possible that the next industrial storm water permit will not reissue for another 15 years, and Permittees could avoid implementing new technologies during that entire time. This is directly contrary to the technology-forcing purpose of the Clean Water Act. *See Weyerhaeuser v. Costle*, 590 F.2d 1011, 1075 (D.C. Cir. 1978) (noting technology-forcing nature of the Clean Water Act).

The Draft Permit allows a Permittee whose discharge contains pollutants that exceed an NAL to submit a "Non-Industrial Source Pollutant Demonstration Technical Report" to claim that the source of the pollutant(s) contributing to an NAL exceedance is due to "run-on from adjacent facilities, non-industrial portions of the Discharger's property, or aerial deposition."[43] Permittees will view this provision as allowing a Permittee to exempt itself from compliance with permit terms. By submitting the Non-Industrial Source Pollutant Demonstration Technical Report, a Permittee will claim to exempt itself from having to implement additional BMPs to comply with Effluent Limitation V.A.[44,45] Permittees are allowed to submit this report even if the pollutant is associated with the Permittee's industrial activity, and/or if the "non-industrial" polluted water commingles with the site's "industrial" storm water. [46,47] Further, nowhere does the Draft Permit require that "run-on" or "aerial deposition" originate from "non-industrial" sources.[48] By merely submitting this report, the Permittee is not required to implement BMPs to control the pollutants identified in the report.

This reporting scheme is impermissible and contrary to both the 1997 Permit and EPA's 2008 Multi-Sector General Permit ("MSGP").[49] First, under the 1997 Permit, dischargers are responsible for controlling run-on to their industrial facilities, and if they cannot are responsible for the pollutant in their discharge.[50] The Draft Permit[51] no longer requires this same level of pollutant control by exempting run-on from permit terms.[52] The 2008 MSGP also requires a discharger address storm water run-on, including developing BMPs and preventing the run-on from flowing onto the site.[53] This is true even if the run-on would not otherwise be regulated under an NPDES permit.[54] To avoid backsliding and be consistent with the 2008 MSGP, the Draft Permit must be modified to reflect the requirements of 1997 Permit and the 2008 MSGP.

The illegal self-regulation arguably allowed by the Non-Industrial Pollutant Source Demonstration Technical Report provision is remedied if this provision is deleted from the Draft Permit. At a minimum, this report must be limited to a pollutant that is not associated with that Permittee's industrial activity, and the Permittee must be required to implement BMPs to control the pollutants identified in the report. CCKA provides proposed changes to Sections XII.E.4.b., XII.E.4.d., and

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[43] Order Section XII.E.4., at 49-50; *see also* Finding #70, at 11; Fact Sheet Section II.K.4.b., at 50.
[44] The portion of the Fact Sheet relating to Non-Industrial Pollutant Source Demonstration Technical Reports suggests that Permittees submitting that report may also develop an alternate NAL. *See* Fact Sheet Section II.K.4.b., at 51. While it is unclear from the Fact Sheet, the Draft Permit, and the Findings how a Permittee would develop that alternate NAL, any alternate NAL would be illegal as explained in section I.B.1., above.
[45] *See* Order Section XII.E.2., at 48.
[46] Order, Section XII.E.4, at 49-50; *see also* Finding #70, at 11; Fact Sheet, Section II.K.4.b, at 50.
[47] As drafted, the Non-Industrial Pollutant Source Demonstration Technical Report is based on too limited a definition of "industrial activity." The Clean Water Act and its implementing regulations require NPDES permit coverage for all discharges of pollutants "*associated with*" industrial activity. 33 U.S.C. § 1342(p)(2)(B).
[48] *See* Finding #70, at 11 (noting that storm water run-on could be from adjacent facilities without excluding adjacent industrial facilities).
[49] Even if the pollutants in the discharge are from a non-industrial source, the failure to require BMPs for non-industrial sources of pollution contradicts the Blue Ribbon Panel's recommendation that the State Water Board require BMPs for non-industrial exposure. *See* Fact Sheet Section I.B, at 5.
[50] *See, e.g.*, 1997 Permit Section A.8.a.viii., at 20.
[51] Order, Section XII.E.4. at 49.
[52] 33 U.S.C. § 1342(o).
[53] *See* 2008 MSGP Section 2.1, at 12 and Section 2.1.2.1, at 13.
[54] *See* 2008 MSGP, Section 1.1.2.3, at 1.

XII.E.4.f. of the Draft Permit that address these issues.[55]

3. The Draft Permit's "Natural Background Demonstration Technical Report" Excludes Pollutants Associated with Industrial Activity From Permit Coverage.

Permittees who submit a Natural Background Demonstration Technical Report are not responsible for the pollutants identified in the report.[56] Permittees will argue that they are exempt from having to implement any BMPs to control the "natural background" pollutants even if the identified pollutant(s) are associated with the Permittee's industrial activity.[57] Thus, by submitting the Natural Background Demonstration Technical Report, a Permittee will unilaterally claim it can exempt itself from controlling the pollution in its discharge, which the Draft Permit would otherwise require absent the filing of such a report.

This is impermissible self-regulation, which is remedied if the Draft Permit language is clarified to assure that Permittees remain subject to all permit terms regardless of whether a Natural Background Demonstration Technical Report has been submitted. At a minimum, the Draft Permit must be revised so that the report is not available for a pollutant that is associated with the Permittees' industrial activity. Otherwise, as drafted, these provisions are unlawful. CCKA has provided proposed changes to Sections XII.E.5.a. and XII.E.2. relating to the Natural Background Demonstration Technical Report that addresses the impermissible self-regulation in Attachment 2.

C. <u>The Draft Permit's Reporting Scheme Must Be Revised or the State Water Board Will Be Required to Engage in a Separate NPDES Permit Process Each Time a Permittee Submits a Report.</u>

In addition to the problems with the reporting scheme addressed above, a Permittee who submits any one of the three Demonstration Technical Reports "automatically returns to Baseline Status."[58] In other words, the Permittees will claim that they are not required to take any further actions, including implementing additional BMPs, after submitting one of the reports. CCKA has proposed revisions to these sections that delete any perceived authorization for self-regulation and/or patent or tacit agency approval of permit modifications absent compliance with the NPDES permit process.[59] In the event the State Water Board rejects CCKA's proposed revisions, the Board would be required to conduct a full NPDES permitting process for each report submitted because each report purports to allow a discharger to write its own effluent limits, and exempt pollutants in its discharges from permit requirements.[60]

By the State Water Board's own estimate, there are approximately 10,000 industrial dischargers covered by the Draft Permit. As such, under the reporting scheme set up by the Draft Permit, the State Water Board would be burdened with facilitating the NPDES permitting process each time a Permittee

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[55] *See* Attachment 2.
[56] *See* Finding #71, at 12; *see also* Fact Sheet Section II.K.4.c., at 51.
[57] *See* Finding #71, at 11-12.
[58] Order Section XII.E.2., at 48.
[59] *See* Attachment 2.
[60] *See Environmental Defense Center, Inc.*, 344 F.3d at 854-56; *see also Waterkeeper Alliance, Inc.*, 399 F.3d at 498-504.

submits a report attempting to establish a permit terms, or up to 30,000 occasions.[61] This is entirely unworkable, and creates additional, unnecessary burdens on limited staff resources. By either eliminating the Demonstration Technical Reports or revising the sections of the Draft Permit as CCKA has proposed, the State Water Board will avoid illegally authorizing Permittees to write their own effluent limits and the added strain on State Water Board resources that would otherwise be incurred.

II. THE DRAFT PERMIT LIMITS THE SCOPE OF PROTECTION AFFORDED UNDER PORTER-COLOGNE AND THE CLEAN WATER ACT.

A. <u>The Draft Permit Should Apply to Both Waters of the State and Waters of the United States</u>.

The protection of water quality provided by the Draft Permit is narrower in scope than the 1997 Permit. Most significantly, the Draft Permit limits the receiving water protections to discharges that go to "waters of the United States," implicitly excluding protection of waters of the State of California.[62] The Draft Permit removes protection over waters of the State, despite the clear mandate of the Porter-Cologne Water Quality Control Act ("Porter-Cologne"), which states "that activities and factors which may affect the quality of the waters of the state shall be regulated."[63] The 1997 Permit ensured this mandate was met by not distinguishing between waters of the State, which Porter-Cologne protects, and waters of the United States (a subset of waters of the State), which the Clean Water Act protects.

At the October 17, 2012 workshop, the State Water Board Staff contended that the 1997 Permit was not intended to prohibit certain discharges to waters of the State, yet the 1997 Permit states that "[s]torm water discharges and authorized non-storm water discharges shall not cause or contribute to an exceedance of any applicable water quality standards contained in a Statewide Water Quality Control Plan or the applicable Regional Water Board's Basin Plan."[64] The 1997 Permit language triggers protection of any State waters for which a Regional Water Board has developed specific water quality protection standards. By not distinguishing between waters of the State and waters of the United States, the 1997 Permit ensured that the protections afforded by the receiving water limitations in the 1997 Permit extended to all waters within the State Water Board's jurisdiction. Inexplicably, the State Water Board has included language in the Draft permit that limits protections provided by the Draft Permit to waters of the United States only.

To ensure the State Water Board takes action to protect all waters of the State, Porter-Cologne mandates that "[t]he state board shall take into consideration the effect of its actions pursuant to this chapter . . . on any other general or coordinated governmental plan looking toward the development, utilization, or conservation of the waters of the state."[65] Porter-Cologne also provides that "the people of the state have a primary interest in the conservation, control, and utilization of the water resources of the state, and that the quality of all the waters of the state shall be protected for use and enjoyment by the people of the state."[66] Further, Porter-Cologne sections 13260(a)(1) and 13263 provide the Regional Board with authority to regulate all discharges of pollution, not just those that reach waters of the United

[61] The State Water Board staff claims that they will review these reports yet has insufficient resources as it is to review Permittees' Annual Reports submitted under the 1997 Permit.
[62] Finding #36, at 5.
[63] Cal. Water Code § 13000.
[64] 1997 Permit, Receiving Water Limitation C.2, at 4.
[65] Cal. Water Code § 13145.
[66] Cal. Water Code § 13000.

States or waters of the State. Section 13260(a)(1) of Porter-Cologne mandates that "[a]ny person discharging waste, or proposing to discharge waste, within any region that *could affect the quality of the waters of the state*" must file a report of waste discharge with the appropriate Regional Board (emphasis added). The purpose of Porter-Cologne, and its application through issuance of waste discharge requirements, unambiguously directs the State Water Board to ensure that it takes action necessary to protect all waters of the State, not just waters of the United States.

Not only does the State Water Board's reference to "water of the United States" undermine the strength and protection of water quality required by Porter-Cologne, the inclusion of the term could allow a Permittee to argue certain permit provisions do not apply to it. This is particularly true given the United States Supreme Court's fractured decision in *Rapanos v. United States*.[67] Subsequent to the Supreme Court's holding in *Rapanos*, lower courts' have issued conflicting interpretations of the term "water of the United States." Thus drawing a distinction between "waters of the United States" and "waters of the State" in the Draft Permit will undoubtedly lead to attempts by some Permittees to avoid compliance by lodging protracted, and costly challenges alleging that discharges are to waters of the State, but not waters of the United States.[68] This is also unfair to the vast majority of Permittees who clearly discharge to waters of the United States as well as the State's waters.

Moreover, the State Water Board's current Water Quality Enforcement Policy aptly observes that "fair, firm and consistent enforcement depends on a foundation of solid requirements in law, regulations, policies, and the adequacy of enforceable orders. . . . The extent to which enforceable orders include *well-defined requirements* . . . affects the consistency of compliance and enforcement" (emphasis added).[69] Given the current complexity surrounding what constitutes a water of the United States under the governing case law, the Draft Permit is inconsistent with the State Water Board's Enforcement Policy's directive that enforceable orders should specify well-defined requirements. In order to be consistent with the Enforcement Policy, the Draft Permit must include clear, unambiguous and thus enforceable receiving water limitations on all storm water discharges, not just those that reach "waters of the United States."

In sum, the State Water Board must replace the term "United States" with "State" in order to remove any question that the State Water Board is fulfilling its mandate to protect all waters of the State, not just waters of the United States.

B. <u>The CEQA Exemption Allows the State Water Board to Issue a Comprehensive Permit Protective of all State Waters.</u>

At the October 17, 2012 workshop, the State Water Board staff stated that one reason the Draft Permit distinguishes between waters of the United States and waters of the State is because the State Water Board must engage in the processes required by CEQA when regulating waters of the State. This is a misinterpretation of the State Water Board's regulatory powers. California Water Code section 13389 provides that an action to adopt an NPDES general permit is exempt from the provisions of the California

[67] *Rapanos v. United States*, 547 U.S. 715 (2006).
[68] *See, e.g.*, *Baykeeper v. West Bay Sanitary District*, 791 F. Supp. 2d 719, 763-69 (N.D. Cal. 2011)(requiring significant private, public, and judicial resources to secure court order declaring that nine waterways, including seasonal creeks and streams, were Waters of the United States).
[69] State Water Board, February 19, 2002 Water Quality Enforcement Policy Section I.A., at 2 (http://www.swrcb.ca.gov/water_issues/programs/enforcement/policy.shtml).

Environmental Quality Act. In *City of Burbank v. State Water Resources Control Board*, the Court of Appeal explained that:

> Water Code section 13389 not only relieves Regional Board of the requirement to prepare an EIR or cause an EIR to be prepared (Pub. Resources Code, § 21100, subd. (a)), but also relieves Regional Board of those CEQA obligations that ordinarily are satisfied through preparation and consideration of an EIR, including the obligation to consider potential environmental impacts, project alternatives, and mitigation measures. Regional Board's obligation in issuing an NPDES Permit is to ensure compliance with both secondary treatment requirements imposed by EPA and state water quality standards, as stated *ante*. CEQA imposes no additional procedural or substantive requirements in these circumstances.[70]

This rule does not change depending on whether the State Water Board is regulating to protect waters of the State or waters of the United States in an NPDES permit. For example, in *Building Industry Association of San Diego v. State Water Resources Control Board*, 124 Cal.App.4th 866, the Fourth District Court of Appeal upheld a municipal storm sewer permit that required strict compliance with receiving water limits, where no EIR was prepared. As the court noted, the California Water Code states that:

> the state board or the regional boards shall, as required or authorized by the [Clean Water Act], as amended, issue waste discharge requirements and dredged or fill material permits which apply and ensure compliance with all applicable provisions of the act and acts amendatory thereof or supplementary, thereto, together with any more stringent effluent standards or limitations necessary to implement water quality control plans, or for the protection of beneficial uses, or to prevent nuisance.[71]

The State Water Board was rightfully unconcerned with the issue it now raises when it adopted the 1997 Permit, which afforded protection to waters of the State and waters of the United States. In fact, as the 1997 Permit makes clear, "[t]his action to adopt an NPDES general permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21100, *et seq.*) in accordance with Section 13389 of the California Water Code."[72] The State Water Board has included this same finding in the Draft Permit, yet fails to regulate to protect all waters of the State.[73]

The State Water Board's failure to regulate under both Porter-Cologne and the Clean Water Act is a significant limitation on the scope of protection now afforded under the 1997 Permit. Further, the Clean Water Act itself authorizes states to incorporate state standards more stringent than federal standards into NPDES permits.[74] Thus, including protections for receiving water standards of waters of the State is wholly consistent with the State Water Board's delegated authority under the Clean Water Act, consistent with its rights and duties under Porter-Cologne, and in no way creates any new obligation that the State Water Board perform CEQA analysis of the proposed permit.

[70] 4 Cal.Rptr.3d 27, 41 (Cal. App. 2003).
[71] Cal. Water Code § 13377.
[72] 1997 Permit Finding #7, at 2.
[73] Finding #5, at 1.
[74] *See* 33 U.S.C. §§ 1311(b)(1)(C), 1342(b), 1370.

C. The Draft Permit Fails to Adequately Regulate Discharges from Permittees' Facilities.

By providing numerous off-ramps to regulation and narrowing the scope of regulated discharges, the State Water Board goes out of its way to provide Permittees with the opportunity to avoid controlling pollution discharging from their facilities. This is not only bad policy, it directly contradicts the Clean Water Act's storm water permitting scheme, which requires NPDES permit coverage for all discharges of storm water "*associated with* industrial activity."[75] To achieve this requirement, the United States Environmental Protection Agency ("EPA") defines discharges of "storm water associated with industrial activity" broadly, and the Clean Water Act and its implementing regulations apply to all discharges of storm water from facilities that conduct certain types of industrial activities.[76] To provide clarity to dischargers about what facilities are required to obtain coverage, the EPA and the State Water Board require permit coverage be obtained by all facilities within certain Standard Industrial Classification ("SIC") codes.[77] Consistent with the structure of the Clean Water Act and the EPA regulations, the 1997 Permit contained provisions to ensure that all Permittees controlled all discharges of storm water associated with industrial activity.[78] The Draft Permit's regulation of only some storm water discharges associated with industrial activity is a significant departure from the 1997 Permit, and is inconsistent with the requirements of the Clean Water Act and EPA regulations.

The Draft Permit limits the scope of pollution control it provides by illegally narrowing the definition of areas of industrial activity that produce storm water associated with industrial activity, and by exempting pollutants in facilities' discharges or exempting the discharge in its entirety from compliance with permit terms. As a result, the Draft Permit fails to require implementation of pollution control measures for many of the pollutants in the regulated facilities' discharges. Examples of the Draft Permit's failure to regulate the discharge of storm water associated with industrial activity as required include:

- Limiting the definition of "storm water associated with industrial activity". The definition provided in Attachment H of the Draft Permit excludes the illustrative language from the EPA definition at 40 C.F.R. § 122.26(b)(14) that explains which discharges of storm water are discharges of "storm water associated with industrial activity."[79] By leaving critical parts of the definition out, the State Water Board fails to provide adequate guidance to dischargers to ensure that they control polluted discharges from all portions of their facility as required.

- Failing to include areas of an industrial facility that produce storm water associated with industrial activity in the description of "Areas of industrial activity subject to this General Permit" defined in Section X.E.3.e. of the Draft Permit.[80] This description does not include access roads, areas of the facility where industrial activity has taken place in the past and significant materials remain, and other areas that produce storm water discharges associated with industrial activity. However, the State Water Board cannot narrow the

[75] 33 U.S.C. § 1342(p)(2)(B) (emphasis added).
[76] 40 C.F.R. § 122.26(b)(14).
[77] *Id*.
[78] *See, e.g.*, 1997 Permit Section A.2., at 11; 40 C.F.R. § 123.25(a)(9).
[79] *Compare* Draft Permit Attachment H to 40 C.F.R. § 122.26(b)(14).
[80] Order, at 27.

scope of areas at the site that produce storm water associated with industrial activity.[81] Access roads, areas of past industrial activity, and buildings and other structures such as fences that limit access to a facility are associated with industrial activity.[82] These portions of an industrial facility can be significant sources of pollutants, and the State Water Board must ensure that Permittees have appropriate pollution control measures to reduce or eliminate discharges from these areas. Not only is excluding these areas from regulation by the permit illegal, it is contrary to the State Water Board's duty to protect water quality.

- Allowing Permittees to produce a Non-Industrial Pollutant Source Demonstration Technical Report, which lets Permittees avoid addressing pollutants in their discharges of storm water associated with industrial activity by submitting a report claiming the pollutant is from non-industrial areas of its site, run-on, or aerial deposition. A Permittee may submit this report even if the pollutant it claims is from a non-industrial source is also associated with its industrial operations. And once the report is submitted, a regulated industrial facility could discharge storm water with pollutants associated with its industrial activity, but not be required to implement any BMPs to control these pollutants. The Clean Water Act and its implementing regulations require dischargers to address all discharges of pollutants "associated with" their industrial activity. However, the Draft Permit does the opposite and limits its scope and thus regulation to control only those pollutants from narrowly defined areas of industrial activity rather than those associated with industrial activity.

The off-ramps and narrowed scope of the Draft Permit contradict the Clean Water Act's requirement that the State Water Board regulate storm water associated with industrial activity. In Attachment 2, CCKA provides proposed revisions to the Draft Permit that address the limited scope and off-ramps that are currently provided.

III. THE DRAFT PERMIT'S SAMPLING SCHEME IS INADEQUATE TO DETERMINE PERMITTEE COMPLIANCE.

The State Water Board, the Blue Ribbon Panel, and the public all share the same goal of collecting more and better quality data. However, the Draft Permit's proposed sampling program will not yield the data needed, as it does not ensure more data is collected, does not require analysis of samples for more parameters, and is not designed to gather higher quality data.[83] As a result, the Draft Permitwill not achieve the State Water Board's data collection goals, and it will not result in the collection of data sufficient to determine Permittees' compliance with Discharge Prohibitions[84], Effluent Limitations[85], and Receiving Water Limitations, as required by the Clean Water Act.[86]

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[81] *See* 40 C.F.R. § 123.25(a)(9) (requiring State Water Board to implement all provisions of 40 C.F.R. § 122.26).
[82] Even parking lots at industrial facilities, if they provide access to industrial operation areas or if any aspect of the facility operations is conducted on them, produce storm water associated with industrial activity. *See* 40 C.F.R. § 122.26(b)(14).
[83] *See* section IV.B., below.
[84] Order Section III., at 20.
[85] Order Section V., at 21-22.
[86] Order Section VI., at 22.

The Draft Permit's monitoring program must therefore be revised to satisfy the State Water Board's goals, follow the Blue Ribbon Panel's directives, and comply with the law.

A. <u>The Draft Permit's Sampling Scheme Will Not Ensure Collection of Data.</u>

One of the State Water Board's stated goals in establishing the Draft Permit's monitoring program is the collection of a more robust storm water discharge sampling data set.[87] The Blue Ribbon Panel also instructed that additional storm water discharge data should be collected.[88] CCKA agrees with this goal, and appreciates the Board's recognition that more data is needed. As proposed, however, the monitoring program will fail to meet this goal.

1. The Draft Permit's Qualifying Storm Event Provision Does Not Ensure that Permittees Will Collect Storm Water Samples.

As proposed, the Draft Permit definition of a Qualifying Storm Event (QSE) will not ensure that Permittees in fact collect storm water samples from their facility.[89] The Draft Permit QSE provision requires sampling from "a storm event that has produced a minimum of 1/10 inch of rainfall within the preceding 24 hour period as measured by an on-site rainfall measurement device; and … that was preceded by 72 hours of dry weather."[90] These factors are cumbersome and must be assessed before a sample is even required to be collected. However, if a Permittee fails to sample a QSE, the Discharger is required to take a sample "from an additional QSE that produces a discharge in a subsequent quarter."[91] Thus, in the event no QSE occurs in a given quarter, no sample need be collected.[92] A Permittee could legally not collect any samples in a reporting year, though one or more storm water discharges (but not a QSE) in fact occurred.

The Draft Permit should be revised so that the definition of "Qualifying Storm Event" serves as a method for prioritizing sample collection, directing Permittees to collect samples from QSEs.[93] But Permittees must be required to collect samples if there is a discharge from the facility, even if the discharge did not result from a QSE, (e.g., if there were only 48 dry hours between rain events, not the 72 hours the Draft Permit requires). This revision will add no burden or costs to Permittees, and it will ensure that Permittees will actually collect samples. Moreover, the requirement that monitoring be conducted when actual discharges occur from the site is not only the same standard used by the EPA[94] but is easy to understand and comply with.

To remedy the identified deficiencies and ensure that the State Water Board has access to more storm water sampling data, the Draft Permit should require a minimum number of samples of storm water discharges from the facility be collected each year. Section XI.B.4. of the Draft Permit sets four (4) as the

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[87] Fact Sheet Section II.D.4., at 20.
[88] Fact Sheet Section II.K.2.b., at 45.
[89] *See* Order Section XI.B.2., at 38.
[90] Order Section XI.B.2., at 38.
[91] Order Section XI.B.4., at 38.
[92] *Id*.
[93] In the event the State Water Board rejects CCKA's proposed revision, the State Water Board must revise the requirement that Permittees certify whether a QSE occurred at their facility according to an on-site rain gauge to require a neutral third-party measurement be included in the explanation of why no sample was collected.
[94] *See* MSGP Section 6.1.3, at 33 (defining "Measurable Storm Events" for all required monitoring).

maximum number of samples required for each location for the reporting year.[95] The Draft Permit should also make clear that Permittees must collect a *minimum* of three (3) storm water samples. This will guarantee that a facility's storm water discharges, when they happen, will be sampled even if no QSE occurs. CCKA has proposed language revising Section XI.B. of the Draft Permit to achieve the State Water Board's data collection goals.[96]

2. The Draft Permit Sampling Scheme Does Not Ensure That All Pollutants in Permittees' Discharges Will Be Identified.

The Draft Permit provides that Permittees analyze samples for "pollutants identified in the pollutant source assessment."[97] CCKA agrees that Permittees must conduct a pollutant source assessment but Section X.G.2. authorizes a discharger to unilaterally identify what pollutants to include in its sample analysis with little or no guidance to ensure samples are properly analyzed for all pollutants likely to be in the discharge. The State Water Board can remedy this ambiguity by incorporating into Section X.G. the language from the Fact Sheet that requires Permittees to "select additional site-specific analytical parameters based upon types of materials that are both exposed to and mobilized by contact with storm water," and to "select additional analytical parameters that are representative of materials handled at the facility (regardless of the degree of storm water contact or relative mobility)."[98] Including this specific language in the Draft Permit's sampling requirements will ensure that the Permittee's pollutant source assessments will identify all pollutants discharging from a Permittee's facility, and that a Permittee's subsequent storm water sampling will be analyzed for all relevant pollutants. CCKA's proposed language is set forth in Attachment 2.

The Draft permit also contradicts the Blue Ribbon Panel's recommendation to the State Water Board to improve their monitoring requirements to require dischargers to sample for *more* pollutants than required by the current 1997 Permit: "The Board needs to … collect new data as required and for additional water quality parameters."[99] However, rather than add parameters to those that must be sampled and analyzed for, the State Water Board has reduced the parameters for which dischargers must analyze their samples. For example, the Board acknowledges the validity of sampling for specific conductance, and even directs the discharger to contact the Regional Board to obtain a numeric action level. There is no basis to remove this parameter from the sampling program. The State Water Board should also expand the list of parameters in Table 4 to provide clarity on what pollutant(s) Permittees must analyze their samples for since a considerable body of evidence demonstrates that many pollutants that may negatively impact water quality are discharged from almost all industrial facilities. For example, many facilities that are known to handle toxic materials such as PCBs and PAHs are not specifically required to sample for them as a parameter listed in Table 4. The State Water Board should heed the advice of the Blue Ribbon Panel and increase, not decrease the parameters required to be analyzed for in storm water discharge samples.

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[95] *See* Order Section XI.B.4., at 38.
[96] *See* Attachment 2.
[97] Order Section X.G., at 28; *see also* Order Section XI.B.5.b., at 39 ("Dischargers shall analyze all effluent samples obtained for the following parameters: … [a]dditional, applicable parameters selected by the Discharger on a facility-specific basis designed to indicate the presence of all industrial pollutants identified in the pollutant source assessment required (Section X.G.2.a).").
[98] Fact Sheet Section II.J.2.b., at 40.
[99] Fact Sheet Section II.K.2.b., at 45.

Finally, we reaffirm our comments of April 29, 2011, noting that sufficient data has been collected under the existing permit to broaden the list of constituents in Table 4 required to be monitored for discrete SIC codes.[100]

B. The Draft Permit Does Not Ensure Collection of Quality Data Sufficient to Determine Permittees' Compliance.

The State Water Board has identified the lack of quality data as an impediment to its permitting process, and has therefore referred to the Draft Permit as a "bridge permit" meant to collect quality storm water discharge data.[101] The Blue Ribbon Panel also concluded that better quality data needs to be collected.[102] Yet, the proposed sampling program will not ensure that Permittees collect quality storm water samples. Poor quality data also undermines the usefulness of the data collected for determining compliance with permit terms, and therefore violates the Clean Water Act requirement that NPDES permits include self-monitoring programs designed to demonstrate Permittees' compliance or non-compliance.[103]

1. The Draft Permit's Allowance for Combining Samples from Different Discharge Locations Will Result in Poor Quality Data.

Section XI.C.4. of the Draft Permit[104] authorizes Permittees to combine samples from different drainage areas for analysis "if the industrial activities and physical characteristics (grade, surface materials, etc.) within each of the drainage areas are substantially similar to one another."[105] Permittees may combine samples pursuant to this provision regardless of whether the same BMPs are employed at each discharge location sampled. Because the results from combining samples fail to focus on each discharge location and BMPs implemented at those locations, the Qualified Combined Samples provision will prevent a careful evaluation of the effectiveness of the facility's BMPs and the need for additional pollution control measures. Thus it will be difficult to know the true quality of the storm water discharging from a Permittee's facility, or to determine if the BMPs at the facility achieve BAT/BCT. In addition, by allowing the combination of samples, the State Water Board fails to follow the Blue Ribbon Panel's instruction to collect better quality data that actually demonstrates the contamination levels in each distinct discharge.[106]

Combination of samples is also authorized even if the water discharging from the combined sample location flows to different waterbodies with different water quality standards and impairments. As such, a Permittee's combined samples may not demonstrate whether its storm water discharges are in compliance with Receiving Water Limitations established in the Draft Permit.

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[100] 2011 Comment Letter, at 12-13.
[101] *See* Finding #32, at 4; *see also* Fact Sheet Section II.D.4., at 20.
[102] Fact Sheet Section II.K.2.b., at 45.
[103] 33 U.S.C. §§ 1342(a)(2); 1318(a)(2); 40 C.F.R. §§ 122.44(i), 122.41(j).
[104] Order, at 43-44.
[105] Order Section XI.C.4.a., at 43-44.
[106] Fact Sheet Section II.K.2.b., at 45.

2. *The Draft Permit's Allowance for the Elimination of Sampling Locations Risks Inaccurate Discharge and Performance Data Collection.*

The proposed Sampling Location Reduction at Section XI.C.3 of the Draft Permit violates the requirement that NPDES permits must include a monitoring program "sufficient to yield data which is representative of the monitored activity."[107] The proposed Sampling Location Reduction scheme will prevent Permittees, the State Water Board, and the public from meaningfully evaluating Permittees' compliance with permit terms. The Sampling Location Reduction and Qualified Combined Sampling provisions also fail to ensure that a larger data set will be collected because the Draft Permit authorizes Permittees to significantly reduce the number of sampling locations and data points analyzed.

The Sampling Location Reduction allows dischargers to choose which discharge locations to sample in each drainage area on the condition that "the industrial activities and physical characteristics for each sampling location are substantially similar."[108] This provision is problematic. First, this section fails to require that Permittee implement substantially identical BMPs at each discharge locations before reduced sampling is conducted. Second, this provision requires only that industrial activities and physical characteristics of the sampling locations be "substantially similar" rather than "substantially identical" as required in the 1997 Permit. Third, there is no limit to the number of discharge locations a Permittee can eliminate in a given drainage area. So long as they are in the same drainage area, any number of discharge locations can be eliminated, even if similar BMPs are not in place at each location.

As a result, the Draft Permit's Sampling Location Reduction scheme not only authorizes Permittees to collect samples from fewer discharge locations, it authorizes Permittees to collect sampling data that provides incomplete information on the effectiveness of Permittees' BMPs. A Permittee's sampling data collected pursuant to the Sampling Location Reduction provision will therefore fail to demonstrate the Permittee's compliance with the permit terms throughout the facility. To avoid this unlawful provision, the Draft Permit must require sampling at each storm water discharge location, or maintain the "reduction in sampling location" scheme set out in the 1997 Permit. CCKA has proposed language in Attachment 2 to address the identified deficiencies in the Sampling Location Reduction provisions.

3. *The Draft Permit's NAL/ERA Process Should Require That Each Effluent Sample Be Compared to an NAL Rather Than Allow the Averaging of All Data Before a Permittee Must Take a Response Action.*

The Draft Permit attempts to build a bridge to better future technology-based effluent limits by requiring, in addition to the general mandate for facilities to install and implement BAT/BCT and comply with water quality standards, "Exceedance Response Actions" ("ERA") through which facilities review and revise their BMPs. These ERAs, however, are only triggered after either (1) all annual samples are averaged and still found to exceed the limits set forth in Table 5, or (2) two samples taken within a year exceed the instantaneous limits set forth in Table 5. This system is flawed, and compounds the problems discussed above of reducing the data quality in each sample. Averaging annual samples may mask daily or seasonal variations at a particular site that nevertheless has regular exceedances due to insufficient BMPs. Also, it is simply incorrect to call two discrete sample exceedances, potentially taken at different places and times, to be "instantaneous." Indeed, this construction is contrary to other instantaneous

[107] 33 U.S.C. §§ 1342(a)(2); 1318(a)(2); 40 C.F.R. §§ 122.44(i), 122.41(j).
[108] Order Section XI.C.3.a., at 43.

concentration limits set forth in numerous Regional Board basin plans, and the California Toxics Rule. This will undermine regulatory certainty. For each of these reasons, the sampling and reporting methodology provided in Draft Permit Section XVII.A will not result in ERAs that produce the highest quality assessment or improve BMPs at facilities statewide.

CCKA suggests that rather than allow averaging of samples and using the results to trigger submission of information pursuant to the ERA process, the State Water Board should require the information it seeks through the BAT/BCT Compliance Demonstration Technical Report through the Annual Reporting process. If the State Water Board's goal is to obtain information that will help it develop numeric technology based effluent limitations ("TBELs"), it must collect information on the technologies employed by the *best* performers. Further, obtaining cost information from all dischargers, not just the worst performers will assist the State Water Board in developing a defensible numeric TBEL based on identified BAT or BCT. To minimize the burden on staff and dischargers, the State Water Board should require rolling submission of the requested information (by SIC code for example), and only require submission of the required information once during the first three (3) years of the permit cycle. That way the State Water Board will have information it thinks it needs well in advance of the next permit adoption in five (5) years.

IV. THE STATE WATER BOARD HAS NOT COMPLIED WITH ITS MANDATORY DUTIES WHEN ESTABLISHING THE DRAFT PERMIT'S TECHNOLOGY-BASED EFFLUENT LIMITATIONS.

The Clean Water Act requires the State Water Board to incorporate or establish, and enforce, TBELs in its NPDES permits.[109] Where EPA has yet to promulgate national effluent limitations guidelines ("ELGs") (to be implemented in NPDES permits as TBELs) for industrial dischargers, the State Water Board exercises its "best professional judgment" ("BPJ") to establish TBELs on a case-by-case basis.[110] For many dischargers subject to the Draft Permit, the EPA has not established ELGs, and thus the State Water Board must develop its own TBELs using its BPJ.

In the exercise of its BPJ, the State Water Board must consider the statutory factors for developing TBELs.[111] There are three categories of TBELs that apply to existing dischargers, each of which requires pollutant reductions or elimination of pollutants achievable through application of increasingly stringent pollutant control: (1) "best practicable control technology currently available" ("BPT"), (2) "best conventional pollution control technology" ("BCT"), and (3) "best available technology economically achievable" ("BAT").[112] The levels of effluent limitations relevant to discharge of conventional and toxic pollutants authorized by the Draft Permit are BCT and BAT, respectively.[113]

There are three major steps that the State Water Board must take when exercising BPJ to develop TBELs. The first step is to identify candidate (potential) technologies that represent BCT or BAT.[114] The second step is to consider the statutory and regulatory mandated factors to evaluate the technological

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[109] 33 U.S.C. §§ 1311(b), 1314(b)(2).
[110] *Natural Res. Def. Council v. EPA*, 863 F.2d 1420, 1424 (9th Cir. 1988).
[111] *Natural Res. Def. Council*, 863 F.2d at 1425; *Texas Oil & Gas Ass'n v. EPA*, 161 F.3d 923, 928-29 (5th Cir. 1998); *see also* 40 C.F.R. §§ 125.3(c)-(d).
[112] 33 U.S.C. § 1311(b).
[113] *See* Order Section V.A., at 21.
[114] 51 Fed. Reg. 24974, 24976 (July 9, 1986).

feasibility and economic achievability of the candidate technologies.[115,116] The third step is to derive TBELs that represent that degree of reduction – expressed in terms of amounts – achievable through the application of BCT and BAT. At the third step, once a technology or technologies that represent BCT or BAT are identified, the State Water Board must derive a specific TBEL equivalent to the pollutant reduction achievable through the application of that technology(ies).[117] TBELs may be numeric or narrative, but TBELs must be expressed as numerical limits, unless numeric limitations are infeasible.[118] Only where the permitting agency has properly determined that numeric limitations are infeasible, may it issue narrative TBELs.[119] In any event, whether expressed numerically or narratively, TBELs must be developed based upon consideration of the factors set forth at sections 1311(b) and 1314(b) of the Clean Water Act.[120]

Attachments 3 and 4 include an evaluation of current storm water quality trends, as well as a summary of recent performance and cost studies for existing industrial storm water management controls. These Attachments reflect and build upon recent efforts by the State of Washington, which recently implemented numeric effluent limitations ("NELs") in its 2012 Industrial Storm Water General Permit. This information indicates that NELs are feasible for all of California's industrial sectors, and that cost-effective technologies currently exist that would facilitate compliance with numeric limitations.

A. <u>The State Water Board Has Not Considered the Statutorily Required BAT/BCT Factors When Developing TBELs in the Draft Permit.</u>

Effluent Limitation V.A.[121] is a TBEL that requires Dischargers to implement BMPs that constitute BAT/BCT to prevent and reduce pollutant discharges.[122] However, the State Water Board has not engaged in the analysis required when a permitting authority establishes TBELs. In addition, nowhere in the Draft Permit, the Findings, or the Fact Sheet does the State Water Board identify or explain its consideration of the required factors.[123] Thus, in establishing these TBELs, the State Water Board attempts to issue the Draft Permit in violation of the Clean Water Act.

First, the State Water Board has complied with its initial mandate to identify candidate technologies, a necessary step to form the basis of its BCT or BAT analyses. Nor does the State Water Board explain that it tried to identify candidate technologies, but it was unable to do so. In fact, the State Water Board admits that it has not considered the required factors: "the State Water Board does not have the information and resources needed to consider the many factors that must be considered when developing TBELs based on BPT, BAT, and BCT."[124] Limited data and lack of resources are not valid excuses for failing to conduct the required analysis. And in this case, there is ample information available

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[115] 33 U.S.C. § 1311(b)(2)(E).
[116] 33 U.S.C. § 1311(b)(2)(B).
[117] *See* 40 C.F.R. § 122.44(k)(3); *see also CBIA v. State Board* at 16:5-8.
[118] *Citizens Coal Council v. EPA*, 447 F.3d 879, 895 (6th Cir. 2006); 40 C.F.R. § 122.44(k)(3).
[119] *Citizens Coal Council*, 447 F.3d at 896; *see also Natural Res. Def. Council, Inc. v. Costle*, 568 F.2d 1369, 1380 (D.C. Cir. 1977).
[120] *Waterkeeper Alliance, Inc.*, 399 F.3d at 511-12.
[121] Order, at 21.
[122] *See also* Order Section X.C.1.b., at 25 and Section X.H.2., at 30.
[123] *See* Finding #30-35, at 4-5; *see also* Fact Sheet Section II.D.4., at 20.
[124] Fact Sheet Section II.D.4., at 20.

to support the State Water Board's analysis.[125] The materials submitted by CCKA (*see* Attachment 4) and others identify myriad potential candidate technologies, provide data on the performance of these technologies, and include information on the costs of implementing these technologies. The State Water Board cannot simply ignore this information and claim it does not have data it needs to undertake the required analyses. Further, where current information is lacking, the State Water Board not only has the authority, but the obligation to obtain that information prior to establishing TBELs.[126] The State Water Board has had since 1992 the mandate to collect the information it must consider when establishing TBELs.[127] Any shortage of necessary information is the responsibility of the State Water Board, and does not justify the State Water Board's failure to conduct the requisite analysis.

Second, without identifying candidate technologies for consideration under the required BAT and BCT factors, the State Water Board has necessarily failed to consider the factors required when determining BAT and BCT. Specifically, the State Water Board has not considered the cost-reasonableness of any candidate BCT technologies. Nor has it considered the costs of achieving pollutant reductions that will result in reasonable further progress toward *the national goal of eliminating the discharge of all pollutants* for any candidate BAT technologies.

Third, even assuming the State Water Board was legally able to postpone its BAT/BCT analyses to allow for collection of data under this "bridge" permit, the reporting and sampling requirements of the Draft Permit are not designed to collect information relevant to the statutory BAT/BCT factors. The BAT/BCT factors are to be applied to the "best" performing technologies.[128] As discussed above, information collected under the Draft Permit reporting scheme will be from dischargers that exceed NALs and are thus not the best performers.[129,130] In addition, the sampling and monitoring provisions will not produce data on what BMPs are implemented at different drainage areas of the facility.[131] Thus sampling data collected under the Draft Permit will not correspond to a Permittee's technology performance.

Finally, the Draft Permit's identification of minimum BMPs does not satisfy the State Water Board's obligation to identify candidate technologies based on all available information. If the State Water Board has done so, it has failed to explain how--by conducting the required analyses of the statutorily mandated factors--the identified Minimum BMPs are BAT or BCT. The State Water Board is obligated to articulate its analysis when establishing permit terms.[132] Further, the State Water Board's reliance on the 2008 MSGP is no substitute for the analysis the State Water Board is required to conduct

[125] *See* Attachments 3 and 4; *see also* 2011 Comment Letter, at 4-14.
[126] *See* Cal. Water Code § 13267(b); *see also Natural Res. Def. Council*, 863 F.2d at 1426-27; 40 C.F.R. §§ 125.3(c), (d).
[127] Apparently, the State Water Board only evaluated electronic data. *See* Fact Sheet Section I.B., at 7. The State Water Board therefore apparently failed to consider any data that preceded the submission of electronic data.
[128] *See* U.S.C. § 1311(b); *see also Ass'n of Pac. Fisheries v. EPA*, 615 F.2d 794, 816 (9th Cir. 1980).
[129] Order Section XII.E.1-2, at 48 (only facilities reporting NAL exceedances are required to submit additional information); Section XI.C.6., at 44 (allows well-performing facilities to discontinue sampling); *see also* Fact Sheet Section II.D.4., at 20.
[130] To ensure that the sampling and reporting provisions of the Order are, in fact, designed to obtain relevant information, CCKA proposes Sections XI.C.3, XI.C.4, and XI.C.6 be revised as set forth in Attachment 2.
[131] *See, e.g.*, Order Section XI.C.3., at 43 (no requirement that "representative sampling locations" have same BMPs), and Section XI.C.4., at 43-44 (allows combination of storm water samples without regard to BMPs).
[132] *Topanga Ass'n for a Scenic Community v. County of Los Angeles*, 11 Cal. 3d 506, 515 (1974).

when establishing TBELs.[133] Absent an explanation "bridging the analytical gap", the Draft Permit's TBELs are unlawful.[134]

To comply with the Clean Water Act, the State Water Board is required to identify candidate BAT and BCT technologies, and to ascertain that they are BAT/BCT upon which the applicable TBEL is derived.[135] The State Water Board does not have discretion to establish TBELs without considering the statutory factors.[136] Yet that is exactly what the State Water Board will have done if it adopts the Draft Permit as proposed.[137] The Draft Permit TBELs are unlawful, and the State Water Board must conduct the required analyses prior to establishing any TBEL to be included in the permit.

B. The State Water Board Has Not Properly Determined that Numeric TBELs Are Infeasible, a Prerequisite for Adopting BMP-based Narrative Effluent Limitations.

Section V. of the Draft Permit expresses narrative TBELs.[138] Non-numerical effluent limitations are the exception, and are only permitted when deriving numeric effluent limitations is infeasible.[139]

1. The State Water Board Has Not Determined Whether It is Capable of Expressing the TBELs in the Draft Permit Numerically.

As the Clean Water Act requires the State Water Board to establish numeric TBELs unless doing so is infeasible, the State Water Board must first examine the feasibility of deriving a numeric TBEL before establishing narrative TBELs. Thus the relevant question the State Water Board must answer in establishing TBELs is whether the degree of pollutant reduction attainable through application of BAT and BCT is capable of being expressed numerically. The State Water Board must answer this question, and must make findings that document how it reached its conclusion.[140] In order to include *only* BMP-based narrative effluent limitations, as the Draft Permit does, the State Water Board must first find that it cannot express numerically the pollutant reduction attainable with application of BAT and BCT, i.e., it must find numeric TBELs are infeasible.[141]

The first step in this feasibility analysis is to identify candidate technologies based on consideration of available technologies and the performance data of those technologies.[142] Further, the State Water Board must consider *all available information*.[143] The State Water Board has failed to satisfy the first step of the feasibility analysis, as it did not identify candidate technologies that represent BAT or BCT when adopting TBELs in the Draft Permit.[144] Without identifying technologies as BAT or BCT, it is

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[133] Finding #32, at 4-5; *see also* Fact Sheet Section II.D.4., at 20.
[134] *Topanga Ass'n for a Scenic Community*, 11 Cal. 3d at 515.
[135] 33 U.S.C. §§ 1311(b), 1314(b); 40 C.F.R. § 125.3(c), (d).
[136] *See* 40 C.F.R. § 125.3(c) and (d); *see also Natural Res. Def. Council*, 863 F.2d at 1425.
[137] *See* Fact Sheet Section II.D.4., at 20.
[138] Order, at 21.
[139] *Costle*, 568 F.2d at 1380.
[140] *See* NPDES Permit Writers Manual, Chapter 5.2.3.6; *see also Topanga Ass'n for a Scenic Community*, 11 Cal. 3d at 515.
[141] *See* 40 C.F.R. § 122.44(k)(3); *see also Costle* at 1380; *CBIA v. State Board* at 16:5-8.
[142] 40 C.F.R. § 125.3(c).
[143] *Id*.
[144] *See* Finding #30-35, at 4-5; *see also* Fact Sheet Section II.D.4., at 20.

impossible for the State Water Board to have taken the next step of evaluating whether it is feasible to express the pollutant reductions achievable through implementation of those technologies numerically.

To facilitate the analysis the State Water Board must perform, CCKA has submitted substantial amounts of information on potential candidate technologies with its 2011 Letter, and submits additional information with these comments.[145] Attachment 3 provides a statistical review of over 187,000 data points from the State Water Board's Storm Water Multiple Application and Report Tracking System (SMARTS) database, where storm water quality statistics are provided for 11 broad industrial sectors, based on data collected between 2005 and 2012. Attachment 4 includes a review of currently available storm water controls, including treatment performance and cost statistics.

2. The State Water Board May Not Use Lack of Information or Staff Resources as Factors for Evaluating the Feasibility of Numeric Effluent Limitations.

Rather than analyze the feasibility of deriving a numeric effluent limit based on the information available regarding performance of various BMPs/model technologies, the State Water Board has summarily concluded that "[i]t is infeasible … to develop numeric TBELs … at this time."[146]

Lack of information, whether perceived or actual, and lack of staff resources are not bases for failing to conduct the required analyses. The State Water Board is required to obtain the necessary information before concluding that a numeric TBEL is infeasible.[147] Similarly, lack of staff resources is not an enumerated statutory factor when establishing TBELs, nor is it an appropriate consideration.[148] The State Water Board may only find a numeric TBEL infeasible when the degree of pollutant reduction achievable through application of BAT and BCT is incapable of being expressed numerically, not when the State Water Board finds it "infeasible" to gather needed information or that it lacks resources to conduct the required analysis. The State Board's SMARTS database contains hundreds of thousands of data points on industrial storm water discharges, submitted by Permittees pursuant to their annual reporting requirements. This information has not been considered to date by the State Water Board, yet is analyzed in Attachment 3. This information can and should be used by the State Water Board to demonstrate (a) that numeric expression of TBELs is feasible and (b) the Permittees will be able to achieve compliance with numeric TBELs.

The State Water Board must conduct the required analysis to determine whether the degree of pollutant reduction achievable through application of BAT or BCT is capable of being expressed numerically before the State Water Board may establish Effluent Limitation V.A. of the Draft Permit as a narrative limit. The State Water Board has not conducted the required analysis, and thus the TBELs and the Draft Permit violate the Clean Water Act.

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[145] *See* Attachments 3-4; *see also* 2011 Comment Letter, at 4-14 and Enclosures thereto.
[146] Fact Sheet Section II.D.4., at 20; Finding #32, at 4.
[147] *Natural Res. Def. Council*, 863 F.2d at 1425-27 (permitting agency lacks discretion and has mandatory duty to consider statutory factors); *Weyerhaeuser v. Costle*, 590 F.2d at 1026; 40 C.F.R. §§ 125.3(c), (d).
[148] *See* 33 U.S.C. § 1311(b); *see also Natural Res. Def. Council*, 863 F.2d at 1425; *Costle,* 568 F.2d at 1380 (EPA cannot cite its own administrative burdens as a reason for not implementing the Clean Water Act as required).

V. THE DRAFT PERMIT DOES NOT CLEARLY DELINEATE THAT A PERMITTEE IS REQUIRED TO STRICTLY COMPLY WITH WATER QUALITY STANDARDS.

The language of the Draft Permit injects ambiguity as to whether Permittees are in fact required to comply with all applicable water quality standards. The law, however, is clear – strict compliance with water quality standards is required.[149] The Fact Sheet acknowledges this, stating, "the General Permit requires strict compliance with WQS."[150]

The California Toxics Rule and other sources of applicable water quality standards establish how to determine whether a Permittee is in compliance.[151] For example, under the California Toxics Rule, the criteria that establish whether beneficial uses are attained and water quality standards are met apply at the end of discharge pipe (i.e., at the point of discharge from the facility), unless a mixing zone has been established.[152]

Despite the clear requirements of the law, and the State Water Board's assertion that the Draft Permit requires strict compliance with water quality standards, Finding 36 and Section VI.A. of the Draft Permit (Receiving Water Limitations) creates confusion regarding a Permittee's obligation to ensure that their discharges do not cause or contribute to violations of WQS. Most significantly, Finding 36 states,

> Water quality standards apply to the quality of the receiving water, not the quality of the industrial storm water discharge. Therefore, compliance with the receiving water limitations can generally not be determined solely by the effluent water quality characteristics.

These two sentences contradict the plain requirements of the CTR, which requires evaluation of water quality at the end of the discharge pipe.[153] The only exception to this requirement is if there is a mixing zone, which has not been established under the Draft Permit. Therefore, by including these sentences in Finding 36, the State Water Board misstates the law, and causes confusion as to how to determine compliance when there is no mixing zone.

In addition to the ambiguity created by Finding 36, Section VI.A of the Draft Permit provides that "Dischargers shall ensure that industrial storm water discharges and authorized NSWDs do not cause or contribute to an exceedance of any applicable WQS in any affected receiving water." It is unclear what the State Water Board means by "any affected receiving water." By definition an "applicable WQS" would be the WQS for the receiving water(s) downstream from a Permittee's facility. This redundant language creates unnecessary confusion.

The Draft Permit further confuses the issue by only requiring monitoring of the discharge effluent from the permitted facility. If it is necessary to consider more than the quality of the effluent to ensure strict compliance with water quality standards, which it is not, then something besides effluent must be monitored.

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[149] *Defenders of Wildlife v. Browner*, 191 F.3d 1159, 1165 (9th Cir. 1999).
[150] Fact Sheet Section II.E., at 21.
[151] 40 C.F.R. § 131.38(c)(2)(i); *Santa Monica Baykeeper v. Kramer Metals, Inc.*, 619 F. Supp. 2d 914, 927 (C.D. Cal. 2009); 65 Fed. Reg. 31682, 31701 (May 18, 2000).
[152] 40 C.F.R. § 131.38(c)(2)(i).
[153] *Id.*

To address the confusion created by Finding 36 and Section VI.A, CCKA provides proposed modifications to the language of each in Attachment 2.

VI. THE DRAFT PERMIT IS INCONSISTENT WITH EXISTING, APPLICABLE TOTAL MAXIMUM DAILY LOADS AND FAILS TO INCORPORATE WASTE LOAD ALLOCATIONS AS WATER QUALITY-BASED EFFLUENT LIMITS.

NPDES Permits must be consistent with all existing, applicable total maximum daily loads ("TMDLs") and must incorporate waste load allocations ("WLAs") from those TMDLs as water quality-based effluent limitations ("WQBELs").[154] The Draft Permit fails to comply with these requirements and must be revised to incorporate all WLAs applicable to Permittees.

A. The Draft Permit Provides an Incomplete List of All Existing and Applicable WLAs.

Attachment D of the Draft Permit provides an incomplete list of TMDLs applicable to Permittees. Many TMDLs that establish WLAs for discharges from industrial facilities are missing from Attachment D. A list of applicable TMDLs missing from Attachment D is included with CCKA's comments as Attachment 5.

The State Water Board must ensure that all existing, applicable WLAs are incorporated into the permit, and must therefore revise Draft Permit Attachment D.

B. The Draft Permit Illegally Delays Incorporation of Waste Load Allocations in Existing, Applicable Total Maximum Daily Loads as Water Quality-Based Effluent Limitations.

Numeric WLAs developed specifically for dischargers covered by the Draft Permit must be directly incorporated into the permit as WQBELs because WLAs are "a type of WQBEL."[155] When developing water quality-based effluent limitations for NPDES permits, such as Section V.C. of the Draft Permit,[156] the permitting authority is required to ensure that "effluent limits are consistent with the assumptions and requirements of any available wasteload allocation for the discharge."[157] It is EPA's longstanding position that NPDES permits must contain effluent limits and conditions that are consistent with the requirements of WLAs in established TMDLs.[158] The State Water Board is obligated to immediately incorporate existing, applicable WLAs as WQBELs into the adopted permit.

Contrary to these requirements, the Draft Permit defers incorporation of any WLAs as WQBELs for at least two (2) years.[159] In addition, the State Water Board shifts its obligation to establish WQBELs

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[154] *See* 40 C.F.R. 122.44 (d)(1)(vii)(B); *Communities for a Better Env't v. State Water Res. Control Bd.* ("*Communities*"), 1 Cal. Rptr. 3d 76, 80 (2003) (citing 40 C.F.R. § 130.2(h)).
[155] *Communities*, 1 Cal. Rptr. 3d at 80 (citing 40 C.F.R. § 130.2(h)).
[156] Order, at 22.
[157] 40 C.F.R. § 122.44(d)(1)(vii)(B); *Communities*, 1 Cal. Rptr. 3d at 80 (citing 40 C.F.R. § 122.44(d)(1)(vii)(B)).
[158] *See* U.S. E.P.A. "Revisions to the November 22, 2002 Memorandum Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs", at 2 (Nov. 2010), available at http://www.epa.gov/npdes/pubs/establishingtmdlwla_revision.pdf.
[159] Order Section VII.A., at 22; Finding #37-41, at 5-7; Fact Sheet Section II.F., at 21-23.

to the Regional Boards.[160] Despite the State Water Board's contention that it will satisfy its mandatory duty to establish WQBELs consistent with existing, applicable WLAs by re-opening the permit to incorporate WLAs at a later date,[161] re-opening the permit to incorporate existing legal requirements does not fall within any of the limited, permissible reasons for a re-opener.[162] The Draft Permit, as proposed, may not be legally adopted.[163]

As a practical matter, the State Water Board has articulated no legitimate basis for not incorporating the WLAs now. A review of TMDLs developed in California reveals that there are many numeric WLAs specifically developed and applicable to industrial dischargers covered by the Draft Permit. Some of these TMDLs include the Ballona Creek and Estuary Metals TMDL, the Los Angeles River Metals TMDL, the LA River Trash TMDL, the Calleguas Creek Watershed Metals and Selenium TMDL, and the Santa Monica Bay DDT and PCB TMDL, among others. Attachment 5 provides a complete list of TMDLs applicable to Permittees, as well as the text of the WLAs established by those TMDLs that regulate Permittees' discharges. These WLAs must be incorporated as WQBELs into the Draft Permit to ensure that the permit complies with legal mandates.[164]

A delay in WLA incorporation is especially unjustified for TMDLs with expired compliance deadlines, such as the Santa Clara River Reach 3 Chloride TMDL, the Los Angeles Area Lakes Nitrogen, Phosphorus, Mercury, Trash, Organochlorine Pesticides and PCBs TMDLs, and the San Gabriel River Metals and Selenium TMDL. A complete list of TMDLs with expired deadlines is provided as Attachment 6.

Rather than deferring incorporation of WLAs to a later day and shifting the burden to the Regional Boards, the State Water Board must revise the Draft Permit to incorporate all existing, applicable WLAs as WQBELs prior to permit adoption.

VII. CONCLUSION

This permit is of the utmost importance to the watersheds and communities that our groups work to protect. California Waterkeepers and other groups have monitored and assessed industrial facilities discharging storm water since the original permit was issued in 1991, and have been consistently engaged in related regulatory processes for more than twenty years. Accordingly, we have a unique understanding of needed industrial storm water regulatory reforms. We urge the State Water Board to develop a permit that provides clarity to dischargers and the public, avoids self-regulation by dischargers, requires sampling and monitoring that ensures the collection of data to assess compliance and inform development of future permits, and ultimately improves pollution control measures and the protection of water quality.

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[160] Fact Sheet Section II.F., at 22 ("The Regional Boards staff, with the assistance of the State Board staff, will develop proposed TMDL-specific permit requirements for each of the TMDLs listed in Attachment D by July 1, 2015.").
[161] 40 C.F.R. § 122.62.
[162] *Id.*
[163] To the extent the State Water Board does re-open the permit to incorporate WLAs at a later date, the State Water Board must provide a public comment period at that time. 40 C.F.R. § 122.62.
[164] *See* 40 C.F.R. § 122.44(d)(1)(vii)(B); *Communities*, 1 Cal.Rptr.3d at 80 (citing 40 C.F.R. § 122.44(d)(1)(vii)(B)).

We look forward to working with State Water Board members and staff in the coming months to develop a permit that achieves these objectives.

Sincerely,

Sara Aminzadeh, Acting Director
California Coastkeeper Alliance
sara@cacoastkeeper.org

Kirsten James, Water Quality Director
Heal The Bay
kjames@healthebay.org

Bill Jennings, Executive Director
California Sportfishing Protection Alliance
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Attachments:

1. Letters from California citizens in support of a strong, enforceable Industrial Storm Water Permit.
2. CCKA's Proposed Draft Permit Revisions and Language.
3. Statistical Review of California-Specific Industrial Storm Water Data Measured from 2005 to 2012.
4. Summary of Treatment Performance and Costs for Currently Available Industrial Storm Water Controls.
5. List of all applicable TMDLs/WLAs.
6. List of TMDLs with expired compliance deadlines.

ATTACHMENT 1

*Submitted in substantially similar form by more than **1,432** Californians.*

October 22, 2012

Charlie Hoppin, Chair and Members
State Water Resources Control Board
1001 I Street
Sacramento, CA 95812-0100
c/o Jeanine Townsend, Clerk to the Board

Dear State Water Board Members:

I appreciate the State Water Board's work to update the 15-year old Industrial General Stormwater Permit. Runoff from industrial facilities can contain heavy metals such as lead, zinc and copper. These pollutants are highly toxic and endanger the health of California communities and watersheds. Unfortunately, after more than two years of work, many aspects of the Permit reflect a step backward from the current permit, and even the 2011 draft permit.

I urge the State Water Board to work with staff to develop a streamlined permit that is clear and enforceable, and achieves the shared goal of collecting more and better data. California needs clear limits on the amount of stormwater pollutants discharged into our waterbodies in order to provide dischargers with a clear path to compliance, and facilitate efficient enforcement by the State and Regional Water Boards. Please develop a strong, enforceable Industrial Stormwater Permit that helps ensure that California waterways are safe for swimming, drinking, and fishing.

Thank you.

ATTACHMENT 2

Draft Permit Section[*]	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
		Findings	
Finding #8	The Fact Sheet is incorporated as findings of this General Permit.	Delete Finding.	Section I., fn. 10.
Finding #29	This General Permit regulates industrial storm water discharges and authorized NSWDs from specific categories of industrial facilities identified in Attachment A hereto, and industrial storm water discharges and authorized NSWDs from facilities designated by the Regional Water Boards to obtain coverage under this General Permit. This General Permit does not apply to industrial storm water discharges and NSWDs that are regulated by other individual or general NPDES permits, including the current Statewide NPDES Construction General Permit.	This General Permit regulates storm water discharges associated with industrial activities and authorized NSWDs from specific categories of industrial facilities identified in Attachment A hereto, and industrial storm water discharges and authorized NSWDs from facilities designated by the Regional Water Boards to obtain coverage under this General Permit. This General Permit does not apply to industrial storm water discharges and NSWDs that are regulated by other individual or general NPDES permits, including the current Statewide NPDES Construction General Permit.	Section I.B.2. & Section II.C.
Finding #30	Section 301(b) of the Clean Water Act and 40 C.F.R. section 122.44 require NPDES permits to include technology-based requirements at a minimum, and any more stringent effluent limitations necessary to meet applicable water quality standards. Clean Water Act section 402(p)(3)(A) requires that discharges of storm water runoff from industrial facilities comply with Clean Water Act section 301.	Section 301(b) of the Clean Water Act and 40 C.F.R. section 122.44 require NPDES permits to include technology-based requirements at a minimum, and any more stringent effluent limitations necessary to meet applicable water quality standards. Clean Water Act section 402(p)(3)(A) requires that storm water discharges associated with industrial activity comply with Clean Water Act section 301.	Section I.B.2. & Section II.C.

[*] CCKA has not provided proposed language for the Fact Sheet because the Fact Sheet need not be part of the Draft Permit. By not providing proposed language revising the Fact Sheet, CCKA in no way intends to approve of the language of the Fact Sheet. The State Water Board should ensure that the Fact Sheet is consistent with CCKA's proposed revisions to the Findings and the Order.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
Finding #36	This General Permit requires all Dischargers to comply with all applicable water quality standards for water of the United States that may be affected by their industrial storm water discharges and NSWDs. Water quality standards apply to the quality of the receiving water, not the quality of the industrial storm water discharge. Therefore, compliance with the receiving water limitations can generally not be determined solely by the effluent water quality characteristics. Compliance with water quality standards may, in some cases, require Dischargers to implement controls that are more protective than the controls that are necessary to meet the technology-based requirements in this General Permit.	This General Permit requires all Dischargers to comply with all applicable water quality standards for waters of the United States and/or the State. Compliance with water quality standards may, in some cases, require Dischargers to implement controls that are more protective than the controls that are necessary to meet the technology-based requirements in this General Permit.	Section II.A. & Section V.
Finding #51	A QISP III can perform the most advanced permit functions and duties, such as preparing Level 2 ERA Technical Reports and Demonstration Technical Reports. A QISP III can represent multiple facilities with any type of industrial activity. The QISP III training is the most advanced training required by this General Permit and is designed for environmental professionals.	A QISP III can perform the most advanced permit functions and duties, such as preparing Level 2 ERA Reports and Technical Reports. A QISP III can represent multiple facilities with any type of industrial activity. The QISP III training is the most advanced training required by this General Permit and is designed for environmental professionals.	Section I.B.
Finding #57	This General Permit complies with 40 C.F.R. section 122.44(i), which establishes monitoring requirements that must be included in storm water permits. Under this General Permit, Dischargers are required to: (a) conduct an Annual Comprehensive Facility Compliance Evaluation (Annual Evaluation) to identify areas of the facility contributing pollutants to industrial storm water discharges, (b) evaluate whether measures to reduce industrial pollutant loads identified in the Discharger's	This General Permit complies with 40 C.F.R. section 122.44(i), which establishes monitoring requirements that must be included in storm water permits. Under this General Permit, Dischargers are required to: (a) conduct an Annual Comprehensive Facility Compliance Evaluation (Annual Evaluation) to identify areas of the facility contributing pollutants to storm water discharges associated with industrial activities, (b) evaluate whether measures to reduce industrial pollutant loads identified in	Section I.B.2., Section II.C., and Section III.A.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	SWPPP are adequate and properly implemented in accordance with the terms of this General Permit, and (c) determine whether additional control measures are needed.	the Discharger's SWPPP are adequate and properly implemented in accordance with the terms of this General Permit, and (c) determine whether additional control measures are needed.	
Finding #58	This General Permit contains additional monitoring requirements that are necessary to determine whether pollutants are being discharged, and whether response actions are necessary. This will in turn help the Discharger to evaluate BMP effectiveness and compliance with this General Permit. Visual observations are one form of monitoring. This General Permit requires the Discharger to perform a variety of visual observations designed to identify pollutants in industrial storm water discharges and their sources. To comply with this General Permit the Discharger shall: electronically self-report any discharge violations via SMARTS, comply with the Level 1 and Level 2 ERA requirements, when applicable, and adequately address and respond to any Regional Water Board comments on the Discharger's compliance reports.	This General Permit contains additional monitoring requirements that are necessary to determine whether pollutants are being discharged, and whether response actions are necessary. This will in turn help the Discharger to evaluate BMP effectiveness and compliance with this General Permit. Visual observations are one form of monitoring. This General Permit requires the Discharger to perform a variety of visual observations designed to identify pollutants in storm water discharges associated with industrial activity and their sources. To comply with this General Permit the Discharger shall: electronically self-report any discharge violations via SMARTS, comply with the Level 1 and Level 2 ERA requirements, when applicable, and adequately address and respond to any Regional Water Board comments on the Discharger's reports.	Section I.B. & Section II.C.
Finding #63	This General Permit reduces the number of qualifying sampling events required to be sampled each year when the Discharger demonstrates both consistent compliance with this General Permit and consistent effluent water quality sampling and analysis results that do not exceed NALs.	This General Permit reduces the number of sampling events required to be sampled each year when the Discharger demonstrates both consistent compliance with this General Permit and consistent effluent water quality sampling and analysis results that do not exceed NALs.	Section III.A.1.
Finding #64	This General Permit includes NALs, new comprehensive training requirements, Level 1 ERA Reports, Level 2 ERA Technical Reports, and Demonstration Technical	This General Permit includes NALs, new comprehensive training requirements, Level 1 ERA Reports, Level 2 ERA Reports, and Technical Reports as part of a multiple	Section I.B.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	Reports as part of a multiple objective performance measurement system. There are two main objectives: (1) inform the Dischargers, the public and the Water Boards on the overall pollutant control performance at any given facility, and (2) inform the Dischargers, the public and the Water Boards on the overall performance of the industrial storm water program. Additionally, the State Water Board expects that this information and assessment process will provide the information needed to determine the feasibility of numeric effluent limitations for industrial sectors in the next reissuance of this General Permit, consistent with the recommendations of the Blue Ribbon Panel of Experts.	objective performance measurement system. There are two main objectives: (1) inform the Dischargers, the public and the Water Boards on the overall pollutant control performance at any given facility, and (2) inform the Dischargers, the public and the Water Boards on the overall performance of the industrial storm water program. Additionally, the State Water Board expects that this information and assessment process will provide the information needed to determine the feasibility of numeric effluent limitations for industrial sectors in the next reissuance of this General Permit, consistent with the recommendations of the Blue Ribbon Panel of Experts.	
Finding #70	Pollutants in storm water discharges that are solely attributable to non-industrial pollutant sources (such as run-on from adjacent facilities, non-industrial portions of the Discharger's property, or aerial deposition) are not subject to NALs, because the NALs are designed to provide feedback on industrial sources of pollutants. Dischargers may submit a Non-Industrial Source Pollutant Demonstration Technical Report to demonstrate that the sources are of the pollutants are non-industrial. Dischargers who submit a Non-Industrial Source Pollutant Demonstration Technical Report must continue to comply with BAT/BCT and receiving water limitations.	Delete Finding #70. If this proposed change is rejected at a minimum revise to say: Dischargers may submit a Non-Industrial Source Pollutant Technical Report only if the pollutant(s) included in the report are not associated with the Discharger's industrial activity. Dischargers who submit a Non-Industrial Source Pollutant Technical Report must continue to implement BMPs to comply with BAT/BCT and receiving water limitations for all pollutants in the discharge.	Section I.B.2.
Finding #71	Pollutants in storm water discharges that are solely attributable to natural background sources are not subject to NALs, because the NALs are designed to provide feedback on industrial sources of pollutants. Dischargers	Pollutants in storm water discharges that are not associated with the Discharger's industrial activity and are solely attributable to natural background sources are not subject to NALs, because the NALs are designed to	Section I.B.3.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	may submit a Natural Background Demonstration Technical Report to demonstrate that the pollutants are naturally occurring. Dischargers who submit a Natural Background Demonstration Technical Report are not responsible for the naturally occurring pollutants identified in the Natural Background Demonstration Technical Report.	provide feedback on industrial sources of pollutants. Dischargers may submit a Natural Background Technical Report setting forth monitoring data and other information which they believe demonstrate that the pollutants are naturally occurring only if the pollutant(s) included in the report are not associated with the Discharger's industrial activity. Dischargers who submit a Natural Background Technical Report must continue to implement BMPs to comply with BAT/BCT and receiving water limitations for all pollutants in the discharge.	
Finding #72	Where a discharger has already designed, installed, and implemented operational any source control, treatment, and/or structural source control BMPs that are required to reduce or prevent pollutants in industrial storm water discharges in compliance with BAT/BCT, the Discharger may submit a BAT/BCT Compliance Demonstration Technical Report. Dischargers who submit a BAT/BCT Compliance Demonstration Technical Report must continue to comply with receiving water limitations.	Where a discharger has designed, installed, and implemented any source control, treatment, and/or structural source control BMPs that are required to reduce or prevent pollutants in storm water discharges associated with industrial activity consistent with BAT/BCT, the Discharger may submit a BAT/BCT Technical Report describing the source control, treatment, and/or structural source control BMPs and information which the discharger believes demonstrates the BMPs are achieving BAT/BCT. Dischargers who submit a BAT/BCT Technical Report must continue to comply with this Permit.	Section I.B.1. & Section II.C.
Finding #74	Compliance Groups are groups of Dischargers (Participants) that share common pollutant sources and industrial activity characteristics. Compliance Groups provide an opportunity for the Participants to pool resources and develop Consolidated Level 1 ERA Reports for Level 1 NAL exceedances and Consolidated	Technical Groups are groups of Dischargers (Participants) that share common pollutant sources and industrial activity characteristics. Technical Groups provide an opportunity for the Participants to pool resources and develop Consolidated Level 1 ERA Reports for Level 1 NAL exceedances and Consolidated	Section I.B.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	Level 2 ERA Technical Reports for Level 2 NAL exceedances that are representative of the entire Compliance Group. Compliance Groups also provide the Water Boards and the public with valuable information as to how industrial storm water discharges are affected by non-industrial background pollutant sources (including natural background) and geographic locations, and what constitutes BAT/BCT. When developing the next reissuance of this General Permit, the State Water Board expects to have a better understanding of the feasibility and benefits of sector-specific and watershed-based permitting approaches, which may include technology- or water quality-based numeric effluent limitations (NELs). The State Water Board intends that the effluent data, BMP performance data and other information provided from Compliance Groups' consolidated reporting will help inform the State Water Board on these issues.	Level 2 ERA Reports for Level 2 NAL exceedances that are representative of the entire Technical Group. Technical Groups also provide the Water Boards and the public with valuable information as to what may constitute BAT/BCT. When developing the next reissuance of this General Permit, the State Water Board expects to have a better understanding of the feasibility and benefits of sector-specific and watershed-based permitting approaches, which may include technology- or water quality-based numeric effluent limitations (NELs). The State Water Board intends that the effluent data, BMP performance data and other information provided from Technical Groups' consolidated reporting will help inform the State Water Board on these issues.	
Finding #79	Regional Water Boards are primarily responsible for enforcement of this General Permit. This General Permit recognizes that Regional Water Boards have the authority to protect the beneficial uses of receiving waters and prevent degradation of water quality. As such, Regional Water Boards may modify monitoring requirements and review, comment, approve or disapprove any Discharger reports required under this General Permit.	Regional Water Boards are primarily responsible for enforcement of this General Permit. This General Permit recognizes that Regional Water Boards have the authority to protect the beneficial uses of receiving waters and prevent degradation of water quality. As such, Regional Water Boards may, as authorized by law, modify monitoring requirements and review and comment upon, and seek to enforce any inadequacies of any Discharger reports required under this General Permit.	Section I.B. & Section I.C.
Finding #81	Regional Water Boards may revise the treatment design storm standard provided in this General Permit for a	Delete Finding.	Section I.B. & Section I.C.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	Discharger based upon (1) sampling data demonstrating that a higher or lower standard would be protective of water quality, and (2) the treatment technology associated with the revised design storm meets BAT/BCT.		
	General Permit Coverage		
Order Section I.A.1.	For the purposes of this General Permit, this coverage is called NOI coverage. The Discharger that discharges storm water associated with industrial activity to waters of the United States is required to meet all the requirements of this General Permit such as designing and implementing a SWPPP in compliance with BAT/BCT, and complying with the monitoring and Annual Monitoring Reporting requirements. The Discharger shall designate a Legally Responsible Person (LRP) to register for coverage under this General Permit by certifying and submitting Permit Registration Documents (PRDs) via the Stormwater Multi-Application Reporting and Tracking System (SMARTS) (http://smarts.waterboards.ca.gov), which consist of	For the purposes of this General Permit, this coverage is called NOI coverage. The Discharger that discharges storm water associated with industrial activity to waters of the United States and/or the State is required to meet all the requirements of this General Permit such as designing and implementing a SWPPP consistent with BAT/BCT, and complying with the monitoring and Annual Monitoring Reporting requirements. The Discharger shall designate a Legally Responsible Person (LRP) to register for coverage under this General Permit by certifying and submitting Permit Registration Documents (PRDs) via the Stormwater Multi-Application Reporting and Tracking System (SMARTS) (http://smarts.waterboards.ca.gov), which consist of	Section II.A. & Section II.C.
Order Section I.D.1.	The previous permit remains in effect until July 1, 2013. Existing Dischargers that have submitted NOIs for the previous permit shall continue coverage under the previous permit until July 1, 2013. Existing Dischargers that have submitted NOIs for the previous permit shall have until July 1, 2013 to register for NOI or NEC coverage. Existing Dischargers that have not submitted NOIs for the previous permit shall have until July 1, 2014	The previous permit remains in effect until July 1, 2013. Existing Dischargers that have submitted NOIs for the previous permit shall continue coverage under the previous permit until July 1, 2013. Existing Dischargers that have submitted NOIs for the previous permit shall have until July 1, 2013 to register for NOI or NEC coverage. Existing Dischargers that have not submitted NOIs for the previous permit shall immediately register	Section II.A.

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	to register for NOI or NEC coverage. Dischargers that have submitted NOIs for the previous permit that do not register for NOI or NEC coverage by July 1, 2013 may have their coverage administratively terminated. Upon administrative termination, Dischargers are subject to enforcement by the Regional Water Boards until coverage under this General Permit is obtained by designating an LRP to submit new PRDs pursuant to the provisions of Section II.	for NOI or NEC coverage. Dischargers that have submitted NOIs for the previous permit that do not register for NOI or NEC coverage by July 1, 2013 may have their coverage administratively terminated. Upon administrative termination, Dischargers are subject to enforcement by the Regional Water Boards until coverage under this General Permit is obtained by designating an LRP to submit new PRDs pursuant to the provisions of Section II.	
Order Section I.G.7.	Level 2 ERA Technical Reports (Section XII.D) and Demonstration Technical Reports for BAT/BCT, Non-Industrial, or Natural Background (Sections XII.E) shall be	Level 2 ERA Reports (Section XII.D) and Technical Reports for BAT/BCT, Non-Industrial, or Natural Background (Sections XII.E) shall be	Section I.B.
	Discharge Prohibitions		
Order Section III.C.	Industrial storm water discharges and authorized NSWDs shall not contain pollutants that cause or threaten to cause pollution, contamination, or nuisance as defined in section 13050 of the Water Code.	Storm water discharges associated with industrial activities and authorized NSWDs shall not contain pollutants that cause or threaten to cause pollution, contamination, or nuisance as defined in section 13050 of the Water Code.	Section II.C.
Order Section III.E.	Industrial storm water discharges and authorized NSWDs regulated by this General Permit shall not contain hazardous substances equal to or in excess of a reportable quantity listed in 40 C.F.R. section 110.6, 117.21, or 302.6.	Storm water discharges associated with industrial activities and authorized NSWDs regulated by this General Permit shall not contain hazardous substances equal to or in excess of a reportable quantity listed in 40 C.F.R. section 110.6, 117.21, or 302.6.	Section II.C.

Draft Permit Section[*]	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	Effluent Limitations		
Order Section V.A.	Dischargers shall implement BMPs that constitute BAT/BCT to prevent and reduce pollutant discharges.	Facility operators covered by this General Permit must reduce or prevent pollutants associated with industrial activity in storm water discharges and authorized non-storm water discharges through implementation of BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.	Section I.B. & Section I.C.
	Receiving Water Limitations		
Order Section VI.A.	Dischargers shall ensure that industrial storm water discharges and authorized NSWDs do not cause or contribute to an exceedance of any applicable WQS in any affected receiving water.	Dischargers shall ensure that storm water discharges and authorized NSWDs do not cause or contribute to an exceedance of any applicable WQS contained in a Statewide Water Quality Control Plan or the applicable Regional Water Board's Basin Plan.	Section II.A.-B. & Section V.
	Training Qualifications		
Order Section IX.Table 1	Level 2 ERA Technical Reports	Level 2 ERA Reports	Section I.B.
Order Section IX.Table 1	Demonstration Technical Reports	Technical Reports	Section I.B.
Order Section IX.Table 2	SWPPP, NEC, SFR, SLR, Level 1 ERA Evaluation and Report, and NOT. May not prepare the Level 2 Technical Report, and BAT/BCT, non-industrial, and Background	SWPPP, NEC, SFR, SLR, Level 1 ERA Evaluation and Report, and NOT. May not prepare the Level 2 ERA Report, and BAT/BCT, non-industrial, and Background	Section I.B.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	Demonstrations in Level 2 ERA	Technical Report in Level 2 ERA	
Order Section IX.Table 2	SWPPPs NEC, SFR, SLR, Level 1&2 ERA plus BAT/BCT, non-industrial, and Background Demonstration Technical Reports, BIER	SWPPPs NEC, SFR, SLR, Level 1&2 ERA Reports, plus BAT/BCT, Non-Industrial, and Background Technical Reports, BIER	Section I.B.
	Storm Water Pollution Prevention Plans		
Order Section X.A.	CCKA proposes a new section be added.	The SWPPP has two major objectives: (a) to identify and evaluate sources of pollutants associated with industrial activities that may affect the quality of storm water discharges and authorized non-storm water discharges from the facility; and (b) to identify and implement site specific best management practices (BMPs) to reduce or prevent pollutants associated with industrial activities in storm water discharges and authorized non-storm water discharges. BMPs may include a variety of pollution prevention measures or other low-cost and pollution control measures. They are generally categorized as non-structural BMPs (activity schedules, prohibitions of practices, maintenance procedures, and other low-cost measures) and as structural BMPs (treatment measures, run-off controls, overhead coverage.) To achieve these objectives, facility operators should consider the five phase process for SWPPP development and implementation as shown in Table A. The SWPPP requirements are designed to be sufficiently flexible to meet the needs of various facilities. SWPPP requirements that are not applicable to a facility should not be included in the SWPPP.	Section II.C., and Section III.A.-B.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
Order Section X.B.3.	List of Significant Materials	List of Materials	Section III.A.
Order Section X.D.1.a.	Identify and evaluate all sources of pollutants that may affect the quality of industrial storm water discharges and authorized NSWDs	Identify and evaluate all sources of pollutants that may affect the quality of storm water discharges and authorized NSWDs	Section II.C.
Order Section X.D.1.b.	Identify and describe the minimum BMPs (Section X.H.2), and additional facility-specific BMPs (Section X.H.4) to reduce or prevent pollutants in industrial storm water discharges and authorized NSWDs. BMPs shall be selected to achieve BAT/BCT and compliance with WQS	Identify and describe the minimum BMPs (Section X.H.2), and additional facility-specific BMPs (Section X.H.4) to reduce or prevent pollutants in storm water discharges and authorized NSWDs. BMPs shall be selected to achieve BAT/BCT and compliance with WQS	Section II.C.
Order Section X.F.3.b.	Locations of storm water collection and conveyance systems, associated points of discharge, and direction of flow. Include any structural control measures that affect industrial storm water discharges, authorized NSWDs, and run-on	Locations of storm water collection and conveyance systems, associated points of discharge, and direction of flow. Include any structural control measures that affect storm water discharges, authorized NSWDs, and run-on	Section II.C.
Order Section X.F.	List of Significant Materials	List of Materials	Section II.C.
Order Section X.G.1.d.	Significant Spills and Leaks	Spills and Leaks	Section II.C.
Order Section X.G.1.a.	Dischargers shall ensure that the SWPPP includes a narrative assessment of all areas of industrial activity with potential industrial pollutant sources. At a minimum, the assessment shall include	Dischargers shall ensure that the SWPPP includes a narrative assessment of all areas of industrial activity with potential industrial pollutant sources. Dischargers are required to select additional site-specific analytical parameters based upon the types of materials that are	Section III.A.2.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
		both exposed to and mobilized by contact with storm water. Dischargers are expected understand how to identify industrial materials that are handled outdoors and which of those materials can easily dissolve or be otherwise transported via storm water. At a minimum, the assessment shall include	
Order Section X.H.2	Dischargers shall implement the minimum BMPs identified in areas of the facility from which industrial storm water is discharged to waters of the United States. Dischargers may eliminate or revise any BMPs determined to be inapplicable, infeasible, inappropriate, or that require operational or physical revisions of the facility that exceed BAT/BCT and compliance with WQS. Dischargers shall document these reasons in the SWPPP. Dischargers shall determine the appropriate BMP inspection frequencies related to the minimum BMPs. Dischargers shall revise, replace and maintain all BMPs, as needed. The Discharger is not required to narratively describe the minimum BMP inspection results in the Annual Monitoring Report. The Annual Monitoring Report only requires a certification that minimum BMP inspections were completed.	Dischargers shall implement the minimum BMPs at the facility. Dischargers may eliminate or revise any BMPs not required to achieve compliance with this Permit including complying with BAT/BCT, or compliance with WQS. Dischargers shall document these reasons in the SWPPP. Dischargers shall inspect, revise, replace and maintain all BMPs, as needed. The Discharger must narratively describe the minimum BMP inspection results in the Annual Monitoring Report. The Annual Monitoring Report also requires a certification that minimum BMP inspections were completed.	Section I.B.1. & Section I.C.
Order Section X.H.7.c.	In lieu of complying with the design storm standards for treatment control BMPs in this section, Dischargers may certify and submit a BAT/BCT Compliance Demonstration Technical Report (Section XII.E.3).	Delete Section.	Section I.B.1. & Section I.C.
Order Section X.H.7.d.	The State Water Board Deputy Director of the Division of Water Quality may revise the treatment design storm standard provided in this General Permit in writing for a	The State Water Board may amend this General Permit to revise the treatment design storm standard for a Discharger or group of Dischargers based upon sampling	Section I.B.1. & Section I.C.

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	Discharger or group of Dischargers based upon sampling data indicating that a revised design storm standard would be protective of water quality, or upon the Deputy Director's determination that the treatment technology associated with the revised design storm standard meets BAT/BCT.	data indicating that a revised design storm standard would be protective of water quality, or upon the State Water Board's determination that the treatment technology associated with the revised design storm standard meets BAT/BCT.	
	Monitoring Requirements		
Order Section XI.A.	CCKA proposes a new section be added.	The objectives of the monitoring program are to: Ensure that storm water discharges are in compliance with the Discharge Prohibitions, Effluent Limitations, and Receiving Water Limitations specified in this General Permit. Ensure practices at the facility to reduce or prevent pollutants in storm water discharges and authorized non storm water discharges are evaluated and revised to meet changing conditions. Aid in the implementation and revision of the SWPPP required by Section A of this General Permit. Measure the effectiveness of best management practices (BMPs) to prevent or reduce pollutants in storm water discharges and authorized non-storm water discharges. Much of the information necessary to develop the monitoring program, such as discharge locations,	Section III.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
		drainage areas, pollutant sources, etc., should be found in the Storm Water Pollution Prevention Plan (SWPPP). The facility's monitoring program shall be a written, site specific document that shall be revised whenever appropriate and be readily available for review by employees or Regional Water Board inspectors.	
Order Section XI.B.1.	Dischargers shall ensure that collection of storm water samples are made at all locations that discharge storm water associated with industrial activity for the first QSE of each quarter in the reporting year. In addition, the first discharge of contained storm water that occurs in each quarter (as defined in this Section A.2.b, above) shall be sampled.	Dischargers shall ensure that collection of storm water samples are made at all discharge locations for the first QSE of each quarter in the reporting year. In addition, the first discharge of contained storm water that occurs in each quarter (as defined in this Section A.2.b, above) shall be sampled.	Section III.B.2.
Order Section XI.B.3.	Samples shall be collected from each drainage location within four (4) hours of: The start of the discharge, or The start of facility operations if the QSE occurs within the previous 12 hour period (storms that begin the previous night). Sample collection is required during scheduled facility operating hours and when sampling conditions are safe. (Section XI.C.5.a).	Samples shall be collected from each drainage location within: Within one (1) hour of the start of the discharge when feasible, or Within four (4) hours of the start of the discharge, or The start of facility operations if the QSE occurs within the previous 12 hour period (storms that begin the previous night). Sample collection is required during scheduled facility operating hours and when sampling conditions are safe. (Section XI.C.5.a).	Section III.A.1.
Order Section XI.B.4.	In the event that the first QSE in a quarter does not produce a discharge that can be sampled at one or more	In the event that the first QSE in a quarter cannot be sampled at one or more sampling locations, dischargers	Section III.A.1.

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	sampling locations, dischargers shall record which sampling locations were observed that did not discharge, and collect samples from those locations from the next QSE(s) that produces a discharge in that quarter. If the Discharger fails to collect a quarterly sample at one or more sampling locations that did produce a discharge within a quarter, the Discharger is required to fulfill the sampling requirement from an additional QSE that produces a discharge in a subsequent quarter. Dischargers shall provide an explanation in the Annual Report for uncompleted quarterly sample collection only for those quarters that at least one QSE occurs. For each discharge location, the maximum number of samples required per reporting year is four (4). The maximum number of samples collected for each discharge location per reporting year shall be reduced for each quarter in which a QSE does not occur or a QSE occurs but that does not produce a discharge.	shall record which sampling locations were observed that did not discharge (if any), and shall record which sampling locations discharged but a sample was not collected. Dischargers shall collect samples from those locations from the next QSE(s) in that quarter. To ensure a minimum of three samples are collected in each reporting year, if the Discharger fails to collect a sample in any quarter, the Discharger shall collect a sample from the next storm event that produces a discharge, whether it is a QSE or not. This requirement is in addition to the requirement that Dischargers collect a sample from one QSE per quarter (i.e., if the next storm event is the first QSE in the next quarter, the discharger is still obligated to collect an additional sample to make up for the sample missed in the previous quarter). Dischargers shall provide an explanation in the Annual Report for uncompleted quarterly sample collection. For each discharge location, the minimum number of samples required per reporting year is three (3).	
Order Section XI.B.5.	Dischargers shall analyze all effluent samples obtained for the following parameters	Dischargers shall analyze all effluent samples obtained for at least the following parameters	Section III.A.2.
Order Section XI.B.5.e.	Additional parameters required by the Regional Water Board. Dischargers shall contact the Regional Water Board to determine appropriate analytical methods for parameters not listed in Table 5; and	Additional parameters required by the Regional Water Board. Dischargers shall contact the Regional Water Board to determine appropriate analytical methods for parameters not listed in Table 5;	Section III.A.2.
Order Section XI.B.5.f.	Additional parameters specifically required by Subchapter N. Dischargers subject to ELGs shall contact the Regional Water Board to determine appropriate	Additional parameters specifically required by Subchapter N. Dischargers subject to ELGs shall contact the Regional Water Board to determine appropriate	Section III.A.2.

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	analytical methods for parameters not listed in Table 5;	analytical methods for parameters not listed in Table 5; and	
Order Section XI.B.5.g.	CCKA proposes a new section be added.	Dischargers are required to select additional site-specific analytical parameters based upon the types of materials that are both exposed to and mobilized by contact with storm water. Dischargers are expected to understand how to identify industrial materials that are handled outdoors and which of those materials can easily dissolve or be otherwise transported via storm water.	Section III.A.2.
Order Section XI.C.2.a.	Dischargers shall ensure that all storm water discharge sampling locations are representative of only those drainage areas associated with industrial activities. The storm water discharge observed and collected from these sampling locations shall be representative of the storm water discharge generated in each drainage area. For sheet flow, the Discharger shall determine the appropriate sampling location(s) which represent industrial storm water discharges generated from the corresponding drainage area.	Dischargers shall ensure that all storm water discharge sampling locations are representative of the storm water discharge generated in each drainage area. For sheet flow, the Discharger shall attempt to collect a sample, but may determine the appropriate sampling location(s) which represent industrial storm water discharges generated from the corresponding sheet flow drainage area.	Section III.B.
Order Section XI.C.2.b.	Dischargers shall identify practicable alternate sample collection locations representative of the facility's storm water discharge if	Dischargers may identify practicable alternate sample collection locations representative of the facility's storm water discharge if	Section III.B.2.
Order Section XI.C.2.b.i.	Specific drainage areas at the facility are affected by storm water run-on from off-site areas or on-site non-industrial areas;	Delete Section.	Section III.B.2.
Order Section	For each drainage area (or sub-drainage areas) with	For each drainage area (or sub-drainage areas) with	Section III.B.2.

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XI.C.3.a.	multiple discharge locations (e.g., roofs with multiple downspouts, equipment storage areas with multiple storm drain inlets), the Discharger may reduce the number of sample locations if a SLR report is prepared documenting that the industrial activities and physical characteristics (grade, surface materials, etc.) of the drainage areas for each sampling location are substantially similar to one another	multiple discharge locations (e.g., roofs with multiple downspouts, equipment storage areas with multiple storm drain inlets), the Discharger may reduce the number of sample locations if a SLR report is prepared documenting that the industrial activities, BMPs, and physical characteristics (grade, surface materials, etc.) of the drainage areas for each sampling location are substantially identical to one another	
Order Section XI.C.3.c.	Regional Water Boards may reject the SLR report and/or request additional supporting documentation. In such instances, the Discharger is not eligible for the SLR until the Regional Water Board provides SLR report approval. Revised SLR reports shall be certified and submitted via SMARTS by the Discharger's LRP.	Regional Water Boards may reject the SLR report and/or request additional supporting documentation. In such instances, the Discharger is not eligible for the SLR until the Regional Water Board provides SLR report approval. Revised SLR reports shall be certified and submitted via SMARTS by the Discharger's LRP. The Regional Water Board's review, comment, or failure to comment shall not be construed to be an acceptance or approval of an SLR report by the Regional Board.	Section III.B.2.
Order Section XI.C.4.a.	Dischargers may authorize the lab to combine samples of equal volume from as many as four (4) drainage areas if the industrial activities and physical characteristics (grade, surface materials, etc.) within each of the drainage areas are substantially similar to one another.	Dischargers may authorize the lab to combine samples of equal flow-weighted volume from as many as two (2) drainage areas if the industrial activities, BMPs, and physical characteristics (grade, surface materials, etc.) within each of the drainage areas are substantially identical to one another.	Section III.B.1.
Order Section XI.C.4.b.	Dischargers shall provide documentation supporting that the above conditions have been evaluated as part of the Annual Monitoring Report submittal. Regional Water Board approval is necessary to combine samples from more than four (4) drainage areas.	Dischargers shall provide documentation supporting that the above conditions have been evaluated as part of the Annual Monitoring Report submittal. Regional Water Board approval is necessary to combine samples from more than two (2) drainage areas.	

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Order Section XI.C.6.a.	Dischargers are eligible to reduce the number of QSEs sampled each reporting year in accordance with the following requirements	Dischargers are eligible to reduce the number of QSEs sampled at a discharge location in a reporting year in accordance with the following requirements	Section III.A.1.
Order Section XI.C.6.a.i.	The Discharger has taken samples in eight (8) consecutive quarters where QSEs occurred that produced a discharge	The Discharger has taken samples in eight (8) consecutive quarters where QSEs occurred that produced a discharge at that discharge location(s)	Section III.A.1.
Order Section XI.C.a.ii.	Sampling results from the eight (8) QSEs did not exceed any NALs as defined in Section XII.A	Sampling results from the eight (8) QSEs at that discharge location(s) did not exceed any NALs as defined in Section XII.A	Section III.A.1.
Order Section XI.C.a.iii.	The Discharger is in full compliance with the requirements of this General Permit and has updated, certified and submitted via SMARTS all documents, data, and reports required by this General Permit during the same eight (8) consecutive quarters in which samples were collected from QSEs. Dischargers subject to enforcement actions by the Regional Water Boards may be excluded from eligibility.	The Discharger is in full compliance with the requirements of this General Permit, including compliance with water quality standards, and has updated, certified and submitted via SMARTS all documents, data, and reports required by this General Permit during the same eight (8) consecutive quarters in which samples were collected from QSEs at that discharge location(s). Dischargers subject to enforcement actions by the Regional Water Boards are excluded from eligibility.	Section III.A.1.
Order Section XI.C.6.c.	Upon submittal of a SFR report the Discharger shall collect and analyze samples from the first QSE producing a discharge occurring on or after October 1 of the next reporting year. Regional Water Boards may reject SFR report and/or request additional supporting documentation. In such instances, the Discharger is not eligible for the SFR until the Regional Water Board	Upon submittal of a SFR report the Discharger shall collect and analyze samples from the first QSE producing a discharge occurring on or after October 1 of the next reporting year, and from at least one (1) other QSE producing a discharge during the reporting year. Regional Water Boards may reject SFR report and/or request additional supporting documentation. In such	Section III.A.1. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	provides SFR report approval. Revised SFR reports shall be certified and submitted via SMARTS by the Discharger's LRP.	instances, the Discharger is not eligible for the SFR until the Regional Water Board provides SFR report approval. Revised SFR reports shall be certified and submitted via SMARTS by the Discharger's LRP. The Regional Water Board's review, comment, or failure to comment shall not be construed to be an acceptance or approval of an SFR report by the Regional Board.	
	Exceedance Response Actions		
Order Section XII.A.1.b.	Instantaneous maximum NAL exceedance: the Discharger shall compare all sampling and analytical results from each distinct sample (individual or combined) to the corresponding instantaneous maximum NAL values in Table 5. An instantaneous maximum NAL exceedance occurs when two or more analytical results for TSS, O&G, or pH from samples taken within a reporting year exceed the instantaneous maximum NAL value (or is outside the NAL pH range).	Instantaneous maximum NAL exceedance: the Discharger shall compare all sampling and analytical results from each distinct sample to the corresponding instantaneous maximum NAL values in Table 5. An instantaneous maximum NAL exceedance occurs when any analytical result from a sample taken within a reporting year exceeds the value (or is outside the NAL pH range) listed in Table 5.	Section I.B. & Section III.A.3.
Order Section XII.B.3.	Dischargers with Level 2 status will return to status upon certifying and submitting a Demonstration Technical Report.	Dischargers with Level 2 status will return to Baseline status upon certifying and submitting a Technical Report, and corrective action(s) to remedy the NAL exceedance has been completed.	Section I.B. & Section I.C.
Order Section XII.C.2.	Within 60 days of obtaining Level 1 status, Dischargers shall complete an evaluation of the facility's SWPPP and all the industrial pollutant sources at the facility. The evaluation shall identify whether additional operational source control BMPs and/or SWPPP implementation	Within 60 days of obtaining Level 1 status, Dischargers shall complete an evaluation of the facility's SWPPP and all the industrial pollutant sources at the facility. The evaluation shall identify what additional operational source control BMPs and/or SWPPP implementation	Section I.C.

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	measures are necessary to prevent or reduce all industrial pollutants in industrial storm water discharges in compliance with BAT/BCT. This evaluation shall not be limited to the parameter(s) exceeding the NAL(s).	measures are necessary to prevent or reduce all pollutants in storm water discharges in compliance with BAT/BCT and Water Quality Standards. This evaluation shall not be limited to the parameter(s) exceeding the NAL(s).	
Order Section XII.D.1.	A Discharger's Level 1 status for any parameter(s) immediately and automatically changes to Level 2 status for the same parameter(s) if sampling results indicate an NAL exceedance in any subsequent reporting year for the same parameter(s).	A Discharger's Level 1 status for any parameter(s) immediately and automatically changes to Level 2 status for the same parameter(s) if sampling results indicate two NAL exceedances for the same parameter(s).	Section III.B.3.
Order Section XII.D.2.b.	Certify and submit via SMARTS a Level 2 ERA Technical Report prepared by a QISP III that includes the following	Certify and submit via SMARTS a Level 2 ERA Report prepared by a QISP III that includes the following	Section I.B.
Order Section XII.D.2.b.iv.	If the Discharger intends to certify and submit a Demonstration Technical Report in lieu of additional structural and/or treatment control BMPs and SWPPP revisions for each parameter that exceeded an NAL, the Discharger shall certify and submit a schedule and a detailed description of the tasks required to complete the Demonstration Technical Report.	If the Discharger intends to certify and submit a Technical Report, the Discharger shall certify and submit a schedule and a detailed description of the tasks required to complete the Technical Report	Section I.B.
Order Section XII.D.3.	Based upon the above evaluation and Level 2 ERA Technical Report, the Discharger shall, as soon as practicable, but no later than one year from obtaining Level 2 status	Based upon the above evaluation and Level 2 ERA Report, the Discharger shall, as soon as practicable, but no later than one year from obtaining Level 2 status	Section I.B.
Order Section XII.E.	ERA Level 2 Demonstration Technical Reports	ERA Level 2 Technical Reports	Section I.B.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
Order Section XII.E.1.	At any time in Level 2 status the Discharger's QISP III may evaluate industrial pollutant sources, the SWPPP, non-industrial pollutant sources, natural background sources, and the impact of industrial storm water discharges to receiving waters, and prepare a Level 2 ERA Demonstration Technical Report (Demonstration Technical Report) as applicable. A Demonstration may address one or more pollutants and/or drainage areas.	At any time in Level 2 status the Discharger's QISP III may evaluate industrial pollutant sources, the SWPPP, natural background sources, and the impact of industrial storm water discharges to receiving waters, and prepare a Level 2 ERA Technical Report (Technical Report) as applicable. A Technical Report may address one or more pollutants and/or drainage areas.	Section I.B.
Order Section XII.E.2	Once a Demonstration Technical Report is submitted, the Discharger automatically returns to Baseline Status for that pollutant for NAL/ERA purposes. If a BAT/BCT Compliance Demonstration Technical Report is submitted, the Discharger remains responsible for compliance with receiving water limitations for the discharge identified in the Demonstration. If a Non-Industrial Source Pollutant Demonstration Technical Report is submitted, the Discharger remains responsible for compliance with BAT/BCT and receiving water limitations for the discharge identified in the Demonstration. If a Natural Background Demonstration Technical Report is submitted, the Discharger is not responsible for the identified parameter(s) in the drainage area(s) in the Demonstration Technical Report.	Once a Technical Report is submitted, the Discharger returns to Baseline Status for that pollutant for NAL/ERA purposes if corrective action(s) to remedy the NAL exceedance has been completed. If any Technical Report is submitted by a Discharger, the Discharger remains responsible for compliance with BAT/BCT and receiving water limitations for the discharge(s) identified in the Technical Report.	Section I.B. & Section I.C.
	BAT/BCT Technical Report		

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
Order Section XII.E.3	BAT/BCT Compliance Demonstration Technical Report	BAT/BCT Technical Report	Section I.B.1.
Order Section XII.E.3.b.	A statement that the Discharger has identified and evaluated all pollutant source(s) associated with industrial activity that are causing an NAL exceedance	A statement that the Discharger has identified and evaluated all pollutant source(s) associated with industrial activity that may be causing the NAL exceedance	Section I.B.1. & Section I.C.
Order Section XII.E.3.c	A statement that the Discharger has already designed, installed, and implemented operational source control, treatment, and/or structural source control BMPs that are required to reduce or prevent pollutants in industrial storm water discharges in compliance with BAT/BCT.	A statement that the Discharger has designed, installed, and implemented operational source control, treatment, and/or structural source control BMPs to reduce or prevent pollutants in industrial storm water discharges, which the Discharger believes have achieved BAT/BCT.	Section I.B.1. & Section I.C.
Order Section XII.E.3.f	A description of all implemented BMPs that constitute BAT/BCT for the specific identified parameter(s) in the drainage area(s);	A description of all implemented BMPs for the specific identified parameter(s) in the drainage area(s)	Section I.B.1. & Section I.C.
Order Section XII.E.3.g	Alternate NALs, if applicable, that correspond to the identified treatment/structural BMPs and reflect BAT/BCT level of control.	Delete Section.	Section I.B.1. & Section I.C.
	Non-Industrial Pollutant Source Demonstration Technical Report		
Order Section XII.E.4.	The Non-Industrial Source Pollutant Demonstration Technical Report shall at a minimum, include the following	Delete Section. If this proposed change is rejected at a minimum revise to say:	Section I.B.2.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
		A Discharger can submit a Non-Industrial Source Pollutant Technical Report for a pollutant that exceeds an NAL only if that pollutant is not associated with the Discharger's industrial activity. The Non-Industrial Source Pollutant Technical Report shall at a minimum, include the following	
Order Section XII.E.4.b	A statement that the Discharger has determined that the pollutants causing the exceedances are solely attributable to storm water run-on to the facility from adjacent properties or non-industrial portions of the Discharger's property or from aerial deposition;	Delete Section. If this proposed change is rejected at a minimum revise to say:	Section I.B.2. & Section I.C.
		A statement that the Discharger has determined that the pollutants found in any discharge exceeding the concentrations in Table 5 are solely attributable to storm water run-on to the facility from non-industrial sources on an adjacent property, or from aerial deposition not associated with the Discharger's industrial operations	
Order Section XII.E.4.d	A quantification of the relative contributions of the pollutant from (1) storm water run-on to the facility from adjacent properties or non-industrial portions of the Discharger's property or from aerial deposition and (2) from the storm water associated with the Discharger's industrial activity;	Delete Section. If this proposed change is rejected at a minimum revise to say:	Section I.B.2. & Section I.C.
		A quantification of the relative contributions of the pollutant from (1) storm water run-on to the facility from non-industrial sources on an adjacent property or from aerial deposition not associated with the Discharger's industrial operations and (2) from the storm water associated with the Discharger's industrial activity	

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
Order Section XII.E.4.f	An evaluation of all on-site/off-site analytical monitoring data demonstrating that the NAL exceedances are solely attributable to pollutants in storm water run-on to the facility from adjacent properties or non-industrial portions of the Discharger's property or from aerial deposition.	Delete Section. If this proposed change is rejected at a minimum revise to say: An evaluation of all on-site/off-site analytical monitoring data demonstrating that the NAL exceedances are solely attributable to pollutants in storm water run-on to the facility from non-industrial sources on an adjacent property, or from aerial deposition not associated with the Discharger's industrial operations.	Section I.B.2. & Section I.C.
	Natural Background Demonstration Technical		
Order Section XII.E.5.	The Natural Background Demonstration Technical Report shall at a minimum, include the following	A Discharger can submit a Natural Background Technical Report for a pollutant that exceeds an NAL only if that pollutant is not associated with the Discharger's industrial activity. The Natural Background Technical Report shall at a minimum, include the following	Section I.B.3. & Section I.C.
Order Section XII.E.5.c.	A summary of any research and published literature that relates the pollutants evaluated at the facility as part of the Natural Background Demonstration	A summary of any research and published literature that relates the pollutants evaluated at the facility as part of the Natural Background	Section I.B.3. & Section I.C.
	Submitting Level 2 ERA Technical Reports		
Order Section XII.E.6.	The Discharger shall certify and submit via SMARTS the Level 2 ERA Demonstration Technical Reports described in this Section.	The Discharger shall certify and submit via SMARTS Level 2 ERA Technical Reports described in this Section	Section I.B.2. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
Order Section XII.E.7.	The State Water Board and Regional Water Board may review any ERA Technical Reports submitted in connection with an ERA Level 2 Technical Report or Demonstration Technical Report. Upon review of a Level 2 Technical Report or ERA Level 2 Demonstration Technical Report, the State Water Board Executive Director or the Regional Water Board may reject the ERA Level 2 Demonstration Technical Report direct the Discharger to take further action(s) to comply with this General Permit.	Pursuant to their respective enforcement authorities, the State Water Board and Regional Water Board may review any ERA Technical Reports submitted in connection with an ERA Level 2 Technical Report or Technical Report. Upon review of a Level 2 Technical Report or ERA Level 2 Technical Report, the State Water Board Executive Director or the Regional Water Board may reject the ERA Level 2 Technical Report direct the Discharger to take further action(s) to comply with this General Permit pursuant to the State and Regional Board's enforcement authorities. Any such enforcement activity by the State Board or Regional Board shall not be construed to be a determination of BAT/BCT for the Discharger unless the State Board or Regional Board formally amends this Permit to include such BAT/BCT determination for the Discharger.	Section I.B.2. & Section I.C.
Order Section XII.F.1.	Dischargers may document the need for additional time to implement treatment and/or structural control BMPs required under ERA Level 2 and/or to complete a Demonstration Technical Report by certifying and submitting a BIER through SMARTS. The BIER shall be prepared by a QISP III and include the following items, as applicable	Dischargers may document the need for additional time to implement treatment and/or structural control BMPs required under ERA Level 2 and/or to complete a Technical Report by certifying and submitting a BIER through SMARTS. The BIER shall be prepared by a QISP III and include the following items, as applicable	Section I.B.2. & Section I.C.
Order Section XII.F.1.d.	A description and schedule for completing specific tasks necessary to support the Demonstration Technical Report.	A description and schedule for completing specific tasks necessary to support the Technical Report.	Section I.B.2. & Section I.C.
Order Section XII.F.2.	Regional Water Boards may review BIERs for completeness and adequacy. Regional Water Boards	Pursuant to their respective enforcement authorities, the State Water Board or Regional Water Boards may review	Section I.B.2. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	may reject a BIER, identify additional tasks necessary to complete the Demonstration Technical Report, require the Discharger to implement additional temporary BMPs, or revise the time allowed to construct and/or implement the BMPs.	BIERs for completeness and adequacy. Regional Water Boards may reject a BIER, identify additional tasks necessary to complete the Technical Report, require the Discharger to implement additional temporary BMPs, or revise the time allowed to construct and/or implement the BMPs pursuant to the State and Regional Board's enforcement authorities. Any such enforcement activity by the State Board or Regional Board shall not be construed to be a determination of BAT/BCT for the Discharger unless the State Board or Regional Board formally amends this Permit to include such BAT/BCT determination for the Discharger.	
	Technical Report Groups and Technical Report Group Leaders		
Order Section XIV.	COMPLIANCE GROUPS AND COMPLIANCE GROUP LEADERS	TECHNICAL REPORT GROUPS AND TECHNICAL REPORT GROUP LEADERS	Section I.B.2. & Section I.C.
Order Section XIV.A.	Baseline/Level 1 Compliance Group (CG1) and Baseline/Level 1 Compliance Group Leader (CGL1) Requirements	Baseline/Level 1 TG1 Technical Report Group (TG1) and Baseline/Level 1 Report Group Leader (TGL1) Requirements	Section I.B.2. & Section I.C.
Order Section XIV.A.1.	CG1 Qualification Requirements Any group of Dischargers of the same industry type may form a CG1. A CG1 shall consist of Dischargers that	TG1 Qualification Requirements Any group of Dischargers of the same industry type may form a TG1. A TG1 shall consist of Dischargers that	Section I.B.2. & Section I.C.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	operate facilities with similar types of industrial activities, pollutant sources, and pollutant characteristics (e.g., scrap metals recyclers differentiated from paper recyclers, truck vehicle maintenance differentiated from airplane vehicle maintenance, etc.). A Discharger participating in a CG1 is termed a CG1 Participant. Participation in a CG1 is not required.	operate facilities with similar types of industrial activities, pollutant sources, and pollutant characteristics (e.g., scrap metals recyclers differentiated from paper recyclers, truck vehicle maintenance differentiated from airplane vehicle maintenance, etc.). A Discharger participating in a TG1 is termed a TG1 Participant. Participation in a TG1 is not required.	
Order Section XIV.A.2.	CGL1 Qualification Requirements The CG1 shall select a CGL1 to assist the CG1 Participants with all compliance activities in this General Permit other than Level 2 ERA compliance activities. For example, the CGL1 shall assist with SWPPP development, monitoring, visual observations and inspections. A CGL1 shall be either a representative of: an industry association or trade group; an engineering or environmental science consulting company; a coalition of public agencies and/or private companies; or any combination of the above. A CGL1 shall be a QISP II or III.	TGL1 Qualification Requirements The TG1 shall select a TGL1 to assist the TG1 Participants with all compliance activities in this General Permit other than Level 2 ERA compliance activities. For example, the TGL1 shall assist with SWPPP development, monitoring, visual observations and inspections. A TGL1 shall be either a representative of: an industry association or trade group; an engineering or environmental science consulting company; a coalition of public agencies and/or private companies; or any combination of the above. A TGL1 shall be a QISP II or III.	Section I.B.2. & Section I.C.
Order Section XIV.A.3.	CGL1 Prepared Consolidated Level 1 ERA Reports A CGL1 may prepare a Consolidated Level 1 ERA Report for all CG1 Participants with Level 1 status. CG1 Participants who certify and submit these Consolidated Level 1 ERA Reports are subject to the same provisions	TGL1 Prepared Consolidated Level 1 ERA Reports A TGL1 may prepare a Consolidated Level 1 ERA Report for all TG1 Participants with Level 1 status. TG1 Participants who certify and submit these Consolidated Level 1 ERA Reports are subject to the same provisions	Section I.B.2. & Section I.C.

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
	as individual Dischargers with Level 1 status, as described in Section XII.C. In the Consolidated Level 1 ERA Reports, the CGL1 shall, at a minimum, provide a description of the common industrial pollutant sources, BMPs, and ERAs as well as the industrial pollutant sources, BMPs and ERAs that are not common between the CG1 Participants. A Consolidated Level 1 ERA Report is equivalent to a Level 1 ERA Report.	as individual Dischargers with Level 1 status, as described in Section XII.C. In the Consolidated Level 1 ERA Reports, the TGL1 shall, at a minimum, provide a description of the common industrial pollutant sources, BMPs, and ERAs as well as the industrial pollutant sources, BMPs and ERAs that are not common between the TG1 Participants. A Consolidated Level 1 ERA Report is equivalent to a Level 1 ERA Report.	
Order Section XIV.A.4.	CGL1 Responsibilities The CGL1 shall be responsible for providing assistance to CG1 Participants that is consistent with this General Permit's requirements. To establish a CG1, a CGL1 shall register as a CGL1 via SMARTS. The registration shall include documentation demonstrating compliance with the CG1 qualification requirements, above, and a list of the CG1 Participants. The CGL1 shall inspect all the facilities of the CG1 Participants at a minimum of once per reporting year (July 1 to June 30). A CGL1 shall prepare a Consolidated Level 1 ERA Report that is consistent with the Level 1 ERA Requirements in Section XII.C. The CGL1 shall also provide a description of the common industrial pollutant sources, BMPs, and ERAs as well as the industrial pollutant sources, BMPs and ERAs that are not common between the CG1 Participants.	TGL1 Responsibilities The TGL1 shall be responsible for providing assistance to TG1 Participants that is consistent with this General Permit's requirements. To establish a TG1, a TGL1 shall register as a TGL1 via SMARTS. The registration shall include documentation demonstrating compliance with the TG1 qualification requirements, above, and a list of the TG1 Participants. The TGL1 shall inspect all the facilities of the TG1 Participants at a minimum of once per reporting year (July 1 to June 30). A TGL1 shall prepare a Consolidated Level 1 ERA Report that is consistent with the Level 1 ERA Requirements in Section XII.C. The TGL1 shall also provide a description of the common industrial pollutant sources, BMPs, and ERAs as well as the industrial pollutant sources, BMPs and ERAs that are not common between the TG1 Participants.	Section I.B.2. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	The CGL1 shall revise the Consolidated Level 1 ERA Report in accordance with any comments received from the Water Boards. The CGL1 shall update the Consolidated Level 1 ERA Report as needed to address additional CG1 Participants that trigger the ERA Level 1 reporting requirements.	The TGL1 shall revise the Consolidated Level 1 ERA Report in accordance with any comments received from the Water Boards. The TGL1 shall update the Consolidated Level 1 ERA Report as needed to address additional TG1 Participants that trigger the ERA Level 1 reporting requirements.	
Order Section XIV.A.5.	CG1 Participant Responsibilities Each CG1 Participant is responsible for permit compliance for the CG1 Participant's facility and for ensuring that the CGL1's activities related to the CG1 Participant's facility comply with this General Permit. CG1 Participants with Level 1 status shall certify and submit via SMARTS the Consolidated Level 1 ERA Report. Alternatively, the CG1 Participant may submit their own individual Level 1 ERA Report in accordance with the provisions in Section XII.C.2.	TG1 Participant Responsibilities Each TG1 Participant is responsible for permit compliance for the TG1 Participant's facility and for ensuring that the TGL1's activities related to the TG1 Participant's facility comply with this General Permit. TG1 Participants with Level 1 status shall certify and submit via SMARTS the Consolidated Level 1 ERA Report. Alternatively, the TG1 Participant may submit their own individual Level 1 ERA Report in accordance with the provisions in Section XII.C.2.	Section I.B.2. & Section I.C.
Order Section XIV.A.6.	The Executive Director of the State Water Board may review CG1 registrations for compliance with the requirements of this Section. The Executive Director may: Reject the CG1, or individual CG1 Participants within the CG1; or, Require the CGL1 to amend the submitted registration	The Executive Director of the State Water Board may review TG1 registrations for compliance with the requirements of this Section. The Executive Director may: Reject the TG1, or individual TG1 Participants within the TG1; or, Require the TGL1 to amend the submitted registration	Section I.B.2. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	documents.	documents.	
Order Section XIV.B.	Level 2 Compliance Group (CG2) and Level 2 Compliance Group Leader (CGL2) Requirements	Level 2 Technical Group (TG2) and Level 2 Technical Group Leader (TGL2) Requirements	Section I.B.2. & Section I.C.
Order Section XIV.B.1.	CG2 Qualification Requirements A CG2 shall consist of Dischargers with Level 2 status that: Operate facilities with similar types of industrial activities, pollutant sources, and pollutant characteristics (e.g., scrap metals recyclers differentiated from paper recyclers, truck vehicle maintenance differentiated from airplane vehicle maintenance, etc.). A Discharger participating in a CG2 is termed a CG2 Participant; Reflect the industrial sector as a whole, by including a significant number of the Dischargers with Level 2 status in the industry sector type; and, Choose to participate in a CG2.	TG2 Qualification Requirements A TG2 shall consist of Dischargers with Level 2 status that: Operate facilities with similar types of industrial activities, pollutant sources, and pollutant characteristics (e.g., scrap metals recyclers differentiated from paper recyclers, truck vehicle maintenance differentiated from airplane vehicle maintenance, etc.). A Discharger participating in a TG2 is termed a TG2 Participant; Reflect the industrial sector as a whole, by including a significant number of the Dischargers with Level 2 status in the industry sector type; and, Choose to participate in a TG2.	Section I.B.2. & Section I.C.
Order Section XIV.B.3.	CGL2 Prepared Level 2 ERA Technical Reports A CGL2 may prepare a Consolidated Level 2 ERA Technical Report for CG2 Participants with Level 2 status. CG2 Participants who certify and submit these Consolidated Level 2 ERA Technical Reports are subject to the same provisions as individual Dischargers with Level 2 status, as described in Section XII.D. A	TGL2 Prepared Level 2 ERA Technical Reports A TGL2 may prepare a Consolidated Level 2 ERA Technical Report for TG2 Participants with Level 2 status. TG2 Participants who certify and submit these Consolidated Level 2 ERA Technical Reports are subject to the same provisions as individual Dischargers with Level 2 status, as described in Section XII.D. A	Section I.B.2. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	Consolidated Level 2 ERA Technical Report is equivalent to a Level 2 ERA Technical Report. The CGL2 may prepare information to be included in a CG2 Participant's Level 2 ERA Demonstration Technical Report. All Level 2 ERA Demonstration Technical Reports must be facility-specific.	Consolidated Level 2 ERA Technical Report is equivalent to a Level 2 ERA Technical Report. The TGL2 may prepare information to be included in a TG2 Participant's Level 2 ERA Technical Report. All Level 2 ERA Technical Reports must be facility-specific.	
Order Section XIV.B.4.	CGL2 Responsibilities The CGL2 shall be responsible for providing assistance to CG2 Participants that is consistent with this General Permit's requirements. To establish a CG2, a CGL2 shall register as a CGL2 via SMARTS. The registration shall include documentation demonstrating compliance with the CG2 qualification requirements, above, and a list of the CG2 Participants. The CGL2 shall inspect all the facilities of the CG2 Participants prior to preparing the Consolidated Level 2 ERA Technical Report. A CGL2 shall prepare a Consolidated Level 2 ERA Technical Report that is consistent with the Level 2 ERA Requirements in Section XII.D and with current, best practices documented in protocols prescribed herein (see Section XIV.B.7 below). The CGL2 shall revise the Consolidated Level 2 ERA Technical Report in accordance with comments received by the State Water Board Executive Director.	TGL2 Responsibilities The TGL2 shall be responsible for providing assistance to TG2 Participants that is consistent with this General Permit's requirements. To establish a TG2, a TGL2 shall register as a TGL2 via SMARTS. The registration shall include documentation demonstrating compliance with the TG2 qualification requirements, above, and a list of the TG2 Participants. The TGL2 shall inspect all the facilities of the TG2 Participants prior to preparing the Consolidated Level 2 ERA Technical Report. A TGL2 shall prepare a Consolidated Level 2 ERA Technical Report that is consistent with the Level 2 ERA Requirements in Section XII.D and with current, best practices documented in protocols prescribed herein (see Section XIV.B.7 below). The TGL2 shall revise the Consolidated Level 2 ERA Technical Report in accordance with comments received by the State Water Board Executive Director.	Section I.B.2. & Section I.C.

Draft Permit Section*	Draft Permit Language	Proposed Language	CCKA Comment Letter Section
	The CGL2 shall update the Consolidated Level 2 ERA Technical Report to address additional CG2 Participants that trigger the ERA Level 2 reporting requirements.	The TGL2 shall update the Consolidated Level 2 ERA Technical Report to address additional TG2 Participants that trigger the ERA Level 2 reporting requirements.	
Order Section XIV.B.5.	CG2 Participant Responsibilities Each CG2 Participant is responsible for permit compliance for the CG2 Participant's facility and for ensuring that the CGL2's activities related to the CG2 Participant's facility comply with this General Permit. CG2 Participants shall certify and submit via SMARTS the Consolidated Level 2 ERA Technical Report prepared by their CGL2. The CG2 Participant shall certify that they have reviewed the Consolidated Level 2 ERA Technical Report and will implement the recommended additional BMPs that meet BAT/BCT and abide by any applicable alternate NALs associated with the BMPs. Alternatively, the CG2 Participant may submit their own individual Level 2 ERA Technical Report in accordance with the provisions in Section XII.D. If applicable, CG2 Participants shall certify and submit via SMARTS a site-specific Level 2 ERA Demonstration Technical Report. The CGL2 may assist in the preparation of the site-specific Level 2 ERA Demonstration Technical Report.	TG2 Participant Responsibilities Each TG2 Participant is responsible for permit compliance for the TG2 Participant's facility and for ensuring that the TGL2's activities related to the TG2 Participant's facility comply with this General Permit. TG2 Participants shall certify and submit via SMARTS the Consolidated Level 2 ERA Technical Report prepared by their TGL2. The TG2 Participant shall certify that they have reviewed the Consolidated Level 2 ERA Technical Report and will implement the recommended additional BMPs and abide by any suggested alternate NALs associated with the BMPs. Alternatively, the TG2 Participant may submit their own individual Level 2 ERA Technical Report in accordance with the provisions in Section XII.D. If applicable, TG2 Participants shall certify and submit via SMARTS a site-specific Level 2 ERA Technical Report. The TGL2 may assist in the preparation of the site-specific Level 2 ERA Technical Report.	Section I.B.2. & Section I.C.
Order Section	The Executive Director of the State Water Board may	The Executive Director of the State Water Board may	Section I.B.2. &

Draft Permit Section*	**Draft Permit Language**	**Proposed Language**	**CCKA Comment Letter Section**
XIV.B.6.	review CG2 membership for compliance with the requirements of this Section. The Executive Director may: Reject the CG2, CGL2, or individual CG2 Participants within the CG2; or Require the CGL2 to amend the submitted registration documents.	review TG2 membership for compliance with the requirements of this Section. The Executive Director may: Reject the TG2, TGL2, or individual TG2 Participants within the TG2; or Require the TGL2 to amend the submitted registration documents.	Section I.C.
Order Section XIV.B.7.	By September 1, 2014, the State Water Board's Executive Director shall approve protocols for how to prepare Consolidated Level 2 ERA Technical Reports in compliance with this General Permit.	By September 1, 2014, the State Water Board's Executive Director shall approve protocols for how to prepare Consolidated Level 2 ERA Reports in compliance with this General Permit.	Section I.B.2. & Section I.C.
	Standard Conditions		
Order Section XXI.K.1.	All Permit Registration Documents (PRDs) for NOI and NEC coverage, Notices of Termination (NOTs), Annual Monitoring Reports, Level 1 ERA Report, Level 2 ERA Technical Reports, Level 2 ERA Demonstration Technical Reports, or any other document required by this General Permit shall be certified and submitted via SMARTS by the Discharger's LRP.	All Permit Registration Documents (PRDs) for NOI and NEC coverage, Notices of Termination (NOTs), Annual Monitoring Reports, Level 1 ERA Report, Level 2 ERA Reports, Level 2 ERA Technical Reports, or any other document required by this General Permit shall be certified and submitted via SMARTS by the Discharger's LRP.	Section I.B.2. & Section I.C.

ATTACHMENT 3

STATISTICAL REVIEW OF CALIFORNIA-SPECIFIC INDUSTRIAL STORMWATER DATA MEASURED FROM 2005 TO 2012

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Prepared on behalf of:

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October 21, 2012

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1. Introduction

The purpose of this document is to analyze California-specific industrial stormwater data, available from the State Water Board's Storm Water Multiple Application and Report Tracking System (SMARTS) database, to document recent trends in stormwater quality from industrial facilities throughout the state, by sector. This data is also compared against benchmarks of stormwater quality to determine likely rates of compliance with California's NPDES General Permit for Stormwater Discharges Associated with Industrial Activities, NDPES No. CAS000001 (General Permit), as currently proposed. This information may be used to inform determinations of feasibility, regarding inclusion of numeric effluent limits in the General Permit, as well as evaluations of best available technology (BAT) or best conventional technology (BCT).

Analysis of around 187,000 unique data records, spanning from 2005 to 2012, from 6,300 California dischargers, indicates a significant proportion of facilities are currently meeting U.S. EPA benchmarks for common indicators of industrial stormwater quality, such as total suspended solids (TSS), heavy metals, and oil and grease. However, a large number of facilities are consistently exceeding benchmarks for these pollutants. Further analysis of this data would allow the State Board to identify high-performing facilities from a variety of industrial sectors, which could serve as a model for other facilities and help identify best management practices (BMPs) employed at these sites to establish BAT and BCT for a range of industrial sectors and sub-categories.

2. Background

Information contained in this report indicates much progress has been made since the State Board convened a panel of stormwater professionals in 2005 to provide advice regarding the feasibility of NELs. At that time, the State Board tasked the Panelists with addressing the following brief questions:

> *Is it technically feasible to establish numeric effluent limitations, or some other quantifiable limit, for inclusion in storm water permits? How would such limitations or criteria be established, and what information and data would be required?*

The Panel was asked to consider these questions for construction, municipal, and industrial stormwater discharges, though the first two areas are outside the scope of this report. With regards to feasibility of numeric effluent limits (NELs) applicable to industrial activities, the Panel believed NELs were feasible for some industrial categories. Further, the Panel suggested that establishment of NELs for industrial stormwater should follow a process analogous to that used in the NPDES wastewater process from the 1970s. At that time, NELs were based upon the use of best currently available technology (BAT), which varied from industry type or category, with the recognition that each industry has its own specific problems and financial viability.[1] To establish NELs for industrial sites, the Panel stated that a reliable

[1] Currier, B. et al. 2006. *Storm Water Panel Recommendations to the California State Water Resources Control Board: The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities*. Available at www.swrcb.ca.gov

database was required, 'describing the current emissions by industry types or categories, and performance of existing BMPs.'

In 2006, a database for collecting industrial stormwater emissions in California was unavailable and few manufacturers or researchers had tested the performance of available stormwater management controls. Since the Storm Water Panel on Numeric Limits was convened in 2006, California's SMARTS Database has matured significantly and a number of stormwater control manufacturers have released numeric performance data to the public. Also since 2006, several states, including New Jersey, Washington and Maryland, have put in place review processes for stormwater management controls, including the review of treatment performance tests. The state of Washington recently commissioned a *Literature Review of Existing Treatment Technologies for Industrial Stormwater*, which includes a database of available stormwater controls, along with treatment performance data and indicative costs, where available.[2] This literature review was used to support the inclusion of NELs into the State of Washington's 2012 Industrial Stormwater Permit and has been provided as an appendix to an accompanying report, submitted in support of the California Coastkeeper Alliance's comments to the Draft General Permit.

Based on the conditions established by the 2006 State Water Panel on Numeric Limits, were this Panel convened again today, it is likely they would find ample data to support the feasibility of NELs for industrial stormwater dischargers. This report presents some of the data contained in the SMARTS data, though additional analysis is possible, including statistical analysis of industrial sub-sectors, and consideration of additional parameters not analyzed here.

3. Industrial Stormwater Data from the SMARTS Database

Pursuant to the current Industrial General Permit, Permittees are required to submit annual reports, including analytical results of stormwater monitoring. Prior to 2010, dischargers were granted a financial incentive to electronically-submit this data to SMARTS. Since that time, the State Board no longer offers this incentive, out of consideration that the current Draft Industrial Stormwater Permit requires Permittees to submit stormwater sampling data directly to SMARTS. On-going delay of the permit has resulted in the majority of Permittees no longer submitting data to the electronic database. However, between 2005 and 2012 over 6,000 Permittees submitted more than 300,000 unique sampling records to SMARTS, resulting in a robust database with enough statistical power to describe concentrations of stormwater-borne pollutants released from industrial dischargers in California.

California's SMARTS database now contains several hundred thousand data points from all nine Water Board regions, which were self-reported from thousands of industrial dischargers. This data was requested from the State Water Board to facilitate preparation of this report, which is in part modeled

[2] Herrera Environmental Consultants. 2011. *Draft Report: Literature Review of Existing Treatment Technologies for Industrial Stormwater*. Prepared on behalf of the Washington Department of Ecology. Available at http://www.wastormwatercenter.org

from and compared against a report prepared on behalf of the Washington State Department of Ecology, in support of their National Pollutant Discharge Elimination System (NPDES) permit program.[3]

3.1. Data Quantity and Quality

On August 31, 2012, the State Water Board's Office of Information Management and Analysis provided all available industrial stormwater data contained in the SMARTS database, spanning from the 2005/2006 to the 2011/2012 reporting period. This included over 310,000 unique data points, representing an array of parameters, which were organized and marginally 'cleaned', to create consistency among units and search for clear outliers and erroneous information. It is apparent the SMARTS system contains few controls and is subject to user error, accounting for approximately 2% of all data. Trends in the errors include:

- Entering zeros in place of values falling below detection level
- Mistaking the less than (<) and equals (=) symbol, possibly due to poorly designed user interaction in the SMARTS forms
- Mistaking units, such as micrograms (µg**)** and milligrams (mg)
- Consistency in particular users making obvious entry errors

For values marked as zeros, these values were converted to the lowest recorded detection limit for that parameter. Negative values and those of which were orders of magnitude greater than a reasonable value were thrown out. All other values were retained and no formal outlier detection tests were conducted, since industrial stormwater data is commonly characterized by wild spikes in pollutant concentrations, which could be erroneously flagged as outliers in an automated query.

Regardless of the presence of user entry error, erroneous values comprise a small fraction of the database, which is robust enough to extract useful information regarding industrial stormwater pollutant trends, by industrial sector.

3.2. Data Classification

To facilitate analysis of stormwater quality by industrial sector, as well as comparison against data presented from the State of Washington, stormwater quality data from 6,097 facilities was filtered into 11 general industrial categories, as defined in 40 Code of Federal Regulations (CFR) §122.26(b)(14) and restated in California's current 1997 General Industrial Stormwater Permit. Categories are defined by Standard Industrial Classification (SIC) codes within the statute, though some discretion is granted to regulators in regards to how some SIC codes are classified. To avoid inconsistency, only those SIC codes expressly defined in 40 CFR §122.26(b)(14) were categorized into the 11 defined categories. To account for the 369 facilities that did not easily fall into one of the broadly defined industrial sectors a twelfth category was created, identified as "Other Facilities".

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[3] Herrera Environmental Consultants, Inc. 2006. *Data Analysis Report: Evaluation of Monitoring Data from General NPDES Permits for Industrial and Construction Stormwater*. Prepared for Washington State Department of Ecology.

Table 1 identifies the industrial categories used for purposes of this analysis and indicates the number of facilities placed within each. No facilities fell under category 1, which include facilities subject to storm water effluent limitation guidelines, new source performance standards, or toxic pollutant effluent standards. Presumably, all such facilities are subject to individual stormwater permits. In addition, data was not found from categories 4, 7, and 10, since such facilities are generally subject to alternative permit programs.

Table 1. Number of facilities by industrial sector

Category	Number of Facilities
1 - Facilities with effluent limitations	0
2 - Manufacturing	1,180
3 - Mineral, metal, oil and gas	191
4 - Hazardous waste treatment, or disposal facilities	0
5 - Landfills	206
6 - Recycling facilities	637
7 - Steam Electric plants	0
8 - Transportation facilities	1,359
9 - Treatment works	71
10 - Construction activity	0
11 - Light industrial activity	2,084
Other facilities	369
Total	6,097

As evident from Table 1, the majority of sites fall into one of three categories: Manufacturing (2), Transportation Facilities (8), and Light Industrial Activity (11). This is consistent with the analysis conducted in Washington, which included analysis of 21,486 data points from 808 facilities. To more clearly illustrate the types of facilities represented from this data, facilities were further subdivided into industrial sectors based on the first two digits of their SIC codes, and compared against the full list of codes, as defined by the US Department of Labor.[4] Table 2 lists the number of facilities falling into each of 61 industrial sub-sectors. Data analysis presented here is restricted to the 11 broad industrial sectors defined in Table 1. However, for several categories sufficient data exists to analyze data for particular sub-sectors.

[4] For reference, the US Department of Labor lists Standard Industrial Classification (SIC) codes at http://www.osha.gov/pls/imis/sic_manual.html

Table 2. Total Number of facilities by industrial sub-sector

SIC Code	Sector	# of Facilities
01--	Agricultural Production Crops	7
02--	Agriculture production livestock and animal specialties	9
07--	Agricultural Services	6
09--	Fishing, hunting and trapping	1
10--	Metal Mining	16
12--	Coal Mining	1
13--	Oil and Gas Extraction	39
14--	Mining and Quarrying of Nonmetallic Minerals, Except Fuels	135
15--	Building Construction General Contractors and Operative Builders	2
16--	Heavy Construction other than Building Construction Contractors	10
17--	Construction Special Trade Contractors	12
20--	Food and Kindred Products	437
21--	Tobacco Products	1
22--	Textile Mill Products	18
23--	Apparel and other Finished Products Made from Fabrics and Similar Materials	2
24--	Lumber and Wood Products, Except Furniture	148
25--	Furniture and Fixtures	37
26--	Paper and Allied Products	92
27--	Printing, Publishing and Allied Industries	40
28--	Chemicals and Allied Products	351
29--	Petroleum Refining and Related Industries	84
30--	Rubber and Miscellaneous Plastics Products	234
31--	Leather and Leather Products	3
32--	Stone, Clay, Glass and Concrete Products	379
33--	Primary Metal Industries	173
34--	Fabricated Metal Products, Except Machinery and Transportation Equipment	485
35--	Industrial and Commercial Machinery and Computer Equipment	139
36--	Electronic and Other Electrical Equipment and Components, Except Computer Equipment	261
37--	Transportation Equipment	217
38--	Measuring, Analyzing and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks	47
39--	Miscellaneous Manufacturing Industries	37
40--	Railroad Transportation	45
41--	Local and Suburban Transit and Interurban Highway Passenger Transportation	372
42--	Motor Freight Transportation and Warehousing	763
43--	United States Postal Service	12
44--	Water Transportation	59
45--	Transportation By Air	129

SIC Code	Sector	# of Facilities
47--	Transportation Services	9
48--	Communications	1
49--	Electric, Gas and Sanitary Services	368
50--	Wholesale Trade-durable Goods	671
51--	Wholesale Trade-non-durable Goods	101
52--	Building Materials, Hardware, Garden Supply and Mobile Home Dealers	4
53--	General Merchandise Stores	1
55--	Automotive Dealers and Gasoline Service Stations	13
59--	Miscellaneous Retail	1
63--	Insurance Carriers	1
72--	Personal Services	5
73--	Business Services	53
75--	Automotive Repair, Services and Parking	15
76--	Miscellaneous Repair Services	15
79--	Amusement and Recreation Services	6
82--	Educational Services	4
86--	Membership Organizations	1
87--	Engineering, Accounting, Research, Management and Related Services	9
91--	Executive, Legislative and General Government, Except Finance	1
95--	Administration Of Environmental Quality and Housing Programs	2
96--	Administration Of Economic Programs	1
97--	National Security and International Affairs	4
99--	Non-classifiable Establishments	3
NC	Not Classified	5
	Total	6,097

3.3. Data Distribution

Hundreds of parameters are represented in the SMARTS database, though a majority of the values are associated with a discrete group of commonly sampled parameters, which for the purposes of this report are referred to as ‘primary parameters’. These include the following, represented by 187,823 entries subject to analysis in this report:

- Zinc, Total
- pH
- Oil and Grease
- Copper, Total
- Lead, Total
- Biological Oxygen Demand (BOD)
- Total Suspended solids (TSS)
- Nickel, Total
- Iron, Total

Tables 3 and 4 characterize the data by sector and sub-sector, respectively, showing that oil and grease, pH, and TSS maintain the largest record, reflecting common requirements among an array of sectors

Table 3. Number of values per parameter, by industrial sector

Category	Zinc, Total	pH	Oil and Grease	Copper, Total	Lead, Total	BOD	TSS	Nickel, Total	Iron, Total
1 - Facilities with effluent limitations	--	--	--	--	--	--	--	--	--
2 - Manufacturing	3,081	9,880	7,427	1,356	821	98	9,916	339	3,673
3 - Mineral, metal, oil and gas	276	1,770	1,474	244	243	3	1,837	7	495
4 - Hazardous waste treatment, or disposal facilities	--	--	--	--	--	--	--	--	--
5 - Landfills	342	2,823	2,119	210	829	54	2,853	63	2,285
6 - Recycling facilities	1,786	2,555	1,893	1,232	2,206	46	2,603	158	1,917
7 - Steam Electric plants	--	--	--	--	--	--	--	--	--
8 - Transportation facilities	1,395	10,026	8,168	726	1,182	821	10,102	294	735
9 - Treatment works	9	808	618	18	32	26	826	17	14
10 - Small construction sites	--	--	--	--	--	--	--	--	--
11 - Light industrial activity	5,191	20,340	15,787	1,757	1,435	613	20,336	1,196	3,496
Other facilities	375	3,684	3,012	308	335	52	3,708	185	1,296
Total	12,455	51,886	40,498	5,851	7,083	1,713	52,167	2,259	13,911

Table 4. Number of values per parameter, by industrial sub-sector

SIC Code	Sector	Zinc, Total	pH	Oil and Grease	Copper, Total	Lead, Total	BOD	TSS	Nickel, Total	Iron, Total
01--	Agricultural Production Crops	4	35	17	0	4	0	35	0	4
02--	Agriculture production livestock & animal specialties	1	68	43	0	0	22	63	0	0
07--	Agricultural Services	0	44	43	0	0	0	44	0	0
09--	Fishing, hunting and trapping	0	5	5	0	0	0	5	0	0
10--	Metal Mining	21	224	162	10	11	0	210	7	15
12--	Coal Mining	0	2	0	0	0	0	2	0	0
13--	Oil and Gas Extraction	8	274	256	0	0	0	289	0	7
14--	Mining and Quarrying of Nonmetallic Minerals, Except Fuels	247	1,271	1,056	234	232	3	1,336	0	473
15--	Building Construction General Contractors and Operative Builders	0	12	5	0	0	0	12	0	0
16--	Heavy Construction other than Building Construction Contractors	12	34	15	3	3	0	34	0	5
17--	Construction Special Trade Contractors	35	86	81	33	32	0	84	19	19
20--	Food and Kindred Products	124	4,837	3,764	31	70	476	4,778	10	39
21--	Tobacco Products	0	33	12	0	0	0	33	0	0
22--	Textile Mill Products	5	325	261	0	5	2	329	0	0
23--	Apparel and other Finished Products Made from Fabrics and Similar Materials	0	7	7	0	0	0	7	0	0
24--	Lumber and Wood Products, Except Furniture	363	1,364	1,063	87	16	48	1,365	18	64
25--	Furniture and Fixtures	40	225	171	20	12	0	223	12	20
26--	Paper and Allied Products	70	766	537	16	23	46	786	9	44
27--	Printing, Publishing and Allied Industries	34	429	369	32	16	0	429	0	57
28--	Chemicals and Allied Products	1,053	3,271	2,499	73	273	27	3,235	67	650
29--	Petroleum Refining and Related Industries	101	766	597	87	83	5	772	53	168

SIC Code	Sector	Zinc, Total	pH	Oil and Grease	Copper, Total	Lead, Total	BOD	TSS	Nickel, Total	Iron, Total
30--	Rubber and Miscellaneous Plastics Products	454	2,124	1,614	33	70	19	2,101	4	51
31--	Leather and Leather Products	0	18	17	1	1	0	18	0	8
32--	Stone, Clay, Glass and Concrete Products	203	3,008	2,152	135	158	10	3,033	56	2,136
33--	Primary Metal Industries	996	1,291	1,065	868	143	2	1,283	51	402
34--	Fabricated Metal Products, Except Machinery and Transportation Equipment	3,296	4,122	3,232	419	350	4	4,095	390	2,848
35--	Industrial and Commercial Machinery and Computer Equipment	321	1,455	1,005	264	194	0	1,449	159	109
36--	Electronic and Other Electrical Equipment and Components, Except Computer Equipment	415	2,607	1,943	625	399	24	2,558	424	115
37--	Transportation Equipment	498	2,037	1,643	305	307	30	2,038	206	276
38--	Measuring, Analyzing and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks	171	580	449	86	69	11	591	55	110
39--	Miscellaneous Manufacturing Industries	21	331	274	10	7	1	330	6	21
40--	Railroad Transportation	55	476	411	55	55	0	474	44	0
41--	Local and Suburban Transit and Interurban Highway Passenger Transportation	165	2,970	2,386	107	199	29	2,988	106	71
42--	Motor Freight Transportation and Warehousing	633	5,371	4,234	271	341	156	5,345	57	325
43--	United States Postal Service	111	126	130	108	104	0	131	0	0
44--	Water Transportation	394	510	459	81	373	0	505	15	389
45--	Transportation By Air	127	1,019	772	120	156	633	1,026	76	9
47--	Transportation Services	8	82	41	0	0	0	82	0	0
48--	Communications	1	1	1	0	0	0	1	0	0
49--	Electric, Gas and Sanitary Services	409	4,845	3,781	299	919	84	4,877	119	3,301
50--	Wholesale Trade-durable Goods	1,814	2,925	2,192	1,245	2,221	46	2,948	158	1,960
51--	Wholesale Trade-non-durable Goods	34	736	574	15	14	13	735	11	13

SIC Code	Sector	Zinc, Total	pH	Oil and Grease	Copper, Total	Lead, Total	BOD	TSS	Nickel, Total	Iron, Total
52--	Building Materials, Hardware, Garden Supply and Mobile Home Dealers	0	32	31	0	0	0	32	0	2
53--	General Merchandise Stores	0	19	19	0	0	1	19	0	0
55--	Automotive Dealers and Gasoline Service Stations	6	111	108	2	6	0	111	0	6
59--	Miscellaneous Retail	0	24	8	0	0	0	24	0	0
63--	Insurance Carriers	0	11	1	0	6	0	11	0	6
72--	Personal Services	2	27	25	0	0	0	26	0	0
73--	Business Services	52	382	345	48	43	0	381	45	96
75--	Automotive Repair, Services and Parking	27	183	102	18	18	0	182	17	64
76--	Miscellaneous Repair Services	19	125	58	1	17	0	126	1	0
79--	Amusement and Recreation Services	0	106	74	0	15	15	110	0	0
82--	Educational Services	2	114	110	2	2	6	114	2	0
86--	Membership Organizations	0	6	6	0	0	0	6	0	0
87--	Engineering, Accounting, Research, Management and Related Services	45	121	76	49	47	0	118	6	36
91--	Executive, Legislative and General Government, Except Finance	0	17	17	0	0	0	17	0	0
95--	Administration Of Environmental Quality and Housing Programs	0	27	19	0	0	0	28	0	0
96--	Administration Of Economic Programs	0	8	8	0	0	0	8	0	0
97--	National Security and International Affairs	56	163	163	56	68	0	163	56	8
99--	Non-classifiable Establishments	2	28	26	2	1	0	28	0	2
NC	Not Classified	16	48	16	16	6	0	48	13	0

4. Data Analysis Methods

Rather than averaging the values for individual facilities or industrial categories, statistical analyses were carried out directly from the raw data, subsequent to categorization, as discussed above. This was to remain consistent with the State of Washington report, which conducted a similar review of industrial data in 2006, but also serves to preserve variation within the entire data set, instead of smoothing out extreme values from particular facilities. Tabular and graphical summaries were generated to illustrate the distribution of industrial stormwater data for particular sectors and parameters. Tabular summaries specifically present the following summary statistics for each monitoring parameter:

- Sample size
- Percent detected
- Mean
- Minimum
- Maximum
- 10th percentile
- 90th percentile
- Lower Quartile (25th percentile)
- Median (50th percentile)
- Upper Quartile (75th percentile)
- Standard Deviation
- Coefficient of variance (CV)
- Lower 95% Confidence Limit about Mean
- Upper 95% Confidence Limit about Mean
- Inter Quartile Range
- Minimum Detected Value
- Maximum Detected Value
- Minimum Reporting Limit
- Maximum Reporting Limit

To account for the large presence of non-detects, Caltrans' Data Analysis Tool (DAT) was used to conduct most of this analysis - an Excel Add-In developed in the early 2000s to specifically address the presence of non-detects in stormwater data. The DAT uses regression on ordered statistics (ROS) to incorporate non-detectable results into standard statistical calculations, rather than reduce them to zeros, half the detection limit, or other methods with less scientific defensibility.[5] Output of the DAT analysis for each primary pollutant considered is included in Appendix 1, which includes additional statistics not contained in the tables in Section 5. Analysis of pH values with the DAT was not necessary, given the inherent lack of non-detects associated with this parameter.

Unsupported by the DAT Add-In is calculation of the 10th and 90th percentile distribution, which was used for preparing the box and whisker plots. For these statistics, the ROS method was not used and instead, non-detects were set equal to ½ the minimum detection for the parameter of interest and the 10th and 90th percentile of the samples were calculated in Excel.

Although useful for some stormwater applications, particularly with smaller data sets, the DAT is poorly suited for applications involving moderately sized data sets (>7,000 values). The DAT was used given its use by Caltrans and other stormwater researchers in California, though alternatives, such as more recently developed modules for the R statistical package, are better suited for this purpose.

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[5] Helsel, D. 2012. *Statistics for Censored Environmental Data Using Minitab and R*. Hoboken, NJ: John Wiley and Sons, Inc.

Due to the large number of values for TSS and oil and grease, Caltrans' DAT was unable to process the volume of data available, when the data was compiled for all facilities, regardless of industrial sector. However, sector-specific analysis was conducted with the DAT for these two parameters. To generate statistics for the compiled data sets of TSS and oil and grease, values below detection level were set equal to 0.0025 and 0.25 mg/L, respectively, which is ½ the minimum recorded detection level for the parameter of interest.

4.1. Presentation of results

Section 5 of this report includes graphical data summaries consisting of box and whisker plots and tables of summary statistics for the nine (9) primary parameters identified previously. These summaries were organized to facilitate comparisons of the data across the 12 industrial categories listed in Table1. Summary statistics are accompanied by a brief summary of the data distribution, comparison among industrial sectors, and relative performance against current U.S. EPA benchmark levels and NALs in the Draft General Permit. Appendix 1 contains data not presented in Section 5, including several of the summary statistics listed above, percentage of non-detect values and indication of what values were derived through ROS statistical methods.

4.2. Comparison to U.S. EPA benchmark levels

In addition to presenting summary statistics, concentration data was compared against benchmark values developed by the U.S. Environmental Protection Agency (U.S. EPA) and published in the 2000 and/or 2008 Multi-Sector General Permit (MSGP).[6,7] This is to estimate likely rates of compliance with the General Permit among industrial sectors for the primary parameters considered here.

In the 2000 version of the MSGP a single set of benchmark values were developed, though the 2008 MSGP features sector-specific benchmarks. For the sake of consistency, all sectors were compared against a single set of benchmarks. These benchmarks are listed in Table 5 and are consistent with the annual Numeric Action Levels (NAL) listed in Table 5 of the 2012 Draft General Permit. Some of the primary parameters considered here are referred to as hardness-dependent metals, given the fact that toxicity in freshwater receiving waters is in part dependent on hardness of that water. Consistent with the 2012 Draft General Permit, benchmarks used here assume receiving water hardness greater than 250 mg/L.

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[6] United States Environmental Protection Agency. 2000. Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (MSGP). Federal Register Vol. 65, No. 210. Available at: http://www.epa.gov/npdes/pubs/msgp2000-final.pdf

[7] United States Environmental Protection Agency. 2008. Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (MSGP). Available at: epa.gov/npdes/pubs/msgp2008_finalpermit.pdf

Table 5. Benchmark values from US EPA's Multi-Sector General Permit used for this analysis

Parameter	Benchmark[a]
Total suspended solids	100
Nickel, Total [b]	1.02
Zinc, Total [b]	0.26
Iron, Total	1.00
pH	6.0 - 9.0 SU
Oil and Grease	15
Copper, Total [b]	0.0332
Lead, Total [b]	0.262
Biological oxygen demand [c]	30

a) all units, with the exception of pH, in milligrams per liter (mg/L)

b) based on the 2008 MSGP, assuming receiving water hardness >250 mg/L

c) based on the 2000 MSGP, since the 2008 MSGP has several benchmarks for various sectors

5. Data Analysis Results

5.1. pH

Data distribution

Graphical and tabular data summaries of pH measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 1 and Table 6.

A small proportion of the pH data in the database were erroneous or associated with user entry error, indicated by values below 1 and greater than 12, which, while possible, were probably misread or entered into SMARTS incorrectly. Such reported results accounted for 370 of 52,256 total data points (0.7%), which were removed, resulting in 51,886 values remaining for analysis. Minimum values from nearly all sectors were highly acidic and should be viewed as suspect. High pH values in the 11-12 range were reported as the maximum, although such values are more likely, given factors such as freshly poured concrete or other basic contaminants that could contribute to high pH results.

A majority of the samples, however, fell in the neutral range, with the average mean and median of all samples being 7.11 and 7.10, respectively. Box plots presented in Figure 1 illustrate little variation about the median.

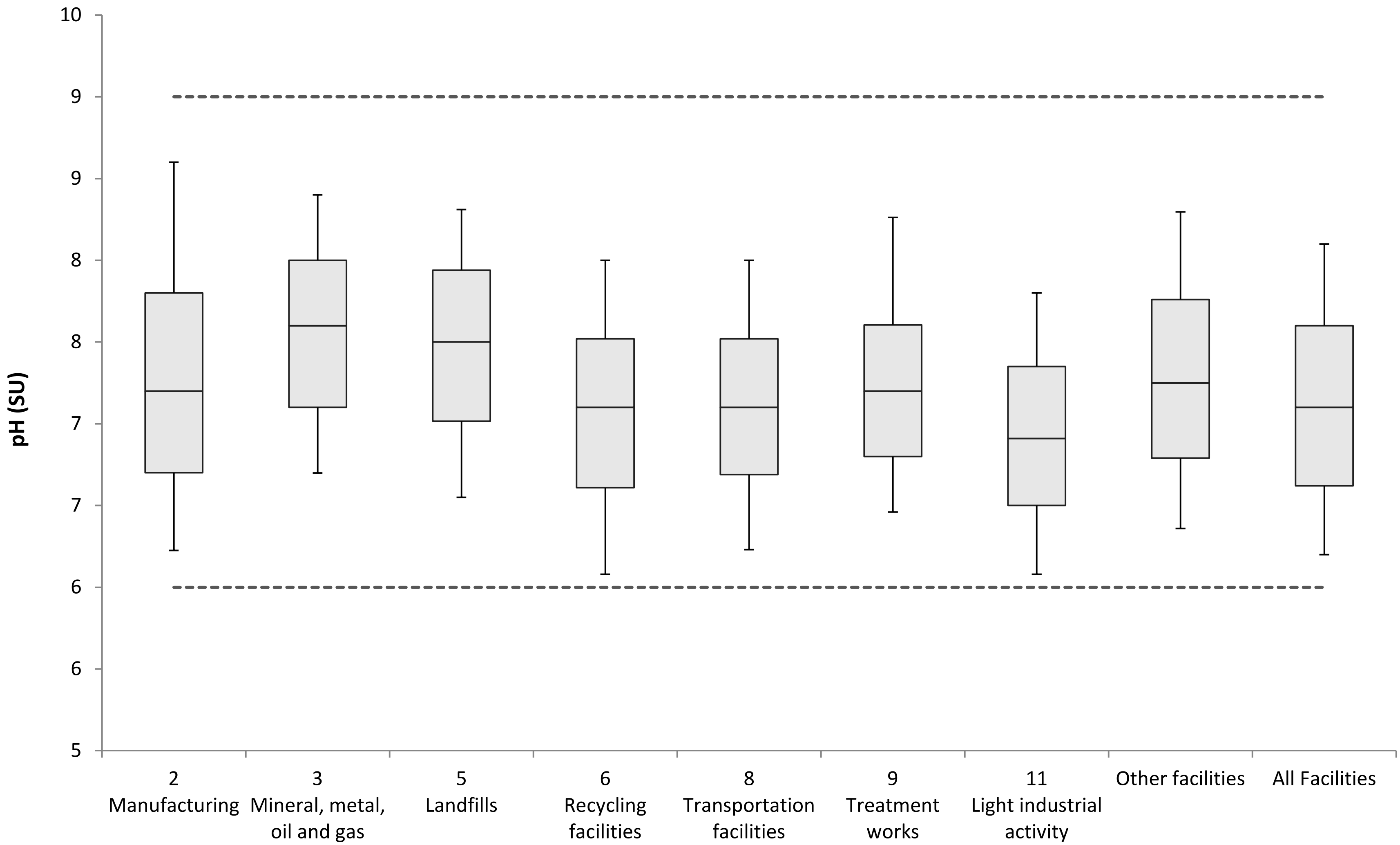
Comparison among industrial sectors

Nearly all Permittees are required to sample for pH, resulting in a significant amount of data from each industrial sector (Table 6). Median values for all sectors were just slightly higher than a neutral value of pH 7. Sectors 3 (Mineral, metal, oil and gas) and 5 (Landfills) were slightly higher, at 7.6 and 7.5, respectively, though not high enough to warrant concern.

Comparison to permit benchmarks and proposed action levels

Benchmark values for pH found in the 2000 and 2008 Multi-Sector General Permit are 6 and 9, meaning that values below and above that range are indicative of poor site management and the presence of contaminants at potentially harmful levels. As shown in Figure 1, all sectors show consistently high attainment of benchmark values. For none of the sectors do the 10^{th} or 90^{th} percentile 'whiskers' fall outside the benchmark values.

The last column of Table 5 shows the percentage of sample failing to comply with benchmark levels. Manufacturing and recycling facilities display the poorest performance, with 12% and 10% of the samples from these respective sectors lying above or below the acceptable range. When compiled together, 9% of samples across all sectors exceeded benchmarks. This is lower than the compiled statistic from the Washington report, which indicated a pH exceedance rate of 14%.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 1. Distribution of pH levels, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 6. Summary statistics for pH, measured in industrial stormwater from 2005 to 2012, by industry sector

Category	n	Mean (SU)	Median (SU)	Minimum (SU)	Maximum (SU)	Lower Quartile - 25% (SU)	Upper Quartile - 75% (SU)	Std. Dev. (SU)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	9,880	7.31	7.20	1.40	12.00	6.70	7.80	1.06	0.15	12%
3 - Mineral, metal, oil and gas	1,770	7.56	7.60	1.80	11.80	7.10	8.00	0.83	0.11	6%
5 – Landfills	2,823	7.46	7.50	1.70	11.00	7.02	7.94	0.79	0.11	5%
6 - Recycling facilities	2,555	7.01	7.10	1.30	12.00	6.61	7.52	1.03	0.15	10%
8 - Transportation facilities	10,026	7.09	7.10	1.30	11.20	6.69	7.52	0.85	0.12	7%
9 - Treatment works	808	7.26	7.20	4.70	11.00	6.80	7.61	0.72	0.10	3%
11 - Light industrial activity	20,340	6.91	6.91	1.20	12.00	6.50	7.35	0.82	0.12	9%
Other facilities	3,684	7.26	7.25	1.28	11.00	6.79	7.76	0.91	0.12	7%
All Facilities	51,886	7.11	7.10	1.20	12.00	6.62	7.60	0.91	0.13	9%

1 Benchmark for pH is less than and greater than 6 and 9 standard units, respectively.

5.2. Oil and Grease

Data distribution

Graphical and tabular data summaries of oil and grease measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 2 and Table 7. Full output of the DAT statistical analysis is presented in Appendix 1.

Due to the large number of oil and grease values of the database (52,167) Caltrans' DAT was unable to process the volume of data available for all facilities, although sector-specific analysis was conducted with the DAT. To generate statistics for all oil and grease values, as found in the final row of Table 8, values below detection level were set equal to 0.25 mg/L, which is equal to ½ the minimum recorded detection level for the parameter of interest, following removal of a few outliers, which were abnormally low detection levels. However, given the large number of non-detects (44%), the median was skewed heavily to the left, in comparison to the sector-specific analysis that relied on ROS methods. Based on this analysis, mean and median oil and grease concentrations were 9.23 and 0.25 mg/L, respectively. In comparison, values from the State of Washington (Appendix 2) were 7.6 and 5.0 mg/L. The significantly higher median value likely reflects a higher reporting limit, which in many instances is equal to 5 mg/L, and the fact that authors of that study did not rely on ROS methods for their analysis.

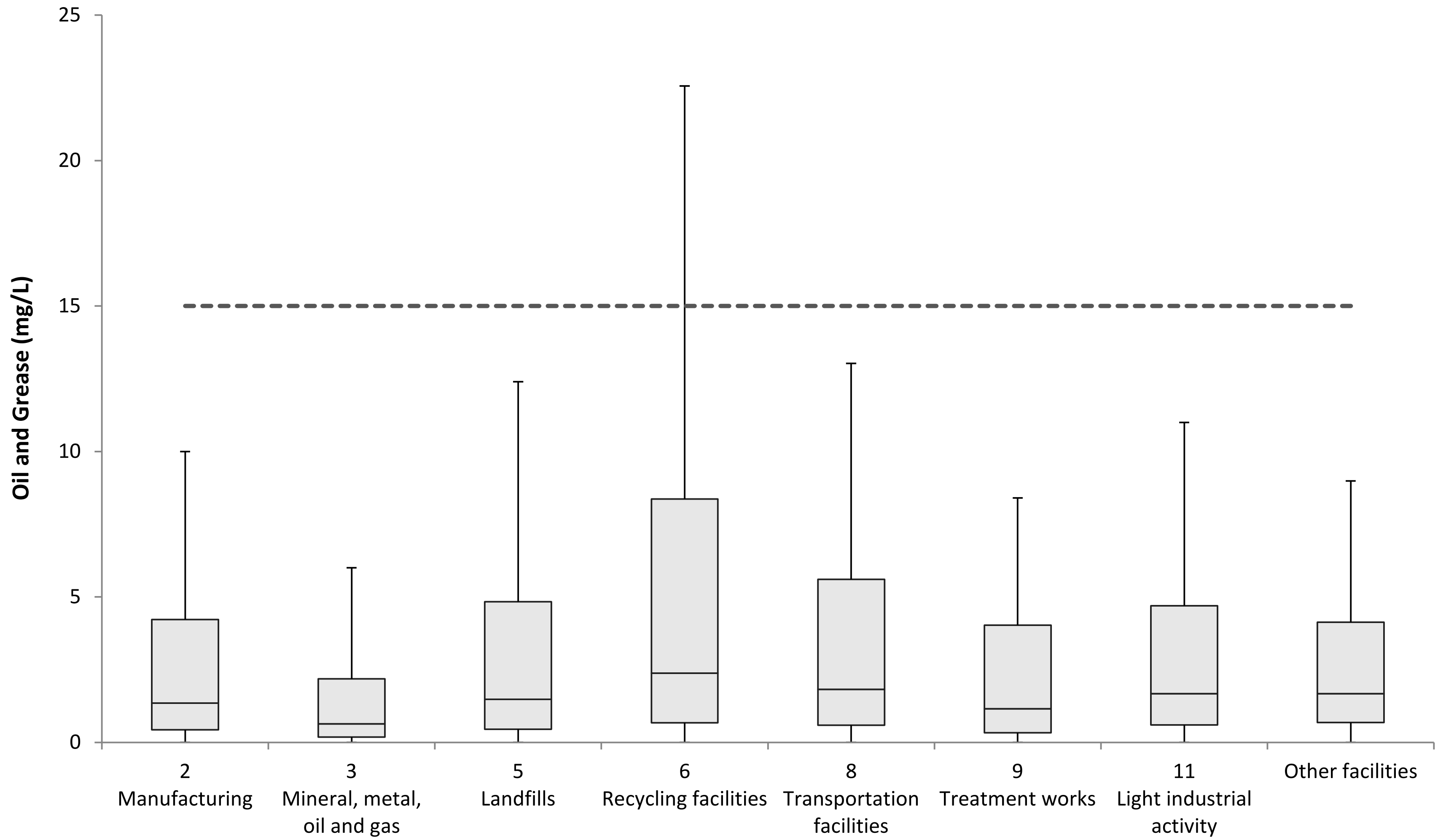
Extremely high values from a small proportion of facilities contributed to the right-skewed distribution. Forty-three (43) samples from 23 facilities resulted in oil and grease concentrations greater than 1,000 mg/L and 302 values from 184 facilities were greater than 100 mg/L. However, the vast majority of oil and grease measurements taken from facilities around California were well below such levels, indicated by the high proportion of non-detects (see Appendix 1) and low median values from the sector-specific analysis, as discussed below.

Comparison among industrial sectors

As with pH and TSS, a high proportion of Permittees are required to sample for oil and grease, resulting in large sample sizes for each industrial sector (Table 7). Highest median values are associated with sector 6 (Recycling Facilities), at 2.38 mg/L, whereas the lowest median was found from sector 3 (Mineral, metal, oil and gas). This compares with results from the State of Washington, where the highest values were reported from sector 6 and 8 (Transportation Facilities). As indicated in Figure 1, 10% of all samples from sector 6 were greater than 22.56 mg/L, while the same proportion of samples from Landfills (5) are greater than 12.40 mg/L.

Comparison to permit benchmarks and proposed action levels

For those sectors subject to mandatory total oil and grease monitoring in the 2008 Multi-Sector General Permit, the benchmark level is 15 mg/L, which is equal to the annual NAL in the Draft General Permit. Median values for all sectors are well below this standard, though 7% of all samples in the database exceed this benchmark. Approximately 3% of samples exceeded this same benchmark in the State of Washington (Appendix 2). In California, 15% of samples from Recycling Facilities exceeded the benchmark, whereas Washington's recyclers reported a 7% exceedance rate.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 2. Distribution of oil and grease concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 7. Summary statistics for oil and grease, measured in industrial stormwater from 2005 to 2012, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	7,427	13.67	1.35	0.0001	10,500	0.43	4.22	236.34	17.29	6%
3 - Mineral, metal, oil and gas	1,474	3.35	0.63	0.2100	393	0.18	2.18	15.88	4.74	3%
5 - Landfills	2,119	8.85	1.48	0.4000	1,640	0.45	4.84	61.96	7.00	8%
6 - Recycling facilities	1,893	20.95	2.38	0.5000	5,390	0.68	8.37	196.02	9.36	15%
8 - Transportation facilities	8,168	9.92	1.83	0.2270	3,400	0.59	5.61	74.45	7.51	8%
9 - Treatment works	618	47.86	1.15	1.0000	21,000	0.33	4.03	1,164.62	24.33	5%
11 - Light industrial activity	15,787	6.63	1.67	0.0200	5,200	0.60	4.69	67.05	10.11	6%
Other facilities	3,012	4.09	1.68	0.1400	210	0.68	4.13	9.42	2.30	4%
All Facilities	40,498	9.23	0.25	0.0001	21,000	0.25	5.00	158.79	17.21	7%

1) Benchmark for oil and grease placed at 15 mg/L, based on the 2000 and 2008 MSGP

Caltrans' Data Analysis Tool (DAT) was unable to process the volume of data available for all facilities

5.3. Total Suspended solids (TSS)

Data distribution

Graphical and tabular data summaries of TSS measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 3 and Table 8. Full output of the DAT statistical analysis is presented in Appendix 1.

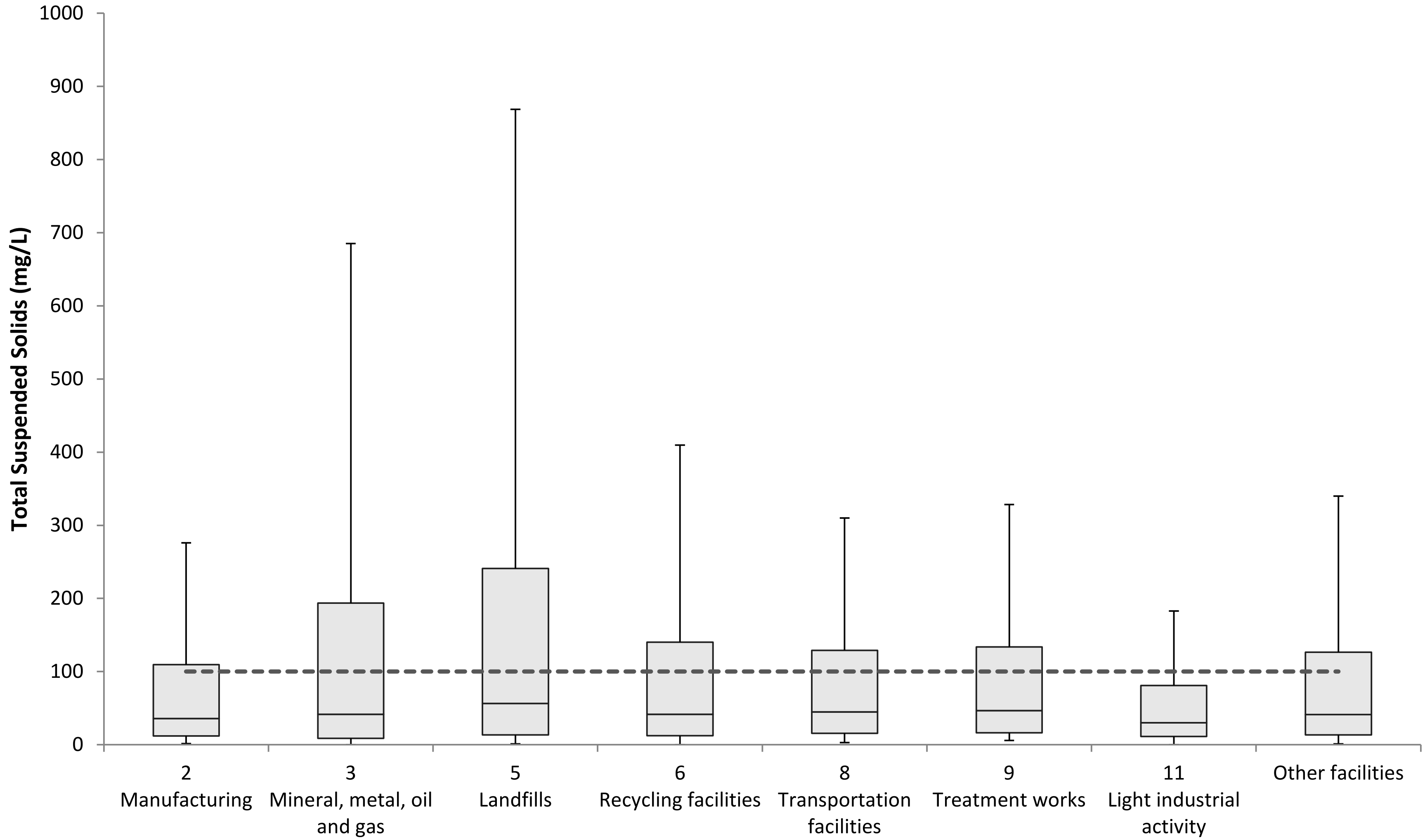
Due to the large number of TSS values of the database (52,167) Caltrans' DAT was unable to process the volume of data available for all facilities, although sector-specific analysis was conducted with the DAT. To generate statistics for all TSS values, as found in the final row of Table 8, values below detection level were set equal to ½ the minimum recorded detection level for the parameter of interest. Based on this analysis, mean and median TSS concentrations were 187.3 and 38.0 mg/L, respectively. Extremely high values from a small proportion of facilities contributed to the right-skewed distribution, meaning that extremely positive values affect the statistics. Sixty-five (65) samples from 37 facilities resulted in TSS concentrations greater than 10,000 mg/L. However, the vast majority of measurements taken from facilities around California were well below such levels, indicated by the median of 38 mg/L. The upper quartile value for all samples is 105 mg/L, indicating that approximately 13,000 samples were greater than this value, while 10% of all samples are greater than 280 mg/L.

Comparison among industrial sectors

Similar to pH, nearly all Permittees are required to sample for TSS, resulting in large sample sizes for each industrial sector (Table 6). Median values for all sectors were roughly similar, though sector 5 (Landfills) and 3 (Mineral, metal, oil and gas) had positively skewed values. Upper quartile (75^{th} percentile) values for sectors 5 and 3 were 194 and 241 mg/L, respectively, while 10% of all samples from these sectors resulted in TSS values greater than 869 and 685 mg/L. The best performing sector was Manufacturing (2), with median value of 36 mg/L, yet 25% of samples exceeded 109.4 mg/L. As expected, poorly performing facilities, with regard to TSS discharges, are typically those located outdoors and involved in earth moving activities, such as landfills.

Comparison to permit benchmarks and proposed action levels

For the purposes of this analysis, benchmark values for TSS were placed at 100 mg/L, based on the 2000 and 2008 MSGP, which is equal to the annual NAL in the Draft General Permit. As shown in Figure 1, median values across all sectors are below this standard, although sectors 3 and 5 recorded a significant proportion of samples above the median. In total, 25% of all values exceed benchmark, while sectors 3, 5, 6, and 9 measure exceedances over 30% of the time. Based on closer inspection of the data, exceedances are distributed among a number of facilities, indicating inconsistent performance among facilities and a general need for better source control and housekeeping throughout all sectors.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 3. Distribution of TSS concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 8. Summary statistics for total suspended solids (TSS), measured in industrial stormwater from 2005 to 2012, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	9,916	174.1	36.0	0.10	52,200	11.9	109.4	1,207.1	6.93	25%
3 - Mineral, metal, oil and gas	1,837	838.0	41.5	0.59	691,000	8.9	193.5	22,027.3	26.28	36%
5 - Landfills	2,853	578.9	56.6	1.00	73,000	13.3	240.9	3,063.2	5.29	38%
6 - Recycling facilities	2,603	180.9	41.7	0.02	28,000	12.4	140.4	747.0	4.13	32%
8 - Transportation facilities	10,102	169.4	45.0	0.50	134,000	15.7	128.9	1,722.7	10.17	29%
9 - Treatment works	826	163.0	46.8	1.00	14,770	16.4	133.6	714.7	4.39	31%
11 - Light industrial activity	20,322	94.9	30.2	0.12	52,200	11.2	80.9	631.8	6.66	19%
Other facilities	3,708	172.6	41.2	0.12	24,000	13.4	126.7	756.2	4.38	29%
All Facilities[2]	52,167	187.3	38.0	0.02	691,000	12.0	105.0	3,284.0	17.53	25%

1 Benchmark for TSS placed at 100 mg/L, based on the 2000 and 2008 MSGP, though the 2008 MSGP has some variation across sectors.

2 Caltrans' Data Analysis Tool (DAT) was unable to process the volume of data available for all facilities. To generate the statistics found in the final row, values below detection level were set equal to ½ the minimum recorded detection level for the parameter of interest.

5.4. Zinc, Total

Data distribution

Graphical and tabular data summaries of total zinc measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 4 and Table 9. Full output of the DAT statistical analysis is presented in Appendix 1.

Based on analysis of 12,471 total zinc values, mean and median concentrations were 27.80 and 0.16 mg/L, respectively. The extreme disparity between these values is due to extreme maximum values, reaching as high as 146,000 mg/L, which was reported from a galvanizing facility in Oakland, CA. Given the type of activity taking place there, and the presence of additional exceptionally high self-reported values, this value is likely accurate. However, the vast majority of measurements taken from facilities around California were well below such levels, indicated by the overall median of 0.157 mg/L.

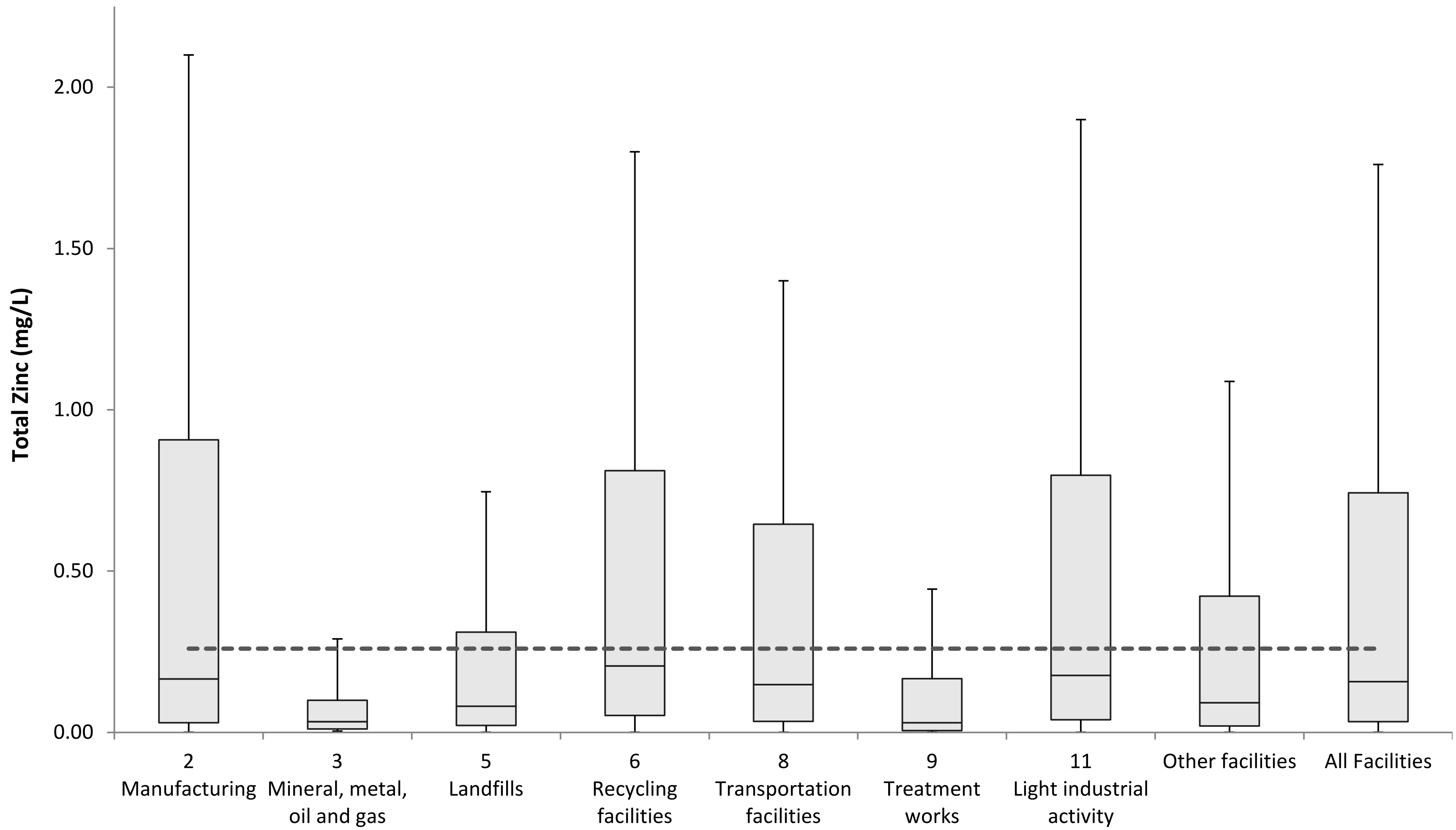
Consistent with results from the State of Washington, total zinc data is highly right-skewed, as indicated by the large boxes and whiskers in Figure 2 towards the positive direction. However, the mean reported by Herrera Environmental Consultants (Appendix 2) was much lower, at 0.469, while the median was generally consistent with California data, at 0.139 mg/L. Across all data, the 90^{th} percentile value was 1.760 mg/L in California, while in Washington this result was 0.692 mg/L. This indicates a higher percentage of facilities in California are associated with discharges posing a significant risk to receiving water quality, compared to Washington.

Comparison among industrial sectors

Sectors 2 (Manufacturing), 6 (Recycling Facilities), and 11 (Light Industry) reported values skewing much higher than sectors 3 (Mineral, metal, oil and gas), 5 (Landfills), 9 (Treatment works), and just slightly higher than sector 8 (Transportation Facilities). Sectors 2, 6, 8, and 11, however, constitute the majority of Permittees that submitted 92% of all reported total zinc values. This indicates significant exceedances across most sectors and a need to conduct more refined analysis at the sub-sector level.

Comparison to permit benchmarks and proposed action levels

For those sectors subject to mandatory total zinc monitoring in the 2008 Multi-Sector General Permit, the benchmark level is 0.26 mg/L, assuming a freshwater receiving water hardness >250 mg/L. This is equal to the annual NAL in the Draft General Permit. Compared against this benchmark, the median value for all sectors lies below this standard (Figure 2). However, as shown in Table 9, 44% of all total zinc values exceed this benchmark, with the rate of exceedance reaching 49% for Recycling Facilities, which is not surprising given the nature of operations at such facilities. The highest performing sector, in terms of benchmark attainment, is sector 3, though this sector represents only 2% of the total zinc data present in the database. Sectors 2, 6, 8, and 11 all have exceedance rates greater than 40%.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 4. Distribution of total zinc concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 9. Summary statistics for total zinc, measured in industrial stormwater from 2005 to 2012, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	3,081	15.46	0.166	0.166	4,800	0.030	0.907	135.86	8.79	44%
3 - Mineral, metal, oil and gas	276	0.13	0.033	0.033	4.79	0.011	0.100	0.426	3.19	11%
5 - Landfills	342	0.62	0.081	0.081	71.0	0.021	0.311	4.956	7.98	30%
6 - Recycling facilities	1,786	9.11	0.206	0.206	3,000	0.052	0.812	113.86	12.50	49%
8 - Transportation facilities	1,395	10.72	0.148	0.148	1,800	0.034	0.645	102.53	9.57	42%
9 - Treatment works	9	0.18	0.030	0.030	1.10	0.005	0.167	0.45	2.46	22%
11 - Light industrial activity	5,191	51.42	0.177	0.177	146,000	0.039	0.797	2,668.54	51.89	45%
Other facilities	375	1.89	0.092	0.092	385	0.020	0.422	26.38	13.98	37%
All Facilities	12,471	27.80	0.157	0.157	146,000	0.033	0.743	1,718.51	61.81	44%

1 Benchmark for total zinc placed at 0.26 mg/L, based on the 2008 MSGP, assuming receiving water hardness >250 mg/L

5.5. Copper, Total

Data distribution

Graphical and tabular data summaries of total copper measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 5 and Table 10. Full output of the DAT statistical analysis is presented in Appendix 1.

Based on analysis of 5,867 total copper values, mean and median concentrations are 2.423 and 0.013 mg/L, respectively. The significant variance between these values is due to extreme maximum values, reaching as high as 1,500 mg/L, which was reported from a ship maintenance facility in San Francisco, CA. Due to first hand involvement in enforcement actions against this facility, this range of values can be confirmed as actual conditions at the site, where copper-coated hulls are routinely resurfaced and maintained. However, the vast majority of measurements taken from facilities around California were well below such levels, indicated by the median of 0.013 mg/L.

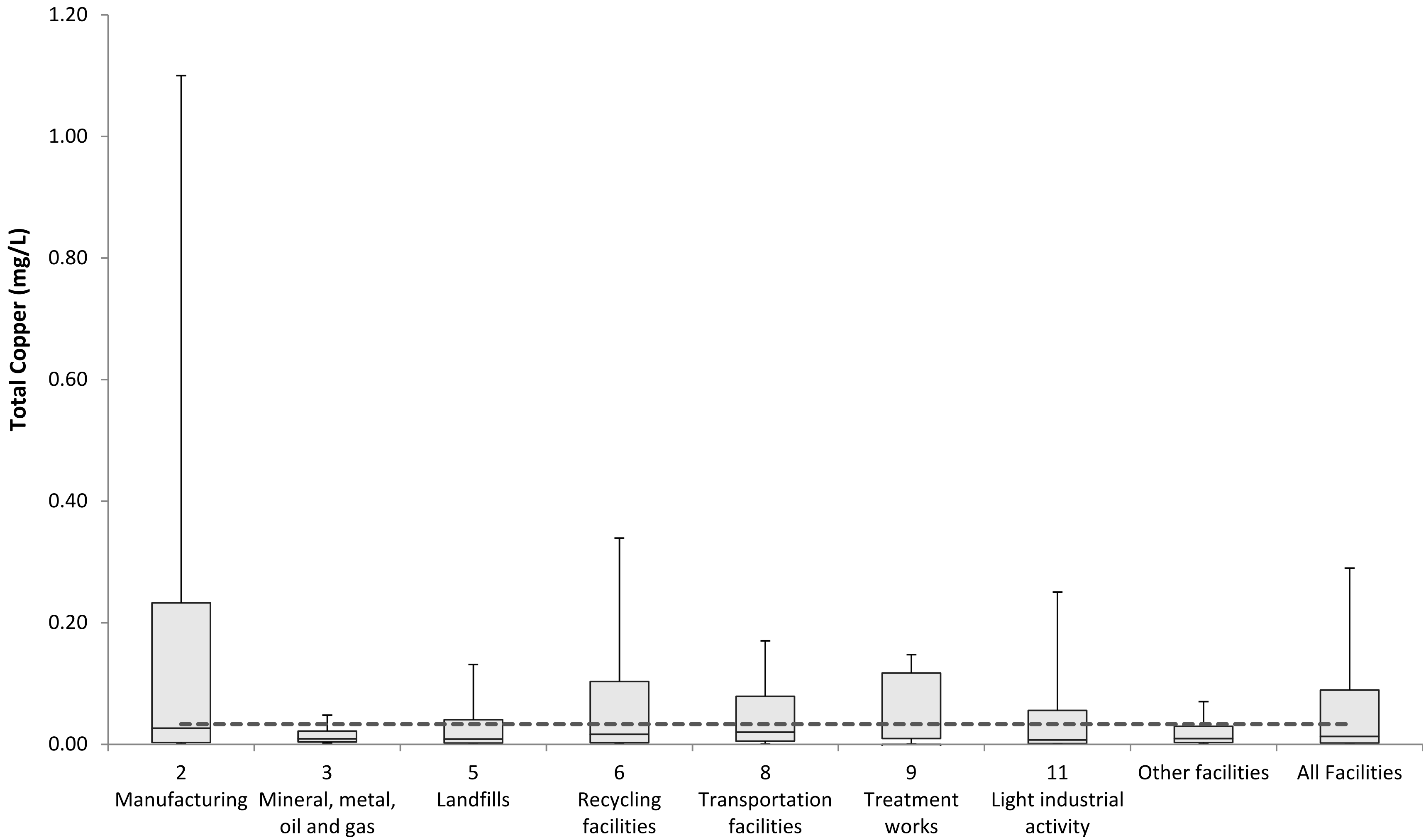
Compared with results from the State of Washington, as documented by Herrera Consultants (Appendix 2), both the central tendency and 90th percentile value for total copper concentrations in California are skewed to the right, indicating generally higher concentrations of copper from industrial facilities, as well as more extreme positive values. The median concentration of total copper in Washington was 0.022, slightly higher than in California, while the 90th percentile was 0.104 mg/l, compared to 0.209 mg/L in California.

Comparison among industrial sectors

Sector 2 (Manufacturing) recorded the highest total copper values, with 25% of all samples greater than 0.233 mg/L. In second place are Recycling Facilities, with 25% of samples greater than 0.103 mg/L. The remaining facilities displayed higher performance, though a significant number of samples from all sectors exceeded benchmarks, as discussed below, indicating the need to conduct more refined analysis at the sub-sector level.

Comparison to permit benchmarks and proposed action levels

For those sectors subject to mandatory total copper monitoring in the 2008 Multi-Sector General Permit, the benchmark level is 0.0332 mg/L, assuming a freshwater receiving water hardness >250 mg/L. This is equal to the annual NAL in the Draft General Permit. Compared against this benchmark, the median value for all sectors lies below this standard (Figure 5). However, as shown in Table 10, 43% of all total copper values exceed this benchmark, with the rate of exceedance reaching 50% for Recycling Facilities, which is consistent with the results of total zinc analysis. Treatment Works reported 56% of samples exceeding benchmarks, though with only 18 samples, statistical power is weaker compared to other sectors. Sectors 2, 6, 8, 9, and 11 all have exceedance rates greater than 40%, which are closely comparable to the results for total zinc.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 5. Distribution of total copper concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 10. Summary statistics for total copper, measured in industrial stormwater, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 – Manufacturing	1,356	9.104	0.026	0.00011	1,500	0.0030	0.233	77.224	8.48	47%
3 - Mineral, metal, oil and gas	244	0.025	0.009	0.00011	1.00	0.0036	0.022	0.082	3.36	15%
5 - Landfills	210	0.063	0.009	0.00010	1.80	0.0019	0.040	0.187	2.99	33%
6 - Recycling facilities	1,232	0.384	0.016	0.00010	150	0.0025	0.103	5.600	14.59	50%
8 - Transportation facilities	726	0.202	0.020	0.00010	32	0.0051	0.079	1.547	7.65	46%
9 - Treatment works	18	0.041	0.000	0.00014	0.10	0.0095	0.058	0.033	0.80	56%
11 - Light industrial activity	1,757	0.697	0.007	0.00010	520	0.0009	0.056	16.071	23.06	40%
Other facilities	308	0.031	0.009	0.00010	0.66	0.0029	0.030	0.062	2.03	28%
All Facilities	5,867	2.423	0.013	0.00010	1,500	0.0018	0.089	38.116	15.73	43%

1 Benchmark for total copper placed at 0.0332 mg/L, based on the 2008 MSGP, assuming receiving water hardness >250 m

5.6. Lead, Total

Data distribution

Graphical and tabular data summaries of total lead measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 6 and Table 11. Full output of the DAT statistical analysis is presented in Appendix 1.

Based on analysis of 7,088 total copper values, mean and median concentrations were 2.028 and 0.004 mg/L, respectively. The significant variance between these values is due to extreme maximum values, reaching as high as 3,600 mg/L, which was reported from a metal manufacturing facility in Livermore, CA. Given the type of activity taking place there, this value is likely accurate and 28 other samples greater than 100 mg/L were recorded from 17 separate facilities. However, the vast majority of total lead measurements taken from facilities around California were well below such levels, indicated by the median of 0.004 mg/L.

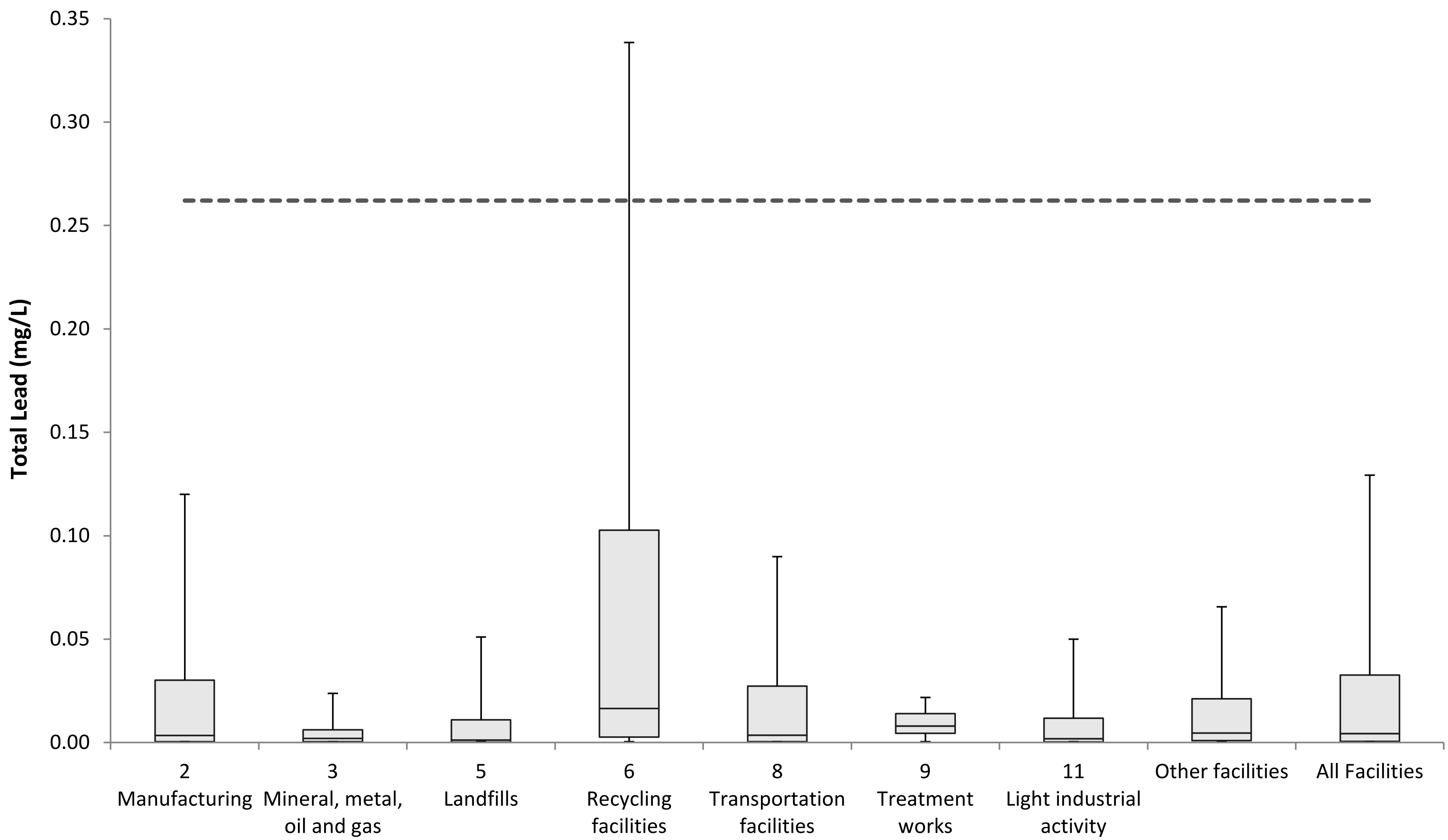
Compared with results from the State of Washington, as documented by Herrera Consultants (Appendix 2), mean total lead concentrations are significantly higher in California, with a value of 2.028 mg/L in CA, compared with 0.048 mg/L in WA. However, median concentrations are generally similar in CA and WA, at 0.004 mg/L and 0.012 mg/L, respectively. This suggests a small proportion of CA facilities are responsible for skewing the means by discharging lead at significant concentrations.

Comparison among industrial sectors

Similar to results found in WA, sector 6 (Recycling Facilities) recorded the highest total lead values, with 25% of all samples greater than 0.103 mg/L. In second place are Recycling Facilities, with 25% of samples greater than 0.030 mg/L. The remaining facilities displayed consistently higher performance, generally within EPA benchmarks, as discussed below.

Comparison to permit benchmarks and proposed action levels

For those sectors subject to mandatory total lead monitoring in the 2008 Multi-Sector General Permit, the benchmark level is 0.262 mg/L, assuming a freshwater receiving water hardness >250 mg/L. This is equal to the annual NAL in the Draft General Permit. Compared against this benchmark, the median value for all sectors lies well below this standard (Figure 6). As shown in Table 11, only 6% of all total lead values exceed this benchmark, though the rate of exceedance reaches 12% for Recycling Facilities, which is also the sector with consistently higher copper and zinc values.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 6. Distribution of total lead concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 11. Summary statistics for total lead, measured in industrial stormwater from 2005 to 2012, by industrial sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	821	1.85	0.0034	0.0034	620.0	0.0004	0.030	27.829	15.02	5%
3 - Mineral, metal, oil and gas	243	0.03	0.0020	0.0020	2.5	0.0004	0.006	0.206	7.98	1%
5 - Landfills	829	0.66	0.0012	0.0012	200.0	0.0001	0.011	9.860	15.03	4%
6 - Recycling facilities	2,206	4.41	0.0165	0.0165	3,600.0	0.0026	0.103	98.830	22.39	12%
8 - Transportation facilities	1,182	1.96	0.0036	0.0036	982.0	0.0005	0.027	36.883	18.85	5%
9 - Treatment works	32	0.01	0.0080	0.0080	0.04	0.0045	0.014	0.008	0.79	0%
11 - Light industrial activity	1,435	0.27	0.0019	0.0019	132.0	0.0003	0.012	4.674	17.58	3%
Other facilities	335	0.23	0.0047	0.0047	30.0	0.0010	0.021	2.346	10.15	2%
All Facilities	7,088	2.03	0.0043	0.0043	3,600.0	0.0006	0.033	55.257	27.24	6%

1 Benchmark for total lead placed at 0.262 mg/L, based on the 2008 MSGP, assuming receiving water hardness >250 mg/L

5.7. Nickel, Total

Data distribution

Graphical and tabular data summaries of total nickel measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 7 and Table 12. Full output of the DAT statistical analysis is presented in Appendix 1.

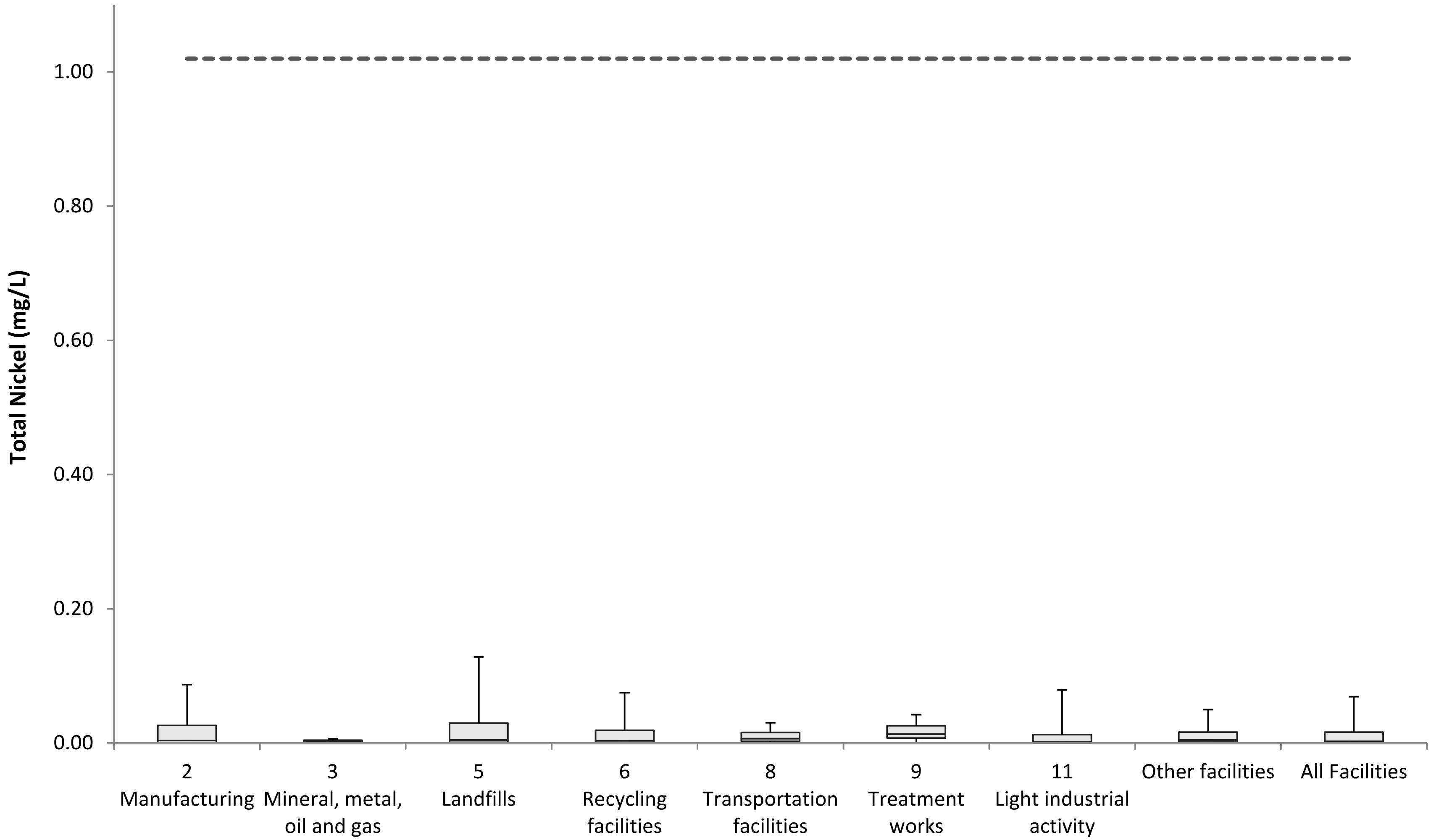
Based on analysis of 2,272 total nickel values, mean and median concentrations were 2.028 and 0.004 mg/L, respectively. The higher mean is due to a small number of facilities that consistently record total nickel concentrations in the 1 – 20 mg/L range. However, as shown in the DAT summary sheet in Appendix 1, 56% of all total nickel samples fall below detection level, resulting in the low median mentioned above.

Comparison among industrial sectors

Sectors 11 (Treatment Works) and 5 (Landfills) registered the highest median values of 0.0135 mg/L and 0.0065 mg/L, respectively, with most sectors recording a median in the single digit microgram (µg) range.

Comparison to permit benchmarks and proposed action levels

For those sectors subject to mandatory nickel monitoring in the 2008 Multi-Sector General Permit, the benchmark level is 1.02 mg/L, assuming a freshwater receiving water hardness >250 mg/L. This is equal to the annual NAL in the Draft General Permit. Compared against this benchmark, the median value for all sectors lies well below this standard (Figure 7). As shown in Table 12, only 1% of all total nickel values exceed this benchmark. The Manufacturing sector (2) showed that 4% of 339 values exceeded benchmark values, which can be attributed to a total of six (6) facilities, based on closer inspection of the data.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 7. Distribution of total nickel concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 12. Summary statistics for total nickel, measured in industrial stormwater from 2005 to 2012, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	339	0.277	0.0037	0.0001	18	0.0005	0.026	1.494	5.39	4%
3 - Mineral, metal, oil and gas	7	0.003	0.0018	0.0017	0.01	0.0008	0.004	0.004	1.39	0%
5 - Landfills	63	0.039	0.0046	0.0001	0.34	0.0007	0.030	0.065	1.65	0%
6 - Recycling facilities	158	0.084	0.0034	0.0001	10	0.0006	0.019	1.101	13.17	1%
8 - Transportation facilities	294	0.026	0.0065	0.0005	4	0.0027	0.016	0.305	11.76	0%
9 - Treatment works	17	0.020	0.0135	0.0060	0.07	0.0071	0.026	0.018	0.95	0%
11 - Light industrial activity	1,196	0.049	0.0014	0.0001	3	0.0002	0.013	0.191	3.93	1%
Other facilities	185	0.023	0.0043	0.0010	0.77	0.0011	0.016	0.076	3.25	0%
All Facilities	2,272	0.079	0.0023	0.0001	18	0.0003	0.016	0.634	8.00	1%

1 Benchmark for total nickel placed at 1.02 mg/L, based on the 2008 MSGP, assuming receiving water hardness >250 mg/

5.8. Iron, Total

Data distribution

Graphical and tabular data summaries of total iron measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 8 and Table 13. Full output of the DAT statistical analysis is presented in Appendix 1.

Based on analysis of 13,911 total iron values, mean and median concentrations were 142.74 and 0.79 mg/L, respectively. The significant variance between these values is due to a number of extremely high values. For instance, one facility belonging to sector 3 (Mineral, metal, oil and gas) recorded a value of 440,000 mg/L, which is likely erroneous; yet 189 other samples from 64 separate facilities yielded total iron concentrations greater than 1,000 mg/L. Despite a number of high values, 53% of all samples were less than 1.0 mg/L, contributing to the relatively low overall median.

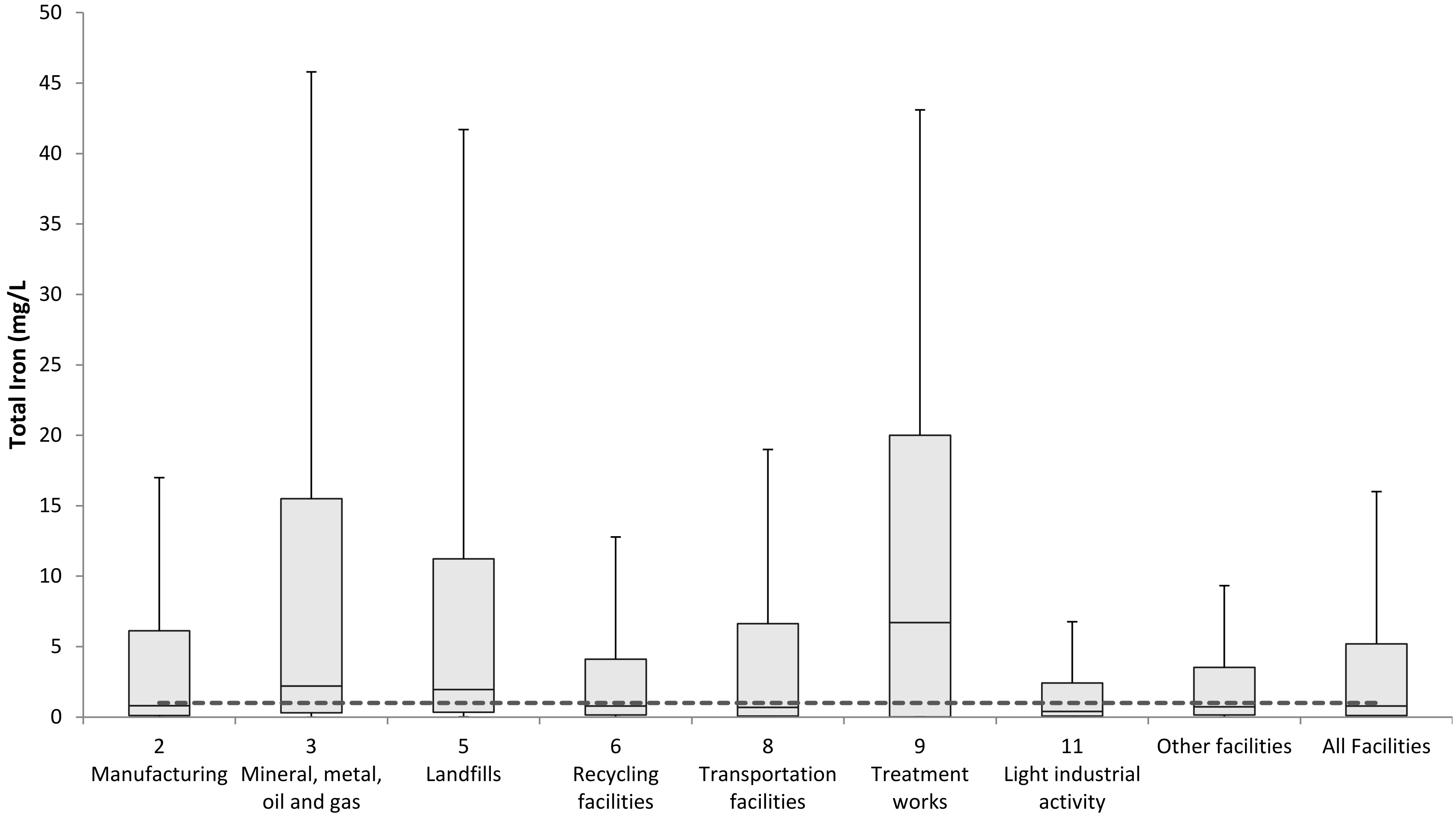
While median values of total iron may be low, 25% of all samples are above 5.20 mg/L and 10% of all samples are greater than 16 mg/L, indicating a need for enhanced controls or advanced treatment at particular facilities and sub-sectors.

Comparison among industrial sectors

Although Sector 9 (Treatment Works) yielded the highest median of 6.70 mg/L, the sample size was only 14. Sectors 3 (Minerals, metal, oil and gas), 5 (Landfills), and 6 (Recycling Facilities) all have sample sizes greater than 495 and median values of 2.20, 1.94, 0.79 mg/L, respectively. From sector 3, 25% of all samples were greater than 15.50 mg/L and the same proportion of samples from sector 5 were greater than 11.22 mg/L. Given sector 9's small sample size, sectors 3, 5, and 8 show the greatest cause of concern, as indicated by medians above benchmark and high values for both the standard deviation and coefficient of variance, indicating a number of samples well above benchmark within these sectors.

Comparison to permit benchmarks and proposed action levels

For those sectors subject to mandatory total iron monitoring in the 2008 Multi-Sector General Permit, the benchmark level is 1.0 mg/L. This is equal to the annual NAL in the Draft General Permit. Compared against this benchmark, the median value for all sectors combined lies below this standard (Figure 8). However, as shown in Table 10, 52% of all total iron values exceed this benchmark, with the rate of exceedance reaching 60% for sectors 3,5, and 9. This illustrates an effect of the ROS method for calculating the median, since the fact that 52% of samples exceed 1.0 mg/L suggests that the median should closely approximate the benchmark. Sector 11 registered the best performance, with 42% of samples exceeding EPA's benchmark.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 8. Distribution of total iron concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 13. Summary statistics for total iron, measured in industrial stormwater from 2005 to 2012, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	3,673	165.10	0.81	0.0010	43,000	0.106	6.12	1,865.3	11.3	54%
3 - Mineral, metal, oil and gas	495	1,018.69	2.20	0.0011	440,000	0.312	15.50	28,369.8	27.9	69%
5 - Landfills	2,285	152.08	1.94	0.0010	90,000	0.337	11.22	2,488.9	16.4	63%
6 - Recycling facilities	1,917	66.01	0.79	0.0010	33,000	0.151	4.12	1,087.9	16.5	51%
8 - Transportation facilities	735	218.30	0.69	0.0011	26,000	0.072	6.62	1,704.8	7.8	55%
9 - Treatment works	14	16.93	6.70	0.0013	100.00	0.011	20.00	30.8	1.8	71%
11 - Light industrial activity	3,496	58.29	0.40	0.0010	42,300	0.066	2.41	996.5	17.1	42%
Other facilities	1,296	28.12	0.73	0.0010	8,700	0.149	3.53	379.9	13.5	51%
All Facilities	13,911	142.74	0.79	0.0010	440,000	0.119	5.20	4,808.3	33.7	52%

1 Benchmark for total iron placed at 1.0 mg/L, based on the 2000 and 2008 MSGP

5.9. Biological Oxygen Demand (BOD)

Data distribution

Graphical and tabular data summaries of BOD measurements taken from stormwater collected at California industrial facilities from 2005 to 2012, categorized by industrial sector, are provided in Figure 9 and Table 14. Full output of the DAT statistical analysis is presented in Appendix 1.

Based on analysis of 1,713 BOD values, mean and median concentrations were 40.2 and 6.6 mg/L, respectively. Maximum values reaching as high as 7,710 mg/L skewed the distribution of all samples to the right, though this can be attributed to a relatively small number of facilities. Three soft drink and food distribution facilities reported values greater than 1,000 mg/L, which can be attributed to sugars and other organic compounds that likely escape the facility. In total, 44 facilities reported 110 samples greater than 100 mg/L, most of which were related to food and beverage, within sector 11, or Recycling Facilities (6).

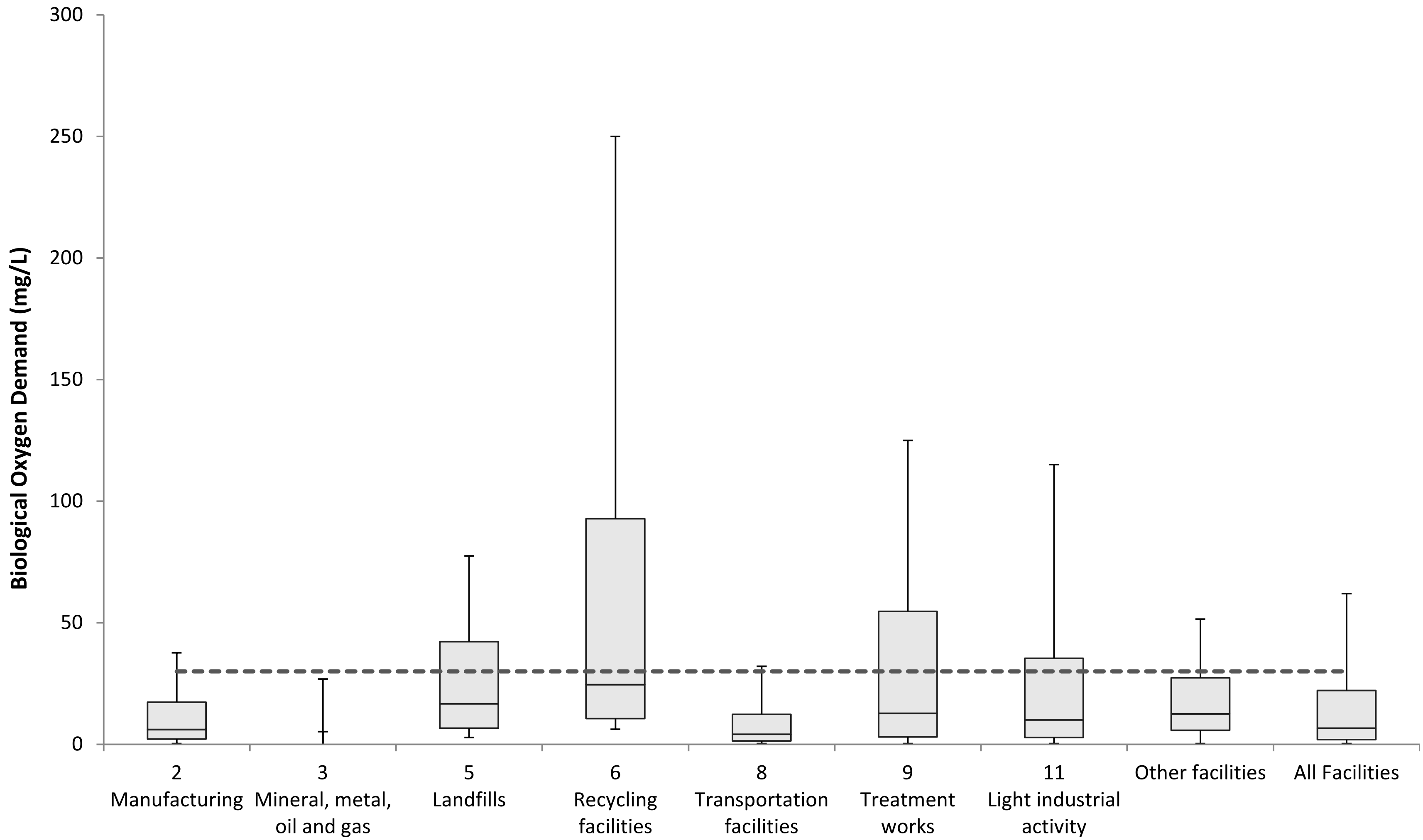
Upper quartile values for all samples indicate 25% of all samples are greater than 22.1 mg/L, and 10% of all samples are greater than 62.0 mg/L, indicating greater need for greater source control and possibly advanced treatment, since BOD is difficult to treat with conventional stormwater control devices (e.g. wattles and drain inlet filters).

Comparison among industrial sectors

Relatively few sectors maintain requirements to test for BOD in industrial stormwater, resulting in variable sample sizes amongst sectors shown in Figure 9. Types of facilities required to conduct BOD testing include food and beverage distributors; recycling facilities where cans and bottles could contribute to BOD loading; and airports and other transportation facilities, where anti-freeze and de-icing can result in high BOD concentrations. Sector 11 (Light Industrial Activity) has many food companies with highly variable results, as shown by the standard deviation of 497.2 mg/L. Whereas sector 6 (Recycling Facilities) registered a median of 24.5 mg/L and 25% of samples were greater than 92.8 mg/L, yet the sample size is only 46, compared to sector 8 (Transportation Facilities) with an n of 821 an fairly low overall concentrations.

Comparison to permit benchmarks and proposed action levels

Benchmark values for BOD, found in the 2008 Multi-Sector General Permit, are variable for different sectors. For consistency, as value of 30 mg/L was selected, which is consistent with the 2000 Multi-Sector General Permit, as well as the annual NAL in the Draft General Permit. Overall, 19% of all samples exceeded this standard, though this value is variable among sectors (Table 14). Sector 6 showed an exceedance rate of 41%, while sector 2 was at 12%. Sectors 5, 8, and 11 are all above 26%, indicating greater need to control this pollutant, which can contribute to low dissolved oxygen in receiving waters.



Boxes show the 25th to 75th percentile range of values; line bisecting the boxes is the median value; whiskers indicate 10th and 90th percentile values; dashed horizontal line indicates EPA benchmark level.

Figure 9. Distribution of biological oxygen demand concentration results, measured in industrial stormwater from 2005 to 2012, by industry sector

Table 14. Summary statistics for Biological Oxygen Demand (BOD) concentrations measured from industrial stormwater, by industry sector

Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Lower Quartile - 25% (mg/L)	Upper Quartile - 75% (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark[1]
2 - Manufacturing	98	25.1	6.1	2.0	539	2.1	17.3	84.6	3.4	12%
3 - Mineral, metal, oil and gas	3	--	--	25.0	27	--	--		--	0%
5 - Landfills	54	35.0	16.6	1.5	170	6.6	42.2	44.3	1.3	37%
6 - Recycling facilities	46	76.6	24.5	5.1	453	10.5	92.8	108.2	1.4	41%
8 - Transportation facilities	821	13.3	4.1	0.7	480	1.4	12.3	28.6	2.1	11%
9 - Treatment works	26	66.6	12.7	1.2	700	3.0	54.7	165.7	2.5	38%
11 - Light industrial activity	613	77.0	10.0	1.7	7,710	2.8	35.3	497.2	6.5	26%
Other facilities	52	21.2	12.5	2.9	98	5.8	27.3	22.4	1.1	23%
All Facilities	1,713	40.2	6.6	0.7	7,710	1.9	22.1	301.0	7.5	19%

1 Benchmark for BOD placed at 30 mg/L, based on the 2000 MSGP, since the 2008 MSGP has several benchmarks for various sectors

Std. Dev.: Standard Deviation

Insufficient data to calculate statistics for sector #3 (Mineral, metal, oil and gas) using regression on ordered statistics (ROS) methods.

6. Discussion and Conclusion of Industrial Stormwater Data Analysis

To remain consistent with Section 5, as well as the report provided as Appendix 2, this discussion of results considers the general distribution of the data, compares the industrial sectors and considers the rates of exceedance of existing benchmarks for the parameters considered in this study.

6.1. General Data Distribution

Consistent with general findings from the Washington State study, all parameters, with the exception of pH, showed a distinctly right-skewed distribution, given the number of extreme values in the positive direction. This is to be expected from stormwater data in general, where pollutant concentrations are in many cases a function of storm intensity. However, this industrial stormwater data shows that particular sectors, and in many cases a handful of facilities within those sectors, are responsible for skewing the distribution to the right.

California's industrial stormwater data is also characterized by high rates of variance across various parameters and sectors. As shown in Table 15, pH is characterized by an extremely low coefficient of variation across all sectors (0.13), while the value for zinc reaches 61.81. This is consistent with the Washington study, where the coefficient of variation was 0.12 for pH and 7.06 for zinc. California's notably higher value for zinc can be attributed to a higher number of facilities reporting extremely high concentrations, pointing to the need for greater enforcement of the worst performing Permittees.

6.2. Comparison among industrial sectors

In general, significant differences in median concentration values were found across sectors (Table 16). This was less the case for pH, copper, nickel and to some extent, TSS, though the low median values for copper and nickel account for this, while pH shows little variation in general; putting into question the general utility of using pH as an indicator parameter for industrial stormwater compliance. This is also reflected in Table 1, where difference in the coefficient of variation is quite extreme for parameters, including zinc and lead.

Observed differences among these broad industrial sectors suggests the need to conduct a similar analysis for sub-sectors, to further refine which sectors are posing the greatest risk to receiving water quality. Table 4 indicates a number of sub-sectors have sufficient sampling data to calculate relevant statistics, which will likely be conducted at a later time.

Table 15. Coefficient of variation for parameters considered in this study, by sector

	Coefficient of variation								
Category	pH	Oil and grease	TSS	Zinc, Total	Copper, Total	Lead, Total	Nickel, Total	Iron, Total	BOD
2 - Manufacturing	0.15	17.29	6.93	8.79	8.48	15.02	5.39	11.3	3.4
3 - Mineral, metal, oil and gas	0.11	4.74	26.28	3.19	3.36	7.98	1.39	27.9	--
5 - Landfills	0.11	7.00	5.29	7.98	2.99	15.03	1.65	16.4	1.3
6 - Recycling facilities	0.15	9.36	4.13	12.50	14.59	22.39	13.17	16.5	1.4
8 - Transportation facilities	0.12	7.51	10.17	9.57	7.65	18.85	11.76	7.8	2.1
9 - Treatment works	0.10	24.33	4.39	2.46	0.80	0.79	0.95	1.8	2.5
11 - Light industrial activity	0.12	10.11	6.66	51.89	23.06	17.58	3.93	17.1	6.5
Other facilities	0.12	2.30	4.38	13.98	2.03	10.15	3.25	13.5	1.1
All Facilities	0.13	17.21	17.53	61.81	15.73	27.24	8.00	33.7	7.5

Table 16. Median values for parameters considered in this study, by sector

	Median (mg/L)								
Category	pH	Oil and grease	TSS	Zinc, Total	Copper, Total	Lead, Total	Nickel, Total	Iron, Total	BOD
2 - Manufacturing	7.20	1.35	36.0	0.166	0.026	0.0034	0.0037	0.81	6.1
3 - Mineral, metal, oil and gas	7.60	0.63	41.5	0.033	0.009	0.0020	0.0018	2.20	--
5 - Landfills	7.50	1.48	56.6	0.081	0.009	0.0012	0.0046	1.94	16.6
6 - Recycling facilities	7.10	2.38	41.7	0.206	0.016	0.0165	0.0034	0.79	24.5
8 - Transportation facilities	7.10	1.83	45.0	0.148	0.020	0.0036	0.0065	0.69	4.1
9 - Treatment works	7.20	1.15	46.8	0.030	0.000	0.0080	0.0135	6.70	12.7
11 - Light industrial activity	6.91	1.67	30.2	0.177	0.007	0.0019	0.0014	0.40	10.0
Other facilities	7.25	1.68	41.2	0.092	0.009	0.0047	0.0043	0.73	12.5
All Facilities	7.10	0.25	38.0	0.157	0.013	0.0043	0.0023	0.79	6.6

6.3. Comparison to permit benchmarks and proposed action levels

Table 17 shows the percentage of samples falling below benchmark limits, by sector. Red cells indicate instances where less than 50% of samples are below benchmark and orange cells indicate where sectors are only attaining benchmark compliance 50-65% of the time. From this, a number of facilities are clearly discharging total iron at a consistently high rate, with an overall benchmark attainment rate of only 48% and reaching as low as 31% and 29% for sectors 3 (Mineral, metal, oil and gas) and 9 (Treatment Works), respectively. Rates of non-compliance are also high for copper and zinc, with sectors 2 (Manufacturing), 6 (Recycling), 8 (Transportation), and 11 (Light Industry) with the poorest performance rates. Table 17 also shows TSS being an issue for a number of facilities, with sectors 3 and 5 (Landfills) reporting compliance only around 63% of the time.

Clearly, particular sectors must do more to control discharges of some pollutants more than others. Yet for some parameters, including oil and grease, lead, nickel, and BOD, high rates of compliance have been reported across all sectors. This data set indicates a significant majority of facilities, across all sectors, are well below benchmark levels. To achieve compliance with existing benchmarks, or future numeric limitations, a number of facilities will require significant facility upgrades, including advanced treatment for some.

Table 17. Percentage of samples exceeding benchmarks, by sector

	Benchmark Exceedance Rate %								
Category	pH	Oil and grease	TSS	Zinc, Total	Copper, Total	Lead, Total	Nickel, Total	Iron, Total	BOD
2 - Manufacturing	88%	94%	75%	**56%**	**53%**	95%	96%	**46%**	88%
3 - Mineral, metal, oil and gas	94%	97%	**64%**	89%	85%	99%	100%	**31%**	100%
5 - Landfills	95%	92%	**62%**	70%	67%	96%	100%	**37%**	63%
6 - Recycling facilities	90%	85%	68%	**51%**	**50%**	88%	99%	**49%**	59%
8 - Transportation facilities	93%	92%	71%	**58%**	**54%**	95%	100%	**45%**	89%
9 - Treatment works	97%	95%	69%	78%	**44%**	100%	100%	**29%**	62%
11 - Light industrial activity	91%	94%	81%	**55%**	**60%**	97%	99%	**58%**	74%
Other facilities	93%	96%	71%	**63%**	72%	98%	100%	**49%**	77%
All Facilities	91%	93%	75%	**56%**	**57%**	94%	99%	**48%**	81%

Red cells indicate more than 50% of all samples exceed benchmark for a given parameter, within a sector. Orange cells indicate between 35% and 50% of samples exceed benchmark

Appendix 1 Statistical output from the Data Analysis Tool (DAT) for primary parameters

Table 1. Statistical summary output from the Data Analysis Tool for total zinc

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities
n	**3,081**	**276**	**342**	**1,786**	**1,395**	**9**	**5,191**	**375**	**12,471**
Percent detected	**79.6%**	**90.2%**	**78.7%**	**83.7%**	**82.5%**	**33.3%**	**78.8%**	**76.3%**	**80.3%**
Mean	15.456	0.132	0.621	9.106	10.715	0.184	51.423	1.886	27.803
Standard Deviation	135.857	0.421	4.954	113.861	102.526	0.454	2668.536	26.376	1718.512
Coefficient of Variation	8.790	3.188	7.980	12.504	9.568	2.460	51.893	13.984	61.811
Lower 95% Confidence Limit about Mean	10.659	0.082	0.096	3.825	5.335	-0.112	-21.171	-0.783	-2.359
Upper 95% Confidence Limit about Mean	20.254	0.182	1.146	14.387	16.095	0.481	124.018	4.556	57.964
Lower Quartile (25th percentile)	0.030	0.011	0.021	0.052	0.034	0.005	0.039	0.020	0.033
Median (50th percentile)	0.166	**0.033**	0.081	0.206	0.148	0.030	0.177	0.092	0.157
Upper Quartile (75th percentile)	0.907	**0.100**	0.311	0.812	0.645	0.167	0.797	0.422	0.743
Inter Quartile Range	0.876	0.089	0.289	0.760	0.611	0.161	0.758	0.402	0.710
Minimum Detected Value	**0.002**	**0.0036**	**0.0025**	**0.0021**	**0.002**	**0.19**	**0.00208**	**0.0022**	**0.002**
Maximum Detected Value	**4,800**	**5**	**71**	**3,000**	**1,800**	**1**	**146,000**	**385**	**146,000**
Minimum Reporting Limit	**0.001**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.001**
Maximum Reporting Limit	**0.56**	**0.02**	**0.1**	**0.1**	**0.05**	**0.05**	**0.845**	**0.2**	**0.845**
Regression Equation	ln(y) = -1.7980 + 2.5214*Z	ln(y) = -3.4067 + 1.6352*Z	ln(y) = -2.5097 + 1.9884*Z	ln(y) = -1.5813+ 2.0361*Z	ln(y) = -1.9074 + 2.1792*Z	ln(y) = -3.4981 + 2.5311*Z	ln(y) = -1.7335 + 2.2346*Z	ln(y) = -2.3848 + 2.2589*Z	ln(y) = -1.8517 + 2.3053*Z
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS). Estimates of distribution parameters become less accurate as the percent detected data decreases, and may be unacceptable below a 40% detection threshold.	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).

Table 2. Statistical summary output from the Data Analysis Tool for total suspended solids

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities[1]
N	**9,916**	**1,837**	**2,853**	**2,603**	**10,102**	**826**	**20,322**	**3,708**	**52,167**
Percent detected	**90.7%**	**85.8%**	**90.3%**	**87.6%**	**91.5%**	**95.8%**	**89.4%**	**90.7%**	
Mean	174.1	838.0	578.9	180.9	169.4	163.0	94.9	172.6	
Standard Deviation	1,207.1	22,027.3	3,063.2	747.0	1,722.7	714.7	631.8	756.2	
Coefficient of Variation	6.9	26.3	5.3	4.1	10.2	4.4	6.7	4.4	
Lower 95% Confidence Limit about Mean	150.4	-169.3	466.5	152.2	135.9	114.2	86.2	148.2	
Upper 95% Confidence Limit about Mean	197.9	1,845.4	691.3	209.5	203.0	211.7	103.6	196.9	
Lower Quartile (25th percentile)	11.9	8.9	13.3	12.4	15.7	16.4	11.2	13.4	
Median (50th percentile)	36.0	**41.5**	56.6	41.7	45.0	46.8	30.2	41.2	
Upper Quartile (75th percentile)	109.4	**193.5**	240.9	140.4	128.9	133.6	80.9	126.7	
Inter Quartile Range	97.6	184.6	227.6	128.0	113.2	117.2	69.6	113.3	
Minimum Detected Value	**0.1**	**0.6**	**1.0**	**0.0**	**0.5**	**1.0**	**0.1**	**0.1**	
Maximum Detected Value	**52,200**	**691,000**	**73,000**	**28,000**	**134,000**	**14,770**	**52,200**	**24,000**	
Minimum Reporting Limit	**0.1**	**0.1**	**0.5**	**0.0**	**0.1**	**0.0**	**0.1**	**1.0**	
Maximum Reporting Limit	**100**	**50**	**50**	**100**	**100**	**50**	**100**	**100**	
Regression Equation	ln(y) = 3.5839 + 1.6486*Z	ln(y) = 3.7259 + 2.2834*Z	ln(y) = 4.0361 + 2.1482*Z	ln(y) = 3.7306 + 1.8000*Z	ln(y) = 3.8056+ 1.5621*Z	ln(y) = 3.8449 + 1.5569*Z	ln(y) = 3.4066 + 1.4631*Z	ln(y) = 3.7173 + 1.6674*Z	
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	

1) Amount of data exceeded the capability of the Data Analysis Tool (DAT)

Table 3. Statistical summary output from the Data Analysis Tool for total oil and grease

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities[1]
n	**7,427**	**1,474**	**2,119**	**1,893**	**8,168**	**618**	**15,787**	**3,012**	**40,498**
Percent detected	**42.4%**	**33.8%**	**45.4%**	**52.0%**	**48.4%**	**40.8%**	**43.9%**	**42.4%**	
Mean	13.7	3.4	8.9	21.0	9.9	47.9	6.6	4.1	
Standard Deviation	236.3	15.9	62.0	196.0	74.5	1164.6	67.1	9.4	
Coefficient of Variation	17.3	4.7	7.0	9.4	7.5	24.3	10.1	2.3	
Lower 95% Confidence Limit about Mean	8.3	2.5	6.2	12.1	8.3	-44.0	5.6	3.8	
Upper 95% Confidence Limit about Mean	19.0	4.2	11.5	29.8	11.5	139.7	7.7	4.4	
Lower Quartile (25th percentile)	0.4	0.2	0.5	0.7	0.6	0.3	0.6	0.7	
Median (50th percentile)	1.3	**0.6**	1.5	2.4	1.8	1.2	1.7	1.7	
Upper Quartile (75th percentile)	4.2	**2.2**	4.8	8.4	5.6	4.0	4.7	4.1	
Inter Quartile Range	3.8	2.0	4.4	7.7	5.0	3.7	4.1	3.5	
Minimum Detected Value	**0.0001**	**0.21**	**0.4**	**0.5**	**0.227**	**1**	**0.02**	**0.14**	
Maximum Detected Value	**10,500**	**393**	**1,640**	**5,390**	**3,400**	**21,000**	**5,200**	**210**	
Minimum Reporting Limit	**0.01**	**0.05**	**0.05**	**0.05**	**0.05**	**0.01**	**0.05**	**0.01**	
Maximum Reporting Limit	**20**	**20**	**20**	**17.9**	**20**	**10**	**20**	**20**	
Regression Equation	ln(y) = 0.2987 + 1.6921*Z	ln(y) = -0.4559 + 1.8342*Z	ln(y) = 0.3904 + 1.7593*Z	ln(y) = 0.8678 + 1.8633*Z	ln(y) = 0.6019 + 1.6647*Z	ln(y) = 0.1422 + 1.85726*Z	ln(y) = 0.5144+ 1.5298*Z	ln(y) = 0.5172 + 1.3373*Z	
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS). Estimates of distribution parameters become less accurate as the percent detected data decreases, and may be unacceptable below a 40% detection threshold.	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	

1) Amount of data exceeded the capability of the Data Analysis Tool (DAT)

Table 4. Statistical summary output from the Data Analysis Tool for total lead

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities
n	**821**	**243**	**829**	**2,206**	**1,182**	**32**	**1,435**	**335**	**7,088**
Percent detected	**55.9%**	**67.9%**	**39.7%**	**65.7%**	**53.6%**	**84.4%**	**40.2%**	**60.3%**	**54.2%**
Mean	1.853	0.026	0.656	4.414	1.957	0.011	0.266	0.231	2.029
Standard Deviation	27.829	0.206	9.860	98.830	36.883	0.008	4.674	2.346	55.257
Coefficient of Variation	15.022	7.983	15.026	22.389	18.850	0.794	17.583	10.155	27.236
Lower 95% Confidence Limit about Mean	-0.051	0.000	-0.015	0.290	-0.146	0.008	0.024	-0.020	0.742
Upper 95% Confidence Limit about Mean	3.756	0.052	1.327	8.539	4.059	0.014	0.508	0.482	3.315
Lower Quartile (25th percentile)	0.000	0.000	0.000	0.003	0.000	0.005	0.000	0.001	0.001
Median (50th percentile)	0.003	**0.002**	0.001	0.016	0.004	0.008	0.002	0.005	0.004
Upper Quartile (75th percentile)	0.030	**0.006**	0.011	0.103	0.027	0.014	0.012	0.021	0.033
Inter Quartile Range	0.030	0.006	0.011	0.100	0.027	0.010	0.011	0.020	0.032
Minimum Detected Value	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.00236**	**0.001**	**0.001**	**0.001**
Maximum Detected Value	**620**	**2.5**	**200**	**3600**	**982**	**0.035**	**132**	**30**	**3600**
Minimum Reporting Limit	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Maximum Reporting Limit	**5**	**0.001**	**5**	**5**	**3**	**0.005**	**0.1**	**0.1**	**5**
Regression Equation	ln(y) = -5.6707 + 3.2193*Z	ln(y) = -6.2760 + 2.1266*Z	ln(y) = -6.6887 + 3.2312*Z	ln(y) = -4.1072 + 2.71577*Z	ln(y) = -5.6375 + 3.0189*Z	ln(y) = -4.8331 + 0.8415*Z	ln(y) = -6.2726 + 2.7155*Z	ln(y) = -5.3688 + 2.2475*Z	ln(y) = -5.4432 + 3.0006*Z
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS). Estimates of distribution parameters become less accurate as the percent detected data decreases, and may be unacceptable below a 40% detection threshold.	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).

Table 5. Statistical summary output from the Data Analysis Tool for total copper

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities
n	**1,356**	**244**	**210**	**1,232**	**726**	**18**	**1,757**	**308**	**5,867**
Percent detected	**78.5%**	**98.4%**	**68.6%**	**76.0%**	**77.1%**	**72.2%**	**69.8%**	**69.2%**	**75.1%**
Mean	9.104	0.025	0.063	0.384	0.202	0.041	0.697	0.031	2.423
Standard Deviation	77.224	0.082	0.187	5.600	1.547	0.033	16.071	0.062	38.116
Coefficient of Variation	8.482	3.360	2.992	14.592	7.650	0.805	23.059	2.028	15.728
Lower 95% Confidence Limit about Mean	4.994	0.014	0.037	0.071	0.090	0.026	-0.055	0.024	1.448
Upper 95% Confidence Limit about Mean	13.215	0.035	0.088	0.696	0.315	0.056	1.448	0.038	3.399
Lower Quartile (25th percentile)	0.003	0.004	0.002	0.003	0.005	0.010	0.001	0.003	0.002
Median (50th percentile)	0.026	**0.009**	0.009	0.016	0.020	-0.050	0.007	0.009	0.013
Upper Quartile (75th percentile)	0.233	**0.022**	0.040	0.103	0.079	0.058	0.056	0.030	0.089
Inter Quartile Range	0.230	0.018	0.039	0.101	0.074	0.048	0.055	0.027	0.087
Minimum Detected Value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Maximum Detected Value	**1,500**	**1**	**2**	**150**	**32**	**0**	**520**	**1**	**1,500**
Minimum Reporting Limit	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.0001**	**0.05**	**0.0001**	**0.0001**	**0.0001**
Maximum Reporting Limit	**10**	**0.0005**	**0.1**	**0.2**	**0.2**	**0.05**	**0.06**	**0.05**	**10**
Regression Equation	ln(y) = -3.6309 + 3.2224*Z	ln(y) = -4.729 + 1.3352*Z	ln(y) = -4.7471 + 2.2824*Z	ln(y) = -4.1220 + 2.7482*Z	ln(y) = -3.9145 + 2.0372*Z	ln(y) = -3.7472 + 1.3437*Z	ln(y) = -4.9479 + 3.0508*Z	ln(y) = -4.6732 + 1.7110*Z	ln(y) = -4.3544 + 2.8747*Z
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).

Table 6. Statistical summary output from the Data Analysis Tool for total nickel

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities
n	**339**	**7**	**63**	**158**	**294**	**17**	**1,196**	**185**	**2,272**
Percent detected	**63.4%**	**71.4%**	**68.3%**	**58.9%**	**48.0%**	**64.7%**	**48.6%**	**55.7%**	**52.7%**
Mean	0.277	0.003	0.039	0.084	0.026	0.020	0.049	0.023	0.079
Standard Deviation	1.494	0.004	0.065	1.101	0.305	0.018	0.191	0.076	0.634
Coefficient of Variation	5.392	1.392	1.652	13.171	11.764	0.946	3.926	3.246	7.997
Lower 95% Confidence Limit about Mean	0.118	0.000	0.023	-0.088	-0.009	0.011	0.038	0.012	0.053
Upper 95% Confidence Limit about Mean	0.436	0.006	0.055	0.255	0.061	0.028	0.060	0.034	0.105
Lower Quartile (25th percentile)	0.001	0.001	0.001	0.001	0.003	0.007	0.000	0.001	0.000
Median (50th percentile)	0.004	**0.002**	0.005	0.003	0.006	0.013	0.001	0.004	0.002
Upper Quartile (75th percentile)	0.026	**0.004**	0.030	0.019	0.016	0.026	0.013	0.016	0.016
Inter Quartile Range	0.026	0.003	0.029	0.018	0.013	0.018	0.013	0.015	0.016
Minimum Detected Value	**0.00007**	**0.00170**	**0.00012**	**0.00005**	**0.00047**	**0.00600**	**0.00005**	**0.00100**	**0.00005**
Maximum Detected Value	**18**	**0**	**0**	**10**	**4**	**0**	**3**	**1**	**18**
Minimum Reporting Limit	**0.00005**	**0.0001**	**0.00005**	**0.00005**	**0.00005**	**0.01**	**0.00005**	**0.00005**	**0.00005**
Maximum Reporting Limit	**0.1**	**0.0005**	**0.1**	**0.1417**	**0.05**	**0.04**	**20**	**0.02**	**20**
Regression Equation	ln(y) = -5.6015 + 2.9079*Z	ln(y) = -6.3158 + 1.2311*Z	ln(y) = -5.3800 + 2.7678*Z	ln(y) = -5.6868 + 2.5546*Z	ln(y) = -5.0386 + 1.3135*Z	ln(y) = -4.3061 + 0.9501*Z	ln(y) = -6.5836 + 3.2865*Z	ln(y) = -5.4521 + 1.9532*Z	ln(y) = -6.0643 + 2.8551*Z
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).

Table 7. Statistical summary output from the Data Analysis Tool for total iron

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities
n	**3,673**	**495**	**2,285**	**1,917**	**735**	**14**	**3,496**	**1,296**	**13,911**
Percent detected	**83.4%**	**88.9%**	**91.1%**	**83.3%**	**84.8%**	**100.0%**	**78.1%**	**86.7%**	**83.9%**
Mean	165.102	1,018.689	152.076	66.010	218.304	16.930	58.290	28.122	142.737
Standard Deviation	1,865.346	28,369.815	2,488.941	1,087.934	1,704.756	30.787	996.472	379.939	4,808.339
Coefficient of Variation	11.298	27.849	16.366	16.481	7.809	1.818	17.095	13.510	33.687
Lower 95% Confidence Limit about Mean	104.776	-1,480.563	50.023	17.308	95.058	0.803	25.258	7.437	62.833
Upper 95% Confidence Limit about Mean	225.428	3,517.940	254.129	114.712	341.551	33.057	91.322	48.808	222.642
Lower Quartile (25th percentile)	0.106	0.312	0.337	0.151	0.072	0.011	0.066	0.149	0.119
Median (50th percentile)	0.806	**2.201**	1.945	0.789	0.690	6.700	0.398	0.725	0.787
Upper Quartile (75th percentile)	6.117	**15.500**	11.224	4.117	6.623	20.000	2.410	3.527	5.202
Inter Quartile Range	6.011	15.187	10.887	3.966	6.551	19.989	2.344	3.378	5.082
Minimum Detected Value	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
Maximum Detected Value	**43,000**	**440,000**	**90,000**	**33,000**	**26,000**	**100**	**42,300**	**8,700**	**440,000**
Minimum Reporting Limit	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**		**0.001**	**0.001**	**0.001**
Maximum Reporting Limit	**0.5**	**0.05**	**0.63**	**0.5**	**0.2**		**0.5**	**0.5**	**0.63**
Regression Equation	ln(y) = -0.2151 + 3.0054*Z	ln(y) = 0.7887 + 2.8954*Z	ln(y) = 0.6652 + 2.5998*Z	ln(y) = -0.2365 + 2.4498*Z	ln(y) = -0.3708 + 3.3541*Z	ln(y) = 0.2353 + 4.1538*Z	ln(y) = -0.9203+ 2.6701*Z	ln(y) = -0.3215 + 2.3466*Z	ln(y) = -0.2389 + 2.8003*Z
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	All data reported as detected. Bolded values are exact calculations.	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).

Table 8. Statistical summary output from the Data Analysis Tool for total biological oxygen demand

Run ID	2 Manufacturing	3 Mineral, metal, oil and gas[1]	5 Landfills	6 Recycling facilities	8 Transportation facilities	9 Treatment works	11 Light industrial activity	Other facilities	All Facilities
n	**98**	**3**	**54**	**46**	**821**	**26**	**613**	**52**	**1,713**
Percent detected	**64.3%**	**66.7%**	**94.4%**	**91.3%**	**62.6%**	**84.6%**	**74.6%**	**84.6%**	**69.8%**
Mean	25.1	--	35.0	76.6	13.3	66.6	77.0	21.2	40.2
Standard Deviation	84.6	--	44.3	108.2	28.6	165.7	497.2	22.4	301.0
Coefficient of Variation	3.4	--	1.3	1.4	2.1	2.5	6.5	1.1	7.5
Lower 95% Confidence Limit about Mean	8.4	--	23.2	45.3	11.4	2.9	37.7	15.1	26.0
Upper 95% Confidence Limit about Mean	41.9	--	46.8	107.8	15.3	130.3	116.4	27.3	54.5
Lower Quartile (25th percentile)	2.1	--	6.6	10.5	1.4	3.0	2.8	5.8	1.9
Median (50th percentile)	6.1	--	16.6	24.5	4.1	12.7	10.0	12.5	6.6
Upper Quartile (75th percentile)	17.3	--	42.2	92.8	12.3	54.7	35.3	27.3	22.1
Inter Quartile Range	15.2	--	35.7	82.3	10.9	51.7	32.5	21.5	20.1
Minimum Detected Value	25.1	--	35.0	76.6	13.3	66.6	77.0	21.2	40.2
Maximum Detected Value	**539**	**27.3**	**170**	**453**	**480**	**700**	**7,710**	**98**	**7,710**
Minimum Reporting Limit	**2**	**10**	**2.4**	**5**	**0.5**	**0.5**	**0.5**	**2**	**0.5**
Maximum Reporting Limit	**20**	**20**	**5**	**5**	**14**	**10**	**30**	**4**	**30**
Regression Equation	ln(y) = 1.8016 + 1.5587*Z		ln(y) = 2.8116 + 1.3814*Z	ln(y) = 3.3892+ 1.5532*Z	ln(y) = 1.4191 + 1.6187*Z	ln(y) = 2.5432+ 2.1635*Z	ln(y) = 2.3038 + 1.8696*Z	ln(y) = 2.5294 + 1.1537*Z	ln(y) = 1.8804 + 1.8015*Z
Note:	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).	Bolded values are exact calculations. Unbolded values are estimated using regression on ordered statistics (ROS).

1) Insufficient data to calculate ROS for this sector

Appendix 2 Data Analysis Report: Evaluation of Monitoring Data from General NPDES Permits for Industrial and Construction Stormwater (WA State Dept. of Ecology)

DATA ANALYSIS REPORT

Evaluation of Monitoring Data from General NPDES Permits for Industrial and Construction Stormwater

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October 19, 2006

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Introduction

The Washington State Department of Ecology (Ecology) is currently implementing a study to evaluate monitoring and reporting requirements identified in the state's existing general National Point Discharge Elimination System (NPDES) permits for industrial and construction stormwater. This study is required pursuant to Engrossed Substitute Senate Bill (ESSB) 6415 that was passed by the state legislature on March 9, 2004. The ultimate goal of this study is to develop improved monitoring requirements for these permits to determine the effectiveness of stormwater best management practices and to ascertain compliance with state water quality standards.

One of the initial tasks related to this study was a compilation, review, and analysis of existing data that have been collected through the general NPDES permits for industrial and construction stormwater. The primary goal of this analysis is to evaluate the utility of these data for gauging permit compliance and understanding the level of water quality protection that is occurring. This report was prepared by Herrera Environmental Consultants (Herrera) to summarize the results from this analysis. In keeping with the overall goal of this study, the specific objectives of this report are as follows:

- Describe the general distribution of industrial and construction stormwater data including central tendency, variation, and presence or absence of outliers.
- Compare existing industrial stormwater data across industrial categories to determine if there are significant differences in pollutant concentrations.
- Compare industrial and construction stormwater data to applicable benchmarks and action levels established by the general permits.
- Compare industrial and construction stormwater data to hypothetical state water quality criterion that are derived based on representative receiving water conditions and dilution factors. (Note that compliance with actual state water quality standards cannot be assessed using data compiled through the general NPDES permits for industrial and construction stormwater. To predict compliance with standards would require additional site-specific data, receiving water data, and assessment of narrative standards and other policies.)

This report begins with a description of the data sources that were used in this analysis. The specific data analysis methods that were used to meet the study objectives identified above are then described in detail. The results from these analyses are then presented with supporting tabular and graphical data summaries provided as necessary. Finally, these results are discussed in relation to the primary goal of the study with major conclusions from this analysis summarized in the final section of the report.

Data Sources

The specific sources for data that were analyzed within this report are summarized under separate subsections below for industrial and construction stormwater, respectively. Included are descriptions of how the data were compiled and the associated temporal and geographic coverage. The total quantity of data that was compiled from each source is also described along with any known quality assurance issues.

Industrial Stormwater

Data Source

Industrial stormwater data were compiled by Ecology from Discharged Monitoring Reports (DMRs) that were submitted by permittees pursuant to the monitoring and reporting requirements of the general NPDES industrial stormwater permit. These data were initially entered into a database system that is maintained at Ecology's headquarter office in Olympia and then exported to a Microsoft Excel® spreadsheet for subsequent analysis by Herrera. This spreadsheet included data from NPDES sampling that was conducted the second, third, and fourth quarters of 2003 and all four quarters of 2004 and 2005. These data were obtained from a total of 808 permitted facilities with 758 located in Western Washington, 45 in Eastern Washington, and 8 unclassified because no address information was provided in the database.

For subsequent analyses of the industrial stormwater data, these 808 facilities were subdivided into one of 11 general industrial categories that are defined in the NPDES permit and Code of Federal Regulations [40 CFR 122.26(b)(14)]. The associated category names were simplified to the descriptions used by the U.S. EPA to define categories of stormwater discharges (U.S. EPA, 2006). A twelfth category identified as "Significant Contributor (12)" was present in the dataset from Ecology, but not defined in the NPDES permit or Code of Federal Regulations. Finally, a thirteenth category, "No Category Specified", was added because several facilities within the dataset could not be classified within any of the other 12 categories. The names of all 13 categories and number of facilities that fall into each of these categories are provided in Table 1. These data indicate that the number of facilities in each category ranges from 0 to 238. However, 83 percent of the facilities were concentrated in just three categories: Manufacturing (02), Transportation Facilities (08), and Light Industrial Activity (11). Out of the remaining facilities, 15 percent were concentrated in the following four categories: Landfills (05), Recycling Facilities (06), Treatment Works (09), and No Category Specified. In general, the analyses performed in this report generally focused on the data from these seven categories.

The facilities were further subdivided into industrial sectors based on the first two digits of their Standard Industrial Classification (SIC) codes. SIC Codes are assigned in the permitting process based on the primary activities performed at a facility. Categorization at this level allows for a more detailed evaluation of the types of facilities that are represented in the database. For this analysis, 35 industrial sectors were identified based on SIC codes that were present in the database. These 35 industrial sectors were generally derived from the 30 sectors of industrial activity that are defined in the Federal Register (Vol. 65, No. 210). However, some variation from the categories in the Federal Register exist due to the exclusion of some SIC codes entirely (e.g., Agricultural Services [07], Forestry [08]) and the combination of multiple SIC codes in a single sector (e.g., Sector Y includes Rubber and Miscellaneous Plastic Products [30] and Miscellaneous Manufacturing Industries [39]). The names of all 35 industrial sectors and number of facilities that fall into each of these sectors are provided in Table 2. These data show the number of facilities in each industrial sector ranges from 1 to 127, with an average of 22 facilities present in each industrial sector across all 35 categories. In general, the analyses performed in this report were not conducted at this level due to the low data volume within each industrial sector.

Table 1. Total number of facilities by industrial category.

Category	Number of Facilities
01 - Facilities with effluent limitations	1
02 - Manufacturing	233
03 - Mineral, metal, oil, and gas	4
04 - Hazardous waste treatment, or disposal facilities	0
05 - Landfills	20
06 - Recycling facilities	64
07 - Steam electric plants	2
08 - Transportation facilities	205
09 - Treatment works	12
10 - Construction sites > 5 acres	1
11 - Light industrial activity	238
12 - Significant contributor	1
NC - No category specified	27

Data Quantity

Overall, the data set obtained for industrial stormwater contained 21,486 values for a total of 22 different parameters. The number of values available for specific monitoring parameters can be divided into high, intermediate, and low categories depending on their associated monitoring requirements as identified in the NPDES permit. For example, turbidity, pH, total zinc, and oil & grease have the highest number of values because all facilities are required by the NPDES permit to conduct sampling for these parameters. As shown in Table 3, the total number of values for these parameters ranges from 2,651 to 4,479.

Table 2. Total number of facilities by industrial sector.

SIC Code	Sector	Number of Facilities
07--	Agricultural Services	1
08--	Forestry	1
10--	Metal Mining	1
12--	Coal Mining	1
17--	Construction Special Trade Contractors	3
20--	Food and Kindred Products	40
22--	Textile Mill Products	3
24--	Lumber and Wood Products	127
25--	Furniture and Fixtures	3
26--	Paper and Allied Products	14
27--	Printing, Publishing and Allied Industries	2
28--	Chemicals and Allied Products	40
29--	Petroleum and Coal Products	6
30--	Rubber and Miscellaneous Plastic Products	37
31--	Leather and Leather Products	1
32--	Stone, Clay and Glass Products	23
33--	Primary Metals Industries	13
34--	Fabricated Metal Products	62
35--	Industrial & Commercial Machinery and Computer Equipment	28
36--	Electronic and Other Electrical Equipment	7
37--	Transportation Equipment	33
38--	Measuring, Analyzing, and Controlling Instruments; Photographic; Optical Goods	1
39--	Miscellaneous Manufacturing Industries	6
40--	Railroad Transportation	11
41--	Local and Interurban Passenger Transportation	23
42--	Motor Freight Transportation and Warehousing	108
44--	Water Transportation	30
45--	Transportation by Air	21
47--	Transportation Services	2
49--	Electric, Gas, and Sanitary Services	42
50--	Wholesale Trade-Durable Goods	63
51--	Wholesale Trade Non-Durable Goods	23
52--	Building Materials, Hardware, Garden Supply, & Mobile Home Dealers	2
82--	Educational Services	1
95--	Environmental Quality Programs	2
	Total	**781**

Table 3. Total number of available data values by monitoring parameter identified in the general NPDES industrial stormwater permit.

Parameter	Total Number of Values
Turbidity	4479
pH	4442
Zinc, Total	4264
Oil & Grease	2651
Copper, Total	1177
Lead, Total	1034
BOD, 5 day, 20 deg. C	1105
Phosphorus, Total	410
Nitrogen, Nitrite + Nitrate, Total	397
Solids, Total Suspended	146
Nitrogen, Ammonia, Total	70
Oxygen, Dissolved	51
Benzoic Acid	46
Phenol	46
P-Cresol (4-Methylphenol)	44
Alpha-Terpineol	40
Coliform, Fecal	18
Mercury, Total	7
Nitrogen, Nitrate, Total	7
Chromium, Total	4
Cadmium, Total	2
Total Dissolved Gas	1

Unlike the four parameters noted above, the NPDES permit only requires routine sampling for total copper, total lead, biochemical oxygen demand (BOD), ammonia nitrogen, nitrate + nitrite nitrogen, and total phosphorus for specific industrial sectors. For example, monitoring for total copper and total lead is only required at facilities that fall into one of the following five industry sectors: Primary Metals, Metal Mining, Automobile Salvage, Scrap Recycling, or Metals Fabricating. Additionally, sampling for these parameters is required if data from a particular facility indicates the benchmark for total zinc has been exceeded for two consecutive quarters. Because of these less stringent sampling requirements, these six parameters are classified as intermediate with regard to the number of data values that are available. As shown in Table 3, the total number of values in this category ranges from 70 to 1,177.

The remaining 12 parameters in Table 3 are classified as low with regard to the number of data values that are available. The total number of values in this category ranges from 1 to 146. Furthermore, there are no specific benchmark or action levels identified in the NPDES permit for these parameters. Due to these considerations, subsequent analyses presented in this report focused on parameters in the high to intermediate data quantity categories. These ten parameters (i.e., turbidity, pH, total zinc, oil & grease, total copper, total lead, BOD, ammonia nitrogen, nitrate + nitrite nitrogen, and total phosphorus) are hereafter referred to as the "primary analysis parameters" within this report.

As noted above, data analyses presented within this report will examine trends in the industrial stormwater data across 13 industrial categories (see Table 1). The number of values that are available within each of these categories is shown in Table 4 for each of the primary analysis parameters. Similarly, the number of values that are available within each of the 35 industrial sectors is shown in Table 5 for these same parameters.

Table 4. Total number of data values for primary analysis parameters by industrial category.

	Number of Values per Parameter						
Industrial Category	Turbidity	pH	Zinc	Oil & Grease	Copper	Lead	BOD
01 - Facilities with effluent limitations	8	8	8	0	4	2	0
02 - Manufacturing	1327	1323	1233	722	280	230	743
03 - Mineral, metal, oil, and gas	24	24	23	23	1	1	0
04 - Hazardous waste treatment, or disposal facilities	0	0	0	0	0	0	0
05 - Landfills	135	135	120	75	22	21	64
06 - Recycling facilities	295	294	288	196	196	178	0
07 - Steam electric plants	3	3	3	1	0	0	0
08 - Transportation facilities	1010	988	959	557	196	169	8
09 - Treatment works	77	77	76	55	18	18	0
10 - Construction sites > 5 acres	6	6	6	6	0	0	0
11 - Light industrial activity	1450	1445	1412	950	440	396	275
12 - Significant contributor	7	7	4	0	0	0	0
NC - No category specified	137	132	132	66	20	19	15
Total	4479	4442	4264	2651	1177	1034	1105

Data Quality

The data quality for industrial stormwater was assessed based on a review of outliers, missing data, and data qualifiers that were present in the database that was obtained from Ecology. In total, there were 22,794 entries in the database with no value reported for various reasons. Three parameters (e.g., arsenic, chlorine, and guthion) had no results reported. There were also 181 facilities in the database that did not report any values. The primary reasons cited for not reporting values are summarized in Figure 1 based on the qualifiers present in the database. These data show that "No Qualifying Storm Event" was cited most frequently (72 percent of the time) for unreported values. Approximately 13 percent of the unreported values were listed as below detection limit; however, no detection limit was provided. Three additional qualifiers within the database (i.e., Not Reported, Value Not Submitted, and DMR Not Submitted) were cited 12 percent of the time for unreported values (these categories are collectively grouped under the "Not Reported" heading in Figure 1). The other frequently cited qualifiers for unreported data include: consistent attainment, equipment failure, incorrect analysis, laboratory error, lost sample, no discharge, and other.

Table 5. Total number of data values for primary analysis parameters by industrial category.

SIC Code	Category	Number of Values per Parameter						
		Turbidity	pH	Zinc, Total	Oil & Grease	Copper, Total	Lead, Total	BOD
07--	Agricultural Services	5	5	5	5			
08--	Forestry	7	7	4				
10--	Metal Mining	1	1	1	1	1	1	
12--	Coal Mining	9	9	9	9			
17--	Construction Special Trade Contractors	19	19	19	5	12	11	
20--	Food and Kindred Products	268	265	269	213	58	55	221
22--	Textile Mill Products	18	18	18	11	10	9	
24--	Lumber and Wood Products	799	784	734	382	83	67	615
25--	Furniture and Fixtures	14	14	12	9			
26--	Paper and Allied Products	77	80	79	69	8	8	20
27--	Printing, Publishing and Allied Industries	10	10	10				
28--	Chemicals and Allied Products	226	226	221	156	49	43	159
29--	Petroleum and Coal Products	27	27	23	18			
30--	Rubber and Miscellaneous Plastic Products	207	206	202	129	43	33	
31--	Leather and Leather Products	4	4	4	4			
32--	Stone, Clay and Glass Products	109	111	100	51	12	4	
33--	Primary Metals Industries	75	76	76	54	65	48	
34--	Fabricated Metal Products	307	302	291	192	215	192	
35--	Industrial & Commercial Machinery & Computer Equip.	86	91	79	36		1	
36--	Electronic and Other Electrical Equipment	63	65	65	53	10	8	
37--	Transportation Equipment	343	344	329	197	132	122	
38--	Measuring, Analyzing, and Controlling Instruments; Photographic; Optical Goods	8	8	8	8			
39--	Miscellaneous Manufacturing Industries	24	24	24	11	3	4	
40--	Railroad Transportation	54	54	50	26	10	8	
41--	Local and Interurban Passenger Transportation	101	100	101	54	13	9	
42--	Motor Freight Transportation & Warehousing	529	526	502	302	127	111	6
44--	Water Transportation	151	151	145	92	30	27	
45--	Transportation by Air	154	137	146	74	15	15	
47--	Transportation Services	4	4	4	3			2
49--	Electric, Gas, and Sanitary Services	250	250	224	153	37	36	64
50--	Wholesale Trade-Durable Goods	289	289	276	191	204	186	
51--	Wholesale Trade Non-Durable Goods	89	88	88	67	16	13	3
52--	Building Materials, Hardware, Garden Supply, & Mobile Home Dealers	2	2	1	1			
82--	Educational Services	1	1	1				
95--	Environmental Quality Programs	12	12	12	9	4	4	
	Total	4342	4310	4132	2585	1157	1015	1090

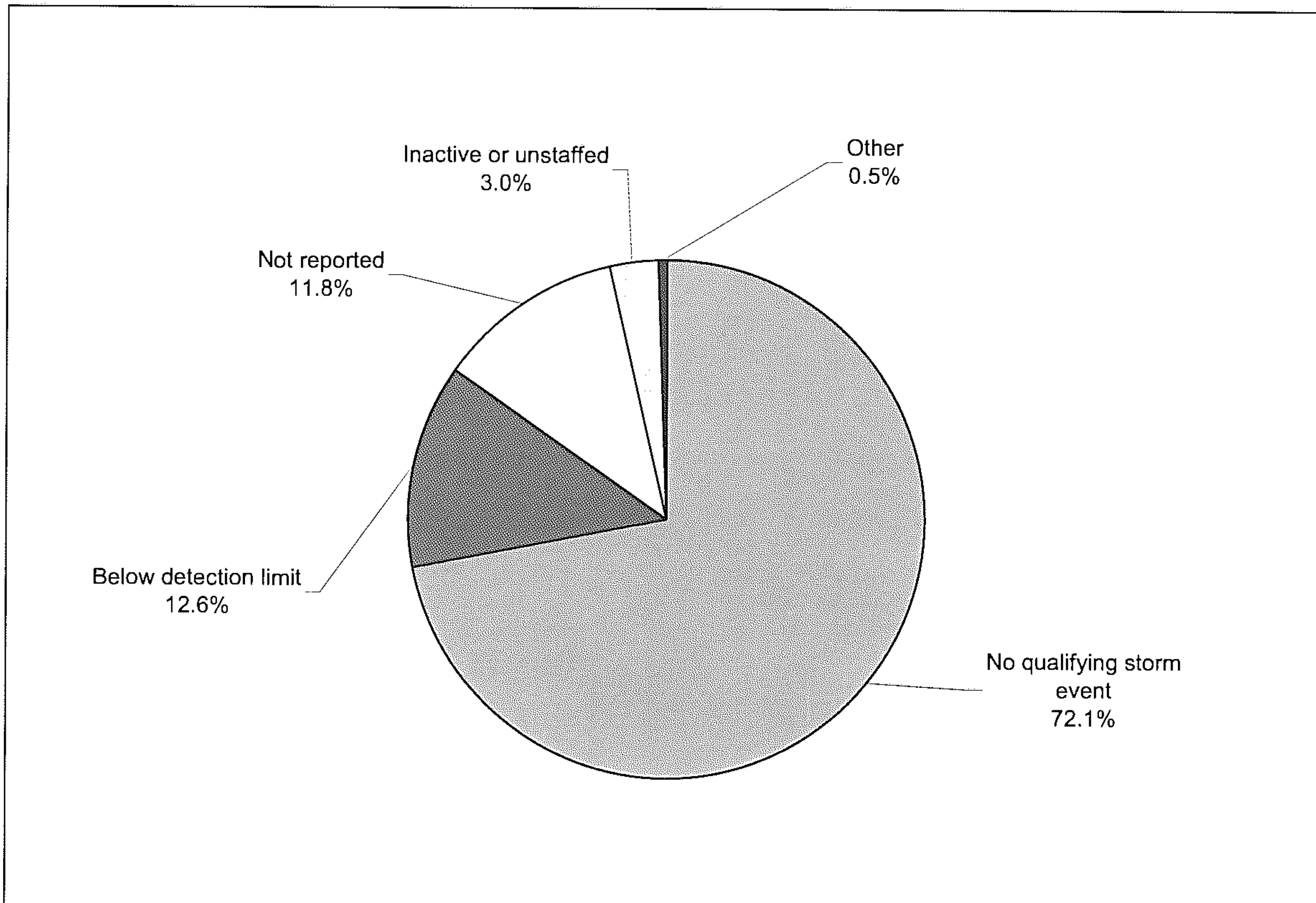

Figure 1. Distribution of unreported values for industrial stormwater by database qualifier.

The reported and unreported values were also summarized for each quarter to determine if the time of year made a difference in the reporting frequency (Table 6). The number entries in the database with the "No Qualifying Storm Event" qualifier was also tallied on a quarterly basis to determine if a lack of rainfall during dry seasons was a primary influence on reporting frequency. These data show there are not substantial differences between the total number of values reported for each quarter; however, the first quarter of 2003 was not included in this dataset, thus the number of values in this quarter only represent two years of sampling instead of three years for the 2nd, 3rd, and 4th quarters. Although the number of values reported on a quarterly basis did not vary greatly, the values not reported and the no qualifying storm event categories do appear to be substantially higher in the 2nd and 3rd quarters. This suggests that reporting frequency was lower during the summer period (April – Sept.) primarily due to a lack of qualifying storm events.

Table 6. Breakdown of reported values, unreported values, and no qualifying storm event values by quarter of the year.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Values reported	5533	5880	4634	5439
Values not reported	4362	8343	7885	4424
No qualifying storm event	*2159*	*5831*	*6200*	*2238*

Construction Stormwater

Data Source

In general, sources for construction stormwater data are extremely limited due to a lack of monitoring and reporting requirements prior to the issuance of the revised general NPDES construction stormwater permit in November 2005. Construction stormwater data that are analyzed within this report were obtained from an Ecology (2005) study that was implemented over two winter wet seasons in 2003/04 and 2004/05. The primary objective of this study was to obtain representative data to characterize the quality of stormwater discharged from construction sites. To meet this objective, a "snap-shot" survey of construction sites was conducted to measure turbidity, transparency, and total suspended solids (TSS) in their associated runoff. In addition to the collection of these data, monitoring personnel also documented site conditions during the surveys including site size, stage of construction, and the types of best management practices (BMPs) that were in use.

In order to conduct this survey, a list of 183 eligible construction sites in four counties within Western Washington (i.e., King, Snohomish, Pierce, and Thurston) was developed using Ecology's Water Quality Permit Life Cycle System (WPLCS) database. Site visits were then conducted at these construction sites and samples were collected if stormwater was observed discharging off-site. In summary, a total of 44 unique sites were sampled in connection with this effort. Out of the remaining 139 sites from the WPLCS database, eight could not be located, 13 had already completed construction, 15 had not yet started construction, and 103 had no discharge at the time of the site visit.

As noted above, Ecology monitoring personnel documented the conditions at each of 44 sampling sites. Based on this information, 36 percent of the sites were described as large (i.e., > 20 acres), 48 percent as medium (i.e., between 5 and 20 acres), 14 percent as small (i.e., < 5 acres), and 2 percent unclassified due to a lack of data. All 44 sites also had at least one of the following BMPs: storm drain protection, stormwater pond or basin, and disturbed soil protection (e.g., mulch, plastic, vegetation, or erosion control blankets). Finally, the Ecology monitoring personnel indicated that six of the sites discharged directly to receiving waters, all of which were small streams with widths of 2 to 5 feet. The remainder of the sites either allowed the stormwater water to infiltrate into the ground or discharged it to a municipal stormwater collection system.

Data Quantity

A total of 47, 49, and 50 values were obtained for transparency, turbidity, and TSS, respectively from sampling conducted at the 44 sites identified above. (Note that multiple samples were collected from several of the 44 sites.) These numbers are consistent with Ecology's goal of collecting at least 45 samples that was established at the study's onset.

Data Quality

The primary data quality issues for construction stormwater are the limited geographic and temporal coverage of the sampling. For example, sampling for this study was limited to a relatively small number of sites spread throughout four counties in Western Washington. Furthermore, the monitoring only spanned two winter seasons, both of which were drier than normal (Ecology 2005). Finally, the total number of values obtained from this study is relatively small. Therefore, definitive conclusions regarding construction stormwater quality cannot be inferred based on these data.

Data Analysis Methods

Analysis methods for the industrial and construction stormwater data are described in the following sections. The presentation of this information is organized under separate subsections for each of the data analysis goals identified in the introduction to this report.

Data Distribution

Tabular and graphical summaries were generated to show the distribution of the compiled industrial and construction stormwater data including: central tendency, variation or spread, skewness, and presence or absence of outliers. The tabular summaries specifically present the following summary statistics for each monitoring parameter:

- Sample size (total number of values)
- Mean
- Median
- Minimum
- 10th Percentile
- 90th Percentile
- Maximum
- Standard deviation
- Coefficient of variance (CV).

Graphical data summaries consisting of "box and whisker" plots were generated to present the following information: the 10th and 90th percentiles of the data as the lower and upper whiskers, respectively; the 25th and 75th percentiles of the data as the lower and upper boundaries of the box, respectively; and the median as the point in the box.

For the industrial stormwater data, the tabular and graphical summaries were generated for the ten primary analysis parameters identified previously. These summaries were organized to facilitate comparisons of the data across the 13 industrial categories (see Table 1). Additional tabular summaries with a subset of the summary statistics identified above were also generated to facilitate comparisons of the data across the 35 industrial sectors (see Table 2). However, these latter summaries are not presented or discussed within the main body of this report; rather, they are presented in Appendix A for reference only.

Only tabular data summaries were prepared for the construction stormwater data. These summaries present the statistics identified above for the transparency, turbidity, and TSS data that were compiled from Ecology (2005).

Comparison among Industrial Categories

Statistical analyses were performed on the data from the ten primary analysis parameters to determine whether there were significant differences in median concentrations across the industrial categories. To ensure that sufficient data were available to accurately describe the data distribution for each parameter, only those industrial categories with at least 25 samples were included in these analyses. In cases where more than two industrial categories had adequate numbers of samples, these statistical comparisons were made using a Kruskal Wallis test (Helsel and Hirch 1992). If the KruskalWallis test indicated that significant differences in median concentrations existed between one or more of the industrial categories, a follow-up nonparametric multiple range test (Zar 1984) was performed on the data to determine which specific categories were different from the others. In cases where only two industrial categories had adequate numbers of samples, the statistical comparisons were made using a Mann Whitney U test. For all tests, statistical significance was evaluated at an alpha level (α) of 0.05.

Comparison to NPDES Permit Benchmarks and Action Levels

In order to assess compliance with the general NPDES industrial stormwater permit, the compiled industrial stormwater data for turbidity, pH, total zinc, oil & grease, total copper, total lead, BOD, ammonia nitrogen, nitrite + nitrate nitrogen, and total phosphorus were compared to applicable benchmarks and action levels identified in Table 7. Similarly, the compiled construction stormwater data for turbidity were compared to the applicable benchmark (i.e., 50 nephelometric turbidity units [NTU]) and action level (i.e., 250 NTU) from the general NPDES construction stormwater permit. Based on these comparisons, the percentage of samples exceeding the benchmark and action levels was calculated. For the industrial stormwater data, these percentages were calculated for each individual industrial category in Table 1, Western Washington, Eastern Washington, and the entire state of Washington.

Table 7. Benchmark values and action levels identified in the general NPDES industrial stormwater permit.

Parameter	Benchmark	Action Level
BOD, 5 day, 20° C (mg/L)	30, 140[a]	60
Copper (µg/L)	63.6	149
Lead (µg/L)	81.6	159
Nitrogen, Ammonia, Total (mg/L)	10[a], 21.8	38
Nitrogen, Nitrite + Nitrate, Total (mg/L)	0.68	1.36
Oil & Grease (mg/L)	15	30
pH	range 6-9	range 5-10
Phosphorus, Total (mg/L)	2	4
Turbidity (NTU)	25	50
Zinc, Total (µg/L)	117	372

mg/L: milligrams/liter.
µg/L: microgram/liter.
NTU: nephelometric turbidity unit.
[a] The 140 mg/L benchmark for BOD and 10 mg/L benchmark for ammonia nitrogen are associated with non-hazardous waste landfills listed in the industrial category 05-Landfills.

Comparison to Hypothetical Water Quality Criteria

The task to determine whether dischargers covered under a general permit are in compliance with the surface water quality standards presents significant challenges. Compliance with Washington's water quality standards requires assessment of the discharger's compliance with the numeric criteria and narrative standards and policies. These physical and chemical criteria have been determined by the U.S. Environmental Protection Agency to be protective of aquatic life, human health, and sediment quality. They are periodically revised to incorporate the best available science. In the case of an individual discharger, Ecology conducts a reasonable potential analysis that compares pollutant concentrations in the discharge with the physical and chemical properties of the receiving water to determine compliance with the numeric criteria.

Water quality standards take into account potential dilution, ratio of dissolved to total metals, water effects ratios, and background concentration. These are site specific parameters. The calculations used for this study take into account only dilution and dissolved to total metals ratio.

The narrative standards and policies portion of the water quality standards are more difficult to quantify. They include such prohibitions as: no toxic substances in toxic amounts, no resulting increase of pollutant concentrations above background (the antidegradation policy), or the loss of a beneficial use. Compliance with narrative standards and policies require conducting site-specific studies of the discharge and its physical, chemical, and biological impacts to receiving water. Assessing compliance with the narrative standards and policies portion of the water quality standards is beyond the scope of the programmatic approach used in this report.

In order to determine if the designated uses of a water body, as defined in WAC 173-201A, are adequately maintained through the general NPDES industrial stormwater permit, the compiled industrial stormwater data for turbidity, total zinc, total copper, and total lead were compared to hypothetical water quality criteria based on a set of representative receiving water conditions and dilution factors. A similar approach was applied to the compiled construction stormwater data for turbidity to determine if the designated uses of a water body are adequately maintained through the general NPDES construction stormwater permit. Based on these comparisons, the percentage of samples that would potentially exceed the water quality criteria was calculated using all the compiled data for each parameter and only those data that did not exceed the benchmark. For the industrial stormwater data, these percentages were also calculated for each individual industrial category identified in Table 1.

To assess the sensitivity of these analyses, these percentages were calculated using three separate sets of representative receiving water conditions to represent typical, worst case, and best case scenarios for the potential to exceed water quality standards. For example, all the conditions (e.g., receiving water background pollutant concentration and hardness) selected under the worst case scenario would make it more likely that the water quality criteria would be exceeded for any given parameter.

The specific steps that were used to compare sample concentrations to the water quality criteria are as follows:

1. Typical, worst case, and best case background concentrations for each parameter were generated for western and eastern Washington, respectively, based on queries of Ecology's Environmental Information Management System (EIM) database (Ecology, 2006). More specifically, the EIM database was queried to obtain data from river systems in each region of the state for the targeted parameters (i.e., turbidity, total zinc, total copper, and total lead). The typical scenario for total zinc, total copper, and total lead was developed using the mean value from the dataset for each parameter. The worst case scenario used the 75th percentile, and the best case the 25th percentile. The typical scenario for turbidity was developed using the mean value from the dataset, the worst case scenario used the 25th percentile, and the best case the 75th percentile. These concentrations are presented in Table 8.

Table 8. Representative theoretical background concentrations of pollutants for receiving water conditions in western and eastern Washington.

	Dissolved Copper µg/L	Dissolved Lead µg/L	Dissolved Zinc µg/L	Turbidity NTU
Western Washington				
Worst-Case	1.5	0.24	5.0	1.7
Typical	0.77	0.047	1.8	3.8
Best-Case	0.46	0.021	1.0	10
Eastern Washington				
Worst-Case	1.18	0.3	33	1.4
Typical	0.71	0.088	3.3	3.8
Best-Case	0.49	0.023	1.0	10

Data source: Queries of Environmental Information Management system; Ecology (2006).
µg/L: microgram/liter.
NTU: nephelometric turbidity unit.

2. Using the sample concentrations from the compiled industrial and construction stormwater, a theoretical receiving water concentration at the facility's point of discharge was calculated using the typical, worst case, and best case background concentrations from Step 1, and assumed dilution factors within the receiving water of 0, 10, 25, and 50 for the facility's stormwater discharge. The following equation was used to make these calculations for the 2.5, 5, and 10 dilution factors:

$$C_r = (1/F_d \times C_f) + ([1 - 1/F_d] \times C_b)$$

where:

C_r = receiving water concentration at facility point of discharge
F_d = dilution factor

C_f = stormwater sample concentration from facility
C_b = receiving water background concentration.

3. Theoretical receiving water concentrations computed for total zinc, total copper, and total lead from Step 2 were converted to dissolved concentrations to facilitate comparisons to the water quality criteria which are based on the dissolved forms of these metals. These conversions were made using "translator values" that were derived from guidance presented by Pelletier (1996). Because these translator values vary depending on the TSS concentration in the receiving water, the EIM database was again queried to obtain typical, worst case, and best case concentrations for this parameter in eastern and western Washington, respectively. The typical scenario was developed using the mean value from each dataset, the worst case scenario used the 25th percentile, and the best case the 75th percentile. These TSS concentrations and the associated translator values are presented in Table 9.

Table 9. Assumed total suspended solids concentrations and associated translator values for converting total metal concentrations to dissolved concentrations for receiving waters in western and eastern Washington.

	Assumed TSS Concentrations [a] (mg/L)	Copper Translator	Lead Translator	Zinc Translator
		Western Washington		
Worst-Case	2	1	0.466	1
Typical	5	1	0.466	1
Best-Case	14	0.931	0.466	0.973
		Eastern Washington		
Worst-Case	3	1	0.466	1
Typical	7	1	0.466	1
Best-Case	23	0.786	0.466	0.868

[a] Data source: Queries of Environmental Information Management system; Ecology (2006).

4. Theoretical receiving water concentrations from Step 2 (turbidity only) and Step 3 (dissolved zinc, dissolved copper, and dissolved lead) were compared to hypothetical water quality criteria. Because state water quality standards for zinc, copper, and lead vary with the hardness of the receiving water, the EIM database was again queried to obtain typical, worst case, and best case concentrations for this parameter in eastern and western Washington, respectively. The typical scenario was developed using the mean value from each dataset, the worst case scenario used the 25th percentile, and the best case the 75th percentile. These hardness concentrations were used to determine the water quality criteria which are

presented in Table 10. The state water quality standard for turbidity requires that stormwater related increases in the receiving water not exceed background turbidity by 5 NTU. To assess compliance with the hypothetical water quality criterion in this analysis, the theoretical receiving water turbidity levels from Step 2 were compared to the background turbidity levels presented in Table 8. If more than a 5 NTU increase was observed, it was assumed that the water quality criterion for turbidity was exceeded.

Table 10. Hypothetical acute and chronic water quality criteria for metals in receiving waters of western and eastern Washington.

	Assumed Hardness [a] (mg/L as $CaCO_3$)	Dissolved Copper		Dissolved Lead		Dissolved Zinc	
		Acute µg/L	Chronic µg/L	Acute µg/L	Chronic µg/L	Acute µg/L	Chronic µg/L
Western Washington							
Worst-Case	18	3.4	2.6	9.6	0.37	27	24
Typical	25	4.6	3.5	14	0.54	35	32
Best-Case	36	6.5	4.7	21	0.81	48	44
Eastern Washington							
Worst-Case	35	6.3	4.6	20	0.79	47	43
Typical	68	12	8.2	42	1.6	83	75
Best-Case	100	17	11	65	2.5	114	105

[a] Hardness used to compute water quality criteria for copper, lead, and zinc. Data source: Queries of Environmental Information Management system; Ecology (2006).
mg/L: milligrams/liter.
µg/L: microgram/liter.

5. For each parameter, the percentage of samples exceeding the water quality criteria was calculated based on all the compiled data and only those data that did not exceed the benchmark. For the industrial stormwater data, these percentages were calculated for each individual industrial category identified in Table 1. These results were then compiled in summary tables.

Data Analysis Results

Data analysis results from the compiled monitoring data are presented herein. These results are organized under separate subsections for industrial and construction stormwater data.

Industrial Stormwater

Data analysis results for industrial stormwater are summarized below under separate sections for each of the primary analysis parameters. For each parameter, the results are presented in relation to the study objectives that were identified in the introduction to this report. Specifically, separate subsections present results for the each of the following analyses as described in the previous section: data distribution, comparison among industrial categories, comparison to NPDES permit benchmarks and action levels, and comparison to state water quality standards (if applicable).

Turbidity

Data Distribution

Tabular and graphical data summaries for turbidity levels are provided in Table 11 and Figure 2, respectively, by individual industrial category and for all categories combined. Tabular data summaries for turbidity are also provided in Appendix A by industrial sector; however, these data are presented for reference only and are not discussed herein. Turbidity had the largest quantity of data of all the parameters with 4,479 values across all the industrial categories. The mean and median values from these data were 66 and 15 NTU, respectively; and the coefficient of variation was 4.1. The asymmetrical shape of the box plots presented in Figure 2 indicate that the turbidity data have a right-skewed distribution due to the presence of numerous outliers in the upper end of the data range. Across all industrial categories, the 90^{th} percentile and maximum values for the data were 120 and 9,700 NTU, respectively.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of turbidity levels were only available in the following seven industrial categories (Table 11). Results from these analyses (i.e., Kruskal Wallis test and follow-up multiple range test) indicate the data can generally be differentiated into two groups with low and high median turbidity levels, respectively (Table 12). Specifically, median levels for the Treatment Works (09), Landfills (05), No Category Specified, and Light Industrial Activity (11) categories were significantly lower than those for the remaining three categories: Transportation Facilities (08), Recycling Facilities (06), and Manufacturing (02).

Table 11. Summary statistics for turbidity levels measured in industrial stormwater by industry category.

Industry Category	n	Mean (NTU)	Median (NTU)	Minimum (NTU)	10th Percentile (NTU)	90th Percentile (NTU)	Maximum (NTU)	Std. Dev. (NTU)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
01 - Facilities with effluent limitations	8	6.7	5.0	1.9	1.9	14	14	4.9	0.73	0%	0%
02 - Manufacturing	1,327	93	20	0.16	3.1	180	9,700	356	3.84	45%	27%
03 - Mineral, metal, oil, and gas	24	8.3	3.2	0.43	1.1	22	52	12	1.51	8%	4%
05 - Landfills	135	15	7.9	0.48	1.4	37	165	21	1.44	16%	4%
06 - Recycling facilities	295	58	19	0.0	3.3	156	710	104	1.80	42%	27%
07 - Steam electric plants	3	9	10	3.7	3.7	12	12	4.4	0.50	0%	0%
08 - Transportation facilities	1,010	81	17	0	2.7	142	5,380	319	3.94	40%	24%
09 - Treatment works	77	13	5.7	0.4	1.0	28	100	18	1.39	10%	8%
10 - Construction sites > 5 acres	6	42	19	4.5	4.5	173	173	65	1.55	50%	17%
11 - Light industrial activity	1,450	45	12	0.05	2.1	77	5,490	189	4.17	31%	16%
12 - Significant contributor	7	31	2.5	1.5	1.5	149	149	56	1.80	29%	29%
No category specified	137	38	8.4	0.7	2.7	72	1,190	118	3.13	24%	15%
All categories	4,479	66	15	0	2.4	120	9,700	272	4.10	37%	21%

[a] Benchmark for turbidity is 25 NTU.
[b] Action level for turbidity is 50 NTU.
Std. Dev.: Standard Deviation.

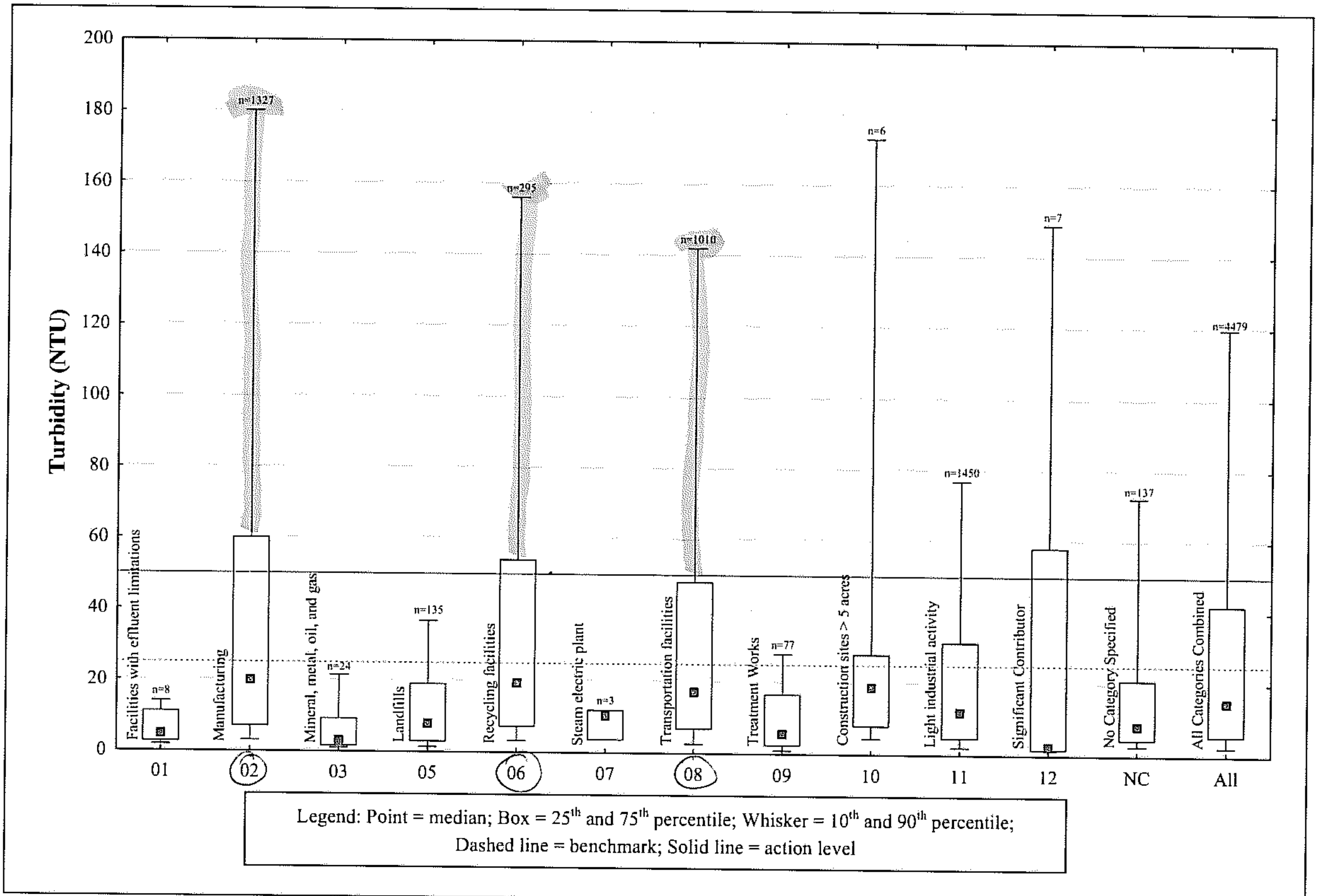

Figure 2. Turbidity levels measured in industrial stormwater by industrial category.

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Table 12. Comparison of median concentrations for industrial stormwater pollutants across industrial sectors.

Parameter	p-value [a]	Industrial Category						
		Low Mean Rank						High Mean Rank
Turbidity	**< 0.0001**	09	05	NC	11	08	06	02
pH	**< 0.0001**	11	NC	02	09	08	06	05
Total Zinc	**< 0.0001**	05	09	06	02	08	NC	11
Oil and Grease	**< 0.0001**	09	11	02	NC	05	08	06
Total Copper	0.4909	02		06		08		11
Total Lead	**< 0.0001**	11		02		08		06
BOD	**< 0.0001**	05			02			11

[a] Values in bold indicate significant differences exist between industrial categories based on a Kruskal Wallis test ($\alpha = 0.05$).
[b] Industrial categories connected by a single unbroken line are not significantly different based on a nonparametric multiple range test.

Comparison to NPDES Permit Benchmarks and Action Levels

Analyses performed across all 13 industrial categories showed that 37 and 21 percent of the samples had turbidity values that exceeded the applicable benchmark (25 NTU) and action level (50 NTU), respectively (Table 11). Considering only the seven industrial categories in Table 11 with a relatively large number of samples (i.e., n > 25), the benchmark and action level for turbidity were exceeded in at least 40 and 24 percent of the samples, respectively, in the following three industrial categories: Manufacturing (02), Recycling Facilities (06), and Transportation Facilities (08). The benchmark and action level for turbidity were exceeded in fewer than 31 and 16 percent of the samples, respectively, for the remaining four industrial categories: Landfills (05), Treatment Works (09), Light Industrial Activity (11), and No Category Specified.

Comparison to Hypothetical Water Quality Criteria

Results from the comparisons of sample concentrations to the hypothetical water quality criterion for turbidity are summarized in Table 13 for western Washington, eastern Washington, and the entire state. The results are subdivided within this table to show the percentage of samples exceeding the applicable criterion based on all collected samples versus only those samples with concentrations below the benchmark. The presentation of these results is also organized under separate subsections below based on these divisions of the data. Finally, Appendix B (Tables B-1 and B-2) provides a more detailed data summary with comparisons by industrial category for samples collected in eastern and western Washington.

All Collected Samples

Analyses of the compiled data showed high percentages of samples exceeding the hypothetical water quality criterion for turbidity with dilution factors of 0 and 10; however, these percentages declined considerably with dilution factors of 25 and higher (Table 13). For example, across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the criterion were 64 and 20 percent given the "typical" receiving water conditions described previously and dilution factors of 0 and 10, respectively. Given the same receiving water conditions and dilution factors of 25 and 50, these percentages dropped to 9 and 5 percent, respectively.

Table 13. Percentage of turbidity samples exceeding the state water quality criterion given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Criterion (%)[a]			
	n	0 DF	10 DF	25 DF	50 DF
		All Samples			
Western Washington	4280	64 (49-70)	20 (18-21)	9 (9)	5 (5)
Eastern Washington	184	80 (65-87)	27 (25-30)	17 (15-17)	8 (8)
All Washington	4464	65 (50-71)	21 (18-21)	10 (9-10)	5 (5)
		Samples with Values ≤ Benchmark			
Western Washington	2740	44 (21-54)	0 (0)	0 (0)	0 (0)
Eastern Washington	85	56 (25-72)	0 (0)	0 (0)	0 (0)
All Washington	2825	44 (21-54)	0 (0)	0 (0)	0 (0)

[a] Values represent the percentage of sample exceeding the water quality criterion based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

Analyses of spatial patterns in the data indicated the percentage of samples exceeding the water quality standard for turbidity was somewhat higher in eastern Washington relative to western Washington (Table 13). For example, 80 to 27 percent of the samples in eastern Washington exceeded the criterion with the typical receiving water conditions and dilution factors of 0 and 10, respectively. With the same receiving water conditions and dilution factors, only 64 to 20 percent of the samples, respectively, exceeded the criterion in western Washington.

The analyses also showed there were substantial differences in the percentages of samples exceeding the water quality criterion for turbidity between industrial categories when lower dilution factors (e.g., 0 and 10) were assumed. For example, when comparing only those industrial categories in Table B-1 with a relatively large sample size (i.e., n > 25), the percentage of samples in western Washington that exceeded the criterion ranged from 39 percent for Treatment Works (09) to 72 percent for Manufacturing (02), assuming the typical receiving water conditions and a dilution factor of 0. Similarly, the percentage of samples in eastern Washington that exceeded the criterion (Table B-1) ranged from 76 percent for Manufacturing (02) to 84 percent for Transportation Facilities (08) assuming the same receiving water conditions and dilution factor. When higher dilution factors (e.g., > 10) were assumed for both eastern and western Washington, the percentages of samples exceeding the water quality criterion were similarly low (<25 percent) across all categories.

Samples with Concentrations Below the Benchmark

In contrast to the results above, analyses performed on the subset of samples with concentrations below the benchmark showed that the hypothetical water quality criterion for turbidity was only exceeded when a dilution factor of 0 was assumed. More specifically, across the entire state of Washington and all 13 industrial categories, the percentage of samples that exceeded the criterion was 44 percent given the "typical" receiving water conditions and a dilution factor of 0 (Table 13). This percentage dropped to 0 assuming the same receiving water conditions and a dilution factor of 10 or higher.

pH — No outlier groups.

Data Distribution

Tabular and graphical data summaries for pH for individual industrial categories and for all categories combined are provided in Table 14 and Figure 3, respectively. Tabular data summaries by industrial sector for pH are also provided in Appendix A. Based on all 4,442 pH values present in the database, the mean and median levels for this parameter were 7.1 and 6.7, respectively, across all of the industrial categories; and the coefficient of variation was 0.12. The mean pH value from this study was generally similar to those reported from other studies. For example, Stenstrom and Lee (2005) reported mean pH values of 7.01 and 7.16 from monitoring data compiled from general NPDES industrial stormwater permits in Los Angeles County, CA and Sacramento County, CA, respectively. The same authors reported a slightly lower mean pH value (6.32) for the state of Connecticut. Coefficients of variation for pH in these same studies ranged from 0.17 to 0.95.

The box plots presented in Figure 3 indicate that the distribution of the data complied for this analysis is relatively symmetrical around the median. The 90th percentile and maximum values for the pH data were 7.6 and 11.6, respectively. (Note that five outliers were eliminated from the dataset prior to this analysis because they exceeded the acceptable range for pH [i.e., 0-14]).

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of pH levels were only available in seven industrial categories (Table 14). Results from these analyses (Table 12) indicate that Light Industrial Activity (11) had a lower median concentration relative to Transportation Facilities (08), Landfills (05), and Recycling Facilities (06). Median turbidity levels in all other remaining industrial categories (Manufacturing (02), Treatment Works (09),

Table 14. Summary statistics for pH levels measured in industrial stormwater by industry category.

Industrial Category	n	Mean	Median	Minimum	10th Percentile	90th Percentile	Maximum	Std. Dev.	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
01 - Facilities with effluent limitations	8	6.3	6.0	6.0	6.0	7.0	7.0	0.46	0.07	0%	0%
02 - Manufacturing	1,323	6.6	6.7	2.0	5.5	7.7	11.6	0.97	0.15	18%	3%
03 - Mineral, metal, oil, and gas	24	7.4	7.3	6.4	6.9	8.0	8.0	0.44	0.06	0%	0%
05 - Landfills	135	6.9	6.9	5.0	6.1	7.5	8.3	0.58	0.08	6%	1%
06 - Recycling facilities	294	6.8	7.0	2.2	6.0	7.6	10.0	0.77	0.11	8%	1%
07 - Steam electric plants	3	7.0	7.0	6.9	6.9	7.0	7.0	0.06	0.01	0%	0%
08 - Transportation facilities	988	6.7	6.7	2.2	6.0	7.5	10.6	0.75	0.11	12%	1%
09 - Treatment works	77	6.8	6.8	5.4	6.0	7.4	7.9	0.53	0.08	8%	0%
10 - Construction sites > 5 acres	6	6.3	6.0	5.4	5.4	7.8	7.8	0.88	0.14	50%	0%
11 - Light industrial activity	1,445	6.6	6.6	1.0	5.6	7.4	10.0	0.78	0.12	16%	2%
12 - Significant contributor	7	5.8	6.0	5.0	5.0	6.5	6.5	0.49	0.08	43%	0%
No category specified	132	6.5	6.6	4.4	5.5	7.5	8.2	0.73	0.11	14%	1%
All categories	4,442	7.1	6.7	1.0	5.5	7.6	11.6	0.83	0.12	14%	2%

[a] Benchmark for pH is <6 or >9.
[b] Action level for pH is <5 or >10.
Std. Dev.: Standard Deviation.

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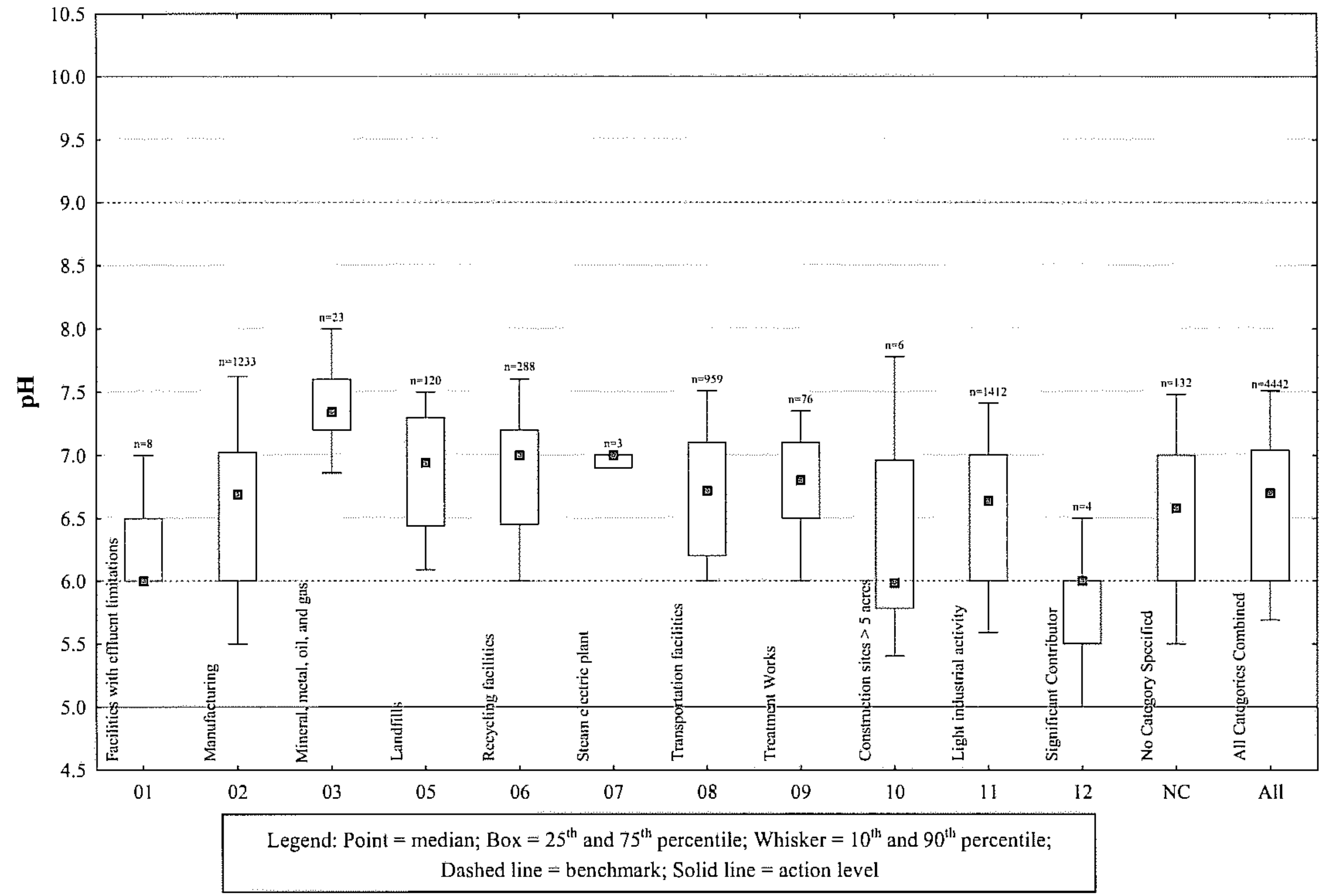


Figure 3. Levels of pH measured in industrial stormwater by industrial category.

and No Category Specified) were intermediate between these two groups and were generally not differentiated in the statistical analysis.

Comparison to NPDES Permit Benchmarks and Action Levels

As shown in Table 14, analyses performed across all 13 industrial categories showed that only 14 and 2 percent of the samples exceeded the applicable benchmark (pH <6 or pH >9) and action level (pH <5 or pH >10), respectively. Considering only the seven industrial categories in Table 14 with a relatively large number of samples (i.e., n > 25), Manufacturing (02) had the highest percentage of samples exceeding the benchmark and action level at 18 and 3 percent, respectively.

Total Zinc

Data Distribution

Tabular and graphical data summaries for total zinc concentrations are provided in Table 15 and Figure 4, respectively, by individual industrial category and for all categories combined. Tabular data summaries for total zinc are also provided in Appendix A by industrial sector. Based on all 4,264 total zinc values that were present in the database, the mean and median concentrations for this parameter were 469 and 139 micrograms per liter (μg/L), respectively, across all the industrial categories; and the coefficient of variation was 7.1. The mean value from this study was generally low relative to the mean value from other studies. For example, Stenstrom and Lee (2005) reported mean values ranging from 510 to 4,960 μg/L for total zinc based on data that were compiled through general NPDES industrial stormwater permits in the following jurisdictions: Los Angeles County, CA; Sacramento County, CA; and the State of Connecticut. The coefficients of variation for total zinc from this same dataset ranged from 7.59 to 13.85.

The asymmetrical shape of the box plots presented in Figure 4 indicate that the total zinc concentrations compiled for this analysis have a right-skewed distribution due to the presence of numerous outliers in the upper end of the data range. Across all industrial categories, the 90th percentile value for the data was 692 μg/L. The maximum (130,000 μg/L) represents an extreme outlier that may indicate the associated value was incorrectly entered in the DMR or database.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of total zinc concentrations were only available in seven industrial categories (Table 15). Results from these analyses (Table 12) indicate the data can be differentiated into two groups with low and high median total zinc concentrations, respectively. Specifically, median concentrations for the Landfills (05) and Treatment Works (09) categories were significantly lower than those for the remaining five categories: Manufacturing (02), Recycling Facilities (06), Transportation Facilities (08), Light Industrial Activity (11), and No Category Specified.

Table 15. Summary statistics for total zinc concentrations measured in industrial stormwater by industry category.

Industrial Category	n	Mean (µg/L)	Median (µg/L)	Minimum (µg/L)	10th Percentile (µg/L)	90th Percentile (µg/L)	Maximum (µg/L)	Std. Dev. (µg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
01 - Facilities with effluent limitations	8	1639	1600	520	520	3110	3,110	779	0.48	100%	100%
02 - Manufacturing	1,233	321	140	0.02	19.0	722	8,110	653	2.03	55%	22%
03 - Mineral, metal, oil, and gas	23	80.2	30.0	2.00	9.00	220	650	147	1.83	17%	4%
05 - Landfills	120	158	35.0	0.002	6.00	347	4,400	457	2.89	18%	8%
06 - Recycling facilities	288	308	119	2.00	24.0	730	6,410	580	1.88	50%	23%
07 - Steam electric plants	3	41.6	34.0	17.8	17.8	73.0	73	28.4	0.68	0%	0%
08 - Transportation facilities	959	318	146	0.136	25.1	604	16,200	810	2.54	57%	20%
09 - Treatment works	76	122	43.6	1.00	12.0	300	1,140	199	1.63	29%	7%
10 - Construction sites > 5 acres	6	796	368	180	180	2600	2,600	931	1.17	100%	50%
11 - Light industrial activity	1,412	774	150	0.00	32.6	750	130,000	5645	7.29	58%	23%
12 - Significant contributor	4	16.3	9.00	0.021	0.021	47.0	47.0	21.2	1.30	0%	0%
No category specified	132	533	149.5	0.255	20.0	881	18,200	1790	3.36	58%	28%
All categories	4,264	469	139	0	20.4	692	130,000	3317	7.06	55%	21%

[a] Benchmark for zinc is 117 µg/L.
[b] Action level for copper is 372 µg/L.
Std. Dev.: Standard Deviation.
µg/L: microgram/liter.

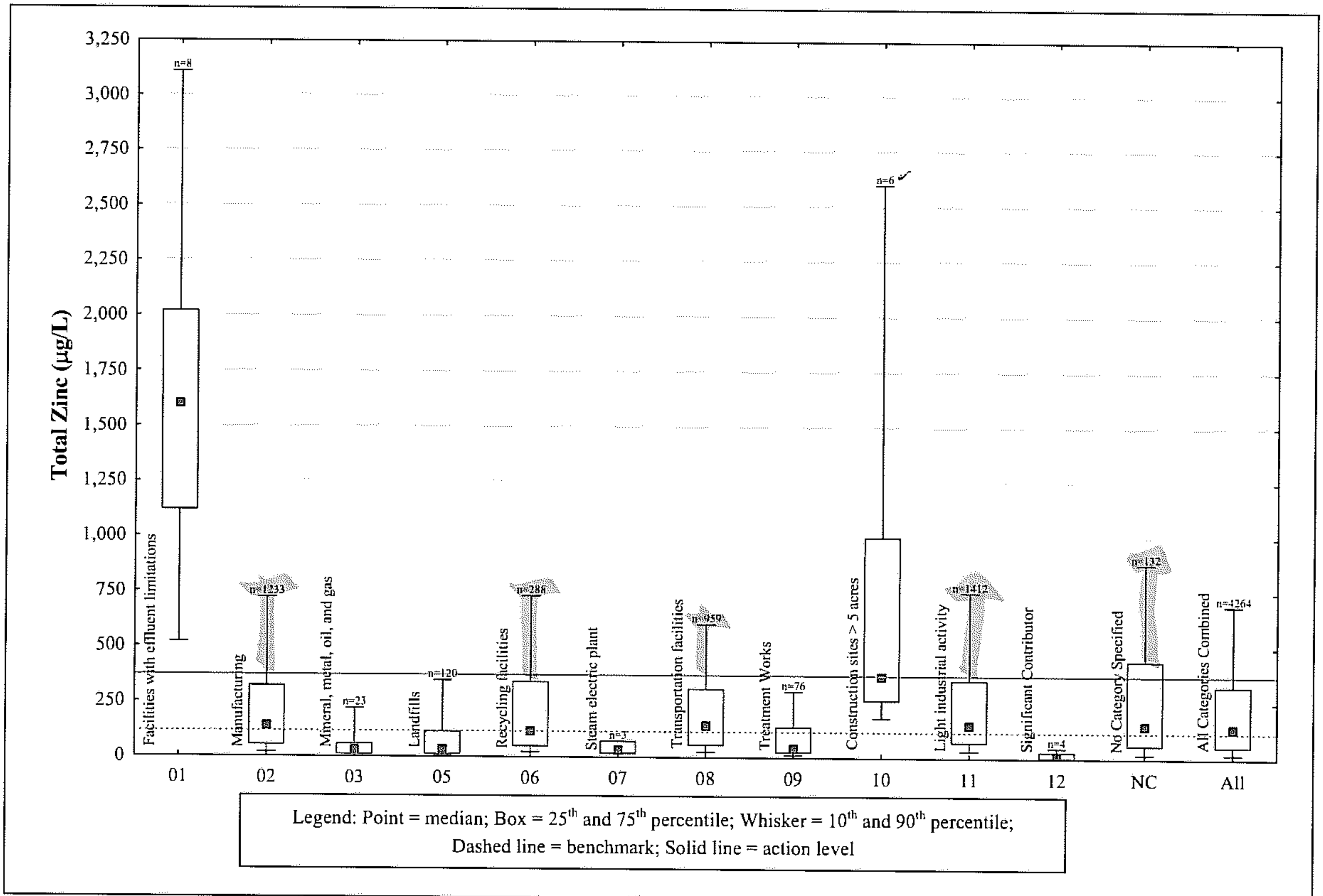


Figure 4. Total zinc concentrations measured in industrial stormwater by industrial category.

Comparison to NPDES Permit Benchmarks and Action Levels

As shown in Table 15, analyses performed across all 13 industrial categories showed that 55 and 21 percent of the samples had total zinc concentrations that exceeded the applicable benchmark (117 μg/L) and action level (372 μg/L), respectively. Considering only the seven industrial categories in Table 15 with a relatively large number of samples (i.e., n > 25), the benchmark and action level for total zinc were exceeded in at least 50 and 20 percent of the samples, respectively, in the following five industrial categories: Manufacturing (02), Recycling Facilities (06), Transportation Facilities (08), Light Industrial Activity (11), and No Category Specified. The benchmark and action level for total zinc were exceeded in fewer than 30 and 8 percent of the samples, respectively, for the remaining two industrial categories: Landfills (05) and Treatment Works (09).

Comparison to Hypothetical Water Quality Criteria

Results from the comparisons of sample concentrations to the hypothetical water quality criterion for dissolved zinc are summarized in Table 16 for western Washington, eastern Washington, and the entire state. The results are subdivided within this table to show the percentage of samples exceeding the applicable criterion based on all collected samples versus only those samples with concentrations below the benchmark. The presentation of these results is also organized under separate subsections below based on these divisions of the data. Finally, Appendix B (Tables B-3 and B-4) provides a more detailed data summary with comparisons by industrial category for samples collected in eastern and western Washington.

All Collected Samples

Similar to the results presented above for turbidity, analyses of the compiled data showed high percentages of samples exceeding the hypothetical water quality criterion for dissolved zinc with dilution factors of 0 and 10; however, these percentages declined considerably with dilution factors of 25 and higher (Table 16). For example, across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the criterion were 83 and 24 percent given the typical receiving water conditions and dilution factors of 0 and 10, respectively. Given the same receiving water conditions and dilution factors of 25 and 50, these percentages dropped to 7 and 3 percent, respectively. Nearly identical results were obtained from comparisons of the data to the chronic criterion for dissolved zinc (see Table 16).

Analyses of spatial patterns in the data indicated the percentage of samples exceeding the water quality criterion for dissolved zinc was only slightly higher in western Washington relative to eastern Washington (Table 16). For example, 84 to 24 percent of the samples in western Washington exceeded the criterion with the typical receiving water conditions and dilution factors of 0 and 10, respectively. With the same receiving water conditions and dilution factors, 70 to 10 percent of the samples, respectively, exceeded the criterion in eastern Washington. A similar pattern was observed in the data when comparisons were made to the chronic criterion for dissolved zinc (see Table 16).

Table 16. Percentage of total zinc samples exceeding state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Acute Criterion (%) [a]				Exceedance of Chronic Criterion (%) [a]			
	n	0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
All Samples									
Western Washington	4066	84 (79-88)	24 (16-35)	7 (5-14)	3 (2-6)	85 (80-88)	26 (17-39)	9 (6-16)	4 (2-6)
Eastern Washington	183	70 (58-83)	10 (4-50)	3 (1-25)	1 (1-12)	75 (60-85)	13 (5-58)	3 (1-33)	1 (1-16)
All Washington	4249	83 (78-88)	24 (15-36)	7 (5-14)	3 (2-6)	85 (79-88)	26 (17-40)	8 (5-16)	4 (2-7)
Samples with Values ≤ Benchmark									
Western Washington	1847	65 (54-73)	0 (0)	0 (0)	0 (0)	67 (57-75)	0 (0)	0 (0)	0 (0)
Eastern Washington	70	23 (0-54)	0 (0)	0 (0)	0 (0)	34 (0-60)	0 (0)	0 (0)	0 (0)
All Washington	1917	63 (52-72)	0 (0)	0 (0)	0 (0)	66 (55-74)	0 (0)	0 (0)	0 (0)

[a] Values represent the percentage of sample exceeding the water quality criteria based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

In comparisons made between the seven industrial categories in western Washington with a relatively large sample size (i.e., n > 25), the percentage of samples that exceeded the acute criterion for dissolved zinc ranged from 56 percent for Treatment Works (09) to 89 percent for Light Industrial Activity (11), assuming the typical receiving water conditions and a dilution factor of 0 (see Table B-3). Similarly, for the three industrial categories in eastern Washington with a large sample size, the percentage of samples that exceeded the criterion ranged from 47 percent for Transportation Facilities (08) to 87 percent for Manufacturing (02), assuming the same receiving water conditions and dilution factor. When higher dilution factors (e.g., > 10) were assumed for both eastern and western Washington, the percentages of samples exceeding the criterion were similarly low (< 25 percent) across all categories. Nearly identical results were obtained from comparisons of the data to the chronic criterion for dissolved zinc (see Table B-3).

Samples with Concentrations Below the Benchmark

Analyses performed on the subset of samples with concentrations below the benchmark showed that the acute and chronic water quality criteria for dissolved zinc were only exceeded when a dilution factor of 0 was assumed. For example, across the entire state of Washington and all 13 industrial categories, the percentage of samples that exceeded the acute criterion was 63 percent given the typical receiving water conditions and a dilution factor of 0 (Table 16). This percentage dropped to 0 assuming the same receiving water conditions and a dilution factor of 10 or higher. Nearly identical results were obtained from comparisons of the data to the chronic criterion for dissolved zinc.

Oil and Grease

Data Distribution

Tabular and graphical data summaries for oil and grease concentrations are provided in Table 17 and Figure 5, respectively, for each industrial category and for all of the categories combined. Tabular data summaries for oil and grease are also provided in Appendix A by industrial sector. Based on all 2,651 oil and grease values that were present in the database, the mean and median concentrations for this parameter were 7.6 and 5.0 milligram per liter (mg/L), respectively, across all the industrial categories; and the coefficient of variation was 3.3. For comparison, Stenstrom and Lee (2005) reported mean values ranging from 5.66 to 11.26 mg/L for oil and grease based on data that were compiled through general NPDES industrial stormwater permits in the following jurisdictions: Los Angeles County, CA; Sacramento County, CA; and the State of Connecticut. The coefficients of variation for total zinc from this dataset ranged from 1.61 to 14.57. The box plots presented in Figure 5 indicate that the oil and grease data frequently have a left-skewed distribution that is most likely related to large numbers of non detect values that are present in the database. Across all industrial categories, the 90th percentile and maximum values for oil and grease were 12 and 914 mg/L, respectively.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of oil and grease concentrations were only available in seven industrial categories (Table 17). Results from these analyses (Table 12) indicate the data can be differentiated into two groups with low and high median oil and grease concentrations, respectively. Specifically, median concentrations for the Treatment Works (09), Light Industrial Activity (11), and Manufacturing (02) categories were significantly lower than those for Recycling Facilities (06) and Transportation Facilities (08). The remaining two categories (No Category Specified and Landfills [05]) had median concentrations that were intermediate between these two groups and were generally not differentiated from the others in the statistical analysis.

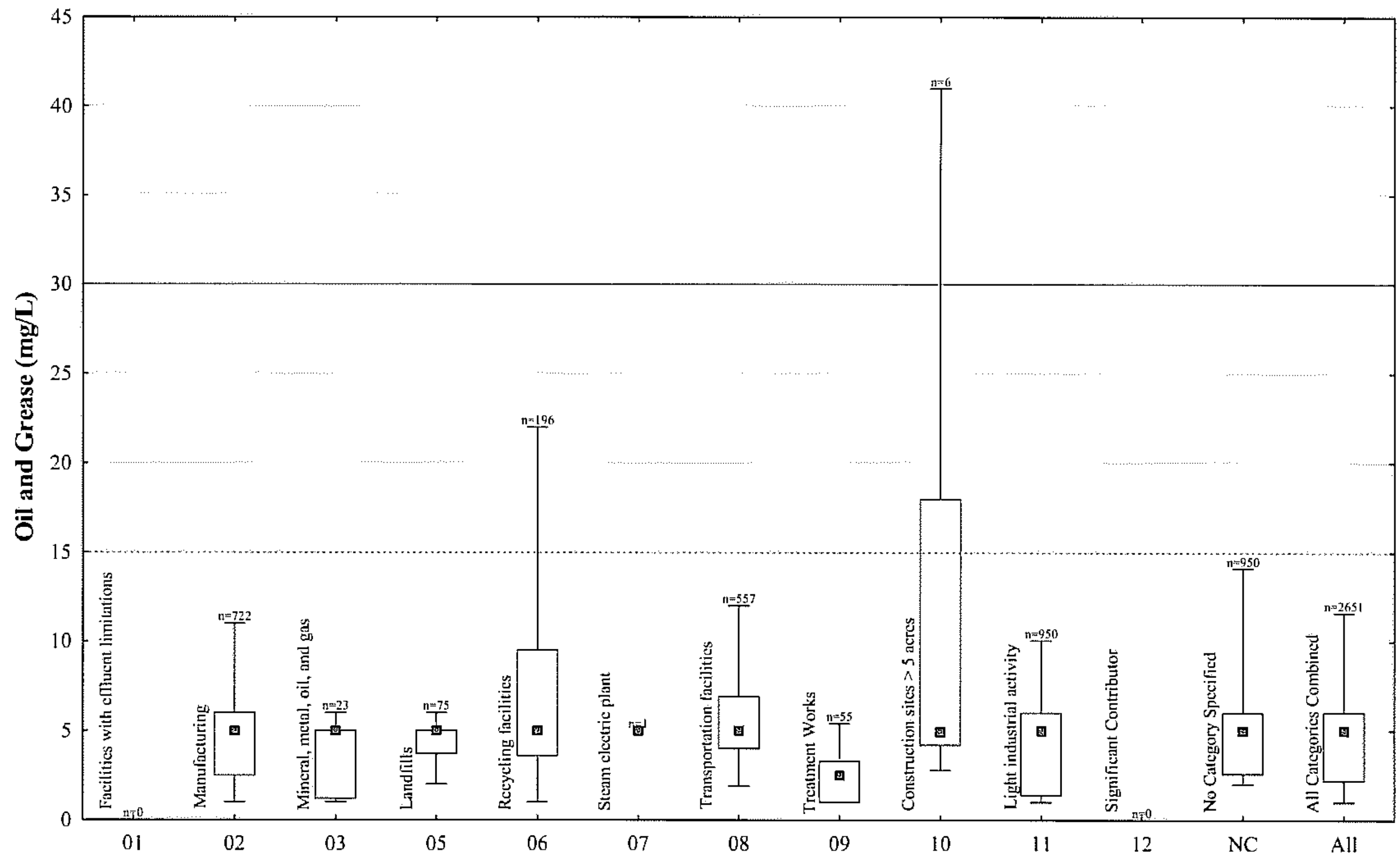
Comparison to NPDES Permit Benchmarks and Action Levels

Analyses performed across all of the industrial categories showed that only 7 and 3 percent of the samples exceeded the applicable benchmark (15 mg/L) and action level (30 mg/L), respectively for oil and grease (Table 17). Considering only the seven industrial categories in Table 17 with a relatively large number of samples (i.e., n > 25), Recycling Facilities (06) had the highest percentage of samples exceeding the benchmark and action level at 16 and 7 percent, respectively.

Table 17. Summary statistics for oil & grease concentrations measured in industrial stormwater by industry category.

Industrial Category	n	Mean (µg/L)	Median (µg/L)	Minimum (µg/L)	10th Percentile (µg/L)	90th Percentile (µg/L)	Maximum (µg/L)	Std. Dev. (µg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
02 - Manufacturing	722	6.3	5.0	0.0	1.0	11	120	8.9	1.4	6%	2%
03 - Mineral, metal, oil, and gas	23	3.7	5.0	1.0	1.0	6.0	8.0	2.2	0.6	0%	0%
05 - Landfills	75	19.6	5.0	1.0	2.0	6.0	914	107	5.5	4%	3%
06 - Recycling facilities	196	12.2	5.0	0.8	1.0	22	232	27	2.2	16%	7%
07 - Steam electric plants	1	5.0	5.0	5.0	--	--	5.0	--	--	0%	0%
08 - Transportation facilities	557	9.4	5.0	0	1.9	12	561	31	3.3	9%	4%
09 - Treatment works	55	5.1	2.5	1.0	1.0	5.4	82	12	2.4	5%	4%
10 - Construction sites > 5 acres	6	12.7	5.0	2.8	2.8	41	41	15	1.2	33%	17%
11 - Light industrial activity	950	5.9	5.0	0.0	1.0	10	151	9.7	1.6	5%	2%
No category specified	66	7.1	5.0	1.3	2.0	14	47	9.7	1.4	8%	6%
All categories	2,651	7.6	5.0	0	1.0	12	914	25	3.3	7%	3%

[a] Benchmark for oil & grease is 15 mg/L.
[b] Action level for oil & grease is 30 mg/L.
Std. Dev.: Standard Deviation.



Legend: Point = median; Box = 25th and 75th percentile; Whisker = 10th and 90th percentile;
Dashed line = benchmark; Solid line = action level

Figure 5. Oil and grease concentrations measured in industrial stormwater by industrial category.

Total Copper

Data Distribution

Tabular and graphical data summaries for total copper concentrations are presented in Table 18 and Figure 6, respectively, by individual industrial category and for all categories combined. Tabular data summaries for total copper are also provided in Appendix A for each industrial sector. Based on the 1,177 total copper values that were present in the database, the mean and median concentrations for this parameter were 73.1 and 22.2 μg/L, respectively, across all the industrial categories; and the coefficient of variation was 5.6. For comparison, Stenstrom and Lee (2005) reported mean values ranging from 130 to 1,010 μg/L for total copper based on data that were compiled through general NPDES industrial stormwater permits in the following jurisdictions: Los Angeles County, CA; Sacramento County, CA; and the State of Connecticut. The coefficients of variation for total copper from this same dataset ranged from 2.31 to 16.50.

The box plots presented in Figure 6 indicate the total copper concentrations compiled for this analysis have a right-skewed distribution due to the presence of numerous outliers in the upper end of the data range. Across all industrial categories, the 90th percentile value for the data was 104 μg/L. The maximum (11,000 μg/L) represents an extreme outlier that may indicate that the associated value was incorrectly entered in the DMR or database.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of total copper concentrations were only available in four industrial categories (Table 18). Results from these analyses (Table 12) indicate there were no significant differences in median total copper concentrations between these categories: Manufacturing (02), Recycling Facilities (06), Transportation Facilities (08), and Light Industrial Activity (11).

Comparison to NPDES Permit Benchmarks and Action Levels

As shown in Table 18, analyses performed across all 13 industrial categories showed that 21 and 6 percent of the samples had total copper concentrations that exceeded the applicable benchmark (63.6 μg/L) and action level (149 μg/L), respectively. Considering only the four industrial categories in Table 18 with a relatively large number of samples (i.e., n > 25), the benchmark was exceeded in 15 to 20 percent of the samples while the action level was exceeded in 5 to 10 percent.

Comparison to Hypothetical Water Quality Criteria

Results from the comparisons of sample concentrations to hypothetical water quality criteria for dissolved copper are summarized in Table 19 for western Washington, eastern Washington, and the entire state. The results are subdivided within this table to show the percentage of samples exceeding the criteria based on all collected samples versus only those samples with concentrations below the benchmark. The presentation of these results is also organized under

Table 18. Summary statistics for total copper concentrations measured in industrial stormwater by industry category.

Industrial Category	n	Mean (μg/L)	Median (μg/L)	Minimum (μg/L)	10th Percentile (μg/L)	90th Percentile (μg/L)	Maximum (μg/L)	Std. Dev. (μg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
01 - Facilities with effluent limitations	4	36	38	6.0	6	63.6	63.6	31.5	0.9	0%	0%
02 - Manufacturing	280	86	22	0.03	5	100	11000	659	7.6	21%	6%
03 - Mineral, metal, oil, and gas	1	158	158	158	--	--	158	--	--	100%	100%
05 - Landfills	22	78	14	2.1	5.9	83	1230	259	3.3	14%	5%
06 - Recycling facilities	196	117	26	2.0	6.7	160	5940	476	4.1	29%	10%
08 - Transportation facilities	196	47	28	0.04	5.9	115	496	72	1.5	28%	6%
09 - Treatment works	18	37	26	5.2	5.7	64	224	49.5	1.4	11%	6%
11 - Light industrial activity	440	48	22	0.01	7	89	1700	111	2.3	16%	5%
No category specified	20	292	10	0.01	2.2	333	4930	1098	3.8	20%	10%
All categories	1177	73.1	22.2	0.01	6	104	11000	410	5.6	21%	6%

[a] Benchmark for copper is 63.6 μg/L.
[b] Action level for copper is 149 μg/L.
Std. Dev.: Standard Deviation.

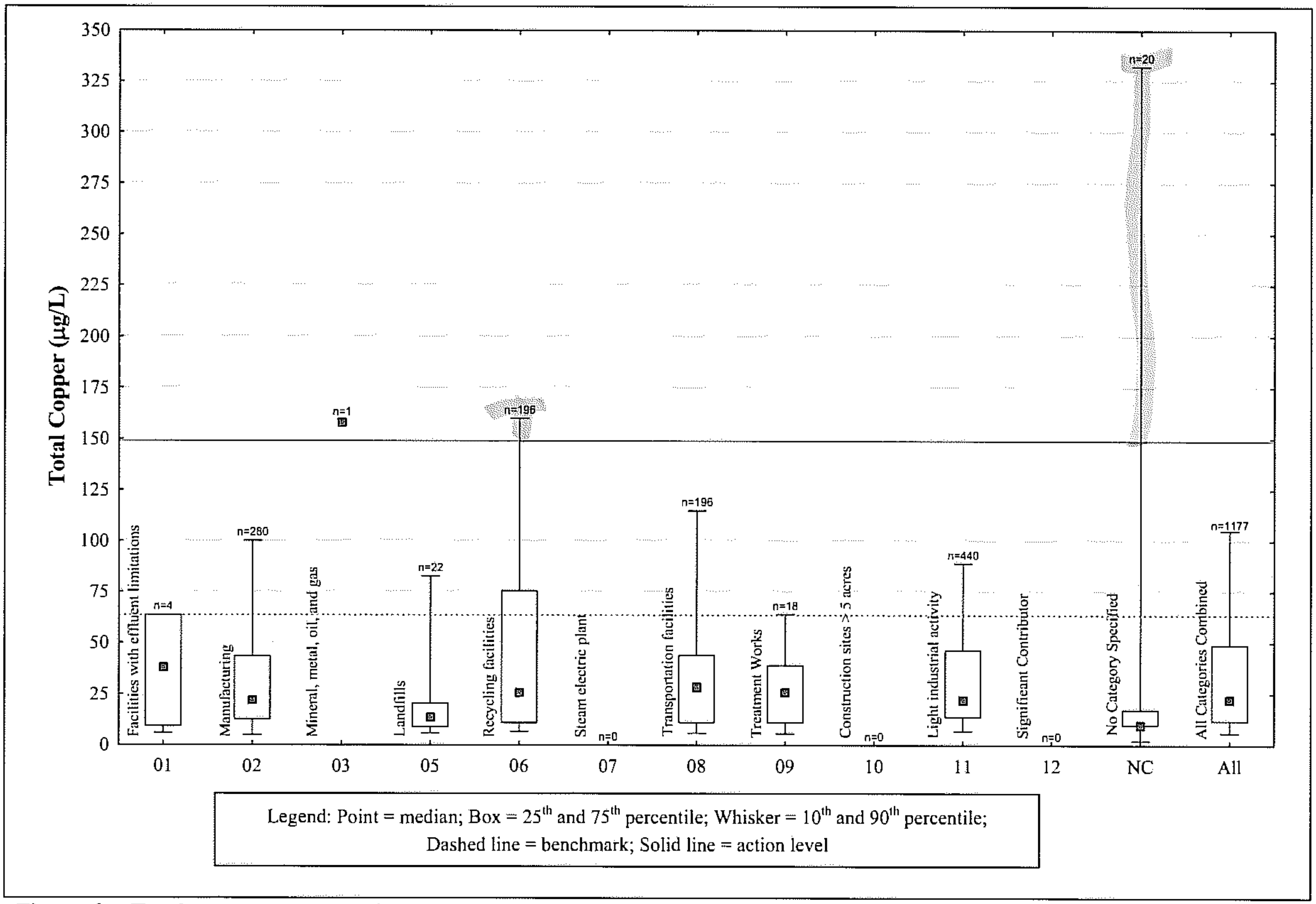


Figure 6. Total copper concentrations measured in industrial stormwater by industrial category.

separate subsections below based on these divisions of the data. Finally, Appendix B (Tables B 5 and B-6) provides a more detailed data summary with comparisons by industrial category for samples collected in eastern and western Washington.

Table 19. Percentage of total copper samples exceeding state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Acute Criterion (%)[a]				Exceedance of Chronic Criterion (%)[a]			
	n	0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
All Samples									
Western Washington	1141	95 (88-96)	31 (18-54)	12 (6-25)	5 (3-12)	96 (92-97)	44 (26-74)	17 (9-42)	7 (4-20)
Eastern Washington	36	64 (47-86)	14 (3-25)	3 (0-8)	0 (0-3)	81 (58-92)	22 (8-31)	3 (3-14)	0 (0-3)
All Washington	1177	94 (87-96)	31 (17-53)	11 (6-24)	5 (3-11)	96 (91-97)	43 (25-73)	17 (9-41)	7 (4-20)
Samples with Values ≤ Benchmark									
Western Washington	926	94 (86-96)	15 (0-43)	0 (0-8)	0 (0)	95 (90-96)	31 (9-68)	0 (0-28)	0 (0-2)
Eastern Washington	27	52 (30-81)	0 (0)	0 (0)	0 (0)	74 (44-89)	0 (0-7)	0 (0)	0 (0)
All Washington	953	93 (84-95)	15 (0-42)	0 (0-7)	0 (0)	95 (89-96)	30 (9-66)	0 (0-27)	0 (0-2)

[a] Values represent the percentage of sample exceeding the water quality criteria based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

All Collected Samples

As with the parameters discussed previously, the analysis performed hereshowed high percentages of the collected samples exceeding the hypothetical water quality criterion for dissolved copper when dilution factors of 0 and 10 were applied; however, these percentages declined considerably with dilution factors of 25 and higher (see Table 19). For example, across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the acute criterion were 94 and 31 percent given the typical receiving water conditions and dilution factors of 0 and 10, respectively. Given the same receiving water conditions and dilution factors of 25 and 50, these percentages dropped to 11 and 5 percent, respectively. Nearly identical results were obtained from comparisons of the data to the chronic criterion for dissolved copper (Table 19).

Analyses of spatial patterns in the data indicated the percentage of samples exceeding the water quality criterion for dissolved copper was only slightly higher in western Washington relative to eastern Washington (Table 19). For example, 95 to 31 percent of the samples in western Washington exceeded the criterion with typical receiving water conditions and dilution factors of

0 and 10, respectively. With the same receiving water conditions and dilution factors, 64 to 14 percent of the samples exceeded the criterion in eastern Washington. A similar, though less pronounced pattern was observed in the data when comparisons were made to the chronic criterion for dissolved copper (see Table 19).

In comparisons that were made between the four industrial categories in western Washington with a relatively large sample size (i.e., n > 25), the percentage of samples that exceeded the acute criterion for dissolved copper (see Table B-5) ranged from 91 percent for Manufacturing (02) to 98 percent for both Recycling Facilities (06) and Light Industrial Activity (11), assuming typical receiving water conditions and a dilution factor of 0. When higher dilution factors (e.g., > 10) were assumed, the percentages of samples exceeding the criterion were similarly low (< 20 percent) across all the categories. Nearly identical results were obtained from comparisons of the data to the chronic criterion for dissolved copper (see Table B-5). However, there were insufficient data to make comparisons between the various industrial categories in eastern Washington.

Samples with Concentrations Below the Benchmark

The analysis performed here on the subset of samples with concentrations below the benchmark showed that the acute and chronic water quality criteria for dissolved copper were only exceeded when dilution factors of 0 and 10 were assumed. For example, across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the acute criterion were 93 and 15 percent given the typical receiving water conditions and dilution factors of 0 and 10, respectively. Given the same receiving water conditions and dilution factors of 25 and 50, these percentages dropped to 0. Nearly identical results were obtained from comparisons of the data to the chronic criterion for dissolved copper (Table 19).

Total Lead

Data Distribution

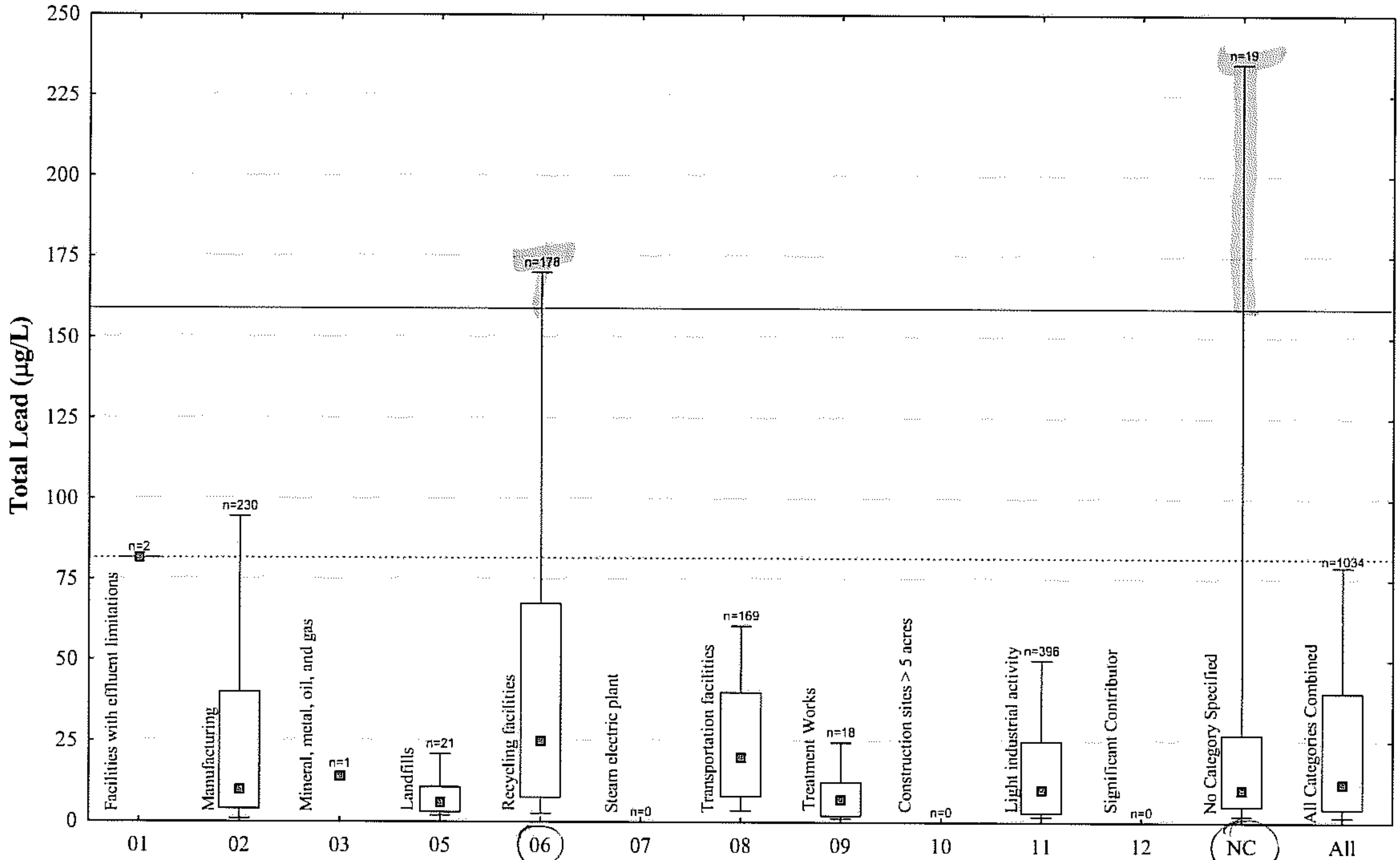
Tabular and graphical data summaries for total lead concentrations are provided in Table 20 and Figure 7, respectively, by individual industrial category and for all categories combined. Tabular data summaries for total lead are also provided in Appendix A by industrial sector. Based on the 1,034 total lead values present in the database, the mean and median concentrations for this parameter were 48 and 12 µg/L, respectively, across all the industrial categories; and the coefficient of variation was 4.0. For comparison, Stenstrom and Lee (2005) reported mean values ranging from 60 to 4,480 µg/L for total lead concentrations based on data that were compiled through general NPDES industrial stormwater permits in the following jurisdictions: Los Angeles County, CA; Sacramento County, CA; and the state of Connecticut. The coefficients of variation for total lead from this same dataset ranged from 3.82 to 14.12.

The box plots presented in Figure 7 indicate the total lead concentrations compiled for this analysis generally have a right-skewed distribution due to the presence of numerous outliers in the upper end of the data range. Across all industrial categories, the 90th percentile and maximum values for the data were 79 and 3,730 µg/L, respectively.

Table 20. Summary statistics for total lead concentrations measured in industrial stormwater by industry category

Industrial Category	n	Mean (µg/L)	Median (µg/L)	Minimum (µg/L)	10th Percentile (µg/L)	90th Percentile (µg/L)	Maximum (µg/L)	Std. Dev. (µg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
01 - Facilities with effluent limitations	2	82	81.6	81.6	81.6	81.6	81.6	0	0	0%	0%
02 - Manufacturing	230	47	10	0.006	1.0	94.5	1,240	145	3.1	12%	4%
03 - Mineral, metal, oil, and gas	1	14	14	14	--	--	13.9	--	--	0%	0%
05 - Landfills	21	14	6	1.0	2.0	20.9	110	25	1.8	5%	0%
06 - Recycling facilities	178	107	25	0.1	2.6	170	3,730	347	3.2	21%	11%
08 - Transportation facilities	169	32	20	0.05	3.5	60.6	289	43	1.4	18%	2%
09 - Treatment works	18	9.4	7.0	0.9	1.2	24.6	30	8.4	0.9	0%	0%
11 - Light industrial activity	396	31	10	0.01	1.7	50	3,000	157	5.0	6%	3%
No category specified	19	53	10	0.007	2.0	235	576	137	2.6	11%	11%
All categories	1,034	48	12	0.006	1.7	79	3,730	190	4.0	12%	4%

[a] Benchmark for lead is 81.6 µg/L.
[b] Action level for lead is 159 µg/L.
Std. Dev.: Standard Deviation.



Legend: Point = median; Box = 25th and 75th percentile; Whisker = 10th and 90th percentile;
Dashed line = benchmark; Solid line = action level

Figure 7. Total lead concentrations measured in industrial stormwater by industrial category.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of total lead concentrations were only available in four industrial categories (Table 20). Results from these analyses (Table 12) indicate the data can be differentiated into two groups with low and high median total lead concentrations, respectively. Specifically, median concentrations for the Light Industrial Activity (11), and Manufacturing (02) categories were significantly lower than those for Transportation Facilities (08) and Recycling Facilities (06).

Comparison to NPDES Permit Benchmarks and Action Levels

Analyses performed across all nine industrial categories reporting total lead concentrations showed that 12 and 4 percent of the samples had total lead concentrations that exceeded the applicable benchmark (81.6 µg/L) and action level (159 µg/L), respectively (Table 20). Considering only the four industrial categories in Table 20 with a relatively large number of samples (i.e., n > 25), the benchmark was exceeded in 6 to 21 percent of the samples while the action level was exceeded in 3 to 11 percent.

Comparison to Hypothetical Water Quality Criteria

Results from the comparisons of sample concentrations to hypothetical water quality criteria for dissolved lead are summarized in Table 21 for western Washington, eastern Washington, and the entire state. The results are subdivided within this table to show the percentage of samples exceeding the applicable criterion based on all collected samples versus only those samples with concentrations below the benchmark. The presentation of these results is also organized under separate subsections below based on these divisions of the data. Finally, Appendix B (Tables B-7 and B-8) provides a more detailed data summary with comparisons by industrial category for samples collected in eastern and western Washington.

All Collected Samples

Across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the acute criterion for dissolved lead were 31, 2, 1 and 0 percent given the typical receiving water conditions and dilution factors of 0, 10, 25, and 50, respectively. In comparison to these results, the percentages of samples exceeding the chronic criterion for dissolved lead were substantially higher. For example, across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the chronic criterion were 93, 51, 33, and 13 percent given the typical receiving water conditions and dilution factors of 0, 10, 25, and 50, respectively.

Analyses of spatial patterns in the data indicate that the percentage of samples exceeding the water quality criterion for dissolved lead was higher in western Washington relative to eastern Washington (Table 21). For example, 32 percent of the samples in western Washington exceeded the criterion with the typical receiving water conditions and a dilution factor of 0, whereas only 17 percent of the samples exceeded the criterion in eastern Washington given the same receiving water conditions and dilution factor. A similar pattern was observed in the data when comparisons were made to the chronic criterion for dissolved lead (see Table 21).

Table 21. Percentage of total lead samples exceeding state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

	n	Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
		0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
All Samples									
Western Washington	999	32 (17-40)	2 (2-3)	1 (1-2)	0 (0-1)	93 (89-97)	52 (45-79)	33 (18-62)	13 (9-47)
Eastern Washington	35	17 (11-23)	0 (0)	0 (0)	0 (0)	86 (69-91)	26 (23-51)	17 (11-26)	11 (6-23)
All Washington	1034	31 (17-39)	2 (2-3)	1 (1-2)	0 (0-1)	93 (89-97)	51 (44-78)	33 (18-61)	13 (9-46)
Samples with Values ≤ Benchmark									
Western Washington	909	25 (9-34)	0 (0)	0 (0)	0 (0)	93 (88-97)	47 (40-77)	27 (10-59)	5 (0-42)
Eastern Washington	29	0 (0-7)	0 (0)	0 (0)	0 (0)	83 (62-90)	10 (7-41)	0 (0-10)	0 (0-7)
All Washington	938	24 (9-33)	0 (0)	0 (0)	0 (0)	92 (87-96)	46 (39-76)	26 (9-57)	4 (0-41)

[a] Values represent the percentage of sample exceeding the water quality criteria based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

In comparisons that were made between the four industrial categories in western Washington with a relatively large sample size (i.e., n > 25), the percentage of samples that exceeded the acute criterion for dissolved lead (see Table B-7) ranged from 24 percent for Light Industrial Activity (11) to 47 percent for Recycling Facilities (06), assuming the typical receiving water conditions and a dilution factor of 0. For the same four industrial categories in Western Washington, the percentage of samples that exceeded the chronic criterion ranged from 87 percent for Manufacturing (02) to 96 percent for both Recycling Facilities (06) and Transportation Facilities (08), assuming the same receiving water conditions and dilution factor. There were insufficient data to make comparisons between industrial categories in eastern Washington.

Samples with Concentrations Below the Benchmark

Analyses performed on the subset of samples with concentrations below the benchmark showed that the acute water quality criterion for dissolved lead was only exceeded when a dilution factor of 0 was assumed. More specifically, across the entire state of Washington and all 13 industrial categories, the percentage of samples that exceeded the acute criterion was 24 percent given the typical receiving water conditions and a dilution factor of 0 (see Table 21). This percentage dropped to 0 given the same receiving water conditions and a dilution factor of 10 or higher. In comparison to these results, the percentages of samples exceeding the chronic criterion for dissolved lead were substantially higher. For example, across the entire state of Washington and all 13 industrial categories, the percentages of samples that exceeded the chronic criterion were 92, 46, 26, and 4 percent given the typical receiving water conditions and dilution factors of 0, 10, 25, and 50, respectively.

Biological Oxygen Demand

Data Distribution

Tabular and graphical data summaries for BOD are provided in Table 22 and Figure 8, respectively, by individual industrial category and for all categories combined. Tabular industrial sector summaries for BOD are also provided in Appendix A. Overall, there were 1,105 BOD values present in the database with mean and median concentrations of 37 and 10 mg/L, respectively. The coefficient of variation for these data was 1.9. The box plots presented in Figure 8 indicate the BOD concentrations generally have a right-skewed distribution due to the presence of outliers in the upper end of the data range. Across all industrial categories, the 90^{th} percentile and maximum values for the data were 101 and 639 mg/L, respectively.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., $n > 25$) for statistical comparisons of BOD concentrations were available for three of the five industrial categories reporting data (Table 22). Results from these analyses (Table 12) indicate the data can be differentiated into two groups with low and high median BOD concentrations, respectively. Specifically, the median concentration for the Landfills (05) category was significantly lower than those for Manufacturing (02) and Light Industrial Activity (11).

Comparison to NPDES Permit Benchmarks and Action Levels

Analyses performed across the five industrial categories reporting BOD values showed that 25 and 16 percent of the samples exceeded the applicable benchmark (30 mg/L, 140 mg/L for non-hazardous waste landfills) and action level (60 mg/L), respectively (Table 22). Considering only the three industrial categories in Table 22 with a relatively large number of samples (i.e., $n > 25$), the benchmark was exceeded in 13 to 27 percent of the samples while the action level was exceeded in 0 to 17 percent.

Ammonia Nitrogen

Data Distribution

Tabular and graphical data summaries for ammonia nitrogen are provided in Table 23 and Figure 9, respectively, by individual industrial category and for all categories combined. Tabular

Table 22. Summary statistics for BOD measured in industrial stormwater by industry category.

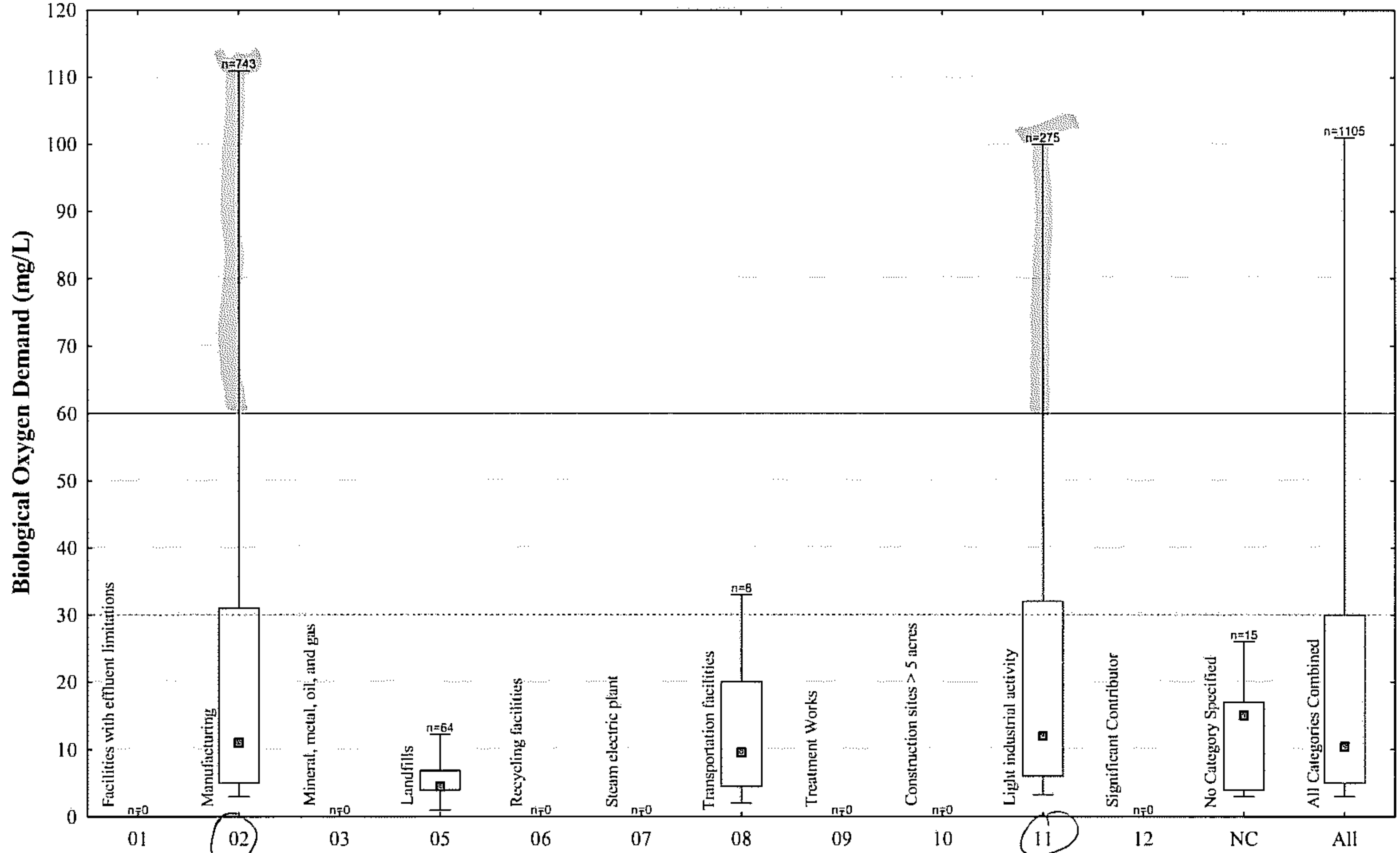
Industrial Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	10th Percentile (mg/L)	90th Percentile (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
02 - Manufacturing	743	40	11	0.5	3	111	639	77	1.9	27%	17%
05 - Landfills	64	7.0	4.5	0.2	1.0	12	39	7.8	1.1	0%	--
08 - Transportation facilities	8	13	9.5	2.0	2	33	33	11	0.9	13%	0%
11 - Light industrial activity	275	35	12	2.0	3.3	100	340	58	1.7	27%	16%
No category specified	15	17	15	3.0	3.0	26	90	21	1.2	7%	7%
All categories	1,105	37	10	0.2	3.0	101	639	70	1.9	25%	16%

[a] Benchmark for BOD is 30 mg/L with the exception of category 05 which has a benchmark of 140 mg/L.
[b] Action level for BOD is 60 mg/L.

Table 23. Summary statistics for ammonia nitrogen measured in industrial stormwater by industry category.

Industrial Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	10th Percentile (mg/L)	90th Percentile (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
05 - Landfills	66	0.27	0.08	0.005	0.01	0.64	4.8	0.64	2.4	0%	0%
11 - Light industrial activity	4	6.9	8.7	0.10	0.1	10.21	10.2	4.8	0.7	0%	0%
All categories	70	0.65	0.10	0.005	0.01	0.96	10.2	1.9	3.0	0%	0%

[a] Benchmark for ammonia nitrogen is 21.8 mg/L, except for Landfills (05) which is 10 mg/L.
[b] Action level for ammonia nitrogen is 38 mg/L.



Legend: Point = median; Box = 25th and 75th percentile; Whisker = 10th and 90th percentile; Dashed line = benchmark; Solid line = action level

Figure 8. Biological oxygen demand concentrations measured in industrial stormwater by industrial category.

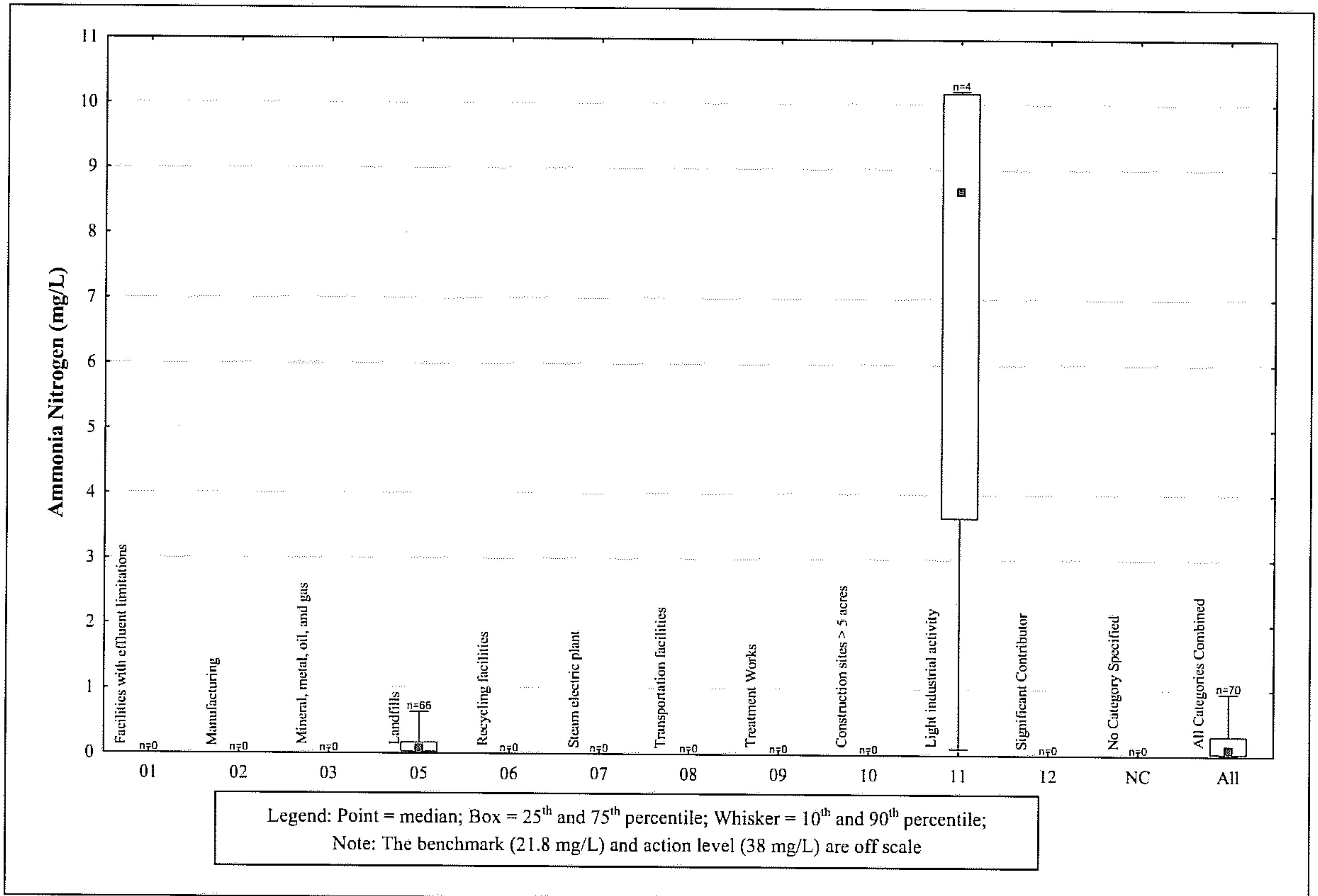


Figure 9. Ammonia nitrogen concentrations measured in industrial stormwater by industrial category.

summaries are also provided in Appendix A by industrial sector. Based on the 70 total ammonia nitrogen values present in the database, the mean and median concentrations for this parameter were 0.65 and 0.10 mg/L, respectively, across all the industrial categories; and the coefficient of variation was 3.0. Similarly, the 90th percentile and maximum values were 0.96 and 10.2 mg/L, respectively.

Comparison Among Industrial Categories

Statistical comparisons of the median concentrations for ammonia nitrogen were not performed because there were insufficient numbers of samples.

Comparison to NPDES Permit Benchmarks and Action Levels

The applicable benchmarks (21.8 mg/L, 10 mg/L for non-hazardous waste landfills) and action level (38 mg/L) for ammonia nitrogen were not exceeded in any sample (Table 23).

Nitrate + Nitrite Nitrogen

Data Distribution

Tabular and graphical data summaries for nitrate + nitrite nitrogen are provided in Table 24 and Figure 10, respectively, by individual industrial category and for all categories combined. Tabular summaries for each industrial sector are also presented in Appendix A. Overall, there were 397 values for nitrate + nitrite nitrogen present in the database. The mean and median concentrations from these values were 2.2 and 0.5 mg/L, respectively: and the coefficient of variation was 4.0. The 90th percentile value for the data was 3.1 mg/L. The maximum value (100 mg/L) represents an extreme outlier that may indicate that the associated value was incorrectly entered in the DMR or database.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., n > 25) for statistical comparisons of nitrate + nitrite nitrogen concentrations were only available for two of the industrial categories reporting nitrate + nitrite data: Manufacturing (02) and Light Industrial Activity (11). Results from these analyses (i.e., Mann Whitney U test) indicated that the median concentration for Manufacturing (02) was significantly higher than that for Light Industrial Activity (11).

Comparison to NPDES Permit Benchmarks and Action Levels

Exceedances of the applicable benchmark (0.68 mg/L) and action level (1.36 mg/L) for nitrate + nitrite occurred in 38 and 21 percent of the samples, respectively (Table 24). Considering only the two industrial categories in Table 24 with a relatively large number of samples (i.e., n > 25), the benchmark and action level were exceeded in 45 and 25 percent of the samples, respectively, for Manufacturing (02) and 34 and 20 percent of the samples, respectively, for Light Industrial Activity (11).

Table 24. Summary statistics for nitrate + nitrite nitrogen measured in industrial stormwater by industry category.

Industrial Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	10th Percentile (mg/L)	90th Percentile (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
02 - Manufacturing	142	2.5	0.6	0.01	0.18	4	83.7	9.5	3.8	45%	25%
08 - Transportation facilities	2	50	50	0.5	0.5	100	100	70	1.4	50%	50%
11 - Light industrial activity	249	1.6	0.4	0.01	0.061	2.68	61	5.3	3.3	34%	20%
No category specified	4	0.8	0.3	0.2	0.202	2.38	2.4	1.0	1.3	25%	25%
All categories	397	2.2	0.5	0.01	0.089	3.1	100	8.6	4.0	38%	21%

[a] Benchmark for nitrate + nitrite nitrogen is 0.68 mg/L.
[b] Action level for nitrate + nitrite nitrogen is 1.36 mg/L.

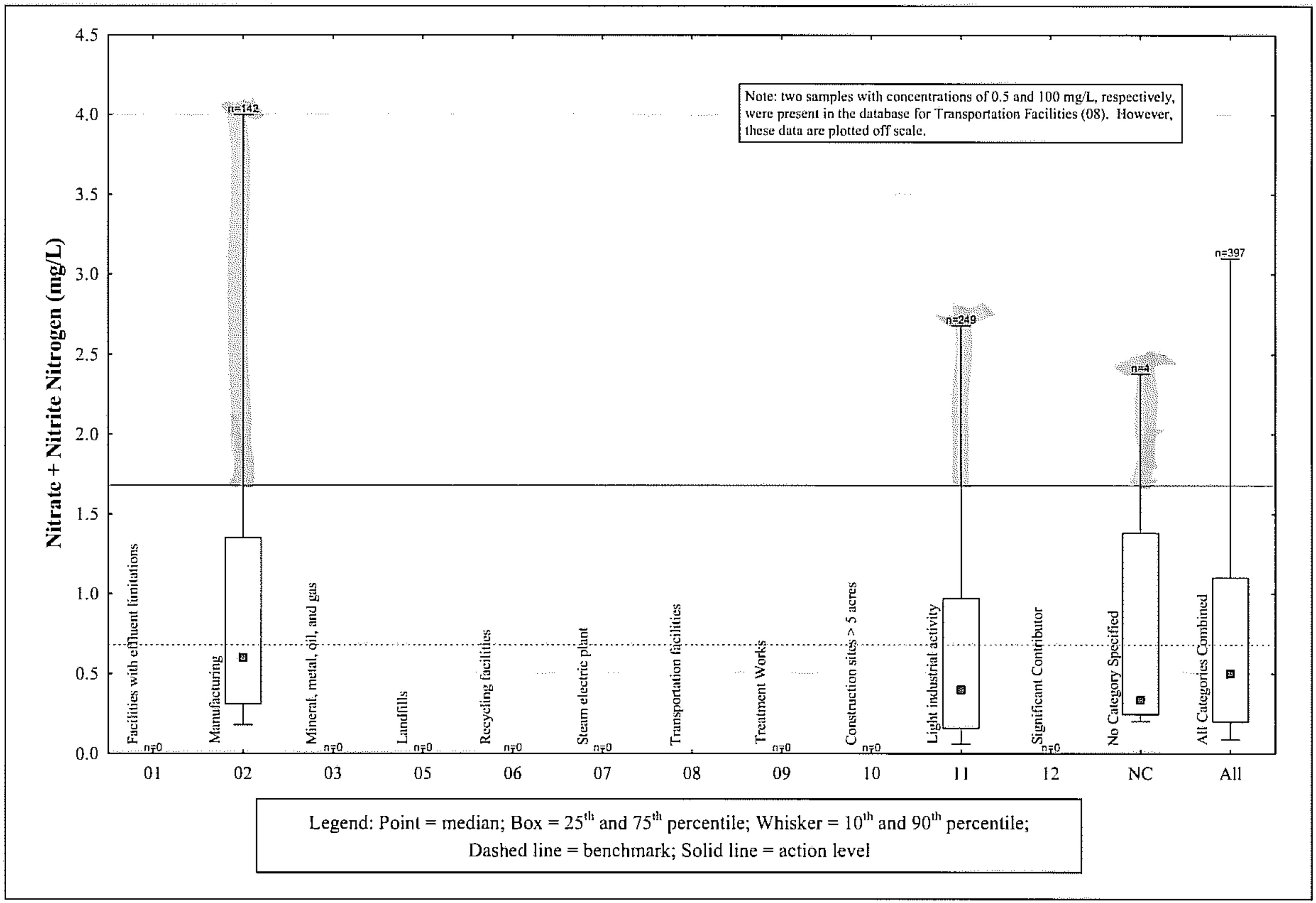


Figure 10. Nitrate + nitrite nitrogen concentrations measured in industrial stormwater by industrial category.

Total Phosphorus

Data Distribution

Tabular and graphical data summaries for total phosphorus are provided in Table 25 and Figure 11, respectively, by individual industrial category and for all categories combined. Tabular data summaries by industrial sector are also provided in Appendix A. Based on the 410 total phosphorus values in the database, the mean and median concentrations were 1.4 and 0.2 mg/L, respectively, across all five of the industrial categories reporting data; and the coefficient of variation was 5.2. For comparison, Stenstrom and Lee (2005) reported a mean value of 0.45 mg/L for total phosphorus concentrations based on data that were compiled through general NPDES industrial stormwater permits in the state of Connecticut. The coefficient of variation from the Connecticut, dataset was 4.3. The 90th percentile value for data compiled through this study was 2.5 mg/L. The maximum value (175 mg/L) represents an extreme outlier that may indicate that the associated value was incorrectly entered in the DMR or database.

Comparison Among Industrial Categories

Sufficient amounts of data (i.e., $n > 25$) for statistical comparisons of TP values were only available for the following two industrial categories: Manufacturing (02) and Light Industrial Activity (11). Results from these analyses indicated that the median concentration for Manufacturing (02) was significantly higher than that for Light Industrial Activity (11).

Comparison to NPDES Permit Benchmarks and Action Levels

As shown in Table 25, analyses performed for all five industrial categories reporting total phosphorus values showed that only 11 and 7 percent of the samples exceeded the applicable benchmark (2 mg/L) and action level (4 mg/L), respectively. Considering only the two industrial categories in Table 25 with a relatively large number of samples (i.e., $n > 25$), the benchmark and action level for TP was exceeded in 9 and 8 percent of the samples for Manufacturing (02) and 12 and 6 percent of the samples for Light Industrial Activity (11).

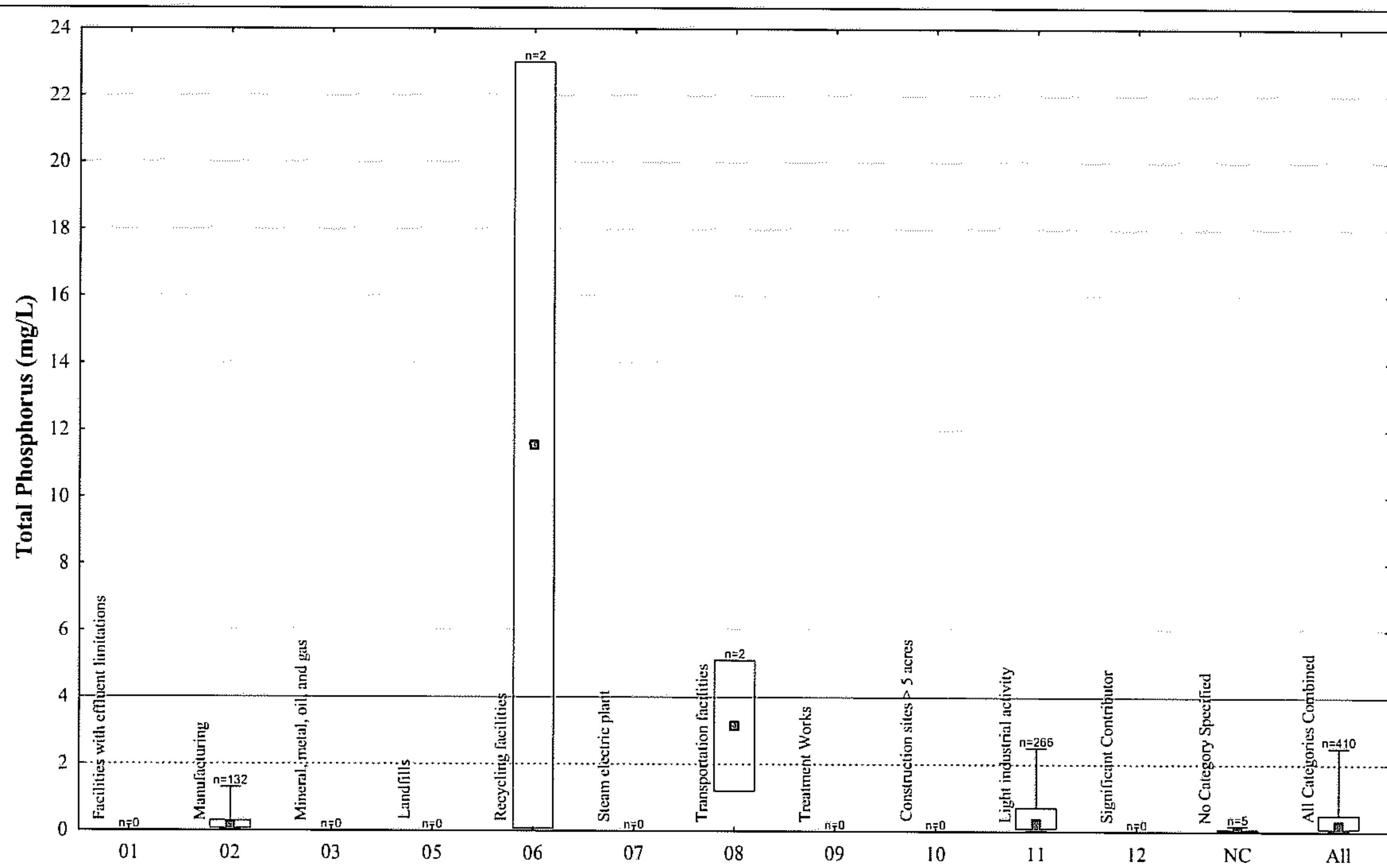
Construction Stormwater

Data analysis results for construction stormwater are summarized below. Specifically, separate subsections present results for each of the following analyses that are described in the Data Analysis Methods section: data distribution, comparison to NPDES permit benchmarks and action levels, and comparison to hypothetical water quality criteria (if applicable). As noted in the Data Sources section, the construction stormwater data presented herein were analyzed previously in Ecology (2005). Due to this consideration, this section only highlights the major trends from these data. For a more detailed analyses of these data, the reader should refer to the earlier Ecology report.

Table 25. Summary statistics for total phosphorus measured in industrial stormwater by industry category.

Industrial Category	n	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	10th Percentile (mg/L)	90th Percentile (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
02 - Manufacturing	135	1.8	0.13	0.004	0.05	1.3	137	12	6.7	9%	8%
06 - Recycling facilities	2	12	12	0.08	0.081	23	23	16	1.4	50%	50%
08 - Transportation facilities	2	3.2	3.2	1.2	1.2	5.1	5.1	2.8	0.9	50%	50%
11 - Light industrial activity	266	1.1	0.26	0.005	0.042	2.5	23	2.9	2.5	12%	6%
No category specified	5	0.08	0.05	0.04	0.044	0.18	0.2	0.06	0.7	0%	0%
All categories	410	1.4	0.2	0.004	0.05	2.5	137	7.3	5.2	11%	7%

[a] Benchmark for total phosphorus is 2 mg/L.
[b] Action level for total phosphorus is 4 mg/L.



Legend: Point = median; Box = 25th and 75th percentile; Whisker = 10th and 90th percentile; Dashed line = benchmark; Solid line = action level

Figure 11. Total phosphorus concentrations measured in industrial stormwater by industrial category.

Data Distribution

A tabular summary for transparency, turbidity, and TSS data collected from Western Washington construction sites is provided in Table 26. In total, there were 47, 49, and 50 values for transparency, turbidity, and TSS, respectively, in the dataset. The mean and median values for transparency were 31 and 27 cm, respectively; and the coefficient of variation was 0.7. Similarly, the mean and median values for turbidity were 69 and 29 NTU, respectively; and the coefficient of variation was 1.3. Finally, the mean and median concentrations for TSS were 256 and 14 mg/L, respectively; and the coefficient of variation was 4.4.

Comparison to NPDES Permit Benchmarks and Action Levels

Turbidity was the only parameter monitored with associated benchmark values and action levels. Exceedances of the applicable benchmark (50 NTU) and action level (250 NTU) occurred in 29 and 6 percent of the samples, respectively.

Comparison to Hypothetical Water Quality Criteria

Results from the comparisons of sample concentrations to state water quality criteria for turbidity are summarized in Table 27. When all collected samples were considered in the analyses, the percentage of samples that exceeded the state water quality criterion for turbidity ranged from 86 to 6 percent given typical receiving water conditions and dilution factors of 0 and 50, respectively. Analyses performed on the subset of samples with concentrations below the benchmark showed that the water quality standard was only exceeded when a dilution factor of 0 was assumed.

Table 26. Summary statistics for transparency, turbidity, and TSS measured in stormwater from Western Washington construction sites.

Parameter	n	Mean	Median	Minimum	10th Percentile	90th Percentile	Maximum	Std. Dev.	Coefficient of Variation	Exceedance of Benchmark [a]	Exceedance of Action Level [b]
Transparency (cm)	47	31	27	0.7	4.6	60	60	22	0.7	--	--
Turbidity (NTU)	49	69	29	2.3	6.2	194	430	94	1.3	29%	6%
TSS (mg/L)	50	256	14	1.0	3.0	123	7470	1115	4.4	--	--

[a] Benchmark for turbidity is 50 NTU.
[b] Action level for turbidity is 250 NTU.

Table 27. Percentage of turbidity samples exceeding state water quality criterion at construction sites given hypothetical receiving water conditions for western Washington and dilution factors of 0, 2.5, 5, and 10.

	n	Exceedance of Criterion (%)			
		0 DF	10 DF	25 DF	50 DF
All Samples					
Western Washington	49	86 (73-90)	27 (27-29)	18 (18)	6 (6)
Samples with Values ≤ Benchmark					
Western Washington	35	80 (63-86)	0 (0)	0 (0)	0 (0)

DF: Dilution factor.
[a] Values represent the percentage of sample exceeding the water quality criterion based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).

Discussion and Conclusion

This section provides a discussion of the data presented herein and summarizes major conclusions from these data relative to the study objectives that were identified in the introduction to this report. To maintain consistency with the previous section, this information is presented under separate subsections for each of the following analyses: data distribution, comparison among industrial categories, comparison to NPDES permit benchmarks and action levels, and comparison to state water quality standards.

Data Distribution

In general, the analyses presented in this report indicate that most of the industrial stormwater parameters exhibited a distinctly right-skewed distribution due to the presence of numerous outliers in the upper end of the data range. This distribution is commonly observed in water quality data that are collected during storm sampling due to the influence of sporadic, high flow events that are associated with high pollutant concentrations. Furthermore, the maximum concentrations for several of the parameters (e.g., total zinc, total copper, nitrate + nitrite nitrogen, total phosphorus) appeared to be extreme outliers that may indicate that the associated values were incorrectly entered in the DMR or database.

The results also indicate that the data for many of the industrial and construction stormwater parameters exhibit a very high degree of variability. For example, the coefficients of variation calculated from these data ranged from 0.12 for pH to 7.06 for total zinc. Similarly, the coefficients of variation calculated from the compiled construction stormwater data ranged from 0.7 for transparency to 4.4 for total suspended solids. The high degree of variability in these data is generally consistent with the findings from other studies of compiled data from general NPDES industrial stormwater permits. For example, Strenstrom and Lee (2005) reported coefficients of variation ranging from 0.2 to 17 for data from a suite of sixteen monitoring parameters that were compiled through general NPDES industrial stormwater permits in the following jurisdictions: Los Angeles County, CA; Sacramento County, CA; and the state of Connecticut.

As noted previously, the available data for the construction stormwater parameters are extremely limited in terms of the total number of samples and geographic coverage. Therefore, additional data are required for these parameters in order to draw more definitive conclusions regarding their associated distributions.

Comparisons Among Industrial Categories

Statistical analyses indicated there were significant differences in median concentrations among industrial categories for all the parameters that were evaluated, with the exception of total copper. (As noted previously, these analyses could not be performed for ammonia nitrogen because there were insufficient data.) However, even where there were significance differences between industrial categories, the overall utility of this information was limited because few meaningful patterns could be discerned in the results from the multiple range tests (see Table 12). More specifically, these tests generally showed little consistency with regard to the industrial categories that were identified as having high or low concentrations across all the parameters or within particular categories parameters (e.g., metals). The only possible exceptions to this broad generalization were observed for the following three industrial categories: Recycling Facilities (06), Treatment Works (09), and Transportation Facilities (11). Recycling Facilities (06) and Transportation Facilities (11) appeared to be differentiated from the majority of other categories due to high turbidity levels and high oil and grease concentrations, whereas Treatment Works (09) could be differentiated based on low total zinc and oil and grease concentrations.

It should be noted that the industrial categories are groupings of different types of facilities at a very broad level. For example, the following industrial sectors from Table 2 are all grouped under the Manufacturing (02) industrial category: Lumber and Wood Products (24--), Chemical and Allied Products (26--), and Primary Metals Industries (33--). Therefore, it is possible that more meaningful results could be obtained if additional comparisons were made at the industrial sector level. However, due to the large number of industrial sectors that are represented in the database and the associated inconsistencies in the amount of available data (see Tables 2 and 5), it was not practical to collectively analyze the industrial sectors using the conventional statistics that were applied in the comparisons of the industrial categories.

Comparison to NPDES Permit Benchmarks and Action Levels

With the exception of ammonia nitrogen, all of the primary monitoring parameters identified in the general NPDES permit for industrial stormwater were measured at levels that exceeded the benchmarks and action thresholds. However, there was a large range in terms of the frequency and magnitude of the exceedances exhibited for each of the parameters. Each parameter was classified as being of high, moderate, and low concern based on the frequency of these exceedances. Specifically, total zinc is identified as the only parameter of high concern because over 50 percent of the associated samples exceeded the applicable benchmark and 21 percent exceeded the action level. Turbidity, total copper, BOD, and nitrate + nitrite nitrogen are identified as being of moderate concern because between 20 and 50 percent of the samples exceeded the benchmark. Finally, pH, oil and grease, total lead, total phosphorus, and ammonia nitrogen are classified as being of low concern because less than 20 percent of the collected samples exceeded the applicable benchmark.

The results for construction stormwater also showed that the applicable benchmark for turbidity was routinely exceeded. However, due to the limited number of samples in this data set, it is difficult to make definitive conclusions regarding the level of concern that should be applied to this parameter.

Comparison to Hypothetical Water Quality Criteria

The existing data compiled through the general NPDES permit for industrial and construction stormwater cannot be used to assess compliance with state water quality standards. The following is a list of the information that would be required in order to make these determinations. Only one of these (i.e., effluent pollutant concentration) is available through the current NPDES permit database.

- Effluent pollutant concentration
- Effluent discharge rate
- Receiving water background pollutant concentration
- Receiving water discharge rate
- Receiving water hardness concentration (for metals only)
- Appropriate translator values (for metals only).

In an effort to further evaluate this question, a set of representative receiving water conditions was generated for each monitoring parameter based on queries of Ecology's EIM database and values from the literature. These representative receiving water conditions were then used to evaluate whether hypothetical water quality criteria would be exceeded given the actual effluent pollutant concentration from the permits and by assuming different dilution factors within the receiving water. However, it should be recognized that this approach seeks to make broad generalizations for processes that are driven almost entirely by site-specific conditions and interactions.

Furthermore, there are several assumptions used in this simplified approach that warrant further discussion, the first being potential correlations between input parameters. Specifically, in highly developed watersheds, background pollutant concentrations frequently show a positive correlation with discharge in the receiving water (Herrera 2001, 2004, 2005). This would tend to make it more difficult to meet water quality criteria for some parameters (e.g., metals) and more easy for other parameters (e.g., turbidity). In addition, hardness frequently shows a negative correlation with discharge due to dilution of ground water inputs to the receiving water that have naturally high mineral concentrations. This would tend to make it more difficult to meet water quality criteria for metals. These relationships were not fully captured in this approach to assessing water quality criteria, although the associated sensitivity analyses do provide some measure of the potential impact. For example, the worst case scenario used higher pollutant concentrations and lower hardness values relative to the typical scenario which, as noted above, are the conditions that would likely prevail if the correlations described above are present in the data.

Another assumption in this approach that warrants further discussion relates to the translator values that were used to estimate dissolved metal concentrations in the receiving water from total metal concentrations in the effluent. The translator values used in this analysis were taken from Pelletier (1996) and represent the 95th percentile value for the predicted dissolved metal concentration in the receiving water. Thus, they provide a conservative estimate relative to what might be expected if the translator values were predicting an average or median concentration.

To evaluate the effect of this assumption on the overall results of this analysis, the EIM database was queried to obtain data on the dissolved and total fractions of zinc from samples collected in western and eastern Washington, respectively. The average ratio of these fractions was then computed for each region (i.e., 0.362 and 0.660 for eastern and western Washington, respectively) and used in place of the values from Pelletier (1996) to predict the percentage of samples exceeding the state water quality standard based on the typical receiving water scenario and a dilution factor of 0. This analysis showed the translator values have a modest impact on the overall results for zinc. For example, the percentages of samples in western Washington that exceeded the water quality criterion for zinc were 84 and 60 percent using the Pelletier (1996) and alternative translator values, respectively. Similarly, the percentages of samples in eastern Washington that exceeded the criterion were 70 and 60 percent using the Pelletier (1996) and alternative translator values, respectively.

A relatively wide range of dilution factors was used in this analysis (i.e., 0, 10, 25, and 50) in order to determine the minimum required dilution necessary to meet water quality criteria. However, the actual dilution factor required to meet water quality criteria can also be calculated for each parameter given its associated benchmark and assumed receiving water conditions. For reference, these required dilution factors are presented in Table 28.

Table 28. Dilution factors required to meet water quality criteria assuming effluent concentrations equal the benchmarks specified in the general NPDES permit for construction and industrial stormwater.

	Turbidity [a]	Zinc [b]		Copper [c]		Lead [d]		Turbidity [e]
		Acute	Chronic	Acute	Chronic	Acute	Chronic	
Western Washington								
Worst-Case	4.7	5.1	5.8	33	56	4.0	190	9.7
Typical	4.2	3.4	3.8	17	23	2.7	76	9.2
Best-Case	3.0	2.4	2.6	10	14	1.8	48	8.0
Eastern Washington								
Worst-Case	4.7	6.0	8.5	12	18	1.9	75	--
Typical	4.2	1.4	1.6	5.7	8.4	0.9	25	--
Best-Case	3.0	0.9	1.0	3.0	4.5	0.6	15	--

[a] Required dilution factors assuming benchmark for turbidity from the general NPDES permit for industrial stormwater (25 NTU).
[b] Required dilution factors assuming benchmark for zinc from the general NPDES permit for industrial stormwater (117 μg/L).
[c] Required dilution factors assuming benchmark for copper from the general NPDES permit for industrial stormwater (63.8 μg/L).
[d] Required dilution factors assuming benchmark for lead from the general NPDES permit for industrial stormwater (81.6 μg/L).
[e] Required dilution factors assuming benchmark for turbidity from the general NPDES permit for construction stormwater (50 NTU).

The results from the analyses of the industrial stormwater data indicate that a high percentage of samples exceed the water quality criteria when dilution factors of 0 and 10 are assumed. Total copper is of particular concern given that over 90 percent of the samples in both eastern and western Washington exceeded the acute and chronic criteria with a dilution factor of 0. Total zinc and turbidity are identified as being of moderate concern with between 40 and 90 percent of the samples in both eastern and western Washington exceeding the associated criteria with a dilution factor of 0. Finally, lead is identified as being of lower concern with less than 40 percent of the samples exceeding the acute criterion in both eastern and western Washington with a dilution factor of 0. However, it should be noted that a high percentage of samples (> 90 percent) still exceeded the chronic criterion for lead with a dilution factor of 0. The percentage of exceedance for all parameters dropped to less than 35 percent with a dilution factor of 25, and less than 15 percent with a dilution factor of 50. Based on these results, it can be concluded that, when little or no dilution is available in the receiving water, discharges of industrial stormwater may be contributing to exceedances of the water quality criteria; however, the number of exceedances drops rapidly when relatively moderate levels of dilution are available.

Analyses performed on the subset of samples from industrial stormwater with concentrations below the benchmark showed that the water quality criteria were typically only exceeded when a dilution factor of 0 was assumed. The only notable exception was the chronic criterion for dissolved lead which exhibited a fairly high percentage of sample exceedances with a dilution factor of 10 in addition to a dilution factor of 0. These results suggest that water quality criteria are generally met if the benchmark values are achieved by the permittees, and a relatively small amount of dilution is assumed in the receiving water.

Analyses performed on the construction stormwater data showed similar trends to those observed for the industrial stormwater data. Specifically, a high percentage of samples exceed the water quality criterion for turbidity when dilution factors of 0 and 10 are assumed; however, the percentage of exceedance dropped off rapidly with higher dilution factors. Analyses performed on the subset of samples with concentrations below the benchmark showed that the water quality criterion was only exceeded when a dilution factor of 0 was assumed.

References

40 CFR 122.26. 1998. Storm water discharges (applicable to State NPDES programs, see 123.25). Code of Federal Regulations.

Ecology. 2005. Stormwater Quality Survey of Western Washington Construction Sites, 2003-2005. Publication No. 05-03-028. Washington State Department of Ecology, Olympia, Washington.

Ecology. 2006. Database retrieval: Water quality data from river systems for hardness, total suspended solids, turbidity, total zinc, total copper, and total lead. Environmental Information Management (EIM) system (<http://www.ecy.wa.gov/eim/index.htm>), Washington State Department of Ecology, Olympia, Washington. March 17, 2006.

Helsel, D.R. and R.M. Hirsch. 1992. Statistical Methods in Water Resources. Studies in Environmental Science 49. Elsevier Publications.

Herrera. 2001. Five-Year Project Report: City of Des Moines Water Quality Monitoring Program. Prepared for the City of Des Moines by Herrera Environmental Consultants, Inc., Seattle, Washington.

Herrera. 2004. Years 2001-2002 Water Quality Data Report: Green Duwamish Watershed Water Quality Assessment. Prepared for King County Department of Natural Resources by Herrera Environmental Consultants, Inc., Seattle, Washington.

Herrera. 2005. Year 2003 Water Quality Data Report: Green Duwamish Watershed Water Quality Assessment. Prepared for King County Department of Natural Resources by Herrera Environmental Consultants, Inc., Seattle, Washington.

Pelletier, G. 1996. Applying Metals Criteria to Water Quality-Based Discharge Limits, Empirical Models of the Dissolved Fraction of Cadmium, Copper, Lead, and Zinc. Watershed Assessments Section, Environmental Investigations and Laboratory Services Program, Washington State Department of Ecology, Olympia, Washington.

Stenstrom, M. K. and H. Lee. 2005. Industrial Storm Water Monitoring Program – Existing Statewide Permit Utility and Proposed Modifications. Final Report. University of California, Civil and Environmental Engineering Department, Los Angeles, California.

U.S. EPA. 2006. Sectors of Industrial Activity that Require Permit Coverage. Obtained February 7 from U.S. Environmental Protection Agency (U.S. EPA) website: <http://cfpub.epa.gov/npdes/stormwater/swcats.cfm>. February 7, 2006.

WAC 173-201A. 2003. Water Quality Standards for Surface Waters of the State of Washington. Washington Administrative Code. July 1, 2003.

Zar, J.H. 1984. Biostatistical Analysis. 2nd edition. Prentice Hall, Inc., Englwood Cliffs, New Jersey.

APPENDIX A

Summary Statistics for Monitoring Parameters Measured In Industrial Stormwater by Industry Sector

Table A-1. Summary statistics for turbidity levels measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (NTU)	Median (NTU)	Minimum (NTU)	Maximum (NTU)	Std. Dev. (NTU)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
07	Agricultural services	1	5	24	16	9.8	60	21	0.9	0%	0%
08	Forestry	1	7	31	2.5	1.5	149	56	1.8	29%	29%
10	Metal mining	1	1	52	52	52	52	--	--	100%	100%
12	Coal mining	1	9	3	2.7	1.3	10	3	0.8	0%	0%
17	Construction special trade contractors	3	19	171	27	3.9	778	240	1.4	58%	37%
20	Food and kindred products	40	268	103	22	0.1	5490	402	3.9	46%	28%
22	Textile mill products	3	12	20	12	1.7	52	18	0.9	33%	8%
23	Apparel and other finished products made from fabrics and similar material	1	6	51	44	18	85	26	0.5	83%	33%
24	Lumber and wood products	127	799	129	27	0.2	9700	452	3.5	51%	33%
25	Furniture and fixtures	3	14	25	22	4.8	91	25	1.0	29%	14%
26	Paper and allied products	14	77	21	10	0.5	190	33	1.5	21%	13%
27	Printing, publishing and allied industries	2	10	11	6.8	1.2	33	11	1.0	20%	0%
28	Chemicals and allied products	40	226	28	14	0.4	193	36	1.3	31%	16%
29	Petroleum and coal products	6	27	55	28	2.3	220	64	1.2	56%	37%
30	Rubber and miscellaneous plastic products	37	207	32	15	0.5	460	51	1.6	34%	20%
31	Leather and leather products	1	4	10	10	4.1	16	5	0.5	0%	0%
32	Stone, clay and glass products	23	109	51	16	0.3	980	116	2.3	41%	23%
33	Primary metals industries	13	75	28	12	0.5	580	72	2.6	23%	11%
34	Fabricated metal products	62	307	48	18	0.2	1150	114	2.4	39%	19%
35	Industrial & commercial machinery & computer equip.	28	86	32	14	0.05	235	52	1.6	33%	16%
36	Electronic and other electrical equipment	7	63	13	6.5	0.5	78	17	1.2	16%	5%
37	Transportation equipment	33	343	23	8.4	0.5	560	61	2.6	18%	8%
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	1	8	6	5.2	1.5	11	3	0.6	0%	0%
39	Miscellaneous manufacturing industries	6	24	23	11	1.2	80	24	1.1	33%	17%
40	Railroad transportation	11	54	115	34	0.6	1990	292	2.5	57%	39%
41	Local and interurban passenger transportation	23	101	35	12	1.5	490	76	2.2	29%	15%
42	Motor freight transportation & warehousing	108	529	116	23	0.3	5380	423	3.7	48%	30%
44	Water transportation	30	151	39	18	0.3	343	56	1.4	39%	21%
45	Transportation by air	21	154	19	5.3	0	690	64	3.3	13%	7%
47	Transportation services	2	4	133	115	50	250	87	0.7	100%	75%
49	Electric, gas, and sanitary services	42	250	23	8.0	0.4	640	56	2.5	17%	9%
50	Wholesale trade-durable goods	63	289	57	19	0	710	103	1.8	42%	27%
51	Wholesale trade non-durable goods	23	89	29	14	0.1	676	74	2.5	28%	9%
52	Building materials, hardware, garden supply, and mobile home dealers	2	2	101	101	2.1	200	140	1.4	50%	50%
82	Educational services	1	1	4	3.8	3.8	3.8	--	--	0%	0%
95	Environmental quality programs	2	12	11	11	2.5	28	8	0.7	8%	0%
	No sector specified	26	137	38	8.4	0.7	1190	118	3.1	24%	15%

[a] Benchmark for turbidity is 25 NTU

[b] Action level for tubidity is 50 NTU

Table A-2. Summary statistics for pH levels measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean	Median	Minimum	Maximum	Std. Dev.	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
07	Agricultural services	1	5	7.7	7.8	6.5	8.4	0.71	0.09	0%	0%
08	Forestry	1	7	5.8	6.0	5.0	6.5	0.49	0.08	43%	0%
10	Metal mining	1	1	7.2	7.2	7.2	7.2	--	--	0%	0%
12	Coal mining	1	9	7.8	8.0	7.5	8.0	0.23	0.03	0%	0%
17	Construction special trade contractors	3	19	6.9	6.9	6.0	8.7	0.76	0.11	0%	0%
20	Food and kindred products	40	265	6.6	6.7	3.8	9.7	0.77	0.12	15%	3%
22	Textile mill products	3	12	6.5	6.7	5.3	7.3	0.60	0.09	17%	0%
23	Apparel and other finished products made from fabrics and similar material	1	6	6.0	6.0	6.0	6.0	0.00		0%	0%
24	Lumber and wood products	127	784	6.5	6.5	2.0	9.8	0.91	0.14	19%	3%
25	Furniture and fixtures	3	14	6.5	6.5	5.6	7.2	0.51	0.08	14%	0%
26	Paper and allied products	14	80	6.7	6.9	4.0	9.1	0.80	0.12	19%	4%
27	Printing, publishing and allied industries	2	10	6.2	6.4	5.0	7.0	0.76	0.12	20%	0%
28	Chemicals and allied products	40	226	6.7	6.8	4.3	10.7	0.92	0.14	14%	4%
29	Petroleum and coal products	6	27	6.8	7.0	5.4	7.9	0.73	0.11	19%	0%
30	Rubber and miscellaneous plastic products	37	206	6.2	6.1	4.0	8.4	0.72	0.12	23%	1%
31	Leather and leather products	1	4	7.1	7.2	6.9	7.2	0.14	0.02	0%	0%
32	Stone, clay and glass products	23	111	7.0	7.0	3.9	11.6	1.04	0.15	9%	4%
33	Primary metals industries	13	76	6.8	7.0	3.2	8.6	1.03	0.15	7%	4%
34	Fabricated metal products	62	300	6.7	6.8	2.3	9.9	0.95	0.14	15%	3%
35	Industrial & commercial machinery & computer equip.	28	91	6.7	6.7	2.6	8.5	0.86	0.13	13%	1%
36	Electronic and other electrical equipment	7	65	6.8	7.0	2.7	8.0	0.83	0.12	8%	3%
37	Transportation equipment	33	344	6.7	6.8	3.8	10.0	0.65	0.10	10%	0.3%
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	1	8	6.6	6.5	6.0	7.0	0.42	0.06	0%	0%
39	Miscellaneous manufacturing industries	6	24	6.3	6.3	5.0	8.4	0.99	0.16	33%	0%
40	Railroad transportation	11	54	6.6	6.6	5.5	10.2	0.79	0.12	9%	2%
41	Local and interurban passenger transportation	23	100	6.6	6.6	4.8	8.5	0.69	0.10	10%	1%
42	Motor freight transportation & warehousing	108	526	6.6	6.5	1.0	9.0	0.77	0.12	12%	1%
44	Water transportation	30	151	6.9	6.9	5.0	9.8	0.74	0.11	7%	0%
45	Transportation by air	21	137	6.9	6.9	4.5	10.6	0.88	0.13	10%	2%
47	Transportation services	2	4	7.0	7.0	6.0	8.1	0.95	0.14	0%	0%
49	Electric, gas, and sanitary services	42	250	6.9	7.0	5.0	9.3	0.59	0.09	6%	0.4%
50	Wholesale trade-durable goods	63	289	6.8	6.9	2.2	10.0	0.79	0.12	8%	1%
51	Wholesale trade non-durable goods	23	88	6.5	6.5	5.0	7.6	0.61	0.09	16%	0%
52	Building materials, hardware, garden supply, and mobile home dealers	2	2	5.8	5.8	5.0	6.5	1.06	0.18	0%	0%
82	Educational services	1	1	6.6	6.6	6.6	6.6	--	--	0%	0%
95	Environmental quality programs	2	12	7.0	6.9	6.5	7.7	0.36	0.05	0%	0%
	No sector specified	26	132	6.5	6.6	4.4	8.2	0.73	0.11	14%	1%

[a] Benchmark for pH is <6 or >9

[b] · ŋ level for pH is <5 or >10

Table A-3. Summary statistics for total zinc concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (µg/L)	Median (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Std. Dev. (µg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
07	Agricultural services	1	5	12	10	0.01	40	16	1.4	0%	0%
08	Forestry	1	4	16	9.0	0.021	47	21	1.3	0%	0%
10	Metal mining	1	1	297	297	297	297	--	--	100%	0%
12	Coal mining	1	9	42	11	2.0	220	69	1.6	11%	0%
17	Construction special trade contractors	3	19	379	392	0.98	1040	278	0.7	79%	53%
20	Food and kindred products	40	269	362	204	0.12	2882	449	1.2	69%	29%
22	Textile mill products	3	12	585	288	87	3400	912	1.6	92%	42%
23	Apparel and other finished products made from fabrics and similar material	1	6	288	225	94	561	191	0.7	83%	33%
24	Lumber and wood products	127	734	224	119	0.362	2600	312	1.4	50%	17%
25	Furniture and fixtures	3	12	144	49	10	800	230	1.6	25%	8%
26	Paper and allied products	14	79	300	90	8	7950	922	3.1	41%	16%
27	Printing, publishing and allied industries	2	10	84	77	0.149	250	69	0.8	20%	0%
28	Chemicals and allied products	40	221	328	179	0.02	8110	643	2.0	61%	27%
29	Petroleum and coal products	6	23	344	140	20.8	2600	558	1.6	57%	22%
30	Rubber and miscellaneous plastic products	37	202	318	160	5.0	2960	435	1.4	62%	22%
31	Leather and leather products	1	4	40	32	12.4	82	31	0.8	0%	0%
32	Stone, clay and glass products	23	100	920	135	0.03	39400	4497	4.9	56%	16%
33	Primary metals industries	13	76	346	100	1.0	5160	881	2.5	41%	14%
34	Fabricated metal products	62	291	2593	310	1.58	130000	11964	4.6	75%	45%
35	Industrial & commercial machinery & computer equip.	28	79	409	96	0.0	9410	1245	3.0	43%	16%
36	Electronic and other electrical equipment	7	65	289	88	5.0	3500	642	2.2	37%	14%
37	Transportation equipment	33	329	249	120	0.05	5300	496	2.0	52%	16%
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches and clocks	1	8	24	20	2.0	56	18	0.8	0%	0%
39	Miscellaneous manufacturing industries	6	24	244	169	19	1200	276	1.1	67%	17%
40	Railroad transportation	11	50	290	183	0.34	1800	339	1.2	70%	22%
41	Local and interurban passenger transportation	23	101	173	103	4.7	1210	193	1.1	46%	10%
42	Motor freight transportation & warehousing	108	502	377	162	0.14	16200	1023	2.7	62%	21%
44	Water transportation	30	145	380	244	0.7	4000	515	1.4	74%	34%
45	Transportation by air	21	146	230	50	1.56	6300	694	3.0	32%	12%
47	Transportation services	2	4	1134	283	71	3900	1848	1.6	75%	50%
49	Electric, gas, and sanitary services	42	224	138	37	0.002	4400	361	2.6	21%	7%
50	Wholesale trade-durable goods	63	276	317	120	2.0	6410	587	1.9	53%	23%
51	Wholesale trade non-durable goods	23	88	323	168	0.37	3110	500	1.5	63%	23%
52	Building materials, hardware, garden supply, and mobile home dealers	2	1	7840	7840	7840	7840	--	--	100%	100%
82	Educational services	1	1	19	19	19	19	--	--	0%	0%
95	Environmental quality programs	2	12	99	72	20	300	91	0.9	25%	0%
	No sector specified	26	132	533	150	0.255	18200	1790	3.4	58%	28%

[a] Benchmark for zinc is 117 µg/L

[b] Action level for zinc is 372 µg/L

Table A-4. Summary statistics for oil and grease concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
07	Agricultural services	1	5	3.6	5.0	1.0	5.0	1.9	0.5	0%	0%
10	Metal mining	1	1	1.8	1.8	1.8	1.8	--	--	0%	0%
12	Coal mining	1	9	1.3	1.0	1.0	2.0	0.4	0.3	0%	0%
17	Construction special trade contractors	3	5	5.5	6.6	2.0	7.2	2.1	0.4	0%	0%
20	Food and kindred products	40	213	8.7	5.0	1.0	151.0	14.4	1.7	12%	5%
22	Textile mill products	3	9	4.6	5.0	3.0	5.0	0.9	0.2	0%	0%
23	Apparel and other finished products made from fabrics	1	2	3.6	3.6	3.6	3.6	--	--	0%	0%
24	Lumber and wood products	127	382	7.2	5.0	0.0	120.0	10.3	1.4	8%	2%
25	Furniture and fixtures	3	9	5.5	5.3	5.0	5.9	0.3	0.1	0%	0%
26	Paper and allied products	14	69	5.1	3.7	1.0	70.0	8.4	1.7	3%	1%
28	Chemicals and allied products	40	156	4.8	4.3	0.3	26.0	4.1	0.9	3%	0%
29	Petroleum and coal products	6	18	7.8	5.0	1.0	41.0	9.1	1.2	11%	6%
30	Rubber and miscellaneous plastic products	37	129	5.0	4.0	0.0	39.1	5.5	1.1	4%	2%
31	Leather and leather products	1	4	5.6	5.4	5.4	6.0	0.3	0.1	0%	0%
32	Stone, clay and glass products	23	51	6.3	5.0	1.0	34.0	6.3	1.0	6%	4%
33	Primary metals industries	13	54	2.8	2.0	0.0	9.6	2.1	0.8	0%	0%
34	Fabricated metal products	62	192	7.1	5.0	0.0	83.3	8.3	1.2	8%	3%
35	Industrial & commercial machinery & computer equip.	28	36	12.9	5.1	0.0	106.0	20.9	1.6	19%	8%
36	Electronic and other electrical equipment	7	53	4.5	5.0	0.0	5.4	1.3	0.3	0%	0%
37	Transportation equipment	33	197	2.5	1.0	0.0	38.0	3.6	1.4	1%	1%
38	Measuring, analyzing, and controlling instruments;	1	8	1.3	1.0	1.0	2.7	0.7	0.5	0%	0%
39	Miscellaneous manufacturing industries	6	11	7.8	7.1	1.0	16.0	4.2	0.5	9%	0%
40	Railroad transportation	11	26	7.3	6.5	2.0	18.8	4.3	0.6	12%	0%
41	Local and interurban passenger transportation	23	54	14.6	5.0	1.0	223.0	37.6	2.6	13%	9%
42	Motor freight transportation & warehousing	108	302	8.6	5.0	1.0	359.0	22.0	2.6	10%	4%
44	Water transportation	30	92	12.1	5.0	0.0	561.0	57.9	4.8	4%	1%
45	Transportation by air	21	74	6.3	5.0	1.0	96.3	11.2	1.8	4%	1%
47	Transportation services	2	3	20.9	7.9	6.9	48.0	23.4	1.1	33%	0%
49	Electric, gas, and sanitary services	42	153	12.5	5.0	1.0	914.0	75.5	6.0	5%	3%
50	Wholesale trade-durable goods	63	191	12.5	5.0	0.8	232.0	27.4	2.2	17%	8%
51	Wholesale trade non-durable goods	23	67	6.8	5.0	1.0	82.0	10.3	1.5	3%	3%
52	Building materials, hardware, garden supply, and mobile	2	1	7.1	7.1	7.1	7.1	--	--	0%	0%
95	Environmental quality programs	2	9	2.6	2.5	2.5	3.0	0.2	0.1	0%	0%
	No sector specified	26	66	7.1	5.0	1.3	46.8	9.7	1.4	8%	6%

[a] Benchmark for oil & grease is 15 mg/L
[b] Action level for oil & grease is 30 mg/L

Table A-5. Summary statistics for total copper concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (µg/L)	Median (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Std. Dev. (µg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
10	Metal mining	1	1	158.0	158.0	158.0	158.0	–	--	100%	100%
17	Construction special trade contractors	3	12	106.3	99.0	7.1	222.0	82.9	0.8	67%	33%
20	Food and kindred products	40	58	47.7	20.5	0.8	734.0	98.4	2.1	17%	3%
22	Textile mill products	3	6	46.0	23.5	6.7	140.0	50.6	1.1	33%	0%
23	Apparel and other finished products made from	1	4	21.0	24.0	5.0	31.0	11.6	0.6	0%	0%
24	Lumber and wood products	127	83	35.7	21.4	0.1	600.0	68.0	1.9	17%	2%
26	Paper and allied products	14	8	50.5	25.0	20.0	140.0	45.7	0.9	25%	0%
28	Chemicals and allied products	40	49	42.3	25.9	5.0	300.0	51.7	1.2	18%	4%
30	Rubber and miscellaneous plastic products	37	43	65.3	20.0	3.6	530.0	116.0	1.8	26%	12%
32	Stone, clay and glass products	23	12	938.1	19.2	10.0	11,000.0	3,168.7	3.4	8%	8%
33	Primary metals industries	13	65	61.4	18.0	0.4	473.0	101.0	1.6	28%	12%
34	Fabricated metal products	62	215	59.9	24.0	0.0	1,700.0	144.4	2.4	21%	7%
36	Electronic and other electrical equipment	7	10	21.5	20.6	3.2	54.3	15.9	0.7	0%	0%
37	Transportation equipment	33	132	29.4	22.8	0.0	177.0	24.5	0.8	8%	1%
39	Miscellaneous manufacturing industries	6	3	7.0	7.1	4.0	10.0	3.0	0.4	0%	0%
40	Railroad transportation	11	10	67.2	22.3	5.0	490.0	149.1	2.2	10%	10%
41	Local and interurban passenger transportation	23	13	18.5	15.5	7.0	41.0	11.4	0.6	0%	0%
42	Motor freight transportation & warehousing	108	127	50.3	29.4	3.8	496.0	72.9	1.5	19%	6%
44	Water transportation	30	30	49.3	36.3	0.0	194.0	46.7	0.9	20%	7%
45	Transportation by air	21	15	39.5	7.0	5.0	150.0	52.9	1.3	27%	7%
49	Electric, gas, and sanitary services	42	37	61.9	16.7	1.0	1,230.0	201.4	3.3	14%	5%
50	Wholesale trade-durable goods	63	204	113.5	22.7	2.0	5,940.0	467.2	4.1	27%	10%
51	Wholesale trade non-durable goods	23	16	18.2	16.5	2.0	63.6	19.3	1.1	0%	0%
95	Environmental quality programs	2	4	22.8	25.0	11.0	30.0	9.1	0.4	0%	0%
	No sector specified	26	20	292.3	10.0	0.0	4,930.0	1,098.1	3.8	20%	10%

[a] Benchmark for copper is 63.6 µg/L
[b] Action level for copper is 149 µg/L

Table A-6. Summary statistics for total lead concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (µg/L)	Median (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Std. Dev. (µg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
10	Metal mining	1	1	13.9	13.9	13.9	13.9	--	--	0%	0%
17	Construction special trade contractors	3	11	29	33	1.7	70	24	0.8	0%	0%
20	Food and kindred products	40	55	20	10	0.05	200	33	1.6	4%	2%
22	Textile mill products	3	5	6.3	6	6	7.56	0.7	0.1	0%	0%
23	Apparel and other finished products made from fabrics	1	4	14	6.5	4	37	16	1.2	0%	0%
24	Lumber and wood products	127	67	20	8	0.006	332	47	2.4	3%	3%
26	Paper and allied products	14	8	34	40	1	110	36	1.1	13%	0%
28	Chemicals and allied products	40	43	65	40	2	597	130	2.0	12%	9%
30	Rubber and miscellaneous plastic products	37	33	15	7	0.08	40	15	1.0	0%	0%
32	Stone, clay and glass products	23	4	29	25	25	40	7.5	0.3	0%	0%
33	Primary metals industries	13	48	98	10	0.01	1240	278	2.9	21%	8%
34	Fabricated metal products	62	192	55	25	0.02	3000	223	4.1	11%	5%
35	Industrial & commercial machinery & computer equip.	28	1	1.7	1.7	1.7	1.7	--	--	0%	0%
36	Electronic and other electrical equipment	7	8	15	6.5	1.44	78	26	1.7	0%	0%
37	Transportation equipment	33	122	7	3.3	0.01	89.7	11	1.6	1%	0%
39	Miscellaneous manufacturing industries	6	4	3.9	4	1.8	5.7	1.8	0.5	0%	0%
40	Railroad transportation	11	8	43	40	1.5	81	22	0.5	0%	0%
41	Local and interurban passenger transportation	23	9	15	4.5	1	40	17	1.2	0%	0%
42	Motor freight transportation & warehousing	108	111	31	15	2	289	49	1.6	6%	4%
44	Water transportation	30	27	33	13	0.05	144	38	1.2	11%	0%
45	Transportation by air	21	15	37	40	25	50	7.3	0.2	0%	0%
49	Electric, gas, and sanitary services	42	36	13	7	0.9	110	19	1.5	3%	0%
50	Wholesale trade-durable goods	63	186	104	25	0.1	3730	339	3.2	22%	10%
51	Wholesale trade non-durable goods	23	13	29	20	2	81.6	28	1.0	0%	0%
95	Environmental quality programs	2	4	3.3	2	1.6	7.6	2.9	0.9	0%	0%
	No sector specified	26	19	53	10	0.007	576	137	2.6	11%	11%

[a] Benchmark for lead is 81.6 µg/L
[b] Action level for lead is 159 µg/L

Table A-7. Summary statistics for biological oxygen demand concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
20	Food and kindred products	40	221	35.9	13.0	2.0	340.0	58.6	1.6	29%	16%
24	Lumber and wood products	127	615	46.7	14.0	0.5	639.0	82.6	1.8	30%	21%
26	Paper and allied products	14	20	10.2	9.0	4.0	27.0	6.1	0.6	0%	0%
28	Chemicals and allied products	40	159	17.2	6.0	1.5	320.0	40.9	2.4	9%	4%
42	Motor freight transportation & warehousing	108	6	7.3	5.5	2.0	14.0	5.0	0.7	0%	0%
47	Transportation services	2	2	29.5	29.5	26.0	33.0	4.9	0.2	50%	0%
49	Electric, gas, and sanitary services	42	64	7.0	4.5	0.2	39.0	7.8	1.1	0%	–
51	Wholesale trade non-durable goods	23	3	6.8	7.0	4.0	9.3	2.7	0.4	0%	0%
	No sector specified	26	15	17.4	15.0	3.0	90.0	21.3	1.2	7%	7%

[a] Benchmark for BOD is 30 mg/L with the exception of sector 49 which has a benchmark of 140 mg/L
[b] Action level for BOD is 60 mg/L

Table A-8. Summary statistics for ammonia nitrogen concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
32	Stone, clay and glass products	23	3	9.2	10.1	7.2	10.2	2	0.2	0%	0%
39	Miscellaneous manufacturing industries	6	1	0.1	0.1	0.1	0.1	--	--	0%	0%
49	Electric, gas, and sanitary services	42	66	0.3	0.1	0.0	4.8	0.6	2.4	0%	0%

[a] Benchmark for ammonia nitrogen is 21.8 mg/L for all sectors except for 49 which has a benchmark of 10 mg/L
[b] Action level for ammonia nitrogen is 38 mg/L

Table A-9. Summary statistics for nitrate + nitrite nitrogen concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
20	Food and kindred products	40	217	1.5	0.4	0.01	61.0	4.9	3.3	34%	21%
28	Chemicals and allied products	40	174	2.5	0.6	0.01	83.7	9.2	3.7	43%	22%
47	Transportation services	2	2	50.3	50.3	0.5	100.0	70.4	1.4	50%	50%
	No sector specified	26	4	0.8	0.3	0.2	2.4	1.0	1.3	25%	25%

[a] Benchmark for nitrate + nitrite nitrogen is 0.68 mg/L
[b] Action level for nitrate + nitrite nitrogen is 1.36 mg/L

Table A-10. Summary statistics for total phosphorus concentrations measured in industrial stormwater by industry sector.

SIC	Sector	# of facilities	# of values	Mean (mg/L)	Median (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Std. Dev. (mg/L)	Coefficient of variation	Exceedance of benchmark[a]	Exceedance of action level[b]
20	Food and kindred products	40	230	1	0.3	0.005	23	3.1	2.4	14%	7%
28	Chemicals and allied products	40	170	1.4	0.1	0.004	137	10.7	7.4	7%	6%
47	Transportation services	2	2	3.2	3.2	1.2	5.1	2.8	0.9	50%	50%
50	Wholesale trade-durable goods	63	2	11.5	11.5	0.081	23	16.2	1.4	50%	50%
51	Wholesale trade non-durable goods	23	1	0.1	0.1	0.12	0.12	--	--	0%	0%
	No sector specified	26	5	0.08	0.1	0.044	0.18	0.1	0.7	0%	0%

[a] Benchmark for total phosphorus is 2 mg/L
[b] Action level for total phosphorus is 4 mg/L

APPENDIX B

Percentages of Samples Exceeding State Water Quality Standards by Industrial Category Given Hypothetical Receiving Water Conditions and Varying Dilution Factors

Table B-1. Percentage of turbidity samples that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

Category	n	Exceedance of Std. (%)[a] 0 DF	10 DF	25 DF	50 DF
Western Washington					
01 - Facilities with effluent limitations	8	25 (0-38)	0 (0)	0 (0)	0 (0)
02 - Manufacturing	1286	72 (58-76)	27 (24-27)	14 (14-15)	8 (7-8)
03 - Mineral, metal, oil, and gas	23	22 (13-26)	0 (0)	0 (0)	0 (0)
05 - Landfills	135	48 (30-54)	4 (3-4)	1 (1)	0 (0)
06 - Recycling facilities	295	71 (57-76)	25 (22-27)	12 (11-12)	4 (4)
07 - Steam electric plants	3	67 (0-67)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	960	68 (53-75)	23 (21-23)	10 (10)	5 (5)
09 - Treatment works	74	39 (27-45)	8 (3-8)	0 (0)	0 (0)
10 - Construction sites > 5 acres	6	67 (50-83)	17 (17)	17 (17)	0 (0)
11 - Light industrial activity	1370	58 (42-65)	15 (13-15)	5 (4-5)	3 (2-3)
12 - Significant contributor	7	29 (29)	29 (14-29)	14 (14)	0 (0)
No category specified	113	50 (35-61)	14 (14)	5 (5)	4 (4)
All Western Washington	**4280**	**64 (49-70)**	**20 (18-21)**	**9 (9)**	**5 (5)**
Eastern Washington					
02 - Manufacturing	41	76 (68-90)	22 (22-24)	22 (20-22)	7 (7)
03 - Mineral, metal, oil, and gas	1	100 (100)	0 (0-100)	0 (0)	0 (0)
08 - Transportation facilities	50	84 (66-88)	30 (26-36)	24 (18-24)	14 (14)
09 - Treatment works	3	67 (33-67)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	80	79 (66-84)	30 (28-30)	14 (13-14)	6 (6)
No category specified	9	89 (44-100)	22 (22)	0 (0)	0 (0)
All Eastern Washington	**184**	**80 (65-87)**	**27 (25-30)**	**17 (15-17)**	**8 (8)**
All Washington	**4464**	65 (50-71)	**21 (18-21)**	**10 (9-10)**	**5 (5)**

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

Table B-2. Percentage of turbidity samples with levels less than the benchmark that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

Category	n	Exceedance of Std. (%)[a]			
		0 DF	10 DF	25 DF	50 DF
Western Washington					
01 - Facilities with effluent limitations	8	25 (0-38)	0 (0)	0 (0)	0 (0)
02 - Manufacturing	713	49 (24-57)	0 (0)	0 (0)	0 (0)
03 - Mineral, metal, oil, and gas	22	18 (9-23)	0 (0)	0 (0)	0 (0)
05 - Landfills	113	38 (17-45)	0 (0)	0 (0)	0 (0)
06 - Recycling facilities	170	49 (25-59)	0 (0)	0 (0)	0 (0)
07 - Steam electric plants	3	67 (0-67)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	584	48 (23-59)	0 (0)	0 (0)	0 (0)
09 - Treatment works	66	32 (18-38)	0 (0)	0 (0)	0 (0)
10 - Construction sites > 5 acres	3	33 (0-67)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	968	40 (19-51)	0 (0)	0 (0)	0 (0)
12 - Significant contributor	5	0 (0)	0 (0)	0 (0)	0 (0)
No category specified	85	33 (13-48)	0 (0)	0 (0)	0 (0)
All Western Washington	**2740**	**44 (21-54)**	**0 (0)**	**0 (0)**	**0 (0)**
Eastern Washington					
02 - Manufacturing	19	47 (32-79)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	20	60 (15-70)	0 (0)	0 (0)	0 (0)
09 - Treatment works	3	67 (33-67)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	38	55 (29-66)	0 (0)	0 (0)	0 (0)
No category specified	5	80 (0-100)	0 (0)	0 (0)	0 (0)
All Eastern Washington	**85**	**56 (25-72)**	**0 (0)**	**0 (0)**	**0 (0)**
All Washington	**2825**	**44 (21-54)**	**0 (0)**	**0 (0)**	**0 (0)**

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

Table B-3. Percentage of total zinc samples that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

Category	n	Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
		0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
Western Washington									
01 - Facilities with effluent limitations	8	100 (100)	100 (100)	88 (63-88)	38 (13-88)	100 (100)	100 (100)	88 (88-100)	63 (13-88)
02 - Manufacturing	1194	83 (78-86)	25 (16-36)	7 (5-14)	3 (2-6)	84 (79-87)	26 (17-40)	9 (6-16)	3 (2-6)
03 - Mineral, metal, oil, and gas	22	36 (27-50)	5 (5)	0 (0-5)	0 (0)	41 (32-50)	5 (5-14)	0 (0-5)	0 (0)
05 - Landfills	120	82 (76-91)	31 (25-38)	21 (21-24)	20 (19-21)	85 (79-94)	34 (26-41)	22 (21-25)	20 (19-21)
06 - Recycling facilities	288	84 (78-88)	26 (19-33)	8 (4-18)	2 (1-5)	85 (80-89)	27 (20-37)	9 (5-19)	3 (1-7)
07 - Steam electric plants	3	33 (33-67)	0 (0)	0 (0)	0 (0)	67 (33-67)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	909	85 (80-90)	24 (13-37)	6 (4-12)	3 (1-5)	87 (81-90)	26 (16-40)	7 (5-13)	3 (1-5)
09 - Treatment works	73	56 (45-74)	7 (5-15)	1 (0-5)	0 (0-1)	59 (48-75)	8 (5-15)	4 (1-5)	0 (0-1)
10 - Construction sites > 5 acres	6	100 (100)	50 (33-83)	33 (17-33)	17 (17)	100 (100)	67 (33-83)	33 (17-33)	17 (17-33)
11 - Light industrial activity	1331	89 (85-92)	26 (17-37)	8 (6-15)	4 (3-7)	90 (86-93)	27 (19-40)	9 (6-16)	5 (3-7)
12 - Significant contributor	4	25 (0-25)	0 (0)	0 (0)	0 (0)	25 (25)	0 (0)	0 (0)	0 (0)
No category specified	108	84 (83-87)	33 (25-44)	12 (9-22)	6 (4-9)	85 (83-87)	37 (27-47)	15 (9-24)	6 (5-10)
All Western Washington	**4066**	**84 (79-88)**	**24 (16-35)**	**7 (5-14)**	**3 (2-6)**	**85 (80-88)**	**26 (17-39)**	**9 (6-16)**	**4 (2-6)**
Eastern Washington									
02 - Manufacturing	39	87 (74-92)	8 (0-64)	0 (0-15)	0 (0-10)	90 (74-92)	10 (3-74)	0 (0-38)	0 (0-10)
03 - Mineral, metal, oil, and gas	1	100 (100)	0 (0-100)	0 (0)	0 (0)	100 (100)	0 (0-100)	0 (0-100)	0 (0)
08 - Transportation facilities	50	47 (39-71)	6 (4-29)	4 (2-14)	2 (2-8)	57 (39-73)	8 (6-39)	4 (2-14)	2 (2-12)
09 - Treatment works	3	0 (0-67)	0 (0)	0 (0)	0 (0)	33 (0-67)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	81	79 (63-86)	14 (6-57)	4 (1-35)	1 (1-16)	80 (67-90)	17 (7-62)	5 (1-41)	1 (1-22)
No category specified	9	67 (67)	11 (0-56)	0 (0-44)	0 (0-11)	67 (67)	11 (0-67)	0 (0-44)	0 (0-22)
All Eastern Washington	**183**	**70 (58-83)**	**10 (4-50)**	**3 (1-25)**	**1 (1-12)**	**75 (60-85)**	**13 (5-58)**	**3 (1-33)**	**1 (1-16)**
All Washington	**4249**	**83 (78-88)**	**24 (15-36)**	**7 (5-14)**	**3 (2-6)**	**85 (79-88)**	**26 (17-40)**	**8 (5-16)**	**4 (2-7)**

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).

DF: Dilution factor.

Table B-4. Percentage of total zinc samples with concentrations less than the benchmark that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
Category	n	0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
Western Washington									
02 - Manufacturing	547	63 (51-70)	0 (0)	0 (0)	0 (0)	65 (55-71)	0 (0)	0 (0)	0 (0)
03 - Mineral, metal, oil, and gas	19	26 (16-42)	0 (0)	0 (0)	0 (0)	32 (21-42)	0 (0)	0 (0)	0 (0)
05 - Landfills	90	33 (30-39)	0 (0)	0 (0)	0 (0)	36 (32-42)	0 (0)	0 (0)	0 (0)
06 - Recycling facilities	143	69 (57-76)	0 (0)	0 (0)	0 (0)	70 (59-78)	0 (0)	0 (0)	0 (0)
07 - Steam electric plants	3	33 (33-67)	0 (0)	0 (0)	0 (0)	67 (33-67)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	381	65 (52-75)	0 (0)	0 (0)	0 (0)	68 (55-77)	0 (0)	0 (0)	0 (0)
09 - Treatment works	51	37 (22-63)	0 (0)	0 (0)	0 (0)	41 (25-65)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	570	74 (64-82)	0 (0)	0 (0)	0 (0)	76 (67-84)	0 (0)	0 (0)	0 (0)
12 - Significant contributor	4	25 (0-25)	0 (0)	0 (0)	0 (0)	25 (25)	0 (0)	0 (0)	0 (0)
No category specified	39	56 (54-64)	0 (0)	0 (0)	0 (0)	59 (54-64)	0 (0)	0 (0)	0 (0)
All Western Washington	**1847**	**65 (54-73)**	**0 (0)**	**0 (0)**	**0 (0)**	**67 (57-75)**	**0 (0)**	**0 (0)**	**0 (0)**
Eastern Washington									
02 - Manufacturing	9	44 (0-67)	0 (0)	0 (0)	0 (0)	56 (0-67)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	30	13 (0-53)	0 (0)	0 (0)	0 (0)	30 (0-57)	0 (0)	0 (0)	0 (0)
09 - Treatment works	3	0 (0-67)	0 (0)	0 (0)	0 (0)	33 (0-67)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	25	32 (0-56)	0 (0)	0 (0)	0 (0)	36 (0-68)	0 (0)	0 (0)	0 (0)
No category specified	3	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
All Eastern Washington	**70**	**23 (0-54)**	**0 (0)**	**0 (0)**	**0 (0)**	**34 (0-60)**	**0 (0)**	**0 (0)**	**0 (0)**
All Washington	**1917**	**63 (52-72)**	**0 (0)**	**0 (0)**	**0 (0)**	**66 (55-74)**	**0 (0)**	**0 (0)**	**0 (0)**

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

Table B-5. Percentage of total copper samples that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
Category	n	0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
Western Washington									
01 - Facilities with effluent limitations	4	100 (75-100)	50 (0-50)	0 (0-50)	0 (0)	100 (100)	50 (50)	0 (0-50)	0 (0-50)
02 - Manufacturing	276	91 (84-92)	29 (18-54)	12 (6-24)	5 (3-12)	92 (88-92)	44 (24-75)	17 (8-41)	7 (4-21)
05 - Landfills	22	91 (82-95)	23 (14-23)	5 (5-23)	5 (5-9)	91 (91-95)	23 (23-59)	14 (5-23)	5 (5-18)
06 - Recycling facilities	196	98 (89-99)	41 (28-53)	18 (10-37)	7 (5-18)	99 (93-99)	49 (38-70)	28 (13-48)	12 (7-31)
08 - Transportation facilities	184	95 (88-96)	30 (15-58)	11 (5-19)	4 (2-11)	96 (91-98)	51 (21-73)	15 (9-48)	5 (3-16)
09 - Treatment works	18	100 (89-100)	22 (6-56)	6 (6-17)	6 (0-6)	100 (100)	50 (17-67)	6 (6-44)	6 (0-11)
11 - Light industrial activity	421	98 (91-99)	29 (15-55)	9 (5-24)	3 (2-9)	99 (95-99)	40 (25-78)	15 (8-38)	6 (2-17)
No category specified	20	85 (85)	20 (20)	15 (10-20)	10 (10-15)	85 (85-90)	20 (20-45)	20 (15-20)	10 (10-20)
All Western Washington	1141	**95** **(88-96)**	**31** **(18-54)**	**12** **(6-25)**	**5** **(3-12)**	**96** **(92-97)**	**44** **(26-74)**	**17** **(9-42)**	**7** **(4-20)**
Eastern Washington									
02 - Manufacturing	4	75 (25-100)	0 (0)	0 (0)	0 (0)	100 (50-100)	0 (0)	0 (0)	0 (0)
03 - Mineral, metal, oil, and gas	1	100 (100)	100 (0-100)	0 (0-100)	0 (0)	100 (100)	100 (100)	0 (0-100)	0 (0)
08 - Transportation facilities	12	58 (50-92)	25 (8-42)	8 (0-17)	0 (0-8)	75 (58-100)	42 (17-42)	8 (8-25)	0 (0-8)
11 - Light industrial activity	19	63 (47-79)	5 (0-16)	0 (0)	0 (0)	79 (58-84)	11 (0-26)	0 (0-5)	0 (0)
All Eastern Washington	36	**64** **(47-86)**	**14** **(3-25)**	**3** **(0-8)**	**0** **(0-3)**	**81** **(58-92)**	**22** **(8-31)**	**3** **(3-14)**	**0** **(0-3)**
All Washington	1177	**94** **(87-96)**	**31** **(17-53)**	**11** **(6-24)**	**5** **(3-11)**	**96** **(91-97)**	**43** **(25-73)**	**17** **(9-41)**	**7** **(4-20)**

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

Table B-6. Percentage of total zinc samples with concentrations less than the benchmark that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

Category	n	Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
		0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
Western Washington									
01 - Facilities with effluent limitations	4	100 (75-100)	50 (0-50)	0 (0-50)	0 (0)	100 (100)	50 (50)	0 (0-50)	0 (0-50)
02 - Manufacturing	222	89 (81-90)	12 (0-42)	0 (0-5)	0 (0)	90 (85-91)	31 (5-69)	0 (0-27)	0 (0-1)
05 - Landfills	19	89 (79-95)	11 (0-11)	0 (0-11)	0 (0)	89 (89-95)	11 (11-53)	0 (0-11)	0 (0-5)
06 - Recycling facilities	140	97 (85-99)	18 (0-34)	0 (0-11)	0 (0)	99 (90-99)	29 (13-59)	0 (0-28)	0 (0-4)
08 - Transportation facilities	155	94 (85-95)	17 (0-50)	0 (0-4)	0 (0)	95 (89-97)	41 (6-68)	0 (0-38)	0 (0)
09 - Treatment works	16	100 (88-100)	13 (0-50)	0 (0-6)	0 (0)	100 (100)	44 (6-63)	0 (0-38)	0 (0)
11 - Light industrial activity	354	97 (90-98)	16 (0-46)	0 (0-9)	0 (0)	98 (94-99)	29 (11-74)	0 (0-26)	0 (0-2)
No category specified	16	81 (81)	0 (0)	0 (0)	0 (0)	81 (81-88)	0 (0-31)	0 (0)	0 (0)
All Western Washington	**926**	**94 (86-96)**	**15 (0-43)**	**0 (0-8)**	**0 (0)**	**95 (90-96)**	**31 (9-68)**	**0 (0-28)**	**0 (0-2)**
Eastern Washington									
02 - Manufacturing	4	75 (25-100)	0 (0)	0 (0)	0 (0)	100 (50-100)	0 (0)	0 (0)	0 (0)
08 - Transportation facilities	7	29 (14-86)	0 (0)	0 (0)	0 (0)	57 (29-100)	0 (0)	0 (0)	0 (0)
11 - Light industrial activity	16	56 (38-75)	0 (0)	0 (0)	0 (0)	75 (50-81)	0 (0-13)	0 (0)	0 (0)
All Eastern Washington	**27**	**52 (30-81)**	**0 (0)**	**0 (0)**	**0 (0)**	**74 (44-89)**	**0 (0-7)**	**0 (0)**	**0 (0)**
All Washington	**953**	**93 (84-95)**	**15 (0-42)**	**0 (0-7)**	**0 (0)**	**95 (89-96)**	**30 (9-66)**	**0 (0-27)**	**0 (0-2)**

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).
DF: Dilution factor.

Table B-7. Percentage of total lead samples that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
Category	n	0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
Western Washington									
01 - Facilities with effluent limitations	2	100 (100)	0 (0)	0 (0)	0 (0)	100 (100)	100 (100)	100 (100)	100 (0-100)
02 - Manufacturing	226	32 (14-38)	3 (2-3)	1 (1-2)	0 (0-1)	87 (87-92)	48 (41-77)	33 (14-60)	12 (10-42)
05 - Landfills	21	10 (10-14)	0 (0)	0 (0)	0 (0)	95 (95-100)	24 (19-71)	10 (10-38)	5 (5-24)
06 - Recycling facilities	178	47 (39-53)	6 (5-8)	4 (2-4)	1 (1-2)	96 (94-99)	64 (60-87)	49 (39-75)	29 (21-63)
08 - Transportation facilities	157	39 (17-49)	0 (0-1)	0 (0)	0 (0)	96 (94-99)	66 (55-90)	43 (17-77)	11 (4-57)
09 - Treatment works	18	6 (0-11)	0 (0)	0 (0)	0 (0)	94 (83-100)	28 (17-72)	6 (0-44)	0 (0-22)
11 - Light industrial activity	378	24 (11-34)	1 (1)	0 (0-1)	0 (0)	94 (86-98)	46 (39-72)	24 (12-54)	8 (5-41)
No category specified	19	21 (11-26)	5 (5-11)	0 (0-5)	0 (0)	95 (95)	37 (32-79)	26 (11-58)	11 (11-32)
All Western Washington	**999**	**32** **(17-40)**	**2** **(2-3)**	**1** **(1-2)**	**0** **(0-1)**	**93** **(89-97)**	**52** **(45-79)**	**33** **(18-62)**	**13** **(9-47)**
Eastern Washington									
02 - Manufacturing	4	50 (50)	0 (0)	0 (0)	0 (0)	100 (75-100)	50 (50-75)	50 (50)	50 (25-50)
03 - Mineral, metal, oil, and gas	1	0 (0)	0 (0)	0 (0)	0 (0)	100 (100)	0 (0-100)	0 (0)	0 (0)
08 - Transportation facilities	12	25 (17-33)	0 (0)	0 (0)	0 (0)	92 (75-100)	33 (33-42)	25 (17-33)	17 (8-33)
11 - Light industrial activity	18	6 (0-11)	0 (0)	0 (0)	0 (0)	78 (61-83)	17 (11-50)	6 (0-17)	0 (0-11)
All Eastern Washington	**35**	**17** **(11-23)**	**0** **(0)**	**0** **(0)**	**0** **(0)**	**86** **(69-91)**	**26** **(23-51)**	**17** **(11-26)**	**11** **(6-23)**
All Washington	**1034**	**31** **(17-39)**	**2** **(2-3)**	**1** **(1-2)**	**0** **(0-1)**	**93** **(89-97)**	**51** **(44-78)**	**33** **(18-61)**	**13** **(9-46)**

DF: Dilution factor.

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).

Table B-8. Percentage of total lead samples with concentrations less than the benchmark that potentially exceed state water quality criteria given hypothetical receiving water conditions for eastern and western Washington and dilution factors of 0, 10, 25, and 50.

		Exceedance of Acute Std. (%)[a]				Exceedance of Chronic Std. (%)[a]			
Category	n	0 DF	10 DF	25 DF	50 DF	0 DF	10 DF	25 DF	50 DF
Western Washington									
01 - Facilities with effluent limitations	2	100 (100)	0 (0)	0 (0)	0 (0)	100 (100)	100 (100)	100 (100)	100 (0-100)
02 - Manufacturing	204	25 (5-31)	0 (0)	0 (0)	0 (0)	85 (85-91)	42 (35-75)	25 (5-56)	2 (5-36)
05 - Landfills	20	5 (5-10)	0 (0)	0 (0)	0 (0)	95 (95-100)	20 (15-70)	5 (5-35)	0 (0-20)
06 - Recycling facilities	140	32 (22-40)	0 (0)	0 (0)	0 (0)	95 (93-99)	54 (49-83)	35 (22-68)	9 (0-53)
08 - Transportation facilities	150	37 (13-47)	0 (0)	0 (0)	0 (0)	96 (94-99)	64 (53-90)	41 (13-76)	7 (0-55)
09 - Treatment works	18	6 (0-11)	0 (0)	0 (0)	0 (0)	94 (83-100)	28 (17-72)	6 (0-44)	0 (0-22)
11 - Light industrial activity	358	20 (6-30)	0 (0)	0 (0)	0 (0)	94 (85-98)	43 (36-70)	20 (7-52)	3 (0-38)
No category specified	17	12 (0-18)	0 (0)	0 (0)	0 (0)	94 (94)	29 (27-76)	18 (0-53)	0 (0-24)
All Western Washington	**909**	**25 (9-34)**	**0 (0)**	**0 (0)**	**0 (0)**	**93 (88-97)**	**47 (40-77)**	**27 (10-59)**	**5 (0-42)**
Eastern Washington									
02 - Manufacturing	2	0 (0)	0 (0)	0 (0)	0 (0)	100 (50-100)	0 (0-50)	0 (0)	0 (0)
03 - Mineral, metal, oil, and gas	1	0 (0)	0 (0)	0 (0)	0 (0)	100 (100)	0 (0-100)	0 (0)	0 (0)
08 - Transportation facilities	9	0 (0-11)	0 (0)	0 (0)	0 (0)	89 (67-100)	11 (11-22)	0 (0-11)	0 (0-11)
11 - Light industrial activity	17	0 (0-6)	0 (0)	0 (0)	0 (0)	76 (59-82)	12 (6-47)	0 (0-12)	0 (0-6)
All Eastern Washington	**29**	**0 (0-7)**	**0 (0)**	**0 (0)**	**0 (0)**	**83 (62-90)**	**10 (7-41)**	**0 (0-10)**	**0 (0-7)**
All Washington	**938**	**24 (9-33)**	**0 (0)**	**0 (0)**	**0 (0)**	**92 (87-96)**	**46 (39-76)**	**26 (9-57)**	**4 (0-41)**

DF: Dilution factor.

[a] Values represent the percentage of sample exceeding the water quality standard based on representative receiving water conditions for the typical scenario (value not in parentheses) and the best and worst case scenarios (values in parentheses).

Appendix II

EVALUATION OF MONITORING METHODS FOR INDUSTRIAL AND CONSTRUCTION NPDES PERMITS

Visual Inspection of Stormwater BMPs

Prepared for

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October 11, 2006

Contents

Introduction

The Washington State Department of Ecology (Ecology) is evaluating monitoring methods for National Pollutant Discharge Elimination System (NPDES) construction and industrial stormwater general permits. As part of this effort, Ecology is interested in determining if visual inspections are adequately identifying the pollution issues present on site, and if the issues being identified during inspections are reflective of water quality monitoring data.

This report has been prepared to assist Ecology in determining if modifications to visual inspection requirements and protocols for onsite best management practices (BMPs) are warranted for NPDES permittees, and to offer recommendations for improved inspections as appropriate. Ecology recently revised its construction site inspection form and has set forth requirements for a training program for construction site inspectors that will be a key component of NPDES construction permit compliance beginning in October 2006. This inspector training program will include visual examples of effective and ineffective BMP applications. It is expected that this required training will provide a strong basis for guiding inspectors to perform productive visual inspections at construction sites. Therefore, this report focuses primarily on suggestions to improve industrial site visual inspections with only a few observations and suggestions related to construction sites.

Background

All NPDES general permit holders have to prepare a Stormwater Pollution Prevention Plan (SWPPP). The purpose of a SWPPP is to outline actions that will be followed to reduce or eliminate pollutants that come in contact with precipitation and stormwater runoff on a site and therefore better protect receiving water quality. Within a SWPPP, stormwater BMPs are identified to reduce or eliminate stormwater pollutants onsite. These BMPs can be structural or nonstructural. Examples of structural BMPs include catch basin filter inserts, vegetated swales, and oil/water separators that capture stormwater pollutants before they leave the site. Examples of nonstructural BMPs include good housekeeping techniques and practices designed to prevent potential pollutants from coming in contact with precipitation and stormwater runoff, such as sweeping of loading docks and installing covers over waste material storage areas. A monitoring plan which includes water quality sampling and visual inspections is also required to be included in a SWPPP.

Periodic visual inspections are required to identify potential stormwater pollutants and determine areas where improvements are needed. A visual inspection should determine if the SWPPP has been implemented, if BMPs are working properly and are being maintained, and if there are other issues of concern for water quality protection. After completing a visual inspection, results must be summarized in an inspection report or recorded on a checklist/inspection form and filed onsite with the SWPPP to comply with the conditions of the general construction permit and general industrial stormwater permit. If the inspection indicates any problems, the report must include a summary of actions that will be taken to address the problem. Reporting any non-compliance with the permit is required.

Existing Guidance and Requirements for Visual Inspections

Construction Sites

Ecology recently produced a guidance document for monitoring at construction sites that describes how to conduct stormwater monitoring and provides limited guidance on visual inspections (Ecology 2006). This document is called "How to do Stormwater Monitoring: A Guide for Construction Sites" (Ecology publication number 06-10-020). In this document, an example site inspection checklist is provided for use by inspectors. This checklist relies upon assignment of a good, fair, or poor rating for the condition and functionality of each BMP in use on the site. There is, however, no explanation given in the guidance document on how to make these assignments; the visual inspection section of this document is vague and provides only a few examples.

Although Ecology's written guidance for visual inspections at construction sites is limited, starting in October 2006, the person conducting the visual inspections must be a Certified Erosion and Sediment Control Lead (CESCL). To become a CESCL an individual must take a certification course. It is anticipated that this course will train inspectors to conduct inspections and properly rate the condition and functionality of the onsite BMPs. Although the training required for the CESCLs will provide this background, the large numbers of courses and trainers that will be involved are an indication that more written detail in the guidance document will still be helpful in standardizing the visual inspection ratings.

Consistency in visual inspections is important not only for fairness in enforcement actions, but it also allows for analysis of the overall effectiveness of stormwater programs at the municipal, county, or state level. If the inspection reports provide enough detail, Ecology may be able to determine, for instance, that the biggest problem affecting runoff interception swales is the lack of maintenance. The lack of maintenance may allow sediment buildup and decrease swale capacity. This level of detail will become increasingly important as communities and permittees deal with waste load allocations under total maximum daily load (TMDL) regulations and begin estimating whether their actions are yielding the required reductions in pollutant loads.

Industrial Sites

The Industrial Stormwater General Permit requires visual monitoring to be conducted at all applicable industrial sites at least quarterly during storm events and at least once during the dry season (Ecology 2005). As part of visual inspections, the general permit also requires each Permittee to identify BMPs that are inadequate or pollutant sources that are not identified or poorly described in the SWPPP. When visual monitoring identifies inadequacies in the SWPPP, due to the actual discharge of or potential to discharge a significant amount of any pollutant, the SWPPP must be modified and BMPs adjusted to correct the deficiency (Ecology 2005).

Although Ecology has published a guidance document that describes how to sample stormwater at an industrial site, it provides limited guidance on how to conduct a visual site inspection at an industrial site (Ecology 2002). Ecology's Guidance Manual for Preparing/Updating a SWPPP for Industrial Facilities (Ecology 2004) describes the process of creating a SWPPP for industrial facilities, but there is little guidance on how to conduct visual site inspections. The appendix for the guidance manual contains a form (worksheet #11) that is the basis for documenting visual BMP inspections. The worksheet contains a table that consists of five columns. In the table the user is to record the date of the inspection, identify the surface or ground water body that receives stormwater discharged from the site, pollutants observed in the stormwater, and recommended action steps. No specific questions are asked, there are no examples given, and very little guidance is provided to promote effective visual inspections and associated record-keeping. The only instructions are found in the form header:

> "List of observed pollutants and descriptions of intensities of each. Include floatables, oil sheen, discoloration, turbidity, odor, etc. in the SW."

Worksheet #11 does not list structural BMPs or nonstructural BMPs, or give guidance on how to inspect them. Using this form, an inspector would have a difficult time knowing what issues to look for onsite, especially if he/she were not trained to understand runoff pollutant sources and corresponding BMP options. Currently, Ecology does not require industrial site inspectors to be certified and there are no training courses readily available for these inspectors. Industrial site inspectors are often foremen, onsite engineers, or site safety officers. They are not required to have a background in stormwater pollution prevention and may not have a clear understanding of what is contributing to stormwater pollution. The worksheet requires that the person making the observations sign a certificate that states, under the penalty of law, that the form is true, accurate, and complete. Without adequate guidance, many of the industrial site employees who conduct the inspections may be reluctant to sign this.

It would be beneficial if Ecology distributed a guidance document describing how to inspect the structural BMPs and what good housekeeping items to look for on the site while conducting a visual inspection. Examples include: how to inspect catch basins and oil/water separators to know when maintenance is required, and what general maintenance is needed on site to keep pollutants out of stormwater.

Survey of BMP Inspection Procedures

As part of the effort to create a new industrial site inspection checklist for Ecology, an extensive web search was conducted to determine how other jurisdictions conduct visual BMP inspections at industrial sites. As noted above, since Ecology has already established a relatively rigorous program for training of construction site BMP inspectors, the review was limited to industrial site inspections. Many industrial site inspection forms were found that are used by cities and state agencies across the country. The majority of these forms were intended to be used by the industrial stormwater permit holders to show compliance with their permit requirements. Forms from nine jurisdictions were selected for closer examination. These jurisdictions included:

- City of Portland, Oregon – Industrial Facility Stormwater Inspection Report (City of Portland undated).
- Sacramento County, California – Checklist Summary of Violations for Stormwater Program (Sacramento County 2004).
- EPA – NPDES Industrial Stormwater Worksheet (Industrial) (EPA 2005).
- Minnesota Pollution Control Agency – Site Inspection Form for Industrial Activities (MPCA 1999).
- City of Austin, Texas – Annual SWP3 Comprehensive Site Compliance Evaluation Inspection (City of Austin 2002).
- Wisconsin Department of Natural Resources – Annual Facility Site Compliance Inspection Report (WDNR 2005).
- City of Bellevue, Washington – Public Inspection and Maintenance Checklists (City of Bellevue 2002).
- Seattle Public Utilities Business Inspection Program Checklist (City of Bellevue 2002).
- Caltrans – Storm Water Quality Handbooks, Maintenance Staff Guide (Caltrans 2003).

A summary of the positive and negative aspects of the inspection forms reviewed were documented and compared to the existing form used in Washington State (worksheet #11 from Ecology's industrial SWPPP guidance manual). The information from these forms was used to create an expanded visual inspection checklist for industrial NPDES permit holders in the State of Washington.

Several questions were considered when reviewing each form. These questions helped to determine what should be included in the Ecology checklist. The following questions were considered:

- Is the length of the form appropriate? Is it too long or too short?
- Is it easy to use? (Is it obvious what is being asked? Are examples provided so the inspector knows what potential sources of stormwater pollutants are possible on the site?)
- If the inspector does not have a background in stormwater management will they be able complete the inspection based on the information

provided in the form? In other words, is the form simple enough for the lay person to complete?

- Are the appropriate questions being asked on the form?

- Is the form complete for most situations (i.e., are all common structural and nonstructural industrial BMPs included and described)?

- Are there items included that are not relevant in the State of Washington that should not appear in Ecology's inspection form?

- Can the information in the form be compiled and analyzed to identify trends on a regional or statewide basis?

The inspection forms from the nine jurisdictions reviewed vary greatly in length, format, and content. The length of the forms range between one and six pages and the format varies between fill-in-the-blank questions, *yes*, *no*, or *N/A* questions, and check boxes. The majority of the forms address nonstructural, good housekeeping techniques and many of them are very thorough in describing what the inspector should be looking for onsite concerning nonstructural BMPs. Most of the forms do not address structural BMPs, and if they are addressed there is very little information about how to inspect the structural BMPs and only a limited number of them are addressed.

In general, the forms that are longer appear to be easier to use. The long forms generally provide more guidance and ask more questions that would help an inspector identify potential stormwater issues onsite. The questions that could be answered with a *yes*, *no*, *N/A*, or check box are the easiest to understand. The fill-in-the-blank questions are often too open-ended and could be difficult for a person without a background in stormwater pollution control to answer. The best fill-in-the-blank questions are specific and include example answers so that the inspector knows what is being asked. For example, the Minnesota Pollution Control Agency's site inspection form asks if there are raw, intermediate, or final products exposed to stormwater. It then lists the following examples: log, coal, salt, sand, gravel, lumber, scrap, metal products, vehicle parts, etc. Having these examples is important because an inspector may have noticed these products onsite but may have not thought to list them. In addition, because of the wide range of products listed the question is applicable to several different types of industries.

Overall, two forms were deemed the easiest to use. These forms are also the most comprehensive of the forms reviewed in this research effort. These inspection forms were prepared by the City of Portland and Seattle Public Utilities. These forms were used as templates in creating a new checklist for Ecology's consideration.

Summary of Findings

Construction Site Visual Inspections

Ecology's guidance and training for construction site BMP inspectors should promote effective BMP inspections and maintenance. However, the value of construction site BMP inspection documentation could be improved through formalizing a joint BMP review process with Ecology inspectors and permittee inspectors. Ecology could use the joint review results to evaluate whether visual BMP inspections are being done consistently and thoroughly and to then refine the CESCL training program to further improve BMP inspections.

Industrial Site Visual Inspections

The web search described above provided background information on how various jurisdictions conduct visual inspections at industrial sites and ideas for improving Ecology's industrial BMP inspection worksheet and guidance materials. After comparing inspection materials from other jurisdictions with the identified needs for NPDES permittees in the State of Washington, five key findings were identified. Each of these findings is presented in this section.

1. For ease of use the visual inspection form should consist mainly of check boxes and yes/no questions. This format allows an inspector to quickly and easily answer the questions. Fill-in-the-blank questions are too open-ended for someone without a background in stormwater management unless there are many examples listed. Examples of potential sources of stormwater pollutants are necessary to give the inspector an idea of what to look for and what could potentially be a stormwater pollutant. The more focused and directed the questions are that are presented in the form of check boxes, the easier it will be for Ecology to discern larger trends.

2. Any questions on the visual inspection form should be specific. Many of the inspection forms that were reviewed are general and do not include specific questions. An example of a general question, from the Minnesota Pollution Control Agency's form, is:

   Determine if the nonstructural and structural BMPs as indicated on your plan are installed and functioning properly. Please describe corrective actions needed to repair nonfunctioning BMPs.

   Even if the inspector had the pollution prevention plan with them, and knew what structural and nonstructural BMPs were being referred to, would they know how to determine if the BMPs are installed and functioning properly? It is better to ask detailed questions or a series of specific questions to address the potential issues associated with the individual BMPs. For example, to determine if catch basins are functioning properly or in need of repair or maintenance, Seattle Public Utilities asks the following series of questions on its inspection form:

Are catch basins present on site? Y/N
If yes how many?
Are catch basins equipped with outlet traps?
Select outlet trap type <u>*PVC elbow*</u> <u>*Metal Elbow*</u>
Has material accumulated to fill over 60% of the capacity of the CB? Y/N
Select material(s) in catch basin <u>*sediment*</u> <u>*plants*</u> <u>*trash*</u>
Is there evidence of contamination in catch basins? Y/N
Select contaminant <u>*Oil/grease*</u> <u>*Paint*</u> <u>*Solvent*</u> <u>*Sewage*</u> <u>*Unknown*</u>

This series of questions tells the inspector exactly what to look for rather than just asking if the catch basin is functioning properly.

Detailed questions make the inspection form longer but allow for a more complete inspection and easier comparisons between visual inspections, regardless of the inspector. Also, for an inspector without knowledge of stormwater management, a more detailed inspection form would be useful to help identify all potential issues on a site; when using a general form it is much easier to overlook or ignore a stormwater pollution problem.

3. The inspection form should include both structural and nonstructural BMPs. None of the inspection forms that were reviewed from other jurisdictions effectively address both types of BMPs. The majority of the inspection forms that were reviewed focus on nonstructural, good housekeeping techniques. Common structural BMPs should also be listed along with a description of the BMP and common maintenance and performance issues.

4. The majority of the forms assume more understanding of stormwater pollution than is most likely appropriate, given most industrial site inspectors have no training or background in stormwater management. For this reason it is important that the forms be easy to use and ask simple questions. The more broad or difficult the questions are to answer, the more likely the inspector will overlook a stormwater pollution issue onsite.

5. Ecology currently does not provide enough guidance, nor is training readily available, for the typical inspector to effectively inspect BMPs at an industrial site. If a training program similar to that for construction site inspectors is not implemented for industrial site inspectors in the State of Washington, then more detailed guidance needs to be provided. The industrial SWPPP guidance manual should be expanded to provide more

information on visual inspections and their importance for overall water quality protection, and to explain how to use a more detailed inspection checklist and why the issues listed in the checklist are important. Having training available for industrial site inspectors would further improve the ability of the inspectors to conduct a thorough visual inspection.

The conclusions reached as part of the industrial site BMP inspection form review were used to create a new visual inspection checklist that Ecology could provide to industrial NPDES permittees. All five of the issues noted above were considered when creating this expanded visual inspection checklist. The expanded checklist asks specific questions that are easy to understand. These questions are aimed at inspectors without formal stormwater management knowledge. The expanded checklist is comprehensive, including the most common structural and nonstructural BMPs used on industrial sites. In addition to the checklist, an accompanying guidance document was prepared to be used with the checklist as a reference. This guidance document is included as Appendix A to this report. It is recommended that this guidance document and the expanded visual inspection checklist be incorporated into Ecology's industrial SWPPP guidance manual.

The information included in the expanded visual inspection checklist was divided into two sections. The inspection of permanent, or relatively consistent, site features was separated from the onsite conditions that could change relatively frequently as a result of activities occurring on the site. The conditions that remain relatively consistent over time are included in Form B - Industrial Site Stormwater Facility Inventory (see Appendix B to this report). The conditions that could change frequently are included in Form C - Industrial Site Stormwater Inspection Checklist (see Appendix C to this report).

Prior to filling out Form C, the inspector should complete Form B. Once Form B has been completed one time it does not need to be completed again unless site operations change, the site is expanded or otherwise reconfigured in a way that alters potential sources of stormwater pollution, or there are changes in the stormwater facilities onsite. Form C should be used each time that routine site inspections are conducted to satisfy the industrial general permit requirements.

Separating the expanded checklist into two forms allows the site specific stormwater issues to be identified (using Form B, or a comparable form) prior to documenting routine inspections (using Form C, or a comparable form tailored to the site). Form B can be used to direct the contents of the routine inspection checklist (Form C). This allows the routine inspections to focus on specific site activities that may generate pollutants in runoff and the BMPs that are used to control pollutants at those locations. A shorter routine inspection checklist will likely increase the likelihood of an inspector using it.

Additional Recommendations

Some other potential changes to Ecology's visual inspection programs for both industrial and construction sites might include:

- Adjusting which visual parameters are emphasized, depending on industry type. For example, oil sheens should be emphasized for sites with many vehicles, turbidity should be emphasized for sites with exposed soils, and identification of galvanized surfaces should be emphasized for sites with a prevalence of exposed structural metal.

- Collecting visual inspection data from construction sites simultaneous to collecting water quality data. Comparison of the visual inspection data with the water quality sampling results would allow assessment of the effectiveness of the visual inspections.

- Implementing independent inspections by Ecology staff to independently rate industrial and/or construction BMP performance using the checklists provided to permittees and then compare them with the onsite inspector's ratings as a means of evaluating effectiveness and consistency of the checklists.

The expanded visual inspection checklist (Form C included in Appendix C to this report) is intended to be an example that should be tailored for a particular site. The industrial general permit covers so many different types of industries and site characteristics that it is impossible to generate a series of forms that would effectively represent all permittees' sites, such that a specific permittee could choose from a collection of inspection forms created by Ecology to pick the one that is best suited to their site. Furthermore, the types of BMPs implemented at different facilities under the same industry category might also vary. Thus, the contents of Form C focus on the different types of BMPs that may be used on a site, and this format requires less than a dozen categories on the visual inspection checklist. Individual permittees should be encouraged to tailor Forms B and C to their site, with site-specific guidance and assistance provided by Ecology personnel as needed to ensure that the resultant visual inspection documentation is as useful as possible to reduce stormwater pollution.

References

Austin, City of. 2002. Annual SWP3 Comprehensive Site Compliance Evaluation Inspection, Storm Water Pollution Prevention Plan, Austin Bergstrom International Airport. City of Austin, Texas. Obtained on May 12, 2006 from city website: <http://www.ci.austin.tx.us/austinairport/downloads/siteinspect.pdf>.

Bellevue, City of. 2002. Utilities Surface Water Maintenance Standards for Public and Private Systems. Public Inspection and Maintenance Checklists. City of Bellevue, Washington. Obtained from SCVURPPP website: <http://www.scvurppp-w2k.com/bmp_om_forms.htm>.

Caltrans. 2003. Storm Water Quality Handbooks, Maintenance Staff Guide. Publication number CTSW-RT-02-057. California Department of Transportation.

Ecology 2002. How to do Stormwater Sampling. A guide for Industrial Facilities. Washington State Department of Ecology, Olympia, Washington. Obtained on May 12, 2006 from agency website: <http://www.ecy.wa.gov/pubs/0210071.pdf>

Ecology. 2004. Guidance Manual for Preparing/Updating a SWPPP for Industrial Facilities. Washington State Department of Ecology, Olympia, Washington. Obtained on May 12, 2006 from agency website: <http://www.ecy.wa.gov/pubs/0410030.pdf>.

Ecology. 2006. How to do Stormwater Monitoring A guide for construction sites. Washington State Department of Ecology, Olympia, Washington. Obtained on May 12, 2006 from agency website: <http://www.ecy.wa.gov/biblio/0610020.html>.

Ecology. 2005. The Industrial Stormwater General Permit: A National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Stormwater Discharges Associated with Industrial Activities. Washington Department of Ecology, Olympia, Washington. Obtained on September 27, 2006 from agency website: http://www.ecy.wa.gov/programs/wq/stormwater/industrial/final%20ISWGP%20Permit%20modification%20after%20comment.pdf

EPA. 2005. National Pollutant Discharge Elimination System (NPDES) Compliance Inspection Manual. Appendix P: NPDES Industrial Storm Water Investigation and Case Development Worksheet (Industrial). Environmental Protection Agency. Obtained on May 12, 2006 from agency website: <http://epa.gov/compliance/resources/publications/monitoring/inspections/npdesinspect/npdesinspectappp.pdf>.

Golding, Stephen. 2006. A Survey of Zinc Concentrations in Industrial Stormwater Runoff. Publication No. 06-03-009. Washington Department of Ecology, Olympia, Washington.

Herrera. 2006. Data Analysis Report: Evaluation of Monitoring Data from General NPDES Permits for Industrial and Construction Stormwater. Prepared for the Washington State Department of Ecology and EnviroVision Corporation by Herrera Environmental Consultants, Inc., Seattle, Washington.

King County. Undated. Oil/Water Separator Fact Sheet. King County, Washington. Obtained on May 12, 2006 from county website: <http://dnr.metrokc.gov/wlr/indwaste/OW_8.5x11.pdf>.

MPCA. 1999. Site Inspection Form, NPDES/SDS General Storm Water Permit MNG611000 for Industrial Activity. Minnesota Pollution Control Agency. Obtained on May 12, 2006 from agency website: <http://www.pca.state.mn.us/water/pubs/sw-isiteins.pdf>.

Portland, City of. Undated. Industrial Facility Stormwater Inspection Report. City of Portland, Oregon. Obtained on May 12, 2006 from city website: <http://www.portlandonline.com/shared/cfm/image.cfm?id=53790>.

Sacramento County. 2004. Checklist Summary of Violations for Stormwater Program. Sacramento County, California. Obtained on May 12, 2006 from county website: <http://www.emd.saccounty.net/WP/EMDstormwater.htm>.

SPU. 2003. SPU Business Inspection Program Checklist. Seattle Public Utilities, Seattle, Washington.

WDNR. 2005. Annual Facility Site Compliance Inspection Report. Wisconsin Department of Natural Resources. Obtained on May 12, 2006 from agency website: <http://prodwbin99.dnr.state.wi.us/org/water/wm/nps/pdf/stormwater/3400176.pdf>.

ATTACHMENT 4

SUMMARY OF TREATMENT PERFORMANCE AND COSTS FOR CURRENTLY AVAILABLE INDUSTRIAL STORMWATER CONTROLS

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Introduction

The purpose of this document is to summarize findings of a document prepared on behalf of the Washington State Department of Ecology, which supported inclusion of numeric effluent limits (NELs) in Washington's 2012 National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Industrial Activities (General Permit). The document, titled *Literature Review of Existing Treatment Technologies for Industrial Stormwater* (Literature Review), was drafted in 2011 and represents a recent review of a number of stormwater management control devices suitable across many industrial sectors.[1]

This brief report summarizes treatment performance and cost-related information contained in the Literature Review by Herrera Environmental, Inc., which produced a series of reports in support of Washington's efforts to include NELs in the most recent iteration of their General Permit. This report also evaluates whether the stormwater management controls evaluated in the Literature Review are likely capable of assisting California Permittees achieve existing benchmarks developed by the U.S. Environmental Protection Agency (EPA) for industrial stormwater quality. Information contained in this report and the attached Literature Review could be used by California's State Water Board to help establish Best Available Technology (BAT) and Best Conventional Technology (BCT) for an array of industrial sectors, as well as inform a determination of the feasibility regarding inclusion of NELs in California's General Permit.

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[1] Herrera Environmental Consultants. 2011. *Draft Report: Literature Review of Existing Treatment Technologies for Industrial Stormwater*. Prepared on behalf of the Washington Department of Ecology. Available at http://www.wastormwatercenter.org

Summary of Current Stormwater Management Controls

In the last decade, researchers and regulators have expressed an increased interest in evaluating stormwater management controls currently on the market, which are generally categorized as drain inlet inserts, hydrodynamic separators, media filtration units, oil/water separators, chemical filtration units, bioretention/biofiltration systems, and electro-coagulation facilities. The market for stormwater controls is unregulated and manufacturers have generally resisted publication of treatment performance data or costs. However, this trend is shifting and several states, including New Jersey, Washington and Maryland, have put in place review processes for stormwater management controls. This has increased pressure on manufacturers to conduct performance tests and present the results to regulators and customers. In addition, manufacturers are increasingly willing to publicize installation and O&M costs. Regulators have an increasing opportunity to determine the feasibility of establishing NELs in NPDES permits and evaluate the best performing treatment systems, which could set a baseline for establishing BAT/BCT.

The Literature Review, prepared on behalf of Washington State Department of Ecology, was used to support the selective inclusion of NELs into the State of Washington's 2012 Industrial Stormwater Permit and has been provided here as Appendix 1. A summary of the results is presented in Table 1. Additional information is available within the Literature Review, though a number of stormwater management controls failed to make available either treatment performance data or indicative cost estimates for installation and on-going maintenance. Controls included in Table 1 include those systems for which the most information was made available.

Manufacturers of the stormwater treatment systems, rather than independent researchers, typically provided information regarding treatment performance, making comparison across treatment systems difficult. Confounding factors include limited information regarding test conditions and replicability of results; lack of data indicating how the systems perform under various conditions; wide variety amongst influent concentrations, which may affect treatment performance; and lack of consistency regarding which constituents are tested. However, several treatment systems provide treatment performance data for several common parameters, including total suspended solids (TSS), total copper, total lead and total zinc.

Treatment performance in comparison with U.S. EPA benchmarks

Table 1 includes treatment performance data for several parameters, which can be compared against benchmarks and actual California-specific industrial stormwater data, to indicate whether implementation of one or more of the products listed are capable of achieving compliance with benchmarks. Benchmarks used for the purposes of this comparison are listed in Table 2, taken

Table 1. Select performance and cost data, summarized from the literature review prepared on behalf of the State of Washington[2]

Treatment System Type	System Name (Manufacturer Name)	Performance Indicators	TSS (mg/L)	Total Copper (mg/L)	Total Zinc (mg/L)	Total Lead (mg/L)	Estimated Costs	$
Bioretention/ Filtration	Filterra Curb Inlet System (Filterra, DBA Americast, Inc.)	median influent	27.5	0.0081	0.384	NA	installation	1,200-7500
		median effluent	4.2	0.0034	0.102	NA	annual O&M	300-3,000
		% removal	85%	54%	56%	NA		
	Filterra Roof Drain System (Filterra, DBA Americast, Inc.)	median influent	27.5	0.0081	0.384	NA	installation	1,200-7500
		median effluent	4.2	0.0034	0.102	NA	annual O&M	300-3,000
		% removal	85%	54%	56%	NA		
	Modular Wetland System - linear (Modular Wetland Systems, Inc./ BioClean Environmental Services)	median influent	27.5	0.04	0.24	NA	installation	12,000-25,000
		median effluent	4.2	NA**	NA**	NA	annual O&M*	8.26-10.50 /gallon
		% removal	85%	>50%	>79%	NA		
Drain Inlet Insert	StormBasin (Fabco Industries, Inc.)	median influent	112	NA	0.335	0.018	installation	750-2,000
		median effluent	3	NA	0.175	0.0049	annual O&M	200-800
		% removal	98%	NA	48%	73%		
	Bio Clean Grate Inlet Skimmer Box (BioClean Environmental Services, Inc.)	median influent	978	1.9	13.7	1.5	installation	635-1,800
		median effluent	329	0.1	0.73	0.2	annual O&M	0.15-0.40 /gallon
		% removal	66%	95%	95%	87%		
Hydrodynamic Separation	Nutrient Separating Baffle Box (BioClean Environmental Services, Inc.)	median influent	366	0.017	0.088	0.014	installation	10,000-200,000
		median effluent	48	0.01	0.038	0.0065	annual O&M	0.33-0.84 /gallon
		% removal	87%	41%	57%	54%		
	UniScreen (Environment 21)	median influent	250	0.08	0.3	0.79	installation	2,000-15,000
		median effluent	175	0.06	0.18	0.56	annual O&M	2,000
		% removal	80%	20%	40%	27%		

[2] Herrera Environmental Consultants. 2011. *Draft Report: Literature Review of Existing Treatment Technologies for Industrial Stormwater*. Prepared on behalf of the Washington Department of Ecology. Available at http://www.wastormwatercenter.org

Treatment System Type	System Name (Manufacturer Name)	Performance Indicators	TSS (mg/L)	Total Copper (mg/L)	Total Zinc (mg/L)	Total Lead (mg/L)	Estimated Costs	$
Hydrodynamic Separation (cont.)	V2B1 Treatment System (Environment 21)	median influent	NA	0.08	0.5	0.79	installation	2,000-15,000
		median effluent	NA	0.05	0.09	0.35	annual O&M	2,000
		% removal	NA	40%	70%	55%		
Media Filtration	Aquip Enhanced Stormwater Filtration System(StormwateRx)	median influent	30	0.152	0.425	0.03	installation	5,000-150,000
		median effluent	3.39	0.008	0.061	0.006	annual O&M	0.0003-0.003 /gallon
		% removal	83%	94%	85%	79%		
	Perk Filter™ (Kristar Enterprises, Inc.)	median influent	70	0.052	0.25	0.15	installation	10,000-200,000
		median effluent	11	0.02	0.1	0.05	annual O&M	1,200-10,000
		% removal	82%	62%	61%	68%		
	PuriStorm (Environment 21)	median influent	250	0.08	0.5	0.79	installation	3,000-25,000
		median effluent	175	0.04	0.06	0.28	annual O&M	0-10,000
		% removal	80%	50%	80%	65%		
	Stormfilter using ZPG Media (CONTECH Stormwater Solutions Inc.)	median influent	83	0.04	0.23	0.12	installation	10,000-2,500,000
		median effluent	23	0.03	0.13	0.04	annual O&M	0.00008-0.00024 /gallon
		% removal	82%	47%	62%	24%		
	ecoStorm + ecoStorm Plus® (Royal Environmental Systems, Inc./Water Tectonics, Inc.)	median influent	200	0.019	0.17	0.005	installation	8,900-37,500
		median effluent	26	0.009	0.073	0.002	annual O&M	500-12,000
		% removal	87%	53%	57%	60%		
	Baker Tank with Sand Filter (Baker Corp.)	median influent*	200	150	2500	500	installation	NA
		median effluent**	10	75	1000	200	annual O&M	NA
		% removal	95%	50%	60%	40%		

Treatment System Type	System Name (Manufacturer Name)	Performance Indicators	TSS (mg/L)	Total Copper (mg/L)	Total Zinc (mg/L)	Total Lead (mg/L)	Estimated Costs	$
Media Filtration (cont.)	JellyFish™ Filter (Imbrium Systems Corp.)	median influent*	74	78	1.45	35	installation	NA
		median effluent*	8	0.3	0.6	5	annual O&M	NA
		% removal	89%	99%	59%	86%		
Chemical Treatment	ACISTBox® (Water Tectonics, Inc.)	median influent	NA	0.341	2.12	0.25	installation	25,000-400,000
		median effluent	NA	0.0179	1.04	0.05	annual O&M	NA
		% removal	NA	95%	51%	80%		
Oil/Water Separator	Clara Gravity Stormwater Separator Vault (StormwateRX)	median influent	284.5	0.516	2.82	0.088	installation	20,000-52,000
		median effluent	173.5	0.078	1.21	0.072	annual O&M	0.0005-0.01 /gallon
		% removal	47%	30%	32%	26%		
Electro-coagulation	OilTrap ElectroPulse Water Treatment System(Oil Trap Environmental)	median influent	600	12.1	151	14.1	installation	25,000-2,200,000
		median effluent	10	0.072	0.34	0.039	annual O&M	0.0005-0.01 /gallon
		% removal	98%	99.4%	99.9%	99.7%		
	WaveIonics™ (Oil Trap Environmental)	median influent	200	4.8	0.516	0.253	installation	60,000-850,000
		median effluent	5	0.0074	0.0315	0.003	annual O&M	0.0008-0.008 /gallon
		% removal	98%	99.9%	94%	99%		

*Units provided by vendor appear to be anomalous

** Data provided suggests results were non-detects, though reported in the Herrera report as NA.

from the U.S. EPA's Multi-Sector General Permit (MSGP) and are consistent with the annual Numeric Action Levels (NAL) listed in Table 5 of the 2012 Draft General Permit.[3] Only 4 parameters are considered here, yet TSS and the heavy metals listed here are useful, serving as indicator parameters for a number of other common industrial stormwater contaminants.

Table 2. Benchmark values from US EPA's Multi-Sector General Permit used for this analysis

Parameter	Benchmark (mg/L)
Total suspended solids	100
Zinc, Total [a]	0.26
Copper, Total [a]	0.0332
Lead, Total [a]	0.262

a) based on the 2008 MSGP, assuming receiving water hardness >250 mg/L

To inform necessary rates of treatment, Table 3 includes the upper quartile concentrations of the parameters listed in Table 3. These values were taken from the data analysis report, which accompanies this report, provided as Attachment 3 to California Coastkeeper Alliance's (CCKA) comment letter on the Draft General Permit. These values mark the parameter concentrations at which 75% of all samples from a given industrial sector are less than or equal to. In other words, only 25% of the samples contain pollutants at concentrations greater than this value. Since this captures a large proportion of the data, as discussed in Attachment 3, this value provides a useful benchmark from which to compare whether treatment controls could reduce contaminant concentrations by an amount necessary to satisfy U.S. EPA benchmarks.

Granted, this analysis does not consider the 25% of samples associated with the poorest performing facilities. Yet for facilities where influent concentrations are higher or where difficult to remove non-conventional pollutants are persistently found in high concentration, two or more passive treatment systems could operate in series to achieve the standards. Where passive systems are insufficient or infeasible, due to space constraints, for example, active treatment systems can be employed at higher expense. Examples of active treatment systems include chemical treatment or electrocoagulation.

Values listed in Table 3 highlighted in bold are concentrations which exceed benchmarks. The adjacent percentage rank is the reduction level necessary to reduce the concentration to a level equivalent with benchmark values. Assuming the treatment performance rates listed in Table 1 are achievable for the range of TSS and heavy metal concentrations expected here, several stormwater treatment controls are capable of reducing concentrations to benchmarks.

[3] United States Environmental Protection Agency. 2000. Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (MSGP). Federal Register Vol. 65, No. 210. Available at: http://www.epa.gov/npdes/pubs/msgp2000-final.pdf

Table 3. Upper quartile concentrations and % reductions necessary to meet benchmarks

	Upper Quartile (75th percentile) Concentrations (mg/L) and % reduction necessary to meet benchmarks			
Category	TSS	Zinc, Total	Copper, Total	Lead, Total
2 - Manufacturing	**109.4 (9%)**	**0.907 (71%)**	**0.233 (86%)**	0.030 (0%)
3 - Mineral, metal, oil and gas	**193.5 (48%)**	0.100 (0%)	0.022 (0%)	0.006 (0%)
5 - Landfills	**240.9 (58%)**	**0.311 (16%)**	**0.040 (17%)**	0.011 (0%)
6 - Recycling facilities	**140.4 (29%)**	**0.812 (68%)**	**0.103 (68%)**	0.103 (0%)
8 - Transportation facilities	**128.9 (22%)**	**0.645 (60%)**	**0.079 (58%)**	0.027 (0%)
9 - Treatment works	**133.6 (25%)**	0.167 (0%)	**0.058 (43%)**	0.014 (0%)
11 - Light industrial activity	80.9 (0%)	**0.797 (67%)**	**0.056 (41%)**	0.012 (0%)
Other facilities	**126.7 (21%)**	**0.422 (38%)**	0.030 (0%)	0.021 (0%)
All Facilities	**105.0 (5%)**	**0.743 (65%)**	**0.089 (63%)**	0.033 (0%)

For example, the Bio Clean Grate Inlet Skimmer Box™, a passive drop-inlet system, is reportedly capable of reducing copper concentrations from 1.9 to 0.1 mg/L and zinc from 13.7 to 0.73 mg/L, a 95% reduction for each. However, given such high influent concentrations, additional measures would be required to achieve benchmark concentrations. In such circumstances, sedimentation or pre-filtration would likely be incorporated, which could reasonably result in benchmark attainment. Under more moderate influent concentrations, the Aquip system, a media filtration unit manufactured by StormwateRx, is capable of reducing concentrations of copper from 0.152 to 0.008 mg/L and zinc from 0.425 to 0.061 mg/L, a reduction of 94% and 85%, respectively. More impressive is the JellyFish™ Filter by Imbrium Systems Corp., which reports an 89% reduction in TSS, from 74 to 8 mg/L and a 99% reduction in copper, from 78 to 0.3 mg/L. Active filtration systems are reliably capable of extreme pollutant removal efficiencies, though the variably high cost may be prohibitive for less profitable industries or individual facilities.

Appendix 1 DATA REPORT: Literature Review of Existing Treatment Technologies for Industrial Stormwater

DATA REPORT

Literature Review of Existing Treatment Technologies for Industrial Stormwater

Prepared for

Science Applications International Corporation

and

Washington State Department of Ecology

July 2011

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

DATA REPORT

Literature Review of Existing Treatment Technologies for Industrial Stormwater

Prepared for

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July 22, 2011

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1.0 Introduction

The Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) are working to clean up contaminated sediments and control sources of recontamination in the Lower Duwamish Waterway (LDW) under an Administrative Order on Consent with the City of Seattle, King County, the Port of Seattle, and The Boeing Company. The LDW site is an approximately 5.5-mile portion of the Lower Duwamish River which flows into Elliott Bay. The sediments along the river contain a wide range of contaminants due to years of industrial activity and runoff from residential areas. These contaminants include polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), chlorinated dioxins and furans, metals, and phthalates.

Ecology is leading contaminant source control efforts in the LDW in cooperation with the City of Seattle, the Port of Seattle, King County, the City of Tukwila, and EPA. Source control is the process of finding and controlling releases of contaminants to the LDW. In order to support Ecology's source control efforts, Herrera Environmental Consultants (Herrera) conducted a literature review to identify technologies that could be used to treat industrial or municipal stormwater for the contaminants of concern in sediments within the LDW. In addition, Herrera has also compiled information on technologies that could be used to treat contaminated groundwater for this same suite of contaminants.

This report summarizes information on the specific stormwater treatment technologies that were identified through this review. It includes a methods section that describes the procedures that were used to compile information about each treatment technology. The compiled information for each treatment technology is then summarized in a results section under the following general categories:

- Vendor information
- Treatment performance
- System design
- Installation and operation and maintenance (O&M) costs

Finally, a discussion section provides guidance on the appropriate application(s) for each general category of treatment technology and identifies logistical issues for monitoring their performance. The discussion section also identifies key data gaps in our understanding of treatment system performance and recommends future research to fill these data gaps.

It should be noted that this review is not intended to constitute a formal analysis of "all known, available, and reasonable methods of treatment", or AKART analysis as defined in Ecology (2010a). An AKART analysis consists of a review of all available technologies for a well-characterized waste stream (such as industrial process wastewaters or fully-characterized and quantified stormwater runoff), and an evaluation of the economic impact of such technologies for the specified site or business. This project, as currently conceived, would not be considered a complete AKART analysis, nor could it be approved by Ecology as such.

This report was prepared by Herrera under Ecology's "Hazardous Substances Site Investigation & Remediation for the Toxics Cleanup Program Contract No. C0700034" between Science Applications International Corporation (SAIC) and Ecology. Herrera is a subcontractor to SAIC under this contract.

2.0 Methods

As described above, Herrera conducted a literature review to identify technologies that could be used to treat industrial or municipal stormwater for the contaminants of concern in sediments within the LDW. This review was intended to identify a broad range of possible technologies for different treatment applications within the LDW, including:

- Runoff treatment at end-of-pipe or point of compliance
- Treatment at the point of entry for runoff to stormwater conveyance system
- Above ground treatment of runoff prior to its point of entry to the conveyance system (e.g., roof-runoff interception)

Since the stormwater treatment technologies in the LDW will typically be used for retrofit applications, this review was not limited to technologies that have been approved through the Technology Assessment Protocol – Ecology (TAPE) process (Ecology 2008). This study primarily focused on proprietary stormwater treatment technologies that are not listed in Volume V of the *Stormwater Management Manual for Western Washington* (Ecology 2005). Most of the non-proprietary stormwater treatment technologies listed in Volume V of the *Stormwater Management Manual for Western Washington* (Ecology 2005) were removed from further research for this study due to aboveground footprint or infiltration requirements as summarized in the Step 3 (Screening Criteria) section below. If in the rare instance a large footprint best management practice (BMP) such as a wet pond or an infiltrating BMP such as bioretention or a media filter drain are deemed appropriate for a site, the reader should refer to Volume V of the *Stormwater Management Manual for Western Washington* (Ecology 2005); the *Low Impact Development Technical Guidance Manual for Puget Sound* (PSAT 2005); or the Washington State Department of Transportation *Highway Runoff Manual* (WSDOT 2010) for additional information on the BMP of interest. Only two non-proprietary stormwater treatment systems are included in this report: underground sand filters (e.g., Delaware Sand Filters and DC Sand Filters) since they may be applicable to retrofits in the LDW. Finally, source control BMPs such as street sweeping and catch basin cleaning discussed in Volume IV of the *Stormwater Management Manual for Western Washington* (Ecology 2005) are also not the focus of this study, but are critical for pollution prevention in the LDW.

The actual literature review and data compilation steps that were performed in conjunction with this effort are as follows:

1. Identify candidate treatment technologies
2. Categorize treatment technologies
3. Screen treatment technologies for potential application in the LDW
4. Compile detailed information on each treatment technology
5. Identify logistical issues for monitoring of each treatment technology

Each of these steps is described in more detail below.

Step 1. Identify Candidate Treatment Technologies

A candidate list of stormwater treatment technologies was compiled using the following resources:

- Web search
- Technologies approved through TAPE (Ecology 2008) and/or New Jersey Corporation for Advanced Technology (NJCAT) using the Technology Acceptance and Reciprocity Partnership [TARP] protocol (TARP 2003).
- Caltrans Treatment BMP Technology Report (Caltrans 2008)
- *Stormwater Management Manual for Western Washington* (Ecology 2005)

Step 2. Categorize Treatment Technologies

Stormwater treatment technologies were then classified as one of two main types:

- **Active treatment systems**: systems that require electricity to operate
- **Passive treatment systems**: systems that do not require electricity to operate and are generally lower cost alternatives when compared to active treatment systems

Within the active treatment system category, treatment systems were further classified into one of the following subcategories (see Figure 1):

- Chemical filtration
- Chemical treatment
- Electrocoagulation
- Filtration
- Ion exchange
- Reverse osmosis

Filtration was further categorized as one of the following types based on the technology description:

- Disc
- Media
- Pressure

Within the passive treatment system category, treatment systems were classified into one of the following subcategories (see Figure 1):

- Bioretention/filtration
- Drain inlet insert
- Hydrodynamic separation
- Media filtration
- Oil/water separator

Drain inlet inserts and media filtration systems were further categorized based on the technology description. Drain inlet inserts can generally be considered one of the following types (see Figure 1):

- Absorbent boom/fabric
- Media filtration
- Media filtration (cartridge)
- Combination system (screen and absorbent boom/fabric)
- Combination system (screen and media filtration)

Media filtration can generally be considered one of the following types (see Figure 1):

- Above ground (pump required)
- Cartridge
- Combination system (with hydrodynamic separation)
- Combination system (with oil/water separator)
- Up-flow

Step 3. Screen Treatment Technologies for Potential Application in the LDW

Technologies were subsequently screened for potential application in the LDW based on a list of screening criteria. These screening criteria reflect the unique logistical issues for treating stormwater in the LDW given the presence of historical sediment contamination, flat site topography, high groundwater table, and a broad list of target contaminants in runoff.

The screening criteria for active treatment systems are as follows:

- Systems must be designed for long-term (i.e., permanent) installation.

- Systems must be designed to treat a relatively wide range of flows and concentrations that are associated with stormwater runoff.

The screening criteria for passive treatment systems are as follows:

- Systems must have a minimal aboveground footprint due to the limited space available for retrofits (e.g., larger aboveground systems such as constructed wetlands, wet ponds, and Austin sand filters were removed).

- Systems must not rely on infiltration for treatment due to high water table and presence of historical soil and/or groundwater contamination (e.g., treatment technologies such as infiltration trenches, bioretention, and proprietary systems that provide storage for underground infiltration were removed).

- Systems must be able to effectively handle a large petroleum or chemical spill from industrial activities (e.g., porous pavement was removed).

- Systems should remove pollutants of concern; those systems with a focus on gross litter and debris removal were not considered (e.g., proprietary systems that have a trash basket catch basin insert design were removed).

- System design should be for a permanent installation; those systems with a construction site or temporary installation focus were not considered (e.g., catch basin filter sock designs were removed).

- Systems must be readily available; those systems with inactive vendor websites or discontinued product lines were not included.

Step 4. Compile Detailed Information on Each Treatment Technology

Once the list of potential active and passive stormwater treatment technologies was narrowed down to those that could potentially be useful in the LDW, the following steps were taken to collect information on each of the systems:

- Review and compile publically available information from vendor websites

- Send questionnaire to vendors

- Conduct follow-up phone contacts with vendors

The vendor questionnaire requested the following specific information:

- Manufacturer name
- Technology name
- Contact information (name, e-mail, phone, website)
- Treatment type/application

- Number of installations in the state of Washington
- Estimated installation cost [range]
- Estimated annual O&M cost [range]
- Design flow rate [range]
- System footprint [range]
- Required head loss [range]
- Internal or external bypass
- Above or below grade
- Median influent concentration [see parameter list below]
- Median effluent concentration [see parameter list below]
- Median percent removal [see parameter list below]

Based on the contaminants of concern in the LDW and the required monitoring parameters in the National Pollutant Discharge Elimination System (NPDES) Industrial Stormwater General Permit (Ecology 2010b), treatment performance data for the following parameters were requested from the each vendor:

- Total suspended solids (TSS) [required for Timber Product Industry (24xx), Paper and Allied Products (26xx), and discharges to 303(d)-listed waters; many pollutants can also be associated with sediment particles, thus TSS removal can also be an indicator of pollutant removal of other parameters]

- Total phosphorus [required for Chemical and Allied Products (28xx), Food and Kindred Products (20xx), and discharges to 303(d)-listed waters]

- Total petroleum hydrocarbons (TPH) [required for Primary Metals (33xx), Metals Mining (10xx), Automobile Salvage and Scrap Recycling (5015 and 5093), and Metals Fabricating (34xx)]

- Oil and grease [this parameter is measured instead of TPH in some portions of the country]

- Total and dissolved copper [total copper is required for all Industrial Stormwater permittees]

- Total and dissolved lead [total lead is required for Primary Metals (33xx), Metals Mining (10xx), Automobile Salvage and Scrap Recycling (5015 and 5093), Metals Fabricating (34xx), and discharges to 303(d)-listed waters]

- Total and dissolved zinc [total zinc is required for all Industrial Stormwater permittees]

- Semivolatile organic compounds (SVOCs) [contaminant of concern in the LDW]

- Polycholrinated biphenyls (PCBs) [contaminant of concern in the LDW]
- Dioxins [contaminant of concern in the LDW]
- Carcinogenic polycyclic aromatic hydrocarbons (cPAHs) [contaminant of concern in the LDW]

Additional monitoring parameters (turbidity, pH, and oil sheen) are required by the NPDES Industrial Stormwater General Permit for all industries; however, these parameters were not listed as contaminants of concern in the LDW or are not commonly used for determining pollutant removal performance; thus, data for these parameters were not requested from the vendors. Specific industrial groups are also required to collect additional monitoring parameters (ammonia total as nitrogen, biochemical oxygen demand [BOD_5], chemical oxygen demand [COD], nitrate/nitrite as nitrogen, and additional metals); however, since these parameters are not required for multiple industries and were not listed as contaminants of concern in the LDW, they were not included as part of this literature review.

Information compiled for each technology was summarized on a two-page Technology Summary Sheets that provides a picture or diagram of each system, and a consistent framework for presenting data on system design, treatment performance, installation costs, O&M costs, and the number of installations in Washington. In addition, more detailed product brochures, drawings, specifications, and O&M information that were obtained from the vendors for each technology were compiled for reference within this document.

3.0 Results

Using the methods identified in the previous section, a total of 91 passive and 18 active systems were identified for possible use in treating industrial or municipal stormwater for the contaminants of concern in sediments within the LDW. Tables 1 and 2 identify these passive and active systems, respectively, with their associated treatment subcategories and vendor contact information. The Technology Summary Sheets that were prepared for each system are provided in Appendix A. The appendix includes a divider to separate information for passive and active systems; the Technology Summary sheets for individual systems are then organized alphabetically by system name.

Information presented in the Technology Summary Sheets was derived in part from questionnaire responses from the vendors for each system (see description of questionnaires in *Methods* section). Questionnaire responses were received from vendors for 58 percent of the passive systems and 67 percent of the active systems; these questionnaire responses are documented in Appendix B. The appendix includes a divider to separate information for passive and active systems; questionnaire responses for individual systems are then organized alphabetically by system name.

When no questionnaire response was obtained from a vendor for a specific treatment system, efforts were made to obtain the required information for this report based on a review of publically available information on that system from the vendor. Limited information was obtained through these reviews for 15 percent of the passive systems and 11 percent of the active system. Publically available product information (e.g., brochures, drawings, specifications, and O&M information) for all the treatment systems identified in Tables 1 and 2 has been compiled in Appendix C (provided electronically on CD). The appendix includes a divider to separate information for passive and active systems; product information for individual systems is then organized alphabetically by system name.

In addition to the appendices described above, the following summary tables are provided in the main body of this report to facilitate rapid comparisons of different treatment system attributes:

Table 3. Treatment system removal performance for total metals.

Table 4. Treatment system removal performance for dissolved metals.

Table 5. Treatment system removal performance for TSS.

Table 6. Treatment system removal performance for total petroleum hydrocarbons and oil and grease.

Table 7. Treatment system removal performance for total phosphorus.

Table 8. Treatment system removal performance for SVOCs, PCBs, dioxins, and cPAHs.

The information contained in Tables 3 through 12 has also been compiled in a separate Microsoft Excel® file to allow rapid sorting and review of the system treatment attributes; this file is designated Appendix D to this document and is provided electronically on CD.

In reviewing the aforementioned tables and appendices, it is important to note that most of the associated data were supplied by the treatment system vendors and have not been verified by an independent third-party. In a few select cases, independent verification of some treatment system attributes has occurred through TAPE and/or NJCAT. System attributes that are verified through TAPE may include removal performance for basic (TSS), enhanced (dissolved metals), phosphorus, and oil treatment. Typical system maintenance schedules are also verified through TAPE. NJCAT only verifies removal performance for TSS. Neither program verifies installation and annual operation and maintenance costs. The specific treatment systems that have been verified through TAPE and/or NJCAT are identified in Table 13. More detailed information on the systems that have been verified through TAPE is available through Ecology's website for emerging stormwater treatment technologies: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html. Detailed information on treatment systems that have been verified through NJCAT may also be obtained through the following website for the State of New Jersey Department of Environmental Protection: http://www.njstormwater.org/treatment.html.

4.0 Discussion

This section provides guidance on the appropriate application(s) for each general category of treatment technology, identifies logistical issues for monitoring performance, identifies key data gaps in our understanding of treatment system performance, and recommends future research to fill these data gaps.

4.1 Treatment Technology Applications

In general, land use in drainage basins to the LDW is predominantly industrial, although there are some limited areas of mixed residential/commercial land use in adjacent neighborhoods (e.g., South Park and Georgetown). Because industrial areas in the LDW are largely built-out (i.e., all the available space is either paved or occupied by buildings), many of the non-proprietary stormwater treatment technologies identified in the *Stormwater Management Manual for Western Washington* (Ecology 2005) are impractical due to their large aboveground footprint. Instead, proprietary treatment technologies that have been specifically designed for retrofit applications will generally be more useful for treating the contaminants of concern in the LDW. To overcome the numerous design restraints in built-out environments, these systems are typically designed to have a small footprint, have low head-loss requirements, and are easily scalable. Because of these attributes, these technologies can be more easily installed in a variety of sites and applications.

The most common treatment applications in industrial areas are the treatment of roof runoff (e.g., for treatment of zinc from galvanized metal roofs) or the treatment of stormwater from pollution generating impervious surfaces at the inlet to the storm drain system or at end-of-pipe. Pumping and treating groundwater, though not technically stormwater, is also a common application in industrial areas. A large variety of treatment technologies is generally available for these applications, including both passive and active systems. In general, passive treatment systems are less expensive to install, operate, and maintain than active systems; however, they typically do not provide as high a level of treatment in comparison to active systems. For the same level of treatment, a passive system usually occupies more space than an active system. The higher level of treatment achieved by active systems typically involves a multi-step process to optimize performance; due to this increased complexity, active systems often require a higher level of operator knowledge and have increased O&M costs.

Description of the most common treatment applications for the general treatment technology categories defined in this report are provided below. Table 14 also identifies common treatment applications for the specific treatment systems that are identified in Tables 1 and 2.

4.1.1 Passive Treatment

1. *Biofiltration/Filtration* – Bioretention systems (e.g., rain gardens) have been shown to achieve a high level of pollutant removal (Davis et al. 2009; Hsieh and

Davis 2005). Manufacturers have taken this technology and adapted it to the ultra-urban environment. These systems have a relatively small footprint and in general are not easily scalable. The majority of bioretention systems are easy to maintain. Bioretention systems are most commonly used to treat stormwater from pollution generating impervious surfaces either at the inlet to the storm drain system or at the end-of-pipe.

2. *Drain Inlet Insert* – These systems are small devices that occupy a catch basin or are inserted into the inlet of a storm drain. Because they are not scalable and occupy existing inlets, it is difficult to correctly size these technologies. They are relatively inexpensive, require minimal head loss, and need to be distributed throughout the site to treat large areas. Drain inserts are most commonly used to treat stormwater from pollution generating impervious surfaces at the inlet to the storm drain system; however, some of these systems are also configured to treat roof runoff.

3. *Hydrodynamic Separation* – These devices can treat high flows in a very small footprint. Maintenance is similar to standard catch basin cleaning. Because these systems are not filters, they do not target dissolved pollutants and, in general, cannot remove fine silt and clay sized particles (Kim and Sansalone 2008). Hydrodynamic separators require minimal head loss. Hydrodynamic separation systems are most commonly used to treat stormwater from pollution generating impervious surfaces at end-of-pipe.

4. *Media Filtration* – Media filters are scalable systems that require head loss (varies from system to system) to drive the water through the filter media. They achieve a relatively high level of treatment for dissolved and particulate pollutants (Geosyntec and Wright Water 2008) but are generally more expensive to maintain than other passive treatment types. Media filtration systems are most commonly used to treat stormwater from pollution generating impervious surfaces either at the inlet to the storm drain system or at the end-of-pipe.

5. *Oil/Water Separators* – These systems target hydrocarbons with simple baffle technologies. They do not target other pollutants but are effective at reducing high concentrations of hydrocarbons and can provide some limited TSS and metals removal via sedimentation. These systems are most commonly used to treat stormwater from pollution generating impervious surfaces at the inlet to the storm drain system.

4.1.2 Active Treatment

1. *Chemical Filtration* – Media filtration is more effective if the average particle size in the stormwater is large. Chemical filtration entails the addition of a flocculent to the stormwater prior to filtration in order to enhance the filtration process. Because the large particles cannot penetrate the media, surface occlusion is an

issue. Many systems use a backflush device to prevent surface occlusion. As with most active treatment devices, water is pumped into these systems and thus head loss restrictions are not an issue. In addition, most active treatment systems are above ground installations and consequently require a large footprint on the site (though less than conventional stormwater ponds). Chemical filtration systems can be used to treat stormwater from pollution generating impervious surfaces at end-of-pipe using a pump system; they are also commonly used to treat contaminated groundwater.

2. *Chemical Treatment* – To target specific analytes, these technologies are simple devices that add a chemical to the influent stormwater. Chemical treatment systems can be used to treat stormwater from pollution generating impervious surfaces at end-of-pipe using a pump system; they are also commonly used to treat contaminated groundwater.

3. *Electrocoagulation* – This technology applies a charge to the influent stream to generate flocculation. The device then settles or filters the floc to generate a clean waste stream. Removal of settled floc is a required and frequent maintenance procedure. This is an effective treatment method that can target dissolved and particulate pollutants, though operation and maintenance can be onerous. Electrocoagulation systems can be used to treat stormwater from pollution generating impervious surfaces at end-of-pipe using a pump system; they are also commonly used to treat contaminated groundwater.

4. *Filtration* – Pressurized filtration enhances the filtration process by increasing the pressure of the water as it moves through the filter. The filtration process is usually followed by a backflushing process to clean the media. As with all system with a backflush, the collected solids must be removed on a regular basis. Filtration systems can be used to treat stormwater from pollution generating impervious surfaces at end-of-pipe using a pump system; they are also commonly used to treat contaminated groundwater.

5. *Ion Exchange* – Ion exchange is a polishing step that specifically targets polar dissolved constituents. Pretreatment is required prior to ion exchange as suspended solids will clog the exchange columns. Ion exchange systems can be used to treat stormwater from pollution generating impervious surfaces at end-of-pipe using a pump system; they are also commonly used to treat contaminated groundwater.

6. *Reverse Osmosis* – These systems are highly effective at removing dissolved contaminants. Using a pump, these systems can be used to treat stormwater from pollution generating impervious surfaces at end-of-pipe and contaminated groundwater. These systems also require pre-treatment as particulate matter can foul the ion selective membrane and reduce performance.

4.2 Logistical Issues for Monitoring Treatment System Performance

In order to ensure that source control efforts in the LDW are effective, some monitoring of stormwater treatment system performance may be required pursuant to future permit requirements or other regulatory drivers. At a minimum, this monitoring would likely involve sampling to characterize contaminant concentrations in treatment system effluent to ensure they are below levels that could contribute to sediment recontamination in the LDW. Influent samples might also be required to determine the actual pollutant removal efficiency of the treatment system.

In general, the following logistical issues are frequently encountered when collecting samples to characterize influent and effluent contaminant concentrations for propriety treatment systems that are designed for retrofit applications:

- The conveyance system for stormwater entering and leaving the treatment system is below grade and not directly accessible; therefore, there is no convenient collection point for influent and/or effluent samples. This situation is most often encountered with systems that are designed to treat stormwater from pollution generating impervious surfaces at end-of-pipe (e.g., biofiltration/filtration, hydrodynamic separation, and media filtration systems).

- Effluent from the stormwater treatment system is discharged directly into a conveyance pipe containing water from another up-gradient source; therefore, it is difficult to obtain a representative effluent sample that is uncontaminated by this other source. This situation is most often encountered with systems that are designed to treat stormwater from pollution generating impervious surfaces at the inlet to the storm drain system (e.g., drain inlet inserts).

- The stormwater treatment system is configured in a manner that allows bypass water to mix directly with treated effluent; therefore, it is difficult to obtain a representative effluent sample that is not contaminated by the bypass water. This situation is frequently encountered with systems that are designed to treat stormwater from pollution generating impervious surfaces at the inlet to the storm drain system (e.g., drain inlet inserts) and at end-of-pipe (e.g., biofiltration/filtration, hydrodynamic separation, and media filtration systems).

- Influent enters the stormwater system as diffuse sheet flow; therefore, the flow is not sufficiently concentrated to facilitate collection of an influent sample. This situation is most often encountered with systems that are designed to treat stormwater from pollution generating impervious surfaces at the inlet to the storm drain system (e.g., drain inlet inserts).

It is often possible to identify sampling procedures to overcome these logistical issues. For example, in situations where there is no convenient collection point for effluent samples at the direct outlet for a treatment system, it is often possible to collect samples at a downgradient access point in the stormwater conveyance system if no additional stormwater inputs have occurred from sources other than the treatment system. However, these sampling strategies typically need to be worked out on a case-by-case basis given the wide variety of treatment system configurations that exist and unique attributes of the stormwater conveyance system at any given monitoring site. Given this consideration, it is not practical to offer generalized sampling strategies to overcome the logistical issues for monitoring that are identified above.

4.3 Data Gaps

Although there are many stormwater treatment technology options, not all of them have been rigorously field tested. This is primarily due to the fact that field testing is expensive and many government agencies do not require field data to approve systems for use in their jurisdictions. Table 13 presents those systems which have gone through the TAPE or TARP field testing process, but even for these rigorously tested systems, there exists a lack of data related to the removal of toxic pollutants. Specifically, few have been tested for any metals besides copper and zinc, SVOCs, PCBs, dioxins, and cPAHs removal. This data gap exists for a number of reasons:

1. Removal of these toxics from stormwater is not the primary concern for the majority of the market.

2. Collection and analysis of these parameters is expensive.

3. Influent concentrations are highly variable, and thus achieving target reduction goals consistently is difficult.

The lack of rigorous field or laboratory testing by independent third parties is another major data gap that needs to be addressed before informed decisions can be made regarding selection of proprietary stormwater treatment systems. There is an obvious conflict of interest when companies test their own products and report the results as fact. In order to address this issue, many more jurisdictions have begun to require third-party verified data to support the performance claims of treatment technology vendors. Still others have been establishing their own verification protocols because the existing protocols (e.g., TAPE and TARP), do not address issues which can be locally important. For instance, TAPE and TARP do not require long-term monitoring to assess system performance over time, or maintenance past the 1- to 2-year time scale. Stormwater managers in Oregon have identified this as a data gap and have begun the process of establishing a monitoring protocol for long-term maintenance and system lifecycle assessments. However, until this monitoring protocol begins to produce results, the long-term performance of these systems and lifecycle expectations will remain a data gap.

4.4 Recommended Future Research

Though there any many treatment technologies on the market, few have been rigorously tested under variable field conditions. Even fewer have been subjected to long-term testing to quantify system lifecycles and long-term O&M requirements. It is recommended that more of these studies be conducted by third party entities so that objective results are available for a wide variety of systems. This is a difficult prospect for treatment technology manufacturers because of their rapid research and development timelines and the large investment required for long-term studies. Due to this consideration, local jurisdictions and/or Industrial Stormwater permittees may need to take on this monitoring themselves in order to reach more informed decisions on which treatment technologies are appropriate and effective for various stormwater treatment applications. As mentioned above, stormwater managers in Oregon have already initiated this process. In Washington, the Port of Seattle also has a long history of monitoring stormwater treatment system performance, including various downspout media filter configurations and oyster shell augmented filtration swales.

Though rigorous field studies exist for a select few treatment technologies, these studies have primarily addressed metals, nutrients, and solids removal. Very little data exist for the removal of toxic pollutants. It is recommended that future studies analyze other metals in addition to copper and zinc (e.g., mercury, cadmium, and chromium), SVOCs, PCBs, dioxins, and cPAHs. Such studies would need to occur in industrial areas because treatment cannot be verified unless influent concentrations are elevated. Alternatively, because of the expense and difficulty of conducting studies of toxics in stormwater, research on toxic pollutant affinity for various particle sizes could be conducted. Such a study would segregate and analyze various particle size fractions for concentrations of SVOCs, PCBs, dioxins, and cPAHs. This approach has been used by researchers to relate metals to particle size classes (Ran et al. 2000; Ranville et al. 1999); a similar approach could be used here for toxic organic chemicals. Once a relationship between particle size and pollutant concentration is developed, removal of various particle size categories by treatment technologies can be used as a proxy for removal of difficult-to-measure toxics.

5.0 References

Caltrans. 2008. Treatment BMP Technology Report. CTSW-RT-08-167.02.02. California Department of Transportation, Division of Environmental Analysis, Sacramento, California. April 2008.

Davis, A.P., W.F. Hunt, R.G. Traver, and M. Clar. 2009. Bioretention Technology: Overview of Current Practice and Future Needs. *Journal of Environmental Engineering-ASCE* 135(3):109-117.

Ecology. 2005. Stormwater Management Manual for Western Washington. Publication No. 05-10-029 through 05-10-033. Washington State Department of Ecology. Water Quality Program, Olympia, Washington. February 2005.

Ecology. 2008. Guidance for Evaluating Emerging Stormwater Treatment Technologies. Technology Assessment Protocol – Ecology (TAPE). Publication Number 02-10-037. Washington State Department of Ecology, Olympia, Washington.

Ecology. 2010a. Water Quality Permit Writer's Manual. Publication No. 92-109. Washington State Department of Ecology. Water Quality Program, Olympia, Washington. November 2010.

Ecology. 2010b. National Pollutant Discharge Elimination System Industrial Stormwater General Permit. Washington State Department of Ecology, Olympia, Washington. January 1, 2010.

Geosyntec and Wright Water. 2008. Analysis of Treatment System Performance: International Stormwater Best Management Practices (BMP) Database [1999-2008]. Prepared for Water Environment Research Foundation, American Society of Civil Engineers (Environmental and Water Resources Institute/Urban Water Resources Research Council), U.S. Environmental Protection Agency, Federal Highway Administration, and American Public Works Association, by GeoSyntec Consultants and Wright Water Engineers, Inc., Chicago, Illinois.

Hsieh, C.H. and A.P. Davis. 2005. Multiple-Event Study of Bioretention for Treatment of Urban Storm Water Runoff. *Water Science and Technology* 51(3-4):177-181.

Kim, J.Y. and J.J. Sansalone. 2008. Hydrodynamic Separation of Particulate Matter Transported by Source Area Runoff. *Journal of Environmental Engineering-ASCE* 134(11):912-922.

PSAT. 2005. Low Impact Development Technical Guidance Manual for Puget Sound. Puget Sound Action Team (PSAT) and Washington State University Pierce County Extension, Olympia, Washington. January 2005.

Ran, Y., J.M. Fu, G.Y. Sheng, R. Beckett, and B.T. Hart. 2000. Fractionation and Composition of Colloidal and Suspended Particulate Materials in Rivers. *Chemosphere* 41(1-2):33-43.

Ranville, J.F., D.J. Chittleborough, F. Shanks, R.J.S. Morrison, T. Harris, F. Doss, and R. Beckett. 1999. Development of Sedimentation Field-Flow Fractionation-Inductively Coupled Plasma Mass-Spectrometry for the Characterization of Environmental Colloids. *Analytica Chimica Acta* 381(2-3):315-329.

TARP. 2003. Protocol for Stormwater Best Management Practice Demonstrations. Prepared by the Technology Acceptance Reciprocity Partnership (http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/pdffiles/Tier2protocol.pdf).

WSDOT. 2010. Highway Runoff Manual. Publication No. M 31 16.02. Washington State Department of Transportation, Olympia, Washington. May 2010.

FIGURES AND TABLES

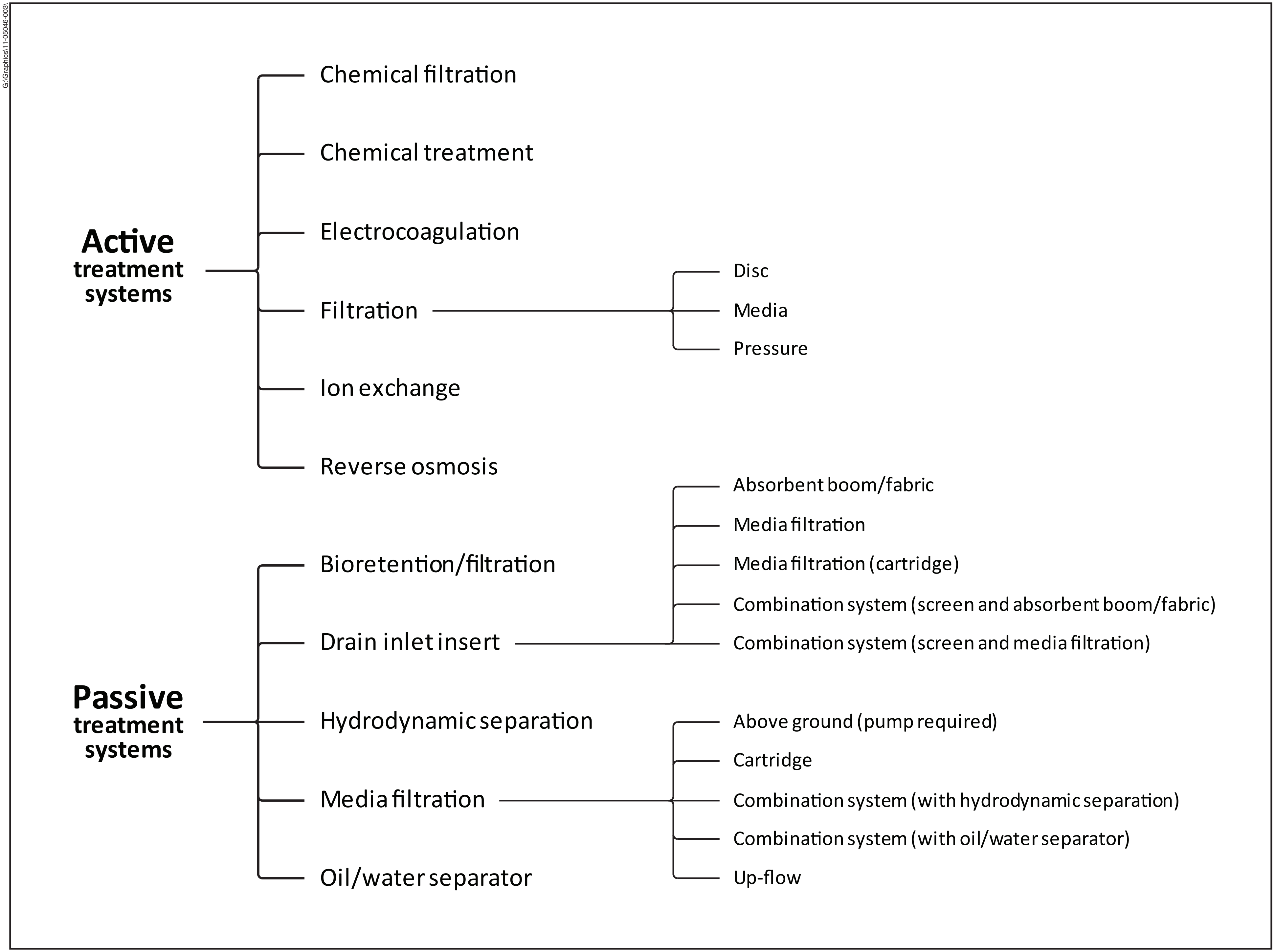


Figure 1. Treatment type categories for active and passive treatment systems.

Table 1. Passive treatment systems that could be used to treat industrial stormwater in the Lower Duwamish basin.

Treatment Type	Treatment System Name	Manufacturer/Vendor Name	Website	Contact Phone No.
Bioretention/Filtration				
	Filterra® Curb Inlet System	Filterra, DBAAmericast, Inc.	www.filterra.com	877-345-1450
	Filterra® Roof Drain System	Filterra, DBAAmericast, Inc.	www.filterra.com	877-345-1450
	Modular Wetland System – Linear	Modular Wetland Systems, Inc./BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Silva Cell	DeepRoot Partners	www.deeproot.com	800 458 7668
	TREEPOD® Biofilter	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	UrbanGreen BioFilter	CONTECH Stormwater Solutions Inc.	www.contech-cpi.com	800-548-4667
Drain Inlet Insert				
Absorbent Boom/Fabric	ADsorb-It	Eco-Tec, Inc.	www.adsorb-it.com	888-668-8982
	Enviro-Drain®	Enviro-Drain, Inc.	www.enviro-drain.com	206-363-0316
	EnviroSafe™ Storm Safe HF10	Transpo Industries, Inc.	www.transpo.com	503-674-9180
	Ultra-Urban Filter™	Abtech Industries	abtechindustries.com	480-874-4000
Media Filtration	EcoVault™ Baffle Box	EcoSense International	www.ecosenseint.com	321-449-0324
	EnviroSafe™	Transpo Industries, Inc.	www.transpo.com	503-674-9180
	HUBER Hydro Filt	Huber Technology, Inc.	www.huber-technology.com	425-392-0491
	Hydro-Kleen™	ACF Environmental, Inc.	www.acfenvironmental.com	800-448-3636
	Raynfiltr™	Environmental Filtration, Inc.	www.raynfiltr.org	800-333-5234
Media Filtration (Cartridge)	StormBasin™	Fabco Industries, Inc.	www.fabco-industries.com	631-393-6024
	StormPod™	Fabco Industries, Inc.	www.fabco-industries.com	631-393-6024
	Triton Drop Inlet Insert	Revel Environmental Manufacturing, Inc./CONTECH Stormwater Solutions Inc.	www.contech-cpi.com	800-548-4667
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Bio Clean Downspout Filter	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Bio Clean Flume Filter	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Bio Clean Grate Inlet Skimmer Box	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Bio Clean Trench Drain Filter	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Clean Way Downspout Filtration Unit	Clean Way	www.cleanwayusa.com	800-723-1373
	DrainPac™	United Storm Water, Inc.	www.unitedstormwater.com	877-71-STORM
	EnviroTrap Catch Basin Insert	Environment 21	www.ENV21.com	800-809-2801
	FloGard® Downspout Filter	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	FloGard® LoPro Matrix Filter	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	FloGard® LoPro Trench Drain Filter	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	FloGard+PLUS®	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	FloGard® Trash & Debris Guard	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	Inceptor®	Stormdrain Solutions	www.stormdrains.com	877-OUR-PIPE
	StormClean Catch Basin Insert	Clean Way	www.cleanwayusa.com	800-723-1373
	StormClean Curb Inlet Insert	Clean Way	www.cleanwayusa.com	800-723-1373
	StormClean Wall Mount Filtration Unit	Clean Way	www.cleanwayusa.com	800-723-1373
	Storm PURE™	Nyloplast/Hancor, Inc.	www.hancor.com	253-255-6302
	SwaleGard® Pre-filter	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	AquaShieldTM, Inc.	www.aquashieldinc.com	888-344-9044
	ClearWater BMP	ClearWater Solutions, Inc.	www.clearwaterbmp.com	800-758-8817
	Coanda Curb Inlet Filter	Coanda, Inc.	www.coanda.com	714-389-2113
	Coanda Downspout Filter	Coanda, Inc.	www.coanda.com	714-389-2113

Table 1. Passive treatment systems that could be used to treat industrial stormwater in the Lower Duwamish basin.

Treatment Type	Treatment System Name	Manufacturer/Vendor Name	Website	Contact Phone No.
Drain Inlet Inserts (cont.)				
	RSF (Rapid Stormwater Filtration) 100	EcoSol Wastewater Filtration Systems	www.ecosol.com.au	+61 8 8262 2528 (Australia)
	RSF (Rapid Stormwater Filtration) 1000	EcoSol Wastewater Filtration Systems	www.ecosol.com.au	+61 8 8262 2528 (Australia)
	RSF (Rapid Stormwater Filtration) 4000	EcoSol Wastewater Filtration Systems	www.ecosol.com.au	+61 8 8262 2528 (Australia)
Hydrodynamic Separation				
	Aqua-Swirl Concentrator	AquaShieldTM, Inc.	www.aquashieldinc.com	888-344-9044
	BaySeparator®	BaySaver Technologies, Inc.	www.BaySaver.com	301-829-6470
	CDS™ Stormwater Treatment System	CONTECH Stormwater Solutions Inc.	www.contech-cpi.com	800-548-4667
	Downstream Defender	Hydro International, Inc.	www.hydro-international.biz	207-756-6200
	FloGard® Dual-Vortex Hydrodynamic Separator	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	HydroGuard	Hydroworks	www.hydroworks.com	888-290-7900
	Nutrient Separating Baffle Box	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Stormceptor®	Imbrium Systems Corp	www.imbriumsystems.com	503-706-6193
	StormTrooper®	Park USA	www.park-usa.com	888-611-PARK
	StormTrooper® EX Extra-Duty	Park USA	www.park-usa.com	888-611-PARK
	Terre Kleen™	Terre Hill Concrete Products	www.terrehill.com	800-242-1509
	UniScreen	Environment 21	www.ENV21.com	800-809-2801
	UniStorm	Environment 21	www.ENV21.com	800-809-2801
	V2B1 Treatment System	Environment 21	www.ENV21.com	800-809-2801
	Vortechs System	CONTECH Stormwater Solutions Inc.	www.contech-cpi.com	800-548-4667
Media Filtration				
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	StormwateRx	www.stormwaterx.com	503-233-4660
Cartridge	BayFilter®	BaySaver Technologies, Inc.	www.BaySaver.com	301-829-6470
	EcoSense™ Stormwater Filtration Systems	EcoSense International	www.ecosenseint.com	321-449-0324
	Perk Filter™	Kristar Enterprises, Inc.	www.kristar.com	800-579-8819
	PuriStorm	Environment 21	www.ENV21.com	800-809-2801
	Sorbtive™ FILTER	Imbrium Systems Corp	www.imbriumsystems.com	503-706-6193
	Stormfilter using ZPG Media	CONTECH Stormwater Solutions Inc.	www.contech-cpi.com	800-548-4667
	StormSafe™ Helix	Fabco Industries, Inc.	www.fabco-industries.com	631-393-6024
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	Rotondo Environmental Solutions, LLC	www.rotondo-es.com	703-212-4830
	Underground Sandfilter (DC Sandfilter)	Rotondo Environmental Solutions, LLC	www.rotondo-es.com	703-212-4830
Combination System (with Hydrodynamic Separation)	Aqua-Filter System	AquaShieldTM, Inc.	www.aquashieldinc.com	888-344-9044
	ecoStorm + ecoStorm Plus®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	Go-Filter	AquaShieldTM, Inc.	www.aquashieldinc.com	888-344-9044
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	CrystalStream Technologies	http://crystalstream.com	800-748-6945
	HydroFilter	Hydroworks	www.hydroworks.com	888-290-7900
Up-Flow	Bio Clean Water Polisher	BioClean Environmental Services, Inc.	www.biocleanenvironmental.com	760-433-7640
	Jellyfish™ Filter	Imbrium Systems Corp	www.imbriumsystems.com	503-706-6193
	Up-Flo™ Filter	Hydro International, Inc.	www.hydro-international.biz	207-756-6200

Table 1. Passive treatment systems that could be used to treat industrial stormwater in the Lower Duwamish basin.

Treatment Type	Treatment System Name	Manufacturer/Vendor Name	Website	Contact Phone No.
Oil/Water Separator				
	ADS® Water Quality Unit	Advanced Drainage Systems, Inc	www.adspipe.com	800-821-6710
	BioSTORM	Bio-Microbics, Inc.	www.biomicrobics.com	800-753-3278
	Clara® Gravity Stormwater Separator Vault	StormwateRx	www.stormwaterx.com	503-233-4660
	CrystalClean Separator	CrystalStream Technologies	http://crystalstream.com	800-748-6945
	ecoLine A®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	ecoLine B®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	ecoSep®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	ecoTop®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	First Flush 1640FF	ABT, Inc.	www.abtdrains.com	800-438-6057
	Hancor Storm Water Quality Unit	Hancor, Inc.	www.hancor.com	253-255-6302
	Kleerwater™	Brown-Minneapolis Tank Co./Kleerwater Technologies, LLC	www.kleerwater.net	800-999-TANK (8265)
	PSI Separator	PSI International, Inc.	www.psinternational.com	605-332-1885
	SNOUT®	Nyloplast/Hancor, Inc.	www.hancor.com	253-255-6302
	VortClarex	CONTECH Stormwater Solutions Inc.	www.contech-cpi.com	800-548-4667

Table 2. Active treatment systems that could be used to treat industrial stormwater in the Lower Duwamish basin.

Treatment Type	Treatment System Name	Manufacturer/Vendor Name	Website	Contact Phone No.
Chemical Filtration				
	Baker Tank with Sand Filter	BakerCorp	www.bakercorp.com	425-347-8811
	Chitosan-Enhanced Sand Filtration Using FlocClear™	Clear Creek Systems	www.clearcreeksystems.com	661-979-2525
	Purus® Stormwater Polishing System	StormwateRx	www.stormwaterx.com	503-233-4660
Chemical Treatment				
	ACISTBox®	Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	pHATBox®	Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
	Wetsep	Waste & Environmental Technologies Ltd.	http://wetsep.com	(65) 64560040
Electrocoagulation				
	High-Flo Electrocoagulation	Kaselco	www.kaselco.com	361-594-3327
	OilTrap ElectroPulse Water Treatment System	OilTrap Environmental	www.oiltrap.com	360-943-6495
	Redbox	Morselt Borne BV	www.morselt.com	317-449-0324
	WaveIonics™	Water Tectonics, Inc.	www.watertectonics.com	866-402-2298
Filtration				
Disc	Arkal Filter (Spin Klin System)	Arkal Filtration Systems/PEP (U.S. Distributor)	www.arkal-filters.com	(972)-4-6775140 (Israel)
Media	Fuzzy Filter	Schreiber		
	WaterTrak Pressurized Media Filter	Aquatech	www.aquatech.com	724-746-5300
	WaterTrak Ultrafiltration	Aquatech	www.aquatech.com	724-746-5300
Pressure	Arkal Media Filter	Arkal Filtration Systems/PEP (U.S. Distributor)	www.arkal-filters.com	(972)-4-6775140 (Israel)
Ion Exchange				
	Wastewater Ion Exchange System (WWIX)	Siemens Water Technologies Inc.	www.siemens.com	860-593-2063
	WaterTrak Ion Exchange	Aquatech	www.aquatech.com	724-746-5300
Reverse Osmosis				
	WaterTrak Reverse Osmosis	Aquatech	www.aquatech.com	724-746-5300

Table 3. Treatment removal performance for total metals.

Treatment Type	Treatment System Name	Total Copper Median Influent (mg/L)	Total Copper Median Effluent (mg/L)	Total Copper Median Removal (%)	Total Lead Median Influent (mg/L)	Total Lead Median Effluent (mg/L)	Total Lead Median Removal (%)	Total Zinc Median Influent (mg/L)	Total Zinc Median Effluent (mg/L)	Total Zinc Median Removal (%)	Notes
Passive Treatment Technologies											
Bioretention/Filtration											
	Filterra® Curb Inlet System	0.0081	0.0034	54%	NA	NA	NA	0.384	0.102	56%	
	Filterra® Roof Drain System	0.0081	0.0034	54%	NA	NA	NA	0.384	0.102	56%	
	Modular Wetland System – Linear	0.04	NA	>50%	NA	NA	NA	0.24	NA	>79%	
	Silva Cell	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	TREEPOD® Biofilter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	UrbanGreen BioFilter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Drain Inlet Insert											
Absorbent Boom/Fabric	ADsorb-It	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Enviro-Drain®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EnviroSafe™ Storm Safe HF10	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Ultra-Urban Filter™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration	EcoVault™ Baffle Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	EnviroSafe™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	HUBER Hydro Filt	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Raynfiltr™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration (Cartridge)	StormBasin™	NA	NA	NA	0.018	0.0049	73%	0.335	0.175	48%	
	StormPod™	NA	NA	NA	0.018	0.0049	73%	0.335	0.175	48%	
	Triton Drop Inlet Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	NA	NA	NA	NA	NA	NA	24.3	10.4	79%	Units reported by vendor appear to be anomalous
	Bio Clean Downspout Filter	NA	NA	76%	NA	NA	96%	NA	NA	69%	
	Bio Clean Flume Filter	NA	NA	NA	NA	NA	17%	NA	NA	NA	
	Bio Clean Grate Inlet Skimmer Box	1.9	0.1	95%	1.5	0.2	87%	13.7	0.73	95%	Units reported by vendor appear to be anomalous
	Bio Clean Trench Drain Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Clean Way Downspout Filtration Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	DrainPac™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EnviroTrap Catch Basin Insert	0.08	0.07	9%	0.79	0.68	14%	0.3	0.24	20%	Testing is not complete for metals; therefore, these values are estimated.
	FloGard® Downspout Filter	NA	NA	NA	NA	NA	NA	10	6	60%	Units reported by vendor appear to be anomalous
	FloGard® LoPro Matrix Filter	NA	NA	NA	NA	NA	NA	10	6	60%	Units reported by vendor appear to be anomalous
	FloGard® LoPro Trench Drain Filter	NA	NA	NA	NA	NA	NA	10	6	60%	Units reported by vendor appear to be anomalous
	FloGard+PLUS®	NA	NA	NA	NA	NA	NA	10	6	60%	Units reported by vendor appear to be anomalous
	FloGard® Trash & Debris Guard	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Inceptor®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Catch Basin Insert	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Storm PURE™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SwaleGard® Pre-filter	NA	NA	NA	NA	NA	NA	10	6	60%	Units reported by vendor appear to be anomalous

Treatment Type	Treatment System Name	Total Copper Median Influent (mg/L)	Total Copper Median Effluent (mg/L)	Total Copper Median Removal (%)	Total Lead Median Influent (mg/L)	Total Lead Median Effluent (mg/L)	Total Lead Median Removal (%)	Total Zinc Median Influent (mg/L)	Total Zinc Median Effluent (mg/L)	Total Zinc Median Removal (%)	Notes
Drain Inlet Insert (continued)											
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ClearWater BMP	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Coanda Curb Inlet Filter	NA	NA	NA	NA	NA	NA	48	15	69%	Units reported by vendor appear to be anomalous
	Coanda Downspout Filter	NA	NA	NA	NA	NA	NA	48	15	69%	Units reported by vendor appear to be anomalous
	RSF (Rapid Stormwater Filtration) 100	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Hydrodynamic Separation											
	Aqua Shield Aqua-Swirl Concentrator	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	BaySeparator®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	CDS™ Stormwater Treatment System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Downstream Defender	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard® Dual-Vortex Hydrodynamic Separator	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	HydroGuard	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Nutrient Separating Baffle Box	0.017	0.01	41%	0.014	0.0065	54%	0.088	0.038	57%	
	Stormceptor®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	StormTrooper®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Terre Kleen™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	UniScreen	0.08	0.06	20%	0.79	0.56	27%	0.3	0.18	40%	Testing is not complete for metals; therefore, these values are estimated.
	UniStorm	0.08	0.06	20%	0.79	0.56	27%	0.3	0.18	40%	Testing is not complete for metals; therefore, these values are estimated.
	V2B1 Treatment System	0.08	0.05	40%	0.79	0.35	55%	0.5	0.09	70%	Testing is not complete for metals; therefore, these values are estimated.
	Vortechs System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration											
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	0.152	0.008	94%	0.03	0.006	79%	0.425	0.061	85%	
Cartridge	BayFilter®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EcoSense™ Stormwater Filtration Systems	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Perk Filter™	0.052	0.02	62%	0.15	0.05	68%	0.25	0.1	61%	
	PuriStorm	0.08	0.04	50%	0.79	0.28	65%	0.5	0.06	80%	Testing is not complete for metals; therefore, these values are estimated.
	Sorbtive™ FILTER	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Stormfilter using ZPG Media	0.04	0.03	47%	0.12	0.04	24%	0.23	0.13	62%	
	StormSafe™ Helix	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoStorm + ecoStorm Plus®	0.019	0.009	53%	0.005	0.002	60%	0.17	0.073	57%	
	Go-Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	HydroFilter	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Jellyfish™ Filter	78	0.3	99%	35	5	86%	1.45	0.6	59%	Zinc concentrations are in mg/L.
	Up-Flo™ Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Treatment Type	Treatment System Name	Total Copper Median Influent (mg/L)	Total Copper Median Effluent (mg/L)	Total Copper Median Removal (%)	Total Lead Median Influent (mg/L)	Total Lead Median Effluent (mg/L)	Total Lead Median Removal (%)	Total Zinc Median Influent (mg/L)	Total Zinc Median Effluent (mg/L)	Total Zinc Median Removal (%)	Notes
Oil/Water Separator											
	ADS® Water Quality Unit	ND	ND	74%	ND	ND	74%	ND	ND	74%	Information obtained from product literature
	BioSTORM	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Clara® Gravity Stormwater Separator Vault	0.516	0.078	29.5	0.088	0.072	25.8	2.82	1.21	32	
	CrystalClean Separator	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	ecoLine A®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoLine B®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoSep®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	ecoTop®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	First Flush 1640FF	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Hancor Storm Water Quality Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Kleerwater™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	PSI Separator	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SNOUT®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	VortClarex	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Active Treatment Technologies											
Chemical Filtration											
	Baker Tank with Sand Filter	150	75	50%	500	200	40%	2500	1000	50%	Units reported by vendor appear to be anomalous
	Chitosan-Enhanced Sand Filtration Using FlocClear™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Purus® Stormwater Polishing System	NA	NA	NA	NA	NA	NA	0.28	0.083	86%	
Chemical Treatment											
	ACISTBox®	0.341	0.0179	95	0.25	0.05	80	2.12	1.04	51	
	pHATBox®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Wetsep	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Electrocoagulation											
	High-Flo Electrocoagulation	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	OilTrap ElectroPulse Water Treatment System	12.1	0.072	99.4%	14.1	0.039	99.7%	151	0.34	99.9%	Units reported by vendor appear to be anomalous
	Redbox	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaveIonics™	4.8	0.0074	100%	0.253	0.003	99%	0.516	0.0315	94%	
Filtration											
Disc	Arkal Filter (Spin Klin System)	ND	ND	ND	ND	ND	ND	ND	ND	99.9%	Information obtained from product literature
Media	Fuzzy Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaterTrak Pressurized Media Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Pressure	Arkal Media Filter	ND	ND	ND	ND	ND	ND	ND	ND	99.9%	Information obtained from product literature
Ion Exchange											
	Wastewater Ion Exchange System (WWIX)	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaterTrak Ion Exchange	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Reverse Osmosis											
	WaterTrak Reverse Osmosis	ND	ND	ND	ND	ND	ND	ND	ND	ND	

mg/L = milligrams per liter
NA = not available; vendor filled out treatment system questionnaire, but did not provide all data
ND = no data; vendor did not fill out treatment system questionnaire

Table 4. Treatment removal performance for dissolved metals.

Treatment Type	Treatment System Name	Dissolved Copper Median Influent (mg/L)	Dissolved Copper Median Effluent (mg/L)	Dissolved Copper Median Removal (%)	Dissolved Lead Median Influent (mg/L)	Dissolved Lead Median Effluent (mg/L)	Dissolved Lead Median Removal (%)	Dissolved Zinc Median Influent (mg/L)	Dissolved Zinc Median Effluent (mg/L)	Dissolved Zinc Median Removal (%)	Notes
Passive Treatment Technologies											
Bioretention/Filtration											
	Filterra® Curb Inlet System	0.0056	0.0033	44%	NA	NA	NA	0.194	0.082	54%	
	Filterra® Roof Drain System	0.0056	0.0033	44%	NA	NA	NA	0.194	0.082	54%	
	Modular Wetland System – Linear	0.757	0.0552	93%	0.543	0.1	81%	0.95	0.185	80%	
	Silva Cell	NA	NA	90%	NA	NA	NA	NA	NA	90%	
	TREEPOD® Biofilter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	UrbanGreen BioFilter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Drain Inlet Insert											
Absorbent Boom/Fabric	ADsorb-It	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Enviro-Drain®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EnviroSafe™ Storm Safe HF10	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Ultra-Urban Filter™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration	EcoVault™ Baffle Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	EnviroSafe™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	HUBER Hydro Filt	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Raynfiltr™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration (Cartridge)	StormBasin™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	StormPod™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Triton Drop Inlet Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Downspout Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Flume Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Grate Inlet Skimmer Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Trench Drain Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Clean Way Downspout Filtration Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	DrainPac™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EnviroTrap Catch Basin Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard® Downspout Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard® LoPro Matrix Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard® LoPro Trench Drain Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard+PLUS®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard® Trash & Debris Guard	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Inceptor®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Catch Basin Insert	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Storm PURE™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SwaleGard® Pre-filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Treatment Type	Treatment System Name	Dissolved Copper Median Influent (mg/L)	Dissolved Copper Median Effluent (mg/L)	Dissolved Copper Median Removal (%)	Dissolved Lead Median Influent (mg/L)	Dissolved Lead Median Effluent (mg/L)	Dissolved Lead Median Removal (%)	Dissolved Zinc Median Influent (mg/L)	Dissolved Zinc Median Effluent (mg/L)	Dissolved Zinc Median Removal (%)	Notes
Drain Inlet Insert (cont)											
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ClearWater BMP	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Coanda Curb Inlet Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Coanda Downspout Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	RSF (Rapid Stormwater Filtration) 100	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Hydrodynamic Separation											
	Aqua Shield Aqua-Swirl Concentrator	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	BaySeparator®	ND	ND	42%	ND	ND	ND	ND	ND	38%	Information obtained from product literature
	CDS™ Stormwater Treatment System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Downstream Defender	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	FloGard® Dual-Vortex Hydrodynamic Separator	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	HydroGuard	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Nutrient Separating Baffle Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Stormceptor®	NA	NA	28%	NA	NA	42%	NA	NA	35%	
	StormTrooper®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Terre Kleen™	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	UniScreen	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	UniStorm	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	V2B1 Treatment System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Vortechs System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration											
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	0.084	0.006	93%	0.008	0.007	51%	0.196	0.06	73%	
Cartridge	BayFilter®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EcoSense™ Stormwater Filtration Systems	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Perk Filter™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	PuriStorm	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Sorbtive™ FILTER	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Stormfilter using ZPG Media	0.0046	0.0042	11%	NA	NA	NA	0.060	0.053	15%	
	StormSafe™ Helix	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoStorm + ecoStorm Plus®	NA	NA	NA	NA	NA	NA	0.066	0.042	36%	
	Go-Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	HydroFilter	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	0.57	0.12	79%	0.38	0.01	98%	0.75	0.16	78%	
	Jellyfish™ Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Up-Flo™ Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Treatment Type	Treatment System Name	Dissolved Copper Median Influent (mg/L)	Dissolved Copper Median Effluent (mg/L)	Dissolved Copper Median Removal (%)	Dissolved Lead Median Influent (mg/L)	Dissolved Lead Median Effluent (mg/L)	Dissolved Lead Median Removal (%)	Dissolved Zinc Median Influent (mg/L)	Dissolved Zinc Median Effluent (mg/L)	Dissolved Zinc Median Removal (%)	Notes
Oil/Water Separator											
	ADS® Water Quality Unit	ND	ND	74%	ND	ND	74%	ND	ND	74%	Information obtained from product literature
	BioSTORM	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Clara® Gravity Stormwater Separator Vault	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	CrystalClean Separator	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	ecoLine A®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoLine B®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoSep®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	ecoTop®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	First Flush 1640FF	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Hancor Storm Water Quality Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Kleerwater™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	PSI Separator	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SNOUT®	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	VortClarex	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Active Treatment Technologies											
Chemical Filtration											
	Baker Tank with Sand Filter	20	10	50%	40	20	50%	400	40	90%	Units reported by vendor appear to be anomalous
	Chitosan-Enhanced Sand Filtration Using FlocClear™	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Purus® Stormwater Polishing System	NA	NA	NA	NA	NA	NA	0.06	0.0074	88%	
Chemical Treatment											
	ACISTBox®	NA	NA	NA	NA	NA	NA	0.817	0.744	9%	
	pHATBox®	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Wetsep	0.007	0.001	86%	0.018	<0.001	94%	NA	NA	NA	Zinc concentrations are in mg/L.
Electrocoagulation											
	High-Flo Electrocoagulation	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	OilTrap ElectroPulse Water Treatment System	8.2	0.072	99%	10.9	0.039	100%	78.6	0.34	99.9%	
	Redbox	NA	NA	99%	NA	NA	99%	NA	NA	99%	
	WaveIonics™	0.0235	0.005	79%	0.0157	0.0031	80%	0.12	0.02	83%	
Filtration											
Disc	Arkal Filter (Spin Klin System)	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Media	Fuzzy Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaterTrak Pressurized Media Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Pressure	Arkal Media Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Ion Exchange											
	Wastewater Ion Exchange System (WWIX)	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaterTrak Ion Exchange	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Reverse Osmosis											
	WaterTrak Reverse Osmosis	ND	ND	ND	ND	ND	ND	ND	ND	ND	

mg/L = milligrams per liter
NA = not available; vendor filled out treatment system questionnaire, but did not provide all data
ND = no data; vendor did not fill out treatment system questionnaire

Table 5. Treatment removal performance for total suspended solids.

Treatment Type	Treatment System Name	Total Suspended Solids (TSS) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Passive Treatment Technologies					
Bioretention/Filtration					
	Filterra® Curb Inlet System	27.5	4.2	85%	
	Filterra® Roof Drain System	27.5	4.2	85%	
	Modular Wetland System – Linear	270	3	98%	
	Silva Cell	NA	NA	80%	
	TREEPOD® Biofilter	NA	NA	NA	
	UrbanGreen BioFilter	NA	NA	NA	
Drain Inlet Insert					
Absorbent Boom/Fabric	ADsorb-It	V	V	80-99%	
	Enviro-Drain®	ND	ND	ND	
	EnviroSafe™ Storm Safe HF10	ND	ND	ND	
	Ultra-Urban Filter™	NA	NA	80%	mm range.
Media Filtration	EcoVault™ Baffle Box	NA	NA	NA	
	EnviroSafe™	ND	ND	ND	
	HUBER Hydro Filt	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	
	Raynfiltr™	NA	NA	NA	
Media Filtration (Cartridge)	StormBasin™	112	3	98%	
	StormPod™	112	3	98%	
	Triton Drop Inlet Insert	NA	NA	NA	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	NA	NA	93%*	*Mass Balance was used for the Suspended Solids Retention Test and therefore mg/L and number of samples does not apply. An OK-90 Sand gradation was used for the testing.
	Bio Clean Downspout Filter	NA	NA	93%*	*Mass Balance was used for the Suspended Solids Retention Test and therefore mg/L and number of samples does not apply. An OK-90 Sand gradation was used for the testing.
	Bio Clean Flume Filter	73	51.6	29%	
	Bio Clean Grate Inlet Skimmer Box	978	329	66%	Units reported by vendor appear to be anomalous
	Bio Clean Trench Drain Filter	NA	NA	NA	
	Clean Way Downspout Filtration Unit	ND	ND	ND	
	DrainPac™	ND	ND	ND	
	EnviroTrap Catch Basin Insert	250	175	30%	The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 180 microns was used.
	FloGard® Downspout Filter	100	20	80%	
	FloGard® LoPro Matrix Filter	100	20	80%	
	FloGard® LoPro Trench Drain Filter	100	20	80%	
	FloGard+PLUS®	100	20	80%	
	FloGard® Trash & Debris Guard	NA	NA	NA	
	Inceptor®	ND	ND	ND	
	StormClean Catch Basin Insert	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	
	Storm PURE™	ND	ND	ND	
	SwaleGard® Pre-filter	100	20	80%	
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	43	5	80%	
	ClearWater BMP	ND	ND	ND	

Treatment Type	Treatment System Name	Total Suspended Solids (TSS) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Drain Inlet Insert (cont.)					
Combination System (Screen and Media Filtration)	Coanda Curb Inlet Filter	1,500	1,376	8%	Units reported by vendor appear to be anomalous
	Coanda Downspout Filter	1,500	1,376	8%	Units reported by vendor appear to be anomalous
	RSF (Rapid Stormwater Filtration) 100	ND	ND	65%	Information obtained from product literature
	RSF (Rapid Stormwater Filtration) 1000	ND	ND	49%	Information obtained from product literature
	RSF (Rapid Stormwater Filtration) 4000	ND	ND	91%	Information obtained from product literature
Hydrodynamic Separation					
	Aqua Shield Aqua-Swirl Concentrator	137	12	86%	
	BaySeparator®	ND	ND	80%	Information obtained from product literature
	CDS™ Stormwater Treatment System	154	26	95%	
	Downstream Defender	ND	ND	50%	Information obtained from product literature
	FloGard® Dual-Vortex Hydrodynamic Separator	202	80	60%	
	HydroGuard	ND	ND	70%	Information obtained from product literature
	Nutrient Separating Baffle Box	366	48	87%	
	Stormceptor®	159	59	53%	
	StormTrooper®	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	
	Terre Kleen™	ND	ND	78%	Information obtained from product literature
	UniScreen	250	175	80%	The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 110 microns was used.
	UniStorm	250	175	80%	The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 110 microns was used.
	V2B1 Treatment System	ND	ND	63.8%	Information obtained from product literature
	Vortechs System	108	28	93%	
Media Filtration					
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	30	3.39	83%	
Cartridge	BayFilter®	ND	ND	80%	Information obtained from product literature
	EcoSense™ Stormwater Filtration Systems	NA	NA	NA	
	Perk Filter™	70	11	82%	
	PuriStorm	250	175	80%	The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 60 microns was used.
	Sorbtive™ FILTER	ND	ND	84%	Information obtained from product literature
	Stormfilter using ZPG Media	83	23	82%	
	StormSafe™ Helix	NA	NA	NA	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	43	5	80%	
	ecoStorm + ecoStorm Plus®	200	26	87%	
	Go-Filter	NA	NA	NA	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	
	HydroFilter	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	84.6	12.4	85%	
	Jellyfish™ Filter	74	8	89%	
	Up-Flo™ Filter	ND	ND	91%	Information obtained from product literature

Treatment Type	Treatment System Name	Total Suspended Solids (TSS) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Oil/Water Separator					
	ADS® Water Quality Unit	ND	ND	80%	Information obtained from product literature
	BioSTORM	227	7.9	95.3%	
	Clara® Gravity Stormwater Separator Vault	284.5	173.5	47%	
	CrystalClean Separator	ND	ND	ND	
	ecoLine A®	NA	NA	NA	
	ecoLine B®	NA	NA	NA	
	ecoSep®	ND	ND	ND	
	ecoTop®	ND	ND	ND	
	First Flush 1640FF	NA	NA	NA	
	Hancor Storm Water Quality Unit	ND	ND	ND	
	Kleerwater™	NA	NA	NA	
	PSI Separator	ND	ND	ND	
	SNOUT®	ND	ND	ND	
	VortClarex	NA	NA	NA	
Active Treatment Technologies					
Chemical Filtration					
	Baker Tank with Sand Filter	200	10	95%	
	Chitosan-Enhanced Sand Filtration Using FlocClear™	NA	NA	NA	
	Purus® Stormwater Polishing System	NA	NA	NA	
Chemical Treatment					
	ACISTBox®	NA	NA	NA	
	pHATBox®	NA	NA	NA	
	Wetsep	112	<2	98%	
Electrocoagulation					
	High-Flo Electrocoagulation	NA	NA	NA	
	OilTrap ElectroPulse Water Treatment System	600	10	98%	Units reported by vendor appear to be anomalous
	Redbox	NA	NA	99%	
	WaveIonics™	200	5	98%	
Filtration					
Disc	Arkal Filter (Spin Klin System)	ND	ND	ND	
Media	Fuzzy Filter	10	2	70-95%	
	WaterTrak Pressurized Media Filter	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	
Pressure	Arkal Media Filter	ND	ND	ND	
Ion Exchange					
	Wastewater Ion Exchange System (WWIX)	NA	NA	NA	
	WaterTrak Ion Exchange	ND	ND	ND	
Reverse Osmosis					
	WaterTrak Reverse Osmosis	ND	ND	ND	

mg/L = milligrams per liter
NA = not available; vendor filled out treatment system questionnaire, but did not provide all data
ND = no data; vendor did not fill out treatment system questionnaire
V = varies

Table 6. Treatment removal performance for total petroleum hydrocarbons and oil and grease.

Treatment Type	Treatment System Name	TPH Median Influent (mg/L)	TPH Median Effluent (mg/L)	TPH Median Removal (%)	Oil and Grease Median Influent (mg/L)	Oil and Grease Median Effluent (mg/L)	Oil and Grease Median Removal (%)	Notes
Passive Treatment Technologies								
Bioretention/Filtration								
	Filterra® Curb Inlet System	43.4	1.2	97%	6.2	5.0 U	>18%	
	Filterra® Roof Drain System	43.4	1.2	97%	6.2	5.0 U	>18%	
	Modular Wetland System – Linear	19	0	>99%	4	U	>99%	
	Silva Cell	NA	NA	NA	NA	NA	NA	
	TREEPOD® Biofilter	NA	NA	NA	NA	NA	NA	
	UrbanGreen BioFilter	NA	NA	NA	NA	NA	NA	
Drain Inlet Insert								
Absorbent Boom/Fabric	ADsorb-It	V	V	99-100%	V	V	99-100%	
	Enviro-Drain®	ND	ND	ND	ND	ND	ND	
	EnviroSafe™ Storm Safe HF10	ND	ND	ND	ND	ND	ND	
	Ultra-Urban Filter™	>100	<10	90%	>100	<10	85%	
Media Filtration	EcoVault™ Baffle Box	NA	NA	NA	NA	NA	NA	
	EnviroSafe™	ND	ND	ND	ND	ND	ND	
	HUBER Hydro Filt	ND	ND	ND	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	ND	ND	ND	
	Raynfiltr™	NA	NA	NA	NA	NA	NA	
Media Filtration (Cartridge)	StormBasin™	NA	NA	NA	59.5	<5	>90%	
	StormPod™	NA	NA	NA	59.5	<5	>90%	
	Triton Drop Inlet Insert	NA	NA	NA	NA	NA	NA	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	NA	NA	NA	NA	NA	NA	
	Bio Clean Downspout Filter	NA	NA	NA	223.5	29.5	87%	Units reported by vendor appear to be anomalous
	Bio Clean Flume Filter	223	29.5	87%	360	62	83%	Units reported by vendor appear to be anomalous
	Bio Clean Grate Inlet Skimmer Box	NA	NA	NA	189	10.43	95%	Units reported by vendor appear to be anomalous
	Bio Clean Trench Drain Filter	NA	NA	NA	NA	NA	NA	
	Clean Way Downspout Filtration Unit	ND	ND	ND	ND	ND	ND	
	DrainPac™	ND	ND	ND	ND	ND	ND	
	EnviroTrap Catch Basin Insert	400	150	63%	400	150	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	FloGard® Downspout Filter	35	7	80%	35	7	80%	
	FloGard® LoPro Matrix Filter	35	7	80%	35	7	80%	
	FloGard® LoPro Trench Drain Filter	35	7	80%	35	7	80%	
	FloGard+PLUS®	35	7	80%	35	7	80%	
	FloGard® Trash & Debris Guard	NA	NA	NA	NA	NA	NA	
	Inceptor®	ND	ND	ND	ND	ND	ND	
	StormClean Catch Basin Insert	ND	ND	ND	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	ND	ND	ND	
	Storm PURE™	ND	ND	ND	ND	ND	ND	
	SwaleGard® Pre-filter	35	7	80%	35	7	80%	

Treatment Type	Treatment System Name	TPH Median Influent (mg/L)	TPH Median Effluent (mg/L)	TPH Median Removal (%)	Oil and Grease Median Influent (mg/L)	Oil and Grease Median Effluent (mg/L)	Oil and Grease Median Removal (%)	Notes
Drain Inlet Insert (cont)								
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	NA	NA	NA	NA	NA	NA	
	ClearWater BMP	NA	NA	NA	NA	NA	NA	
	Coanda Curb Inlet Filter	NA	NA	NA	NA	NA	NA	
	Coanda Downspout Filter	NA	NA	NA	NA	NA	NA	
	RSF (Rapid Stormwater Filtration) 100	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 1000	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 4000	ND	ND	ND	ND	ND	ND	
Hydrodynamic Separation								
	Aqua Shield Aqua-Swirl Concentrator	NA	NA	NA	NA	NA	NA	
	BaySeparator®	ND	ND	ND	ND	ND	80%	Information obtained from product literature
	CDS™ Stormwater Treatment System	NA	NA	NA	22	5	64%	
	Downstream Defender	NA	NA	NA	NA	NA	NA	
	FloGard® Dual-Vortex Hydrodynamic Separator	NA	NA	NA	NA	NA	NA	
	HydroGuard	ND	ND	ND	ND	ND	ND	
	Nutrient Separating Baffle Box	NA	NA	NA	4	ND	>99%	
	Stormceptor®	29	4	73%	NA	NA	NA	
	StormTrooper®	ND	ND	ND	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	ND	ND	ND	
	Terre Kleen™	ND	ND	ND	ND	ND	ND	
	UniScreen	400	150	63%	400	150	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	UniStorm	400	150	63%	400	150	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	V2B1 Treatment System	400	150	63%	400	150	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	Vortechs System	NA	NA	NA	NA	NA	NA	
Media Filtration								
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	NA	NA	NA	9.9	3	70%	
Cartridge	BayFilter®	ND	ND	ND	ND	ND	80%	Information obtained from product literature
	EcoSense™ Stormwater Filtration Systems	NA	NA	NA	NA	NA	NA	
	Perk Filter™	20	5	75%	20	5	75%	
	PuriStorm	400	80	80%	400	80	80%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	Sorbtive™ FILTER	ND	ND	ND	ND	ND	ND	
	Stormfilter using ZPG Media	NA	NA	NA	NA	NA	NA	
	StormSafe™ Helix	NA	NA	NA	NA	NA	NA	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	NA	NA	NA	NA	NA	NA	
	ecoStorm + ecoStorm Plus®	NA	NA	NA	NA	NA	NA	
	Go-Filter	NA	NA	NA	NA	NA	NA	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	ND	ND	ND	
	HydroFilter	ND	ND	ND	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	1.4	0	>99%	69.8	6.5	91%	
	Jellyfish™ Filter	NA	NA	NA	NA	NA	NA	
	Up-Flo™ Filter	ND	ND	ND	ND	ND	ND	

Treatment Type	Treatment System Name	TPH Median Influent (mg/L)	TPH Median Effluent (mg/L)	TPH Median Removal (%)	Oil and Grease Median Influent (mg/L)	Oil and Grease Median Effluent (mg/L)	Oil and Grease Median Removal (%)	Notes
Oil/Water Separator								
	ADS® Water Quality Unit	ND	ND	ND	ND	ND	80%	Information obtained from product literature
	BioSTORM	NA	NA	NA	NA	NA	NA	
	Clara® Gravity Stormwater Separator Vault	NA	NA	NA	NA	NA	NA	
	CrystalClean Separator	ND	ND	ND	ND	ND	ND	
	ecoLine A®	NA	NA	NA	NA	NA	NA	
	ecoLine B®	NA	NA	NA	NA	NA	NA	
	ecoSep®	ND	ND	ND	ND	ND	ND	
	ecoTop®	ND	ND	ND	ND	ND	ND	
	First Flush 1640FF	NA	NA	NA	NA	NA	NA	
	Hancor Storm Water Quality Unit	ND	ND	ND	ND	ND	ND	
	Kleerwater™	NA	NA	NA	NA	NA	NA	
	PSI Separator	ND	ND	ND	ND	ND	ND	
	SNOUT®	ND	ND	ND	ND	ND	ND	
	VortClarex	NA	NA	NA	NA	NA	NA	
Active Treatment Technologies								
Chemical Filtration								
	Baker Tank with Sand Filter	NA	NA	NA	NA	NA	NA	
	Chitosan-Enhanced Sand Filtration Using FlocClear™	NA	NA	NA	NA	NA	NA	
	Purus® Stormwater Polishing System	NA	NA	NA	NA	NA	NA	
Chemical Treatment								
	ACISTBox®	3.12	0.38	88%	NA	NA	NA	
	pHATBox®	NA	NA	NA	NA	NA	NA	
	Wetsep	NA	NA	NA	NA	NA	NA	
Electrocoagulation								
	High-Flo Electrocoagulation	NA	NA	NA	NA	NA	NA	
	OilTrap ElectroPulse Water Treatment System	78	0.27	100%	136	<5.0	>96.3%	Units reported by vendor appear to be anomalous
	Redbox	NA	NA	NA	NA	NA	NA	
	WaveIonics™	45.6	0.25	99%	197	4.76	98%	Units reported by vendor appear to be anomalous
Filtration								
Disc	Arkal Filter (Spin Klin System)	ND	ND	ND	ND	ND	ND	
Media	Fuzzy Filter	NA	NA	NA	NA	NA	NA	
	WaterTrak Pressurized Media Filter	ND	ND	ND	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	ND	ND	ND	
Pressure	Arkal Media Filter	ND	ND	ND	ND	ND	ND	
Ion Exchange								
	Wastewater Ion Exchange System (WWIX)	NA	NA	NA	NA	NA	NA	
	WaterTrak Ion Exchange	ND	ND	ND	ND	ND	ND	
Reverse Osmosis								
	WaterTrak Reverse Osmosis	ND	ND	ND	ND	ND	ND	

mg/L = milligrams per liter
NA = not available; vendor filled out treatment system questionnaire, but did not provide all data
ND = no data; vendor did not fill out treatment system questionnaire
TPH = Total Petroleum Hydrocarbons
U = at or below detection limit
V = varies

Table 7. Treatment removal performance for total phosphorus.

Treatment Type	Treatment System Name	Total Phosphorus (TP) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Passive Treatment Technologies					
Bioretention/Filtration					
	Filterra® Curb Inlet System	0.15	0.14	7%	during TAPE study. 69.5% efficiency ratio
	Filterra® Roof Drain System	0.15	0.14	7%	during TAPE study. 69.5% efficiency ratio
	Modular Wetland System – Linear	NA	NA	NA	
	Silva Cell	NA	NA	68%	
	TREEPOD® Biofilter	NA	NA	NA	
	UrbanGreen BioFilter	NA	NA	NA	
Drain Inlet Insert					
Absorbent Boom/Fabric	ADsorb-It	NA	NA	NA	
	Enviro-Drain®	NA	NA	NA	
	EnviroSafe™ Storm Safe HF10	NA	NA	NA	
	Ultra-Urban Filter™	NA	NA	NA	
Media Filtration	EcoVault™ Baffle Box	NA	NA	NA	
	EnviroSafe™	NA	NA	NA	
	HUBER Hydro Filt	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	
	Raynfiltr™	NA	NA	NA	
Media Filtration (Cartridge)	StormBasin™	0.57	0.3	47%	
	StormPod™	0.57	0.3	47%	
	Triton Drop Inlet Insert	NA	NA	NA	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	85.8	73.4	71-96%	anomalous
	Bio Clean Downspout Filter	NA	NA	NA	
	Bio Clean Flume Filter	NA	NA	NA	
	Bio Clean Grate Inlet Skimmer Box	18.6	0.452	98%	anomalous
	Bio Clean Trench Drain Filter	NA	NA	NA	
	Clean Way Downspout Filtration Unit	ND	ND	ND	
	DrainPac™	ND	ND	ND	
	EnviroTrap Catch Basin Insert	ND	ND	ND	

Treatment Type	Treatment System Name	Total Phosphorus (TP) Median Influent (mg/L)	Total Phosphorus (TP) Median Effluent (mg/L)	Total Phosphorus (TP) Median Removal (%)	Notes
Drain Inlet Insert (cont.)					
	FloGard® Downspout Filter	NA	NA	NA	
	FloGard® LoPro Matrix Filter	NA	NA	NA	
	FloGard® LoPro Trench Drain Filter	NA	NA	NA	
	FloGard+PLUS®	NA	NA	NA	
	FloGard® Trash & Debris Guard	NA	NA	NA	
	Inceptor®	ND	ND	ND	
	StormClean Catch Basin Insert	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	
	Storm PURE™	ND	ND	ND	
	SwaleGard® Pre-filter	NA	NA	NA	
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	NA	NA	NA	
	ClearWater BMP	ND	ND	ND	
	Coanda Curb Inlet Filter	NA	NA	NA	
Combination System (Screen and Media Filtration)	Coanda Downspout Filter	NA	NA	NA	
	RSF (Rapid Stormwater Filtration) 100	NA	NA	40%	
	RSF (Rapid Stormwater Filtration) 1000	NA	NA	30%	
	RSF (Rapid Stormwater Filtration) 4000	NA	NA	30%	
Hydrodynamic Separation					
	Aqua Shield Aqua-Swirl Concentrator	NA	NA	80%	
	BaySeparator®	NA	NA	19.4%	
	CDS™ Stormwater Treatment System	NA	NA	NA	
	Downstream Defender	NA	NA	NA	
	FloGard® Dual-Vortex Hydrodynamic Separator	NA	NA	NA	
	HydroGuard	NA	NA	NA	
	Nutrient Separating Baffle Box	1.49	0.44	70%	
	Stormceptor®	0.275	0.175	21.8%	
	StormTrooper®	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	
	Terre Kleen™	NA	NA	NA	
	UniScreen	ND	ND	ND	
	UniStorm	ND	ND	40%	Information obtained from product literature

Treatment Type	Treatment System Name	Total Phosphorus (TP) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Hydrodynamic Separation (cont)					
	V2B1 Treatment System	ND	ND	40%	Information obtained from product literature
	Vortechs System	NA	NA	NA	
Media Filtration					
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	NA	NA	NA	
Cartridge	BayFilter®	NA	NA	>50%	
	EcoSense™ Stormwater Filtration Systems	NA	NA	NA	
	Perk Filter™	NA	NA	NA	
	PuriStorm	ND	ND	ND	
	Sorbtive™ FILTER	ND	ND	>77%	Information obtained from product literature
	Stormfilter using ZPG Media	NA	NA	NA	
	StormSafe™ Helix	NA	NA	NA	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	NA	NA	NA	
	ecoStorm + ecoStorm Plus®	NA	NA	NA	
	Go-Filter	NA	NA	NA	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	
	HydroFilter	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	2.07	0.63	70%	
	Jellyfish™ Filter	NA	NA	50%	
	Up-Flo™ Filter	NA	NA	NA	
Oil/Water Separator					
	ADS® Water Quality Unit	NA	NA	>43%	
	BioSTORM	NA	NA	NA	
	Clara® Gravity Stormwater Separator Vault	NA	NA	NA	
	CrystalClean Separator	ND	ND	ND	
	ecoLine A®	NA	NA	NA	
	ecoLine B®	NA	NA	NA	

Treatment Type	Treatment System Name	Total Phosphorus (TP) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Oil/Water Separator (cont.)					
	ecoSep®	ND	ND	ND	
	ecoTop®	ND	ND	ND	
	First Flush 1640FF	NA	NA	NA	
	Hancor Storm Water Quality Unit	ND	ND	ND	
	Kleerwater™	NA	NA	NA	
	PSI Separator	ND	ND	ND	
	SNOUT®	ND	ND	ND	
	VortClarex	NA	NA	NA	
Active Treatment Technologies					
Chemical Filtration					
	Baker Tank with Sand Filter	NA	NA	NA	
	Chitosan-Enhanced Sand Filtration Using FlocClear™	NA	NA	NA	
	Purus® Stormwater Polishing System	NA	NA	NA	
Chemical Treatment					
	ACISTBox®	NA	NA	NA	
	pHATBox®	NA	NA	NA	
	Wetsep	13.4	1.9	86%	
Electrocoagulation					
	High-Flo Electrocoagulation	NA	NA	NA	
	OilTrap ElectroPulse Water Treatment System	NA	NA	NA	
	Redbox	NA	NA	NA	
	WaveIonics™	NA	NA	NA	
Filtration					
Disc	Arkal Filter (Spin Klin System)	NA	NA	NA	
Media	Fuzzy Filter	NA	NA	NA	
	WaterTrak Pressurized Media Filter	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	
Pressure	Arkal Media Filter	NA	NA	NA	

Treatment Type	Treatment System Name	Total Phosphorus (TP) Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Notes
Ion Exchange					
	Wastewater Ion Exchange System (WWIX)	NA	NA	NA	
	WaterTrak Ion Exchange	ND	ND	ND	
Reverse Osmosis					
	WaterTrak Reverse Osmosis	ND	ND	ND	

mg/L = milligrams per liter

NA = not available; vendor filled out treatment system questionnaire, but did not provide all data

ND = no data; vendor did not fill out treatment system questionnaire

Table 8. Treatment removal performance for SVOCs, PCBs, dioxins, and CPAHs.

		SVOCs			PCBs			Dioxins			CPAHs		
Treatment Type	**Treatment System Name**	**Median Influent (mg/L)**	**Median Effluent (mg/L)**	**Median Removal (%)**	**Median Influent (mg/L)**	**Median Effluent (mg/L)**	**Median Removal (%)**	**Median Influent (mg/L)**	**Median Effluent (mg/L)**	**Median Removal (%)**	**Median Influent (mg/L)**	**Median Remova l (%)**	**Notes**
Passive Treatment Technologies													
Bioretention/Filtration													
	Filterra® Curb Inlet System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Filterra® Roof Drain System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Modular Wetland System – Linear	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Silva Cell	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	TREEPOD® Biofilter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	UrbanGreen BioFilter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Drain Inlet Insert													
Absorbent Boom/Fabric	ADsorb-It	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Enviro-Drain®	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EnviroSafe™ Storm Safe HF10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Ultra-Urban Filter™	180	>4.4	40%	NA	NA	NA	NA	NA	NA	>100	605	Units reported by vendor appear to be anomalous
Media Filtration	EcoVault™ Baffle Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	EnviroSafe™	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	HUBER Hydro Filt	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Raynfiltr™	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration (Cartridge)	StormBasin™	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	StormPod™	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Triton Drop Inlet Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Downspout Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Flume Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Grate Inlet Skimmer Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Bio Clean Trench Drain Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Clean Way Downspout Filtration Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	DrainPac™	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EnviroTrap Catch Basin Insert	400	150	0.625	400	150	0.625	400	150	0.625	400	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	FloGard® Downspout Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	7%	
	FloGard® LoPro Matrix Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	7%	
	FloGard® LoPro Trench Drain Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	7%	
	FloGard+PLUS®	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	7%	
	FloGard® Trash & Debris Guard	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Inceptor®	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Catch Basin Insert	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Storm PURE™	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	SwaleGard® Pre-filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	7%	
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ClearWater BMP	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Coanda Curb Inlet Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

Treatment Type	Treatment System Name	SVOCs Median Influent (mg/L)	SVOCs Median Effluent (mg/L)	SVOCs Median Removal (%)	PCBs Median Influent (mg/L)	PCBs Median Effluent (mg/L)	PCBs Median Removal (%)	Dioxins Median Influent (mg/L)	Dioxins Median Effluent (mg/L)	Dioxins Median Removal (%)	CPAHs Median Influent (mg/L)	CPAHs Median Removal (%)	Notes
Drain Inlet Insert (cont)													
	Coanda Downspout Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	RSF (Rapid Stormwater Filtration) 100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 1000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 4000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Hydrodynamic Separation													
	Aqua Shield Aqua-Swirl Concentrator	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	BaySeparator®	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	CDS™ Stormwater Treatment System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Downstream Defender	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	FloGard® Dual-Vortex Hydrodynamic Separator	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	HydroGuard	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Nutrient Separating Baffle Box	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Stormceptor®	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	StormTrooper®	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Terre Kleen™	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	UniScreen	400	150	63%	400	150	63%	400	150	63%	400	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	UniStorm	400	150	63%	400	150	63%	400	150	63%	400	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	V2B1 Treatment System	400	150	63%	400	150	63%	400	150	63%	400	63%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
	Vortechs System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Media Filtration													
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Cartridge	BayFilter®	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	EcoSense™ Stormwater Filtration Systems	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Perk Filter™	NA	NA	NA	NA	NA	NA	NA	NA	NA	20	75%	Units reported by vendor appear to be anomalous
	PuriStorm	400	80	80%	400	80	80%	400	80	80%	400	80%	Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.

		SVOCs			PCBs			Dioxins			CPAHs		
Treatment Type	Treatment System Name	Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Median Influent (mg/L)	Median Effluent (mg/L)	Median Removal (%)	Median Influent (mg/L)	Median Removal (%)	Notes
Cartridge (cont'd)	Sorbtive™ FILTER	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Stormfilter using ZPG Media	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.12	42%	
	StormSafe™ Helix	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoStorm + ecoStorm Plus®	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Go-Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	HydroFilter	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Jellyfish™ Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Up-Flo™ Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Oil/Water Separator													
	ADS® Water Quality Unit	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	BioSTORM	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Clara® Gravity Stormwater Separator Vault	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	CrystalClean Separator												
	ecoLine A®	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoLine B®	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	ecoSep®												
	ecoTop®												
	First Flush 1640FF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Hancor Storm Water Quality Unit												
	Kleerwater™	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	PSI Separator												
	SNOUT®												
	VortClarex	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Active Treatment Technologies													
Chemical Filtration													
	Baker Tank with Sand Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Chitosan-Enhanced Sand Filtration Using FlocClear™	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Purus® Stormwater Polishing System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Chemical Treatment													
	ACISTBox®	0.0199	0.00002	99.9%	NA	NA	NA	NA	NA	NA	0.00028	93%	
	pHATBox®	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	Wetsep	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Electrocoagulation													
	High-Flo Electrocoagulation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	OilTrap ElectroPulse Water Treatment System	28	0.43	98.4%	NA	NA	NA	NA	NA	NA	NA	NA	Units reported by vendor appear to
	Redbox	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaveIonics™	2.34	0.00002	100%	0.0024	0.00011	95.5%	NA	NA	NA	0.091	99.98%	
Filtration													
Disc	Arkal Filter (Spin Klin System)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Media	Fuzzy Filter	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaterTrak Pressurized Media Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Pressure	Arkal Media Filter	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

Treatment Type	Treatment System Name	SVOCs Median Influent (mg/L)	SVOCs Median Effluent (mg/L)	SVOCs Median Removal (%)	PCBs Median Influent (mg/L)	PCBs Median Effluent (mg/L)	PCBs Median Removal (%)	Dioxins Median Influent (mg/L)	Dioxins Median Effluent (mg/L)	Dioxins Median Removal (%)	CPAHs Median Influent (mg/L)	CPAHs Median Removal (%)	Notes
Ion Exchange													
	Wastewater Ion Exchange System (WWIX)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	WaterTrak Ion Exchange	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Reverse Osmosis													
	WaterTrak Reverse Osmosis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

cPAHs = carcinogenic polycyclic aromatic hydrocarbons
mg/L = milligrams per liter
NA = not available; vendor filled out treatment system questionnaire, but did not provide all data
ND = no data; vendor did not fill out treatment system questionnaire
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds

Table 9. System design information for passive treatment systems.

Treatment Type	Treatment System Name	Design Flow Rate (gpm) Low	Design Flow Rate (gpm) High	System Footprint (sf) Low	System Footprint (sf) High	Required Head Loss (feet) Low	Required Head Loss (feet) High	Internal or External Bypass	Above or Below Grade	Bypass Notes
Bioretention/Filtration										
	Filterra® Roofdrain System	8.5	>50	16	72	2.5	2.5	Internal/External	Both	System footprint obtained from Western Washington Engineering Design Assistance Kit
	Filterra® System	8.5	>50	16	72	2.5	2.5	Internal/External	Both	System footprint obtained from Western Washington Engineering Design Assistance Kit
	Modular Wetland System – Linear	22.4	120	16	84	2	4	Internal	Both	External bypass in some situations
	Silva Cell	20 in/hr	3 in/hr	NA	NA	NA	NA	Internal/External	Below	
	TREEPOD® Biofilter	16	72	24	84	0	0.5	Internal	Both	
	UrbanGreen BioFilter	4	60	0	0	3	6	Internal/External	Below	
Drain Inlet Insert										
Absorbent Boom/Fabric	Adsorb-It	80/SF	100/SF	V	V	NA	NA	NA	Below	Per individual application
	Enviro-Drain®	2	71	0	0	NA	NA	NA	Below	Information obtained from product literature
	EnviroSafe™ Storm Safe HF10	900	9000	0	0	NA	NA	External	Below	Information obtained from product literature
	Ultra-Urban Filter™	190	500	0	0	0.5	1.5	Internal	Below	
Media Filtration	EcoVault™ Baffle Box	1,346	48,000	NA	NA	V	V	Internal/External	Below	
	EnviroSafe™	115	230	0	0	NA	NA	External	Below	Information obtained from product literature
	HUBER Hydro Filt	ND	ND	0	0	ND	ND	ND	Below	
	Hydro-Kleen™	ND	ND	ND	ND	ND	ND	ND	Below	
	Raynfiltr™	0	900	0	0	NA	NA	NA	Below	
Media Filtration (Cartridge)	StormBasin™	50	2,500	4	200	1.25	2.5	Internal/External	Below	
	StormPod™	50	2,500	4	200	1.25	2.5	Internal/External	Below	
	Triton Drop Inlet Insert	100	5,404	0	0	NA	NA	Internal/External	Below	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	381	898	0	0	0.5	2	External	Below	Installed in catch basin - does not affect basin hydraulics
	Bio Clean Downspout Filter	249	1,145	0.31 CF	1.57 CF	1	2	Internal	Above	High flow unimpeded - UPC approved and tested
	Bio Clean Flume Filter	116	583	1	6	0.083	0.5	Internal/External	Above	Internal bypass up to specific flow - configured to allow for high flow external bypass
	Bio Clean Grate Inlet Skimmer Box	224	8,980	0	0	0.5	2	Internal	Below	High flow rate
	Bio Clean Trench Drain Filter	28	86	0	0	4	12	Internal/External	Below	Internal bypass up to specific flow - configured to allow for high flow external bypass
	Clean Way Downspout Filtration Unit	ND	ND	ND	ND	ND	ND	ND	Above	
	DrainPac™	ND	ND	ND	ND	ND	ND	ND	Below	
	EnviroTrap Catch Basin Insert	0	2700	NA	NA	0	0.5	NA	Below	
	FloGard® Downspout Filter	30	325	0.5	1.0	0	0.5	Internal	Above	
	FloGard® LoPro Matrix Filter	45	800	0.75	16	0	0.5	Internal	Above	
	FloGard® LoPro Trench Drain Filter	200	500	1.0	20	0	0.25	Internal	Above	
	FloGard+PLUS®	100	2,000	1.0	10	0	0.25	Internal	Above	
	FloGard® Trash & Debris Guard	50	500	0.5	4	0	0.25	Internal	Above	
	Inceptor®	ND	ND	ND	ND	ND	ND	ND	Below	
	StormClean Catch Basin Insert	ND	ND	ND	ND	ND	ND	ND	Below	
	StormClean Curb Inlet Insert	ND	ND	ND	ND	ND	ND	ND	Below	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	ND	ND	ND	ND	Above	
	Storm PURE™	ND	ND	ND	ND	ND	ND	ND	Below	
	SwaleGard® Pre-filter	100	800	4	16	0	0.5	Internal	Above	

Treatment Type	Treatment System Name	Design Flow Rate (gpm) Low	Design Flow Rate (gpm) High	System Footprint (sf) Low	System Footprint (sf) High	Required Head Loss (feet) Low	Required Head Loss (feet) High	Internal or External Bypass	Above or Below Grade	Bypass Notes
Drain Inlet Insert (cont)										
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	5/400*	100/940*	NA	NA	0	0	Internal/External	Below	* x/x = flow thru perlite/flow thru perlite + filter cloth
	ClearWater BMP	200	200	5	6	NA	NA	External	Above	Information obtained from product literature
	Coanda Curb Inlet Filter	50	360,000	2	2000	1.5	3	Internal	Above	Optional internal bypass is provided.
	Coanda Downspout Filter	50	360,000	2	2000	1.5	3	Internal	Above	Optional internal bypass is provided.
	RSF (Rapid Stormwater Filtration) 100	1,784	7,000	0	0	0.5	0.5	Internal	Below	Information obtained from product literature
	RSF (Rapid Stormwater Filtration) 1000	12,000	18,162	0	0	0.5	0.5	Internal	Below	Information obtained from product literature
	RSF (Rapid Stormwater Filtration) 4000	837	68,270	0	0	0.5	0.5	Internal	Below	Information obtained from product literature
Hydrodynamic Separation										
	Aqua Shield Aqua-Swirl Concentrator	100	2,600	NA	NA	0.25	0.25	Internal/External	Below	
	BaySeparator®	450	1,350	0	0	NA	NA	NA	Below	Information obtained from product literature
	CDS™ Stormwater Treatment System	20	44,900	NA	NA	0.1	0.1	Internal/External	Below	
	Downstream Defender	500	7,800	0	0	0.5	0.9	NA	Below	Information obtained from product literature
	FloGard® Dual-Vortex Hydrodynamic Separator	150	6,500	7	113	0	3	Internal	Below	
	HydroGuard	360	3,232	0	0	0	2	NA	Below	Information obtained from product literature
	Nutrient Separating Baffle Box	148	8,858	0	0	0	0	Internal	Below	External bypass in some situations
	Stormceptor®	0	11,000	NA	NA	0.22	0.22	Internal	Below	
	StormTrooper®	ND	ND	ND	ND	ND	ND	ND	Below	
	StormTrooper® EX Extra-Duty	ND	ND	ND	ND	ND	ND	ND	Below	
	Terre Kleen™	1.5	100	0	0	NA	NA	Internal	Below	Information obtained from product literature
	UniScreen	0	15700	20	135	0	0.5	Both	Above	
	UniStorm	0	15700	20	135	0	0.5	Both	Above	
	V2B1 Treatment System	0	63000	20	800	0	0.5	Both	Above	
	Vortechs System	50	22,450	NA	NA	0.1	0.1	Internal/External	Below	
Media Filtration										
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	10	350	14	320	4	7	External	Above	
Cartridge	BayFilter®	15	30	0	0	ND	ND	ND	Below	Information obtained from product literature
	EcoSense™ Stormwater Filtration Systems	25	1,662	NA	NA	V	V	Internal	Below	Hooded
	Perk Filter™	12	1,000	10	150	1.7	3.5	Internal	Below	
	PuriStorm	0	2000	9	600	0	0.5	Both	Above	
	Sorbtive™ FILTER	ND	ND	ND	ND	ND	ND	ND	Below	
	Stormfilter using ZPG Media	2	44,900	8	6,050	1.8	12	Internal/External	Below	
	StormSafe™ Helix	3	9	160	250	0	3	Internal/External	Below	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	ND	ND	ND	ND	Below	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	ND	ND	ND	ND	Below	

Treatment Type	Treatment System Name	Design Flow Rate (gpm) Low	High	System Footprint (sf) Low	High	Required Head Loss (feet) Low	High	Internal or External Bypass	Above or Below Grade	Bypass Notes
Media Filtration (cont)										
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	25	>960	NA	NA	0.8	0.8	Internal/External	Below	
	ecoStorm + ecoStorm Plus®	NA	180	NA	NA	0.41 (a)	NA	Internal/External	Below	Head loss based on: - Current monitoring configuration: 1 ecoStorm upstream of 2 ecoStorm plus units. - 360 gpm through the system, 180 gpm per filter. - Site specific model calibrated onsite at known flow rates. - Headloss negating effects of drop structure were neglected (located between the ecoStorm and ecoStorm plus units). - Filters assumed to be at the point of required maintenance (twice the head loss measured for new filters).
	Go-Filter	50	675	NA	NA	0.5	0.5	Internal/External	Below	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	ND	ND	ND	ND	Below	
	HydroFilter	ND	ND	ND	ND	ND	ND	ND	Below	
Up-Flow	Bio Clean Water Polisher	191	528	0	0	1	2	Internal	Below	High Flow Unimpeded
	Jellyfish™ Filter	60	2,300	12	113	1	2	Internal/External	Below	
	Up-Flo™ Filter	147	448	0	0	1.7	2.5	Internal	Below	Information obtained from product literature
Oil/Water Separator										
	ADS® Water Quality Unit	1,800	126,000	0	0	NA	NA	External	Below	
	BioSTORM	225	4,800	45	162	0.5	0.17	External	Below	
	Clara® Gravity Stormwater Separator Vault	5	1,120	0	150	0.5	1.5	Internal	Below	
	CrystalClean Separator	ND	ND	ND	ND	ND	ND	ND	Below	
	ecoLine A®	25	626	12	70	6	6	V	Below	
	ecoLine B®	50	1,110	NA	NA	6	6	V	Below	
	ecoSep®	ND	ND	ND	ND	ND	ND	ND	Below	
	ecoTop®	ND	ND	ND	ND	ND	ND	ND	Below	
	First Flush 1640FF	449	538	0	0	0	0	NA	Below	
	Hancor Storm Water Quality Unit	ND	ND	ND	ND	ND	ND	ND	Below	
	Kleerwater™	25	10,000	NA	NA	0	0	External	Below	
	PSI Separator	ND	ND	ND	ND	ND	ND	ND	Below	
	SNOUT®	ND	ND	ND	ND	ND	ND	ND	Below	
	VortClarex	100	2,000	0	0	0.1	0.1	Internal/External	Below	

CF = cubic feet
gpm = gallons per minute
in/hr = inches per hour
NA = not available; vendor filled out Treatment System Summary form, but did not provide all data
ND = no data; vendor did not fill out Treatment System Summary form
SF = square foot
V = varies

Table 10. System design information for active treatment systems.

Treatment Type	Treatment System Name	Design Flow Rate (gpm) Low	Design Flow Rate (gpm) High	System Footprint (sf) Low	System Footprint (sf) High	(feet) Low	(feet) High	Internal or External Bypass	Above or Below Grade	Notes
Chemical Filtration										
	Baker Tank with Sand Filter	15	>1000	1000	2500	NA	NA	NA	Above	
	Chitosan-Enhanced Sand Filtration Using FlocClear™	< 25	> 2,000	< 25	> 2,000	NA	NA	External	Above	Offline facility
	Purus® Stormwater Polishing System	5	210	10	90	70	120	External	Above	
Chemical Treatment										
	ACISTBox®	100	> 1,000	200	> 2,000	NA	NA	NA	Above	
	pHATBox®	250	350	10	24	NA (a)	NA (a)	NA	Above	(a) Packaged in 4' -6' (w) x 2.5' (d) x 4' (t) industrial steel box w/hinged top opening lid. Additional storage space for additive will depend on volume of additive storage (up to 35-gal drums in box, larger must go external) - plus secondary containment).
	Wetsep	20	260	NA	NA	40	40	External	NA	
Electrocoagulation										
	High-Flo Electrocoagulation	2.5	> 1,200	40	4,000	2	20	External	Above	
	OilTrap ElectroPulse Water Treatment System	5	500	40	1,500	5	15	Internal/External	Above	
	Redbox	0.5	150	NA	NA	NA	NA	NA	Above	
	WaveIonics™	50	> 1,000	200	> 4,000	NA	NA	NA	Above	
Filtration										
Disc	Arkal Filter (Spin Klin System)	100	4400	16	16	0.1	14	NA	Above	Information obtained from product literature
Media	Fuzzy Filter	70	Unlimited	NA	NA	35	35	External	Above	
	WaterTrak Pressurized Media Filter	27	905	43	119	ND	ND	ND	Above	Information obtained from product literature
	WaterTrak Ultrafiltration	38	377	31	62	ND	ND	ND	Above	Information obtained from product literature
Pressure	Arkal Media Filter	44	150	16	16	3	28	NA	Above	Information obtained from product literature
Ion Exchange										
	Wastewater Ion Exchange System (WWIX)	1	5000	NA	NA	20	20	NA	Above	
	WaterTrak Ion Exchange	23	866	65	113	ND	ND	ND	Above	Information obtained from product literature
Reverse Osmosis										
	WaterTrak Reverse Osmosis	65	275	143	243	350	350	ND	Above	Information obtained from product literature

gpm = gallons per minute

NA = not available; vendor filled out Treatment System Summary form, but did not provide all data

ND = no data; vendor did not fill out Treatment System Summary form

SF = square foot

Table 11. Installation and annual operation and maintenance costs for passive treatment systems.

Treatment Type	Treatment System Name	Installation Cost Low	Installation Cost High	Annual O&M Cost Low	Annual O&M Cost High	Notes
Bioretention/Filtration						
	Filterra® Curb Inlet System	$1,200	$7,500	$300	$3,000	
	Filterra® Roof Drain System	$1,200	$7,500	$300	$3,000	
	Modular Wetland System – Linear	$12,000	$25,000	$8.26/gal	$10.50/gal	
	Silva Cell	$4,000-5,600	$10,000-14,000	$100-200	100-200	Depends on selected tree species (small or large)
	TREEPOD® Biofilter	$10,000	$50,000	$400	$750	
	UrbanGreen BioFilter	$10,000	$250,000	$0.0001/gal	$0.0003/gal	
Drain Inlet Insert						
Absorbent Boom/Fabric	ADsorb-It	$0.91/SF	$0.91/SF	$0.91/SF	$0.91/SF	
	Enviro-Drain®	ND	ND	ND	ND	
	EnviroSafe™ Storm Safe HF10	ND	ND	ND	ND	
	Ultra-Urban Filter™	$400	$1,700	NA	NA	
Media Filtration	EcoVault™ Baffle Box	$25,000	$125,000	$200	$1,800	
	EnviroSafe™	ND	ND	ND	ND	
	HUBER Hydro Filt	ND	ND	ND	ND	
	Hydro-Kleen™	ND	ND	ND	ND	
	Raynfiltr™	$531	$554	NA	NA	
Media Filtration (Cartridge)	StormBasin™	$750	$2,000	$200	$800	
	StormPod™	$750	$2,000	$200	$800	
	Triton Drop Inlet Insert	$300	$2,500	$0.000002/gal	$0.00008/gal	
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket	$445	$1,600	$0.20/gal	$0.40/gal	
	Bio Clean Downspout Filter	$1,035	$1,200	$0.16/gal	$0.22/gal	
	Bio Clean Flume Filter	$660	$1,302	$0.23/gal	$0.74/gal	
	Bio Clean Grate Inlet Skimmer Box	$635	$1,800	$0.15/gal	$0.40/gal	
	Bio Clean Trench Drain Filter	$660	$1,302	$0.23/gal	$0.74/gal	
	Clean Way Downspout Filtration Unit	ND	ND	ND	ND	
	DrainPac™	ND	ND	ND	ND	
	EnviroTrap Catch Basin Insert	$200	$1000	$0	$1000	
	FloGard® Downspout Filter	$1,500	$3,500	$75	$250	
	FloGard® LoPro Matrix Filter	$400	$1,000	$75	$300	
	FloGard® LoPro Trench Drain Filter	$600	$3,000	$75	$350	
	FloGard+PLUS®	$250	$1,800	$75	$350	
	FloGard® Trash & Debris Guard	$450	$1,500	$50	$200	
	Inceptor®	ND	ND	ND	ND	

Treatment Type	Treatment System Name	Installation Cost Low	Installation Cost High	Annual O&M Cost Low	Annual O&M Cost High	Notes
Drain Inlet Insert (cont)						
	StormClean Catch Basin Insert	ND	ND	ND	ND	
	StormClean Curb Inlet Insert	ND	ND	ND	ND	
	StormClean Wall Mount Filtration Unit	ND	ND	ND	ND	
	Storm PURE™	ND	ND	ND	ND	
	SwaleGard® Pre-filter	$4,500	$4,500	$75	$300	
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert	V	V	V	V	
	ClearWater BMP	ND	ND	ND	ND	
	Coanda Curb Inlet Filter	$2,000	$3,500	$0	$0	
	Coanda Downspout Filter	$2,000	$3,500	$0	$0	
	RSF (Rapid Stormwater Filtration) 100	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 1000	ND	ND	ND	ND	
	RSF (Rapid Stormwater Filtration) 4000	ND	ND	ND	ND	
Hydrodynamic Separation						
	Aqua Shield Aqua-Swirl Concentrator	V	V	V	V	
	BaySeparator®	ND	ND	ND	ND	
	CDS™ Stormwater Treatment System	$10,000	$2,500,000	$0.00001/gal	$0.00001/gal	
	Downstream Defender	ND	ND	ND	ND	
	FloGard® Dual-Vortex Hydrodynamic Separator	$10,000	$100,000	$300	$3,500	
	HydroGuard	ND	ND	ND	ND	
	Nutrient Separating Baffle Box	$10,000	$200,000	$0.33/gal	$0.84/gal	
	Stormceptor®	$3,000	$15,000	$500	$5,000	
	StormTrooper®	ND	ND	ND	ND	
	StormTrooper® EX Extra-Duty	ND	ND	ND	ND	
	Terre Kleen™	ND	ND	ND	ND	
	UniScreen	$2000	$15000	0	$2000	
	UniStorm	$2000	$15000	0	$2000	
	V2B1 Treatment System	$2000	$15000	0	$2000	
	Vortechs System	$20,000	$500,000	$0.00001/gal	$0.00004/gal	
Media Filtration						
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System	$5,000	$150,000	$0.0003/gal	$0.003/gal	
Cartridge	BayFilter®	ND	ND	ND	ND	
	EcoSense™ Stormwater Filtration Systems	$400	$2,000	$100	$500	
	Perk Filter™	$10,000	$200,000	$1,200	$10,000	
	PuriStorm	$3000	$25000	$0	$10000	
	Sorbtive™ FILTER	ND	ND	ND	ND	
	Stormfilter using ZPG Media	$10,000	$2,500,000	$0.00008/gal	$0.00024/gal	

Treatment Type	Treatment System Name	Installation Cost Low	Installation Cost High	Annual O&M Cost Low	Annual O&M Cost High	Notes
Media Filtration (cont)						
	StormSafe™ Helix	$20,000	$60,000	$2,000	$6,000	
Sand Filter	Perimeter Sandfilter (Delaware Sandfilter)	ND	ND	ND	ND	
	Underground Sandfilter (DC Sandfilter)	ND	ND	ND	ND	
Combination System (with Hydrodynamic Separation)	Aqua Shield Aqua-Filter System	V	V	V	V	
	ecoStorm + ecoStorm Plus®	$8,900 (a)	$37,500 (a)	NA (b)	NA (b)	(a) Cost varies based on combination of units, number of units, and final design requirements. (b) $500 - $1000 per cleaning/backflush event; Minimum of 1X per year to monthly for stormwater.
	Go-Filter	V	V	V	V	
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher	ND	ND	ND	ND	
	HydroFilter	ND	ND	ND	ND	
Up-Flow	Bio Clean Water Polisher	$25,000	$125,000	$5.24/gal	$7.85/gal	
	Jellyfish™ Filter	NA	NA	NA	NA	
	Up-Flo™ Filter	ND	ND	ND	ND	
Oil/Water Separator						
	ADS® Water Quality Unit					
	BioSTORM	$500	$2,000	$400	$4,000	
	Clara® Gravity Stormwater Separator Vault	$20,000	$52,000	$0.0005/gal	$0.01/gal	

Treatment Type	Treatment System Name	Installation Cost Low	Installation Cost High	Annual O&M Cost Low	Annual O&M Cost High	Notes
Oil/Water Separator (cont.)						
	CrystalClean Separator	ND	ND	ND	ND	
	ecoLine A®	$6,700	$44,250	NA	NA	Gravity flow system has no moving parts or power requirement. Oil coalescing media pack can be removed, rinsed, and replaced. In the event of damage to the coalescing media, new coalescing panels can be purchased for a low cost.
	ecoLine B®	$8,200	$81,900	NA	NA	Gravity flow system has no moving parts or power requirement. Oil coalescing media pack can be removed, rinsed, and replaced. In the event of damage to the coalescing media, new coalescing panels can be purchased for a low cost.
	ecoSep®	ND	ND	ND	ND	
	ecoTop®	ND	ND	ND	ND	
	First Flush 1640FF	$5,000	$10,000	$500	$3,000	
	Hancor Storm Water Quality Unit	ND	ND	ND	ND	
	Kleerwater™	V	V	V	V	
	PSI Separator	ND	ND	ND	ND	
	SNOUT®	ND	ND	ND	ND	
	VortClarex	$10,000	$300,000	$0.00008/gal	$0.001/gal	

gal = gallon

NA = not available; vendor filled out treatment system questionaire, but did not provide all data

ND = no data; vendor did not complete treatment system questionaire

SF = square foot

V = varies

Table 12. Installation and annual operation and maintenance costs for active treatment systems.

Treatment Type	Treatment System Name	Installation Cost Low	Installation Cost High	Annual O&M Cost Low	Annual O&M Cost High	Notes
Chemical Filtration						
	Baker Tank with Sand Filter	NA	NA	NA	NA	
	Chitosan-Enhanced Sand Filtration Using FlocClear™	$15,000	>$250,000	<$0.001/gal	>0.003/gal	
	Purus® Stormwater Polishing System	$10,000	$140,000	$0.0024/gal	$0.0047/gal	
Chemical Treatment						
	ACISTBox®	$25,000	$400,000	NA	NA	
	pHATBox®	$19,500	$28,500	NA	NA	Depends on buffering capacity of waterstream, flow rate, total volume processed, specific pH adjustment additive selected, and final pH point required.
	Wetsep	$1,000	$2,500	$100/day	$250/day	
Electrocoagulation						
	High-Flo Electrocoagulation	$2,500	$2,200,000	$0.0005/gal	$0.01/gal	
	OilTrap ElectroPulse Water Treatment System	$25,000	$500,000	$0.002/gal	$0.005/gal	
	Redbox	$42,000	$1,000,000	$1,000	$20,000	
	WaveIonics™	$60,000	$850,000	$0.0008/gal	$0.008/gal	
Filtration						
Disc	Arkal Filter (Spin Klin System)	ND	ND	ND	ND	
Media	Fuzzy Filter	NA	NA	NA	NA	
	WaterTrak Pressurized Media Filter	ND	ND	ND	ND	
	WaterTrak Ultrafiltration	ND	ND	ND	ND	
Pressure	Arkal Media Filter	ND	ND	ND	ND	
Ion Exchange						
	Wastewater Ion Exchange System (WWIX)	$3,000	$250,000	$3,000	$500,000	
	WaterTrak Ion Exchange	ND	ND	ND	ND	
Reverse Osmosis						
	WaterTrak Reverse Osmosis	ND	ND	ND	ND	

gal = gallon

NA = not available; vendor filled out treatment system questionaire, but did not provide all data

ND = no data; vendor did not complete treatment system questionaire

Table 13. TAPE and NJCAT approvals for passive stormwater treatment technologies.

Treatment Type	Treatment System Name	Technology Assessment Protocol - Ecology (TAPE)					New Jersey Corporation for Advanced Technology (NJCAT)	
		Pretreatment	Basic	Enhanced	Phosphorus	Oil	50% TSS Removal	80% TSS Removal
Bioretention/Filtration								
	Filterra® Curb Inlet System		GULD	GULD		GULD		
	Silva Cell		GULD	GULD				
Hydrodynamic Separation								
	Aqua Shield Aqua-Swirl Concentrator	GULD					X	
	BaySeparator®	CULD					X	
	CDS™ Stormwater Treatment System	GULD	GULD			PULD	X	
	Downstream Defender	GULD					X	
	FloGard® Dual-Vortex Hydrodynamic Separator						X	
	HydroGuard						X	
	Nutrient Separating Baffle Box						X	
	Stormceptor®						X	
	Terre Kleen™						X	
	V2B1 Treatment System	PULD					X	
	Vortechs System	GULD					X	
Media Filtration								
Cartridge	BayFilter®		CULD	CULD	CULD			X
	Perk Filter™		GULD		GULD			
	Stormfilter using ZPG Media		GULD					X
Combination System (with Hydrodyanamic Separation)	Aqua Shield Aqua-Filter System		PULD	PULD	PULD	PULD		X
	ecoStorm + ecoStorm Plus®		CULD					
	Jellyfish™ Filter		PULD					X
	Up-Flo™ Filter		PULD					X
Oil/Water Separator								
	ecoSep®					PULD		

CULD = Conditional Use Level Designation
GULD = General Use Level Designation
PULD = Pilot Use Level Designation
TSS = Total Suspended Solids

Table 14. Treatment system applications.

Treatment Type	Treatment System Name	Treatment of Roof Runoff	Treatment at Inlet to Storm Drain System	Treatment at End-of-pipe	Treatment of Pumped Groundwater
Bioretention/Filtration					
	Filterra® Roofdrain System	•			
	Filterra® System		•		
	Modular Wetland System – Linear		•	•	
	Silva Cell		•		
	TREEPOD® Biofilter		•	•	
	UrbanGreen BioFilter		•	•	
Drain Inlet Insert					
Absorbent Boom/Fabric	Adsorb-It		•		
	Enviro-Drain®		•		
	EnviroSafe™ Storm Safe HF10		•		
	Ultra-Urban Filter™		•		
Media Filtration	EcoVault™ Baffle Box		•		
	EnviroSafe™		•		
	HUBER Hydro Filt		•		
	Hydro-Kleen™		•		
	Raynfiltr™		•		
Media Filtration (Cartridge)	StormBasin™		•		
	StormPod™		•		
	Triton Drop Inlet Insert		•		
Combination System (Screen and Absorbent Boom/Fabric)	Bio Clean Curb Inlet Basket		•		
	Bio Clean Downspout Filter	•			
	Bio Clean Flume Filter		•		

Treatment Type	Treatment System Name	Treatment of Roof Runoff	Treatment at Inlet to Storm Drain System	Treatment at End-of-pipe	Treatment of Pumped Groundwater
Drain Inlet Insert (cont)					
	Bio Clean Grate Inlet Skimmer Box		•		
	Bio Clean Trench Drain Filter		•		
	Clean Way Downspout Filtration Unit	•			
	DrainPac™		•		
	EnviroTrap Catch Basin Insert		•		
	FloGard® Downspout Filter	•			
	FloGard® LoPro Matrix Filter		•		
	FloGard® LoPro Trench Drain Filter		•		
	FloGard+PLUS®		•		
	FloGard® Trash & Debris Guard		•		
	Inceptor®		•		
	StormClean Catch Basin Insert		•		
	StormClean Curb Inlet Insert		•		
	StormClean Wall Mount Filtration Unit		•		
	Storm PURE™		•		
	SwaleGard® Pre-filter		•		
Combination System (Screen and Media Filtration)	Aqua-Guardian™ Catch Basin Insert		•		
	ClearWater BMP		•		
	Coanda Curb Inlet Filter		•		
	Coanda Downspout Filter	•			
	RSF (Rapid Stormwater Filtration) 100		•		
	RSF (Rapid Stormwater Filtration) 1000		•		
	RSF (Rapid Stormwater Filtration) 4000		•		
Hydrodynamic Separation					
	Aqua Shield Aqua-Swirl Concentrator			•	
	BaySeparator®			•	
	CDS™ Stormwater Treatment System			•	
	Downstream Defender			•	

Treatment Type	Treatment System Name	Treatment of Roof Runoff	Treatment at Inlet to Storm Drain System	Treatment at End-of-pipe	Treatment of Pumped Groundwater
Hydrodynamic Separation (cont)					
	FloGard® Dual-Vortex Hydrodynamic Separator			•	
	HydroGuard			•	
	Nutrient Separating Baffle Box			•	
	Stormceptor®			•	
	StormTrooper®			•	
	StormTrooper® EX Extra-Duty			•	
	Terre Kleen™			•	
	UniScreen			•	
	UniStorm			•	
	V2B1 Treatment System			•	
	Vortechs System			•	
Media Filtration					
Above ground (pump required)	Aquip® Enhanced Stormwater Filtration System			•	
Cartridge	BayFilter®			•	
	EcoSense™ Stormwater Filtration Systems		•		
	Perk Filter™		•	•	
	PuriStorm		•	•	
	Sorbtive™ FILTER			•	
	Stormfilter using ZPG Media		•	•	
	StormSafe™ Helix			•	
Combination System (with Hydrodyanamic Separation)	Aqua Shield Aqua-Filter System			•	
	ecoStorm + ecoStorm Plus®			•	
	Go-Filter			•	

Treatment Type	Treatment System Name	Treatment of Roof Runoff	Treatment at Inlet to Storm Drain System	Treatment at End-of-pipe	Treatment of Pumped Groundwater
Media Filtration (cont)					
Combination System (with Oil/Water Separator)	CrystalCombo Hybrid Polisher			•	
	HydroFilter			•	
Up-Flow	Bio Clean Water Polisher			•	
	Jellyfish™ Filter			•	
	Up-Flo™ Filter			•	
Oil/Water Separator					
	ADS® Water Quality Unit			•	
	BioSTORM		•	•	
	Clara® Gravity Stormwater Separator Vault		•	•	
	CrystalClean Separator			•	
	ecoLine A®			•	•
	ecoLine B®			•	
	ecoSep®			•	
	ecoTop®			•	•
	First Flush 1640FF		•	•	
	Hancor Storm Water Quality Unit			•	
	Kleerwater™			•	
	PSI Separator			•	
	SNOUT®		•		
	VortClarex		•	•	
Chemical Filtration					
	Baker Tank with Sand Filter			•	•
	Chitosan-Enhanced Sand Filtration Using FlocClear™			•	•
	Purus® Stormwater Polishing System			•	•
Chemical Treatment					
	ACISTBox®			•	•
	pHATBox®			•	•
	Wetsep			•	•

Treatment Type	Treatment System Name	Treatment of Roof Runoff	Treatment at Inlet to Storm Drain System	Treatment at End-of-pipe	Treatment of Pumped Groundwater
Electrocoagulation					
	High-Flo Electrocoagulation			•	•
	OilTrap ElectroPulse Water Treatment System			•	•
	WaveIonics™			•	•
	Redbox			•	•
Filtration					
Disc	Arkal Filter (Spin Klin System)			•	•
Media	Fuzzy Filter			•	•
Filtration (cont)					
	WaterTrak Pressurized Media Filter			•	•
	WaterTrak Ultrafiltration			•	•
Pressure	Arkal Media Filter			•	•
Ion Exchange					
	Wastewater Ion Exchange System (WWIX)			•	•
	WaterTrak Ion Exchange			•	•
Reverse Osmosis					
	WaterTrak Reverse Osmosis			•	•

APPENDIX A

Technology Summary Sheets

Appendix A Index (by Treatment System Name)

Appendix A Index (by Treatment System Name)

Appendix A Index (by Manufacturer/Vendor Name)

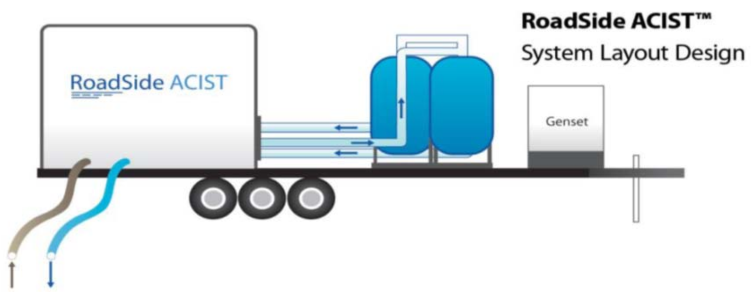
Appendix A Index (by Manufacturer/Vendor Name)

Active

Treatment Technology Summary Report

Manufacturer/Vendor: WaterTectonics
Name of Technology: ACIST
Technology Type: Chemical Treatment

Schematic



System Design Information

Design Flow Rate (gpm):
low: 100
high: >1000

System Footprint (sq. ft.): 200-2000

Required Head Loss (ft): NA

Internal or External Bypass: None - auto recirculation

Application
Stormwater/Process Water/
Wastewater/Ground Water

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):			3.12		0.0199			0.00028
Median Effluent (mg/L):			0.38		0.00002			0.00002
Median Removal (%):			88		99.9			93

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	0.341	0.25	2.12			0.817
Median Effluent (mg/L):	0.0179	0.05	1.04			0.744
Median Removal (%):	95	80	51			9

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 5

Estimated Costs

Estimated Installation Cost: low: $25,000 high: $400,000
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: WaterTectonics
Name of Technology: ACIST
Technology Type: Chemical Treatment

Treatment Notes

Field by operator; in-line real-time with sensors/data loggers for turbidity and pH; in-house and independent party grab/composite sampling; in-house and 3rd party independent analytical laboratory testing.

Additional Notes

Provided under DOE issued GULD as Chitosan-Enhanced Sandfiltration (CESF), a stand alone system. Water Tectonics expands CESF application for removal of LNAPL, NWTPH, cPAH/PAH's, and metals by system modification to include oil/water separation, enhanced pre-treatment, post SF micron filtration, and granular activated carbon and/or other media adsorption. As a stand-alone technology it is designated for turbidity and pH. If raw water turbidity is >600 NTU, pretreatment is required. CESF has limited to no ability to remove turbidity consisting of rock dust, rock flour, or other rock source fines that have not been geochemically weathered over time. Chitosan performance is typically compromised by acidic or alkaline pH conditions out side the neutral range. Performance data presented is from from full-scale use at temporary projects where RSA CESF technology was used in accordance with GULD specifications with modifications for enhanced removal components (e.g., granular activated carbon). Untreated construction water ranging from >25 NTU to > 5000 NTU (with pretreatment if over 600 NTU) have all been reduced to <10 NTU, but typically to <5 NTU. Flow ranges for various conventional system sizes range from 100 to over 1000 gpm for 24/7 continuous operations.

Treatment Technology Summary Report

Manufacturer/Vendor: Arkal Filtration Systems/PEP (U.S. Distributor)
Name of Technology: Arkal Filter (Spin Klin System)
Technology Type: Filtration(Disc)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 100
high: 4400

System Footprint (sq. ft.): 16
Required Head Loss (ft): 0.1,14
Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			ND			
Median Effluent (mg/L):			ND			
Median Removal (%):			99.9			

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	Arkal Filtration Systems/PEP (U.S. Distributor)
Name of Technology:	Arkal Filter (Spin Klin System)
Technology Type:	Filtration(Disc)

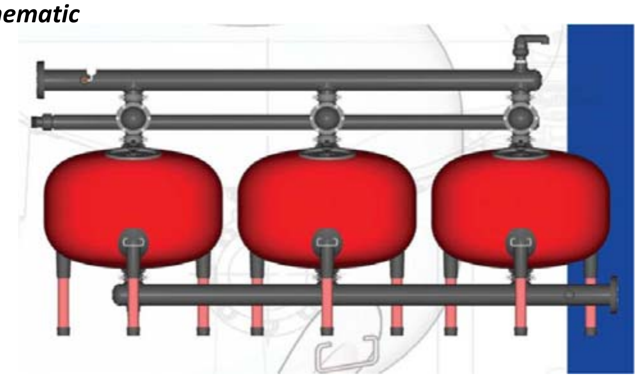
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Arkal Filtration Systems/PEP (U.S. Distributor)
Name of Technology: Arkal Media Filter
Technology Type: Filtration(Pressure)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 44
high: 150

System Footprint (sq. ft.): 16
Required Head Loss (ft): 3,28
Internal or External Bypass:
Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			ND			
Median Effluent (mg/L):			ND			
Median Removal (%):			99.9			

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

Treatment Technology Summary Report

Manufacturer/Vendor:	Arkal Filtration Systems/PEP (U.S. Distributor)
Name of Technology:	Arkal Media Filter
Technology Type:	Filtration(Pressure)

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: BakerCorp
Name of Technology: Baker Tank with Sand Filter
Technology Type: Filtration(Media)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 15
high: 1,000+

System Footprint (sq. ft.): 1000-2500

Required Head Loss (ft): NA

Internal or External Bypass: NA

Application
Stormwater/Process Water/
Wastewater/Groundwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	200							
Median Effluent (mg/L):	10							
Median Removal (%):	95							

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	150	500	2500	20	40	400
Median Effluent (mg/L):	75	200	1000	10	20	40
Median Removal (%):	50	40	50	50	50	90

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 1

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

Treatment Technology Summary Report

Manufacturer/Vendor:	BakerCorp
Name of Technology:	Baker Tank with Sand Filter
Technology Type:	Filtration(Media)

Treatment Notes

TSS, total metals, and dissolved metals removal will depend upon the degree that they will absorb to particulate matter. The values provided for these parameters are based upon a study done by Dungeness Environmental during 2009-2010. Dungeness Environmental does not have relevant data for the organics listed in this table. For any questions, please contact Chris Palczewski at Dungeness Environmental: 425-481-0600 or cpalczewski@dungenessenviro.com. Thank you.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Clear Creek Systems, Inc.
Name of Technology: Chitosan-Enhanced Sand Filtration Using FlocClear
Technology Type: Chemical Filtration

Schematic

System Design Information

Design Flow Rate (gpm):
low: < 25
high: > 2,000

System Footprint (sq. ft.):
< 25 - > 2,000

Required Head Loss (ft):
NA

Internal or External Bypass:
External - Offline Facility

Application
Stormwater/Process water/
Groundwater/Wastewater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: > 15 on the West Coast

Estimated Costs

Estimated Installation Cost: **low:** $15,000 **high:** >$250,000
Estimated Annual O&M Cost: **low:** < $0.001/gal **high:** > $0.003/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	Clear Creek Systems, Inc.
Name of Technology:	Chitosan-Enhanced Sand Filtration Using FlocClear
Technology Type:	Chemical Filtration

Treatment Notes

Attached data was collected from grab samples that were analyzed by an accredited laboratory.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Schreiber LLC
Name of Technology: Fuzzy Filter
Technology Type: Filtration(Media)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 70
high: unlimited

System Footprint (sq. ft.):

Required Head Loss (ft): 3.5

Internal or External Bypass: External

Application
Stormwater/Process Water/
Wastewater/Ground water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	10							
Median Effluent (mg/L):	2							
Median Removal (%):	70-95							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Schreiber LLC
Name of Technology: Fuzzy Filter
Technology Type: Filtration(Media)

Treatment Notes

Fuzzy Filter removes suspende solids 4 microns and above. The media is compressible so that pore size can be adjusted thru changes in compressioon of the media via the integral actuator connected to a perforated compression plate. Influent solids should be less than 100 mg/l with many typical applications processing water streams containing 20 mg/l and less.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: KASELCO, LLC
Name of Technology: High-Flo Electrocoagulation
Technology Type: Electrocoagulation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 2.5
high: 1,200+

System Footprint (sq. ft.):
40 - 4000

Required Head Loss (ft):
2,20

Internal or External Bypass:
External

Application
Stormwater/Process Water/
Groundwater/Wastewater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0 in WA, 2 in Vancouver

Estimated Costs

Estimated Installation Cost: **low:** $25,000 **high:** $2,200,000
Estimated Annual O&M Cost: **low:** $0.0005/gal **high:** $0.01/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	KASELCO, LLC
Name of Technology:	High-Flo Electrocoagulation
Technology Type:	Electrocoagulation

Treatment Notes

System Performance has been evaluated in lab as well as in field research applications and existing installations. Grab samples are analyzed both internally as well as by a third party lab.

Additional Notes

Have attached actual test result parameters. We are currently in the process of having detailed third party test evaluations and will supply those results as available.

Treatment Technology Summary Report

Manufacturer/Vendor: OilTrap Environmental Prod
Name of Technology: OilTrap ElectroPulse Water Treatment System
Technology Type: Electrocoagulation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 5
high: 500

System Footprint (sq. ft.): 40-1500

Required Head Loss (ft): 5,15

Internal or External Bypass: Either

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	600		78	136	28	NA	NA	NA
Median Effluent (mg/L):	10		0.27	<5.0	0.43	NA	NA	NA
Median Removal (%):	98.3		99.6	>96.3	98.4	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	12.1	14.1	151	8.2	10.9	78.6
Median Effluent (mg/L):	0.072	0.039	0.34	0.072	0.039	0.34
Median Removal (%):	99.4	99.7	99.9	99.1	99.6	99.9

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 33

Estimated Costs

Estimated Installation Cost: **low:** $25,000 **high:** $500,000
Estimated Annual O&M Cost: **low:** $0.002/gal **high:** $0.005/gal

Treatment Technology Summary Report

Manufacturer/Vendor: OilTrap Environmental Prod
Name of Technology: OilTrap ElectroPulse Water Treatment System
Technology Type: Electrocoagulation

Treatment Notes

Samples were collected as routine grab samples and tested by an EPA certified laboratory.

Additional Notes

We have not worked with wastewater with PCB or dioxins. We generally see 90%+ in reduction of pesticides also.

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: WaterTectonics
Name of Technology: pHATBox
Technology Type: Chemical Treatment

Schematic

System Design Information

Design Flow Rate (gpm):
low: 250
high: 350

System Footprint (sq. ft.): 10-24 (b)

Required Head Loss (ft): N/A

Internal or External Bypass: N/A

Application
Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	(c)		(c)	(c)	(c)	(c)	(c)	(c)
Median Effluent (mg/L):	(c)		(c)	(c)	(c)	(c)	(c)	(c)
Median Removal (%):	(c)		(c)	(c)	(c)	(c)	(c)	(c)

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	(c)	(c)	(c)	(c)	(c)	(c)
Median Effluent (mg/L):	(c)	(c)	(c)	(c)	(c)	(c)
Median Removal (%):	(c)	(c)	(c)	(c)	(c)	(c)

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 20+

Estimated Costs

Estimated Installation Cost: **low:** $ 19,500 **high:** $ 28,500
Estimated Annual O&M Cost: **low:** (a) **high:** (a)

Treatment Technology Summary Report

Manufacturer/Vendor: WaterTectonics
Name of Technology: pHATBox
Technology Type: Chemical Treatment

Treatment Notes

Field. Real-time with in-line probes. 2-point buffer calibration.

Additional Notes

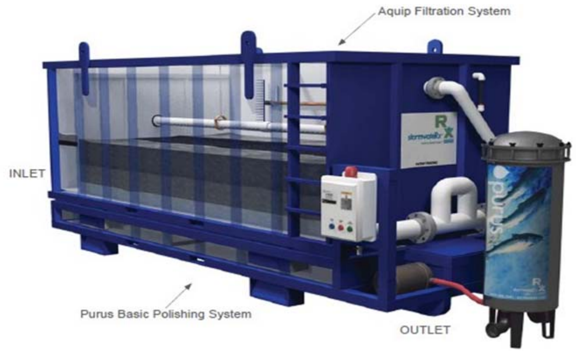
(a) Depends on buffering capacity of waterstream, flow rate, total volume processed, specific pH adjustment additive selected, and final pH point required.
(b) Packaged in 4' -6' (w) x 2.5' (d) x 4' (t) industrial steel box w/hinged top opening lid. Additional storage space for addtive will depend on volume of additive storage (up to 35-gal drums in box, larger must go external) - plus secondary containment). Unit has in-line pH probe for real time monitoring and data logger expandable for dual pH adjustment (multi injection/mixing loops), and flow recording. pH set-point(s) programmable into controller.
(c) Adjusts pH. System performance data - not applicable.

Additional Notes:
-Effective for controlling alkaline waters from cement/concrete operations using carbon dioxide.
-Suitable for inclusion as pH adustment component in variety of water treatment systems.
-pH set-points (high/low) variable for application.

Treatment Technology Summary Report

Manufacturer/Vendor: StormwateRx LLC
Name of Technology: Purus Stormwater Polishing System
Technology Type: Chemical Filtration

Schematic



System Design Information

Design Flow Rate (gpm):
low: 5
high: 210

System Footprint (sq. ft.): 10,90

Required Head Loss (ft): 70 - 120

Internal or External Bypass: External

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):			YES		YES	YES		YES

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			0.28			0.06
Median Effluent (mg/L):			0.083			0.0074
Median Removal (%):			86			88

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: YES

Estimated Costs

Estimated Installation Cost: **low:** $10,000 **high:** $140,000
Estimated Annual O&M Cost: **low:** $0.0024/gal **high:** $0.0047/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	StormwateRx LLC
Name of Technology:	Purus Stormwater Polishing System
Technology Type:	Chemical Filtration

Treatment Notes

These samples were collected as grab samples by StormwateRx, consulting engineers, and facility treatment system operators. All analytical data is from a third party certified analytical lab. Non-detects were assumed to have the value of one half the detection limit.

Additional Notes

Additional pollutant removal includes bacteria (>99%), PCBs, PAHs and toxic organics.

Treatment Technology Summary Report

Manufacturer/Vendor: Morselt Borne BV
Name of Technology: Redbox
Technology Type: Electrocoagulation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 0.5
high: 150

System Footprint (sq. ft.):

Required Head Loss (ft):
NA

Internal or External Bypass:
NA

Application
Wastewater/Process Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):	99							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):				99	99	99

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: **low:** $42,000 **high:** $1,000,000
Estimated Annual O&M Cost: **low:** $1,000 **high:** $20,000

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Treatment Technology Summary Report

Manufacturer/Vendor: Morselt Borne BV
Name of Technology: Redbox
Technology Type: Electrocoagulation

Treatment Notes

Third part analysis has been performed in many cases. Results show very high removal rates, especially for heavy metals.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Aquatech
Name of Technology: WaterTrak Ion Exchange
Technology Type: Ion Exchange

Schematic

System Design Information

Design Flow Rate (gpm):
low: 23
high: 866

System Footprint (sq. ft.):
65,113

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	Aquatech
Name of Technology:	WaterTrak Ion Exchange
Technology Type:	Ion Exchange

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Aquatech
Name of Technology: WaterTrak Pressurized Media Filter
Technology Type: Filtration(Media)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 27
high: 905

System Footprint (sq. ft.): 43,119

Required Head Loss (ft):

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	Aquatech
Name of Technology:	WaterTrak Pressurized Media Filter
Technology Type:	Filtration(Media)

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Aquatech
Name of Technology: WaterTrak Reverse Osmosis
Technology Type: Reverse Osmosis

Schematic

System Design Information

Design Flow Rate (gpm):
low: 65
high: 275

System Footprint (sq. ft.): 143,243
Required Head Loss (ft): 350
Internal or External Bypass:
Application

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* Blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: Aquatech
Name of Technology: WaterTrak Reverse Osmosis
Technology Type: Reverse Osmosis

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Aquatech
Name of Technology: WaterTrak Ultrafiltration
Technology Type: Filtration(Media)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 38
high: 377

System Footprint (sq. ft.): 31,62
Required Head Loss (ft):
Internal or External Bypass:
Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: Aquatech
Name of Technology: WaterTrak Ultrafiltration
Technology Type: Filtration(Media)

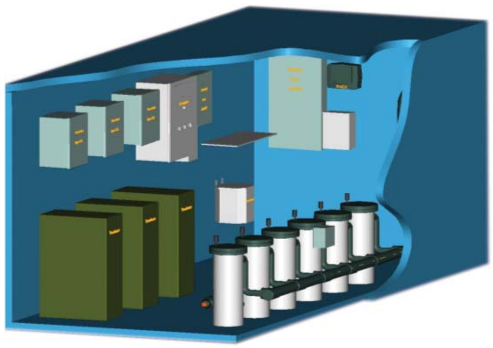
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: WaterTectonics
Name of Technology: WaveIonics
Technology Type: Electrocoagulation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 50
high: >1000

System Footprint (sq. ft.): 200-4000

Required Head Loss (ft): NA

Internal or External Bypass: NONE-auto recirculation

Application
Stormwater/Process Water/Wastewater/Ground water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):		200	45.6	197	2.34	0.0024		
Median Effluent (mg/L):		5	0.25	4.76	0.00002	0.00011		
Median Removal (%):		98	99	98	100	95		

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	4.8	0.253	0.516	0.0235	0.0157	0.12
Median Effluent (mg/L):	0.0074	0.003	0.0315	0.005	0.0031	0.02
Median Removal (%):	100	99	94	79	80	83

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 35+

Estimated Costs

Estimated Installation Cost: **low:** $60000 **high:** $850000
Estimated Annual O&M Cost: **low:** $0.0008/gal **high:** $0.008/gal

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Treatment Technology Summary Report

Manufacturer/Vendor: WaterTectonics
Name of Technology: WaveIonics
Technology Type: Electrocoagulation

Treatment Notes

Field via hand-held instruments, Technology's in-line and real-time water quality monitoring system, Oversight Engineers/Project Owners, 3rd party analytical testing laboratories using both instantaneous grab and composting methods (manual and automated). System performance "Median" data presented below does not accommodate analytical data results for parameters report as ND (<MDL's, or <MCL's). All ND data was utilized in the calculations as the value of the MDL or MCL. Influent data is limited in that our Clients typically do not incur cost expenditure to evaluate raw water characteristics once the system has been designed, installed, and made operational. They focus on monitoring effluent quality. Further, effluent data generated by our Clients/System Owners do not typically provide us with DMR's they submit to Ecology or other regulatory agencies. Effluent data points do not reflect technology ability to achieve lower than reported results. Permit discharge limitations have historically varied from site to site, permit to permit , and therefore data reflect treatment efforts and not technology limitations.

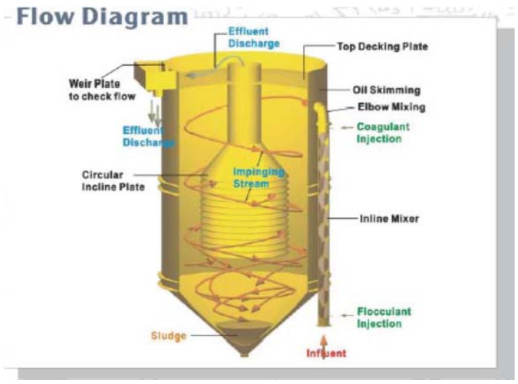
Additional Notes

WaveIonics electrocoagulation (EC) reactions will depend on the nature of constituents present, their reaction chemistry, pH sensitivity, and water conductivity. Bacteria disinfection has been demonstrated at laboratory and full-scale applications. Technology viability and optimization is recommended for non-conventional constituents of concern, or for complex matrices where interferences and competing conditions are problematic to conventional advanced treatment processes. System Performance data fields (above) call for "Median" data points that do not allow for presentation of worst-case conditions, nor do they adequately reflect "mean" conditions, both of which are more elevated than the "Median" data presented for influent characteristics. Effluent "median" data do not reflect <MDL or <MCL data as reported by laboratories. However, ND results utilized in the calculation were the numeric value of the actual MDL or MCL. SVOC and cPAH data reflect a summation of all individual constituents in SVOC or cPAH parameter suites as totals. PCB's are totals of all Arochlor congeners. Oil and Grease data reflect both Freon and Hexane extraction analytical methods. Technology has not been used to specifically remove Dioxins and when technology was utilized, Dioxins were not targeted for analytical testing. Other data available upon request for: bacteria; other heavy metals; color from humics, etc.

Treatment Technology Summary Report

Manufacturer/Vendor: Waste & Environmental Technologies Ltd.
Name of Technology: Wetsep
Technology Type: Chemical Treatment

Schematic



System Design Information

Design Flow Rate (gpm):
low: 20
high: 260

System Footprint (sq. ft.):

Required Head Loss (ft):
40 feet

Internal or External Bypass:
External Bypass

Application
Stormwater/Wastewater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	112	13.4						
Median Effluent (mg/L):	<2	1.9						
Median Removal (%):	98	86						

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):				7 µg/L	18 µg/L	
Median Effluent (mg/L):				1 µg/L	<1 µg/L	
Median Removal (%):				86	94	

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 1

Estimated Costs

Estimated Installation Cost: **low:** $1000 **high:** $2500
Estimated Annual O&M Cost: **low:** $100/day **high:** $250/day

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Waste & Environmental Technologies Ltd.
Name of Technology:	Wetsep
Technology Type:	Chemical Treatment

Treatment Notes

The data can be stored and downloaded from data logger for flowrate, pH and Turbidity. Grab samples can also be taken at various points in the system to be varified by a third party (i.e. laboratory).
Please aslo find the Field Study for the WetSep filtration System

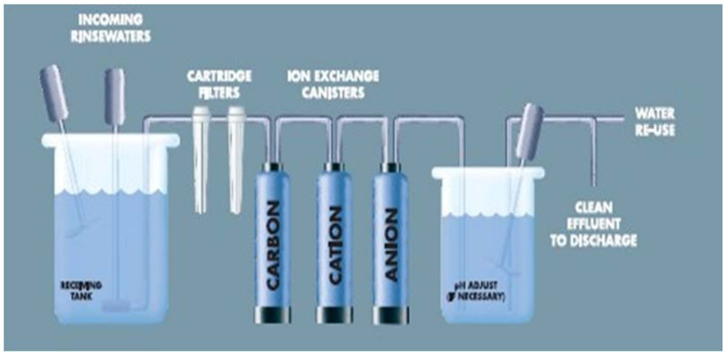
Additional Notes

The WetSep system was used in the State of Washington at the Canada/US border crossing. The main Contractor for this job was JE Dunn Construction. The main use of the unit was for treatment of construction waste runoff.

Treatment Technology Summary Report

Manufacturer/Vendor: Siemens
Name of Technology: Waste Water Ion Exchange System (WWIX)
Technology Type: Ion Exchange

Schematic



System Design Information

Design Flow Rate (gpm):
low: 1gpm
high: 5000gpm

System Footprint (sq. ft.):

Required Head Loss (ft):
20psi

Internal or External Bypass:
None

Application
Stormwater/Process Water/ Wastewater/Groundwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

*** Blank cells indicate no information was received from vendor**

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: >500

Estimated Costs

Estimated Installation Cost: **low:** $3,000 **high:** $250,000
Estimated Annual O&M Cost: **low:** $3,000 **high:** $500,000

Treatment Technology Summary Report

Manufacturer/Vendor: Siemens
Name of Technology: Waste Water Ion Exchange System (WWIX)
Technology Type: Ion Exchange

Treatment Notes

For stormwater treatment systems Siemens has media tailored to achieve low discharge levels as low as 1ppb and 12ppt for mercury. Siemens systems are typically sampled by customer and checked with on site test kits or samples shipped to local certified laboratories for evaluation.

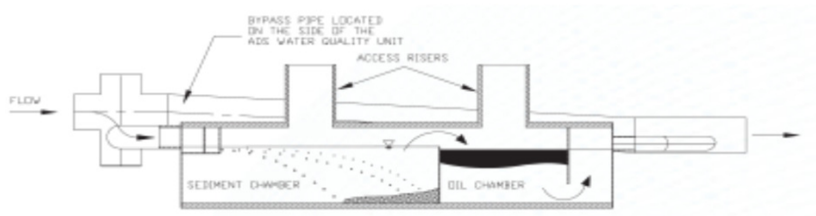
Additional Notes

Passive

Treatment Technology Summary Report

Manufacturer/Vendor: Advanced Drainage Systems, Inc
Name of Technology: ADS® Water Quality Unit
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: 1800
high: 126000

System Footprint (sq. ft.): 0

Required Head Loss (ft):

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	NA		ND				
Median Effluent (mg/L):	ND	NA		ND				
Median Removal (%):	80	>43		80				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	ND	ND	ND	ND	ND	ND
Median Effluent (mg/L):	ND	ND	ND	ND	ND	ND
Median Removal (%):	74	74	74	74	74	74

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: Advanced Drainage Systems, Inc
Name of Technology: ADS® Water Quality Unit
Technology Type: Oil/Water Separator

Treatment Notes

Additional Notes

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Eco-Tec, Inc
Name of Technology: ADsorb-it
Technology Type: Drain Inlet Inset (Absorbent Boom/Fabric)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 80/SF
high: 100/SF

System Footprint (sq. ft.): Varies

Required Head Loss (ft): NA

Internal or External Bypass: Per individual application

Application
Stormwater, Groundwater, Wastewater, Process Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	Varies		Varies	Varies				
Median Effluent (mg/L):	Varies		Varies	Varies				
Median Removal (%):	80-99		99-100	99-100				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):	Varies	Varies	Varies	Varies	Varies	Varies

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 61

Estimated Costs

Estimated Installation Cost: **low:** $0.91/SF **high:** $0.91/SF
Estimated Annual O&M Cost: **low:** $0.91/SF **high:** $0.91/SF

Treatment Technology Summary Report

Manufacturer/Vendor:	Eco-Tec, Inc
Name of Technology:	ADsorb-it
Technology Type:	Drain Inlet Inset (Absorbent Boom/Fabric)

Treatment Notes

A variety of sampling methods have been implemented over the years based on specific installations of the ADsorb-it Filtration Fabric and associated application specific product configurations manufactured from the ADsorb-it Fabric. ADsorb-it is designed to be versatile in its installation for diverse filtration applications, thus it can be configured for Downspout, Drain Inlet Inset, Below Ground Vault, Above Ground Vault, Shoreline, Oil Water Separator, and General Stormwater applications. ADsorb-it is approved by the Department of Ecology (Ecology) for use as a Catch Basin Insert and is used by Ecology for spill response and general oil/water related issues.

Additional Notes

As can be seen on our web site at www.eco-tec-inc.com, miles of ADsorb-it Fabric were deployed along the Gulf Coast Shoreline as an Oil Fence to provide effective removal of advancing oils from the BP Deepwater Horizon Release. Additional testing data can be accessed on our web site simply by clicking on "Test Data" in the left hand column. As a note, ADsorb-it is highly effective at removing hydrocarbons, including fats, oils and greases (FOG) from water, thus any other contaminants that would be attached to the hydrocarbon such as PCBs would be removed in conjuncton with hydrocarbon / FOG removal. ADsorb-it is an environmentally compatible product in that it is: Made from waste fibers from the textile manufacturing industry, it effectively removes hydrocarbons and associated / attached contaminants from the environment, it can be cleaned and reused indefinitely, it can be disposed of as a fuel source with a higher BTU per pound value than coal and less than 1% residual ash.

Treatment Technology Summary Report

Manufacturer/Vendor: AquaShield, Inc.
Name of Technology: Aqua-Filter
Technology Type: Media Filtration(Combination System (with Hydrodyanamic Separation))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 25
high: 960+

System Footprint (sq. ft.): NA
Required Head Loss (ft): 0.8
Internal or External Bypass: Both
Application: Stormwater/ Process Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	160							
Median Influent (mg/L):	43							
Median Effluent (mg/L):	5							
Median Removal (%):	80							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		PULD	PULD	PULD	PULD

	50% TSS Removal	80% TSS Removal
NJCAT		X

Other Approvals:

Local Installations

# of Installations in Washington: 13

Estimated Costs

Estimated Installation Cost: **low:** Site-specific **high:** Site-specific
Estimated Annual O&M Cost: **low:** Site-specific **high:** Site-specific

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: AquaShield, Inc.
Name of Technology: Aqua-Filter
Technology Type: Media Filtration(Combination System (with Hydrodyanamic Separation))

Treatment Notes

Independent lab by grab samples. Field by auto-composite sampling, 6 sample pairs per TARP qualifying storm.

Additional Notes

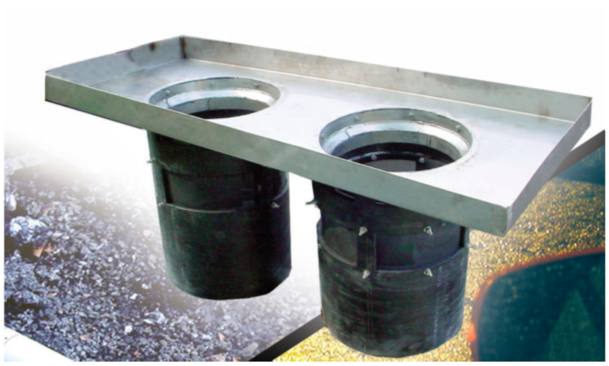
Aqua-Filter filtration cartridge has been verified by NJCAT. AF--5.3 model is currently undergoing independent TARP Tier II field testing in Maryland averaging 96% TSS removal. Anticipate completion in 2012. AF-4.2 model field tested at Univeristy of New Hampshire Stormwater Center, 80% TSS removal efficiency (see above parameters).

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: AquaShield, Inc.
Name of Technology: Aqua-Guardian
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 5/400*
high: 100/940*

System Footprint (sq. ft.): NA

Required Head Loss (ft): 0

Internal or External Bypass: Both

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	160							
Median Influent (mg/L):	43							
Median Effluent (mg/L):	5							
Median Removal (%):	80							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 15

Estimated Costs

Estimated Installation Cost: **low:** Site-specific **high:** Site-specific
Estimated Annual O&M Cost: **low:** Site-specific **high:** Site-specific

Treatment Technology Summary Report

Manufacturer/Vendor:	AquaShield, Inc.
Name of Technology:	Aqua-Guardian
Technology Type:	Drain Inlet Insert(Combination System (Screen and Media Filtration))

Treatment Notes

* x/x = flow thru perlite/flow thru perlite + filter cloth. See Aqua-Filter, since this device uses same media. Independent lab by grab samples. Field by auto-composite sampling, 6 sample pairs per TARP qualifying storm.

Additional Notes

See Aqua-Filter since this device uses same filter media. Aqua-Filter filtration cartridge has been verified by NJCAT. AF-5.3 model is currently undergoing independent TARP Tier II field testing in Maryland averaging 96% TSS removal. Anticipate completion in 2012. AF-4.2 model field tested at Univeristy of New Hampshire Stormwater Center, 80% TSS removal efficiency (see above parameters).

Treatment Technology Summary Report

Manufacturer/Vendor: AquaShield, Inc.
Name of Technology: Aqua-Swirl
Technology Type: Hydrodynamic Separation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 100
high: 2,600

System Footprint (sq. ft.):

Required Head Loss (ft): 0.25

Internal or External Bypass: Both

Application: Stormwater/Process Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	192							
Median Influent (mg/L):	137							
Median Effluent (mg/L):	12							
Median Removal (%):	86							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE	GULD				

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: 82

Estimated Costs

Estimated Installation Cost: **low:** Site-specific **high:** Site-specific
Estimated Annual O&M Cost: **low:** Site-specific **high:** Site-specific

Treatment Technology Summary Report

Manufacturer/Vendor:	AquaShield, Inc.
Name of Technology:	Aqua-Swirl
Technology Type:	Hydrodynamic Separation

Treatment Notes

Lab tested by Tennessee Tech University using autosamplers. Field by auto-composite sampling, 6 sample pairs per TARP.

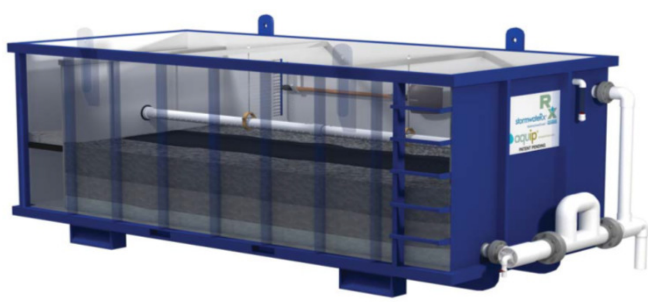
Additional Notes

Independent field testing underway per TARP Tier II in Maryland, anticipate completion in 2011. 16 storms and 14 inches of rain sampled to date. Sample parameters above are for field test. Lab testing verified by NJCAT.

Treatment Technology Summary Report

Manufacturer/Vendor: StormwateRx LLC
Name of Technology: Aquip Enhanced Filtration System
Technology Type: Media Filtration(Above ground (pump required))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 10
high: 350

System Footprint (sq. ft.):
14 - 320

Required Head Loss (ft):
4 - 7

Internal or External Bypass:
External

Application
Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	30			9.9				
Median Effluent (mg/L):	3.39			3				
Median Removal (%):	83		YES	70	YES	YES		YES

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	0.152	0.03	0.425	0.084	0.008	0.196
Median Effluent (mg/L):	0.008	0.006	0.061	0.006	0.007	0.06
Median Removal (%):	94	79	85	93	51	73

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 30

Estimated Costs

Estimated Installation Cost: **low:** $5,000 **high:** $150,000
Estimated Annual O&M Cost: **low:** $0.0003/gal **high:** $0.003/gal

Treatment Technology Summary Report

Manufacturer/Vendor: StormwateRx LLC
Name of Technology: Aquip Enhanced Filtration System
Technology Type: Media Filtration(Above ground (pump required))

Treatment Notes

These samples were collected as grab samples by StormwateRx, consulting engineers, and facility treatment system operators. All analytical data is from a third party certified analytical lab. Non-detects were assumed to have the value of one half the detection limit.

Additional Notes

Non-detects were assumed to have the value of one half the detection limit.

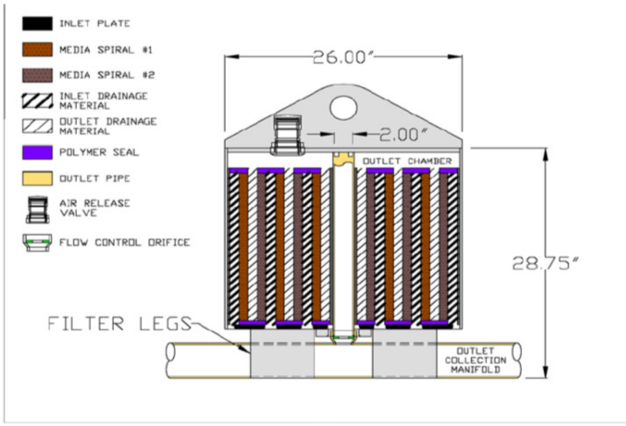
Aquip removes PCBs, PAHs and other toxic organics through particle filtration and absorption to one of the filtration media in the bed. VOC and SVOC removal is through absorption and biological degradation.

The Aquip is a secondary defense against oil and grease and removes TPH and soluble oils through biodegredataion, absorption and bio-mechanical means.

Treatment Technology Summary Report

Manufacturer/Vendor: BaySaver Technologies, Inc.
Name of Technology: BayFilter®
Technology Type: Media Filtration(Cartridge)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 15
high: 30

System Footprint (sq. ft.): 0

Required Head Loss (ft):

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	NA		ND				
Median Effluent (mg/L):	ND	NA		ND				
Median Removal (%):	80	>50		80				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		CULD	CULD	CULD	

	50% TSS Removal	80% TSS Removal
NJCAT		X

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

Treatment Technology Summary Report

Manufacturer/Vendor:	BaySaver Technologies, Inc.
Name of Technology:	BayFilter®
Technology Type:	Media Filtration(Cartridge)

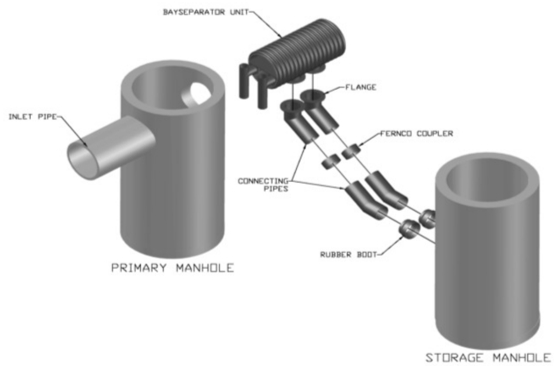
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: BaySaver Technologies, Inc.
Name of Technology: BaySeparator®
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 450
high: 1350

System Footprint (sq. ft.): 0

Required Head Loss (ft):

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	NA		ND				
Median Effluent (mg/L):	ND	NA		ND				
Median Removal (%):	80	19		80				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):				ND		ND
Median Effluent (mg/L):				ND		ND
Median Removal (%):				42		38

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE	CULD				

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	BaySaver Technologies, Inc.
Name of Technology:	BaySeparator®
Technology Type:	Hydrodynamic Separation

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Curb Inlet Basket
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 381
high: 898

System Footprint (sq. ft.): 0

Required Head Loss (ft): 0.5-2

Internal or External Bypass: External

Application Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	NA	85.8	NA	NA	NA	NA	NA	NA
Median Effluent (mg/L):	NA	73.4	NA	NA	NA	NA	NA	NA
Median Removal (%):	93*	14	NA	NA	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	NA	NA	24.3	NA	NA	NA
Median Effluent (mg/L):	NA	NA	10.4	NA	NA	NA
Median Removal (%):	NA	NA	79	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0 WA

Estimated Costs

Estimated Installation Cost: low: $445 high: $1,600
Estimated Annual O&M Cost: low: $0.20/gal high: $0.40/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio Clean Environmental
Name of Technology:	Bio Clean Curb Inlet Basket
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

The Curb Inlet Basket has been in use since the mid 90's. Several field and laboratory studies have been performed on the system. For this reason several reports are being listed below.
--Univerisity of Southern California Independent Field Testing (Turbidity in NTUs)
--Suspended Solids Retention Testing Full Scale Lab Testing

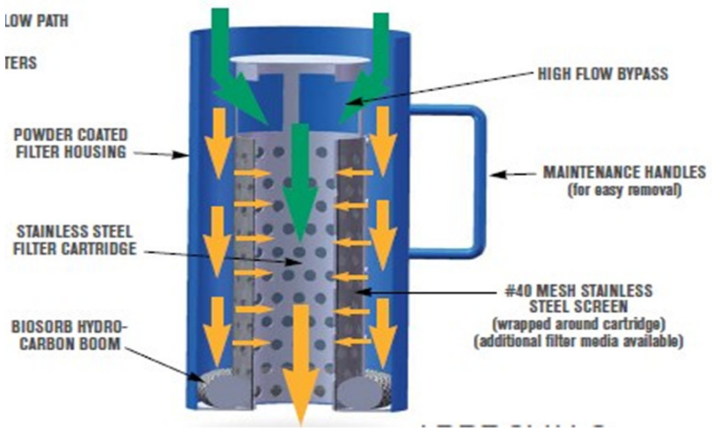
Additional Notes

*Mass Balance was used for the Suspended Solids Retention Test and therefore mg/L and number of samples does not apply. An OK-90 Sand gradation was used for the testing.

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Downspout Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 249
high: 1,145

System Footprint (sq. ft.): 0.31-1.57 (cu ft)

Required Head Loss (ft): 1,2

Internal or External Bypass: Internal Bypass - High Flow Unimpeded

Application Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	NA	NA		223.5	NA	NA	NA	NA
Median Effluent (mg/L):	NA	NA		29.5	NA	NA	NA	NA
Median Removal (%):	93*	NA		87	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	NA	NA	NA	NA	NA	NA
Median Effluent (mg/L):	NA	NA	NA	NA	NA	NA
Median Removal (%):	76	96	69	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 17 (Port of Olympia)

Estimated Costs

Estimated Installation Cost: **low:** $1,035 **high:** $1,200
Estimated Annual O&M Cost: **low:** $0.16/gal **high:** $0.22/gal

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio Clean Environmental
Name of Technology:	Bio Clean Downspout Filter
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

The Bio Clean Downspout Filter has been used since 2003. It has been tested and approved by IAMPO. The downspout filter has UPC certification. The filter has been tested under the IAMPO to verify treatment and bypass flow rates. The filter also meets the protocol's minimum pollutant removal specification of at least 60% TSS at a concentration of 150 mg/L over a several hour period up to the storage capacity of the product. The filter has also been tested in full scale labratory testing.
--Full Scale Laboratory Testing D-Tek Analytical
--X-Tex-Z-200 Testing for Metals - From Xextex Corporation, USA

Additional Notes

*Mass Balance was used for the TSS Tesing and therefore mg/L and number of samples does not apply. Turbidity in NTUs. This filter is made of all stainless steel and is istalled inline with new or existing downspouts. The Bio Clean Downspout Filter is also available with added for ion exchange embedded filter fabric for enhanced removal of metals. The filter is adaptable to downspout sizes 4" to 12".

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Flume Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 116
high: 583

System Footprint (sq. ft.): 1,6

Required Head Loss (ft): 0.083,0.5

Internal or External Bypass: Internal Bypass

Application Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	73	NA	223	360	NA	NA	NA	NA
Median Effluent (mg/L):	51.6	NA	29.5	62	NA	NA	NA	NA
Median Removal (%):	29	NA	87	83	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	NA	NA	NA	NA	NA	NA
Median Effluent (mg/L):	NA	NA	NA	NA	NA	NA
Median Removal (%):	NA	17	NA	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0 WA

Estimated Costs

Estimated Installation Cost: **low:** $660 **high:** $1,302
Estimated Annual O&M Cost: **low:** $0.23/gal **high:** $0.74/gal

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Flume Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

The Bio Clean Flume Filter has been tested indepedently in a full scale laboratory setting.. A series of 5 composite influent and effluent samples were collcted over a period of two days. The Flume Filter Tested utilized a series of three BioSorb Hydrocarbon Booms.
--Full Scale Laboratory Testing D-Tek Analytical

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Grate Inlet Skimmer Box
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 224
high: 8,980

System Footprint (sq. ft.): 0

Required Head Loss (ft): 0.5,2

Internal or External Bypass: Internal - High Flow Rate

Application Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	NA	18.6	NA	189	NA	NA	NA	NA
Median Effluent (mg/L):	NA	0.452	NA	10.43	NA	NA	NA	NA
Median Removal (%):	86*	98	NA	95	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	1.9	1.5	13.7	NA	NA	NA
Median Effluent (mg/L):	0.1	0.2	0.73	NA	NA	NA
Median Removal (%):	95	87	95	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0 WA, 123 OR

Estimated Costs

Estimated Installation Cost: **low:** $635 **high:** $1,800
Estimated Annual O&M Cost: **low:** $0.15/gal **high:** $0.40/gal

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio Clean Environmental
Name of Technology:	Bio Clean Grate Inlet Skimmer Box
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

The Grate Inlet Skimmer Basket has been in use since the mid 90's. Several field and laboratory studies have been performed on the system. For this reason several reports are being listed below.
--Longo Toyota - Independent Field Testing
--Suspended Solids Retention Testing Full Scale Lab Testing
--Reedy Creek Improvement District Independent Field Testing
--UC Irvine Independent Testing
--Whitman’s Pond
--Creech Engineering

Additional Notes

*Mass Balance was used for the Suspended Solids Retention Test and therefore mg/L and number of samples does not apply. An OK-90 Sand gradation was used for the testing.

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio Clean Environmental
Name of Technology:	Bio Clean Trench Drain Filter
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 28
high: 86

System Footprint (sq. ft.):
0

Required Head Loss (ft):
4,12

Internal or External Bypass:
Internal Bypass

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	NA	NA	NA	NA	NA	NA	NA	NA
Median Effluent (mg/L):	NA	NA	NA	NA	NA	NA	NA	NA
Median Removal (%):	NA	NA	NA	NA	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	NA	NA	NA	NA	NA	NA
Median Effluent (mg/L):	NA	NA	NA	NA	NA	NA
Median Removal (%):	NA	NA	NA	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost:	**low:**	$660	**high:**	$1,302
Estimated Annual O&M Cost:	**low:**	$0.23/gal	**high:**	$0.74/gal

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Trench Drain Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

No testing has been done on the trench drain filter.

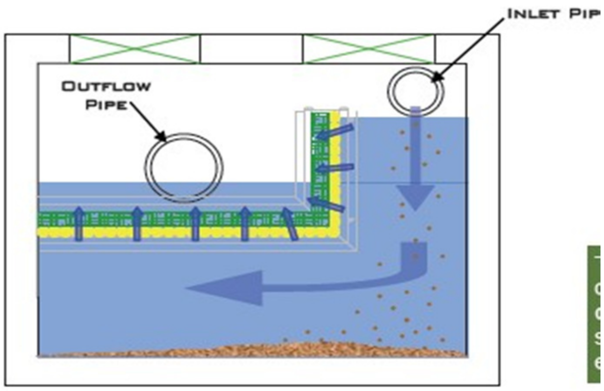
Additional Notes

The Bio Clean Trench Drain Filter comes standard with BioSorb Hydrocarbon booms or can use BioMediaGREEN. The filter is designed to utilize varoius media based upon pollutants of concern. The Trench Drain Filter can be used in various size trench drains.

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Bio Clean Water Polisher - Up Flow Filter
Technology Type: Hydrodynamic Separation(Up-Flow)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 191
high: 528

System Footprint (sq. ft.):
0

Required Head Loss (ft):
1,2

Internal or External Bypass:
Internal Bypass - High Flow Unimpeded

Application
Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	84.6	2.07	1.4	69.8	NA	NA	NA	NA
Median Effluent (mg/L):	12.4	0.63	0	6.5	NA	NA	NA	NA
Median Removal (%):	85	70	>99	91	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	NA	NA	NA	0.57	0.38	0.75
Median Effluent (mg/L):	NA	NA	NA	0.12	0.01	0.16
Median Removal (%):	NA	NA	NA	79	98	78

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $25,000 **high:** $125,000
Estimated Annual O&M Cost: **low:** $5.24/gal **high:** $7.85/gal

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio Clean Environmental
Name of Technology:	Bio Clean Water Polisher - Up Flow Filter
Technology Type:	Hydrodynamic Separation(Up-Flow)

Treatment Notes

The Bio Clean Water Polisher is a unique upflow media filter designed as a stand alone treatment unit or incorporated with the Nutrient Separating Baffle Box to form a complete treatment train. The Bio Clean Water Polisher utilizes the revolutionary filter media, BioMediaGREEN. The BioMediaGREEN has been independently tested in full scale labaratory testing. Media surface loading rate during the testing averaged 2-5 gpm with minimal head. A series of 8 composite influent and effluent grab samples we collected over a perioud of two days. --
BioMediaGREEN Performance Testing by Waves Environmental - Independent Full Scale Lab Testing

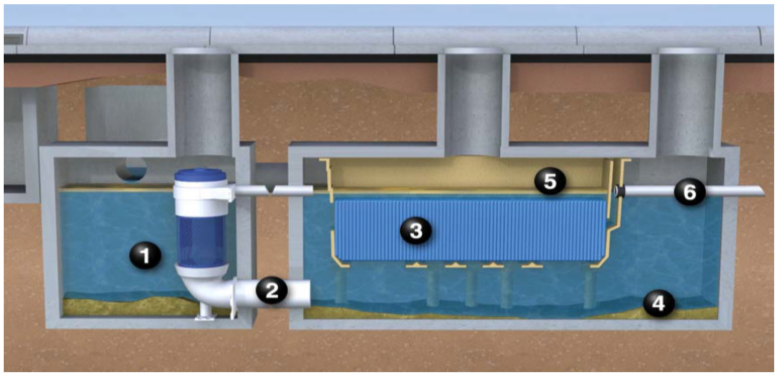
Additional Notes

The Bio Clean Water Polisher utilizes the revolutionary filter media, BioMediaGREEN. This material is made of billions of small fibers formed into solid blocks. The media composition consists of various oxides to allow for ion exchange and precipitation of dissolved pollutants. The physical structure of the media provides high peformance for the entrapment of particulate pollutants. The media has 80% void space which allows for double the hydraulic retention time when compared to granular media which leads to better overall performance. Another result of the void space is a high hydraulic conductivity. The media surface area loading rate for the media is approximately 7 gpm/sq ft surface area at a head pressure of 18".

Treatment Technology Summary Report

Manufacturer/Vendor: Bio-Microbics, Inc.
Name of Technology: BioStorm®
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: 225
high: 4,800

System Footprint (sq. ft.): 45 - 162

Required Head Loss (ft): 0.5 - 0.17

Internal or External Bypass: External

Application
Stormwater/Groundwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	227							
Median Effluent (mg/L):	7.9							
Median Removal (%):	95.3							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $500 **high:** $2,000
Estimated Annual O&M Cost: **low:** $400 **high:** $4,000

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio-Microbics, Inc.
Name of Technology:	BioStorm®
Technology Type:	Oil/Water Separator

Treatment Notes

TSS results are from grab samples done in a lab setting. Unit was tested from 50% of design flow up to 125%. Numbers reported below are at 100% of design flow.

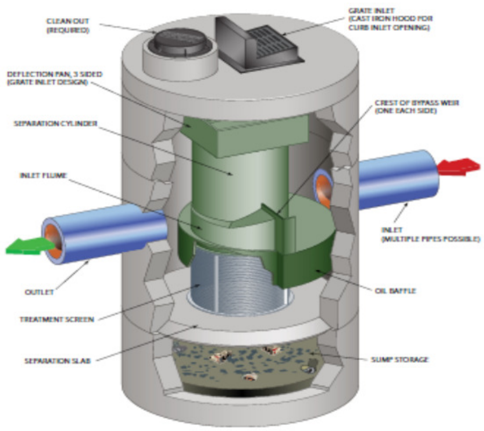
Additional Notes

Installation costs and O&M costs are estimates for the Washington area and do not include equipment or tank costs. Drawings and further information on the product can be obtained on our website at the following url: http://biomicrobics.com/?p=77

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: CDS
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 20
high: 44,900

System Footprint (sq. ft.): NA

Required Head Loss (ft): 0.1

Internal or External Bypass: Both Available

Application
Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	154			22				
Median Effluent (mg/L):	26			5				
Median Removal (%):	95			64				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE	GULD	GULD			PULD

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: > 250

Estimated Costs

Estimated Installation Cost: **low:** $10,000 **high:** $2.5M
Estimated Annual O&M Cost: **low:** $0.00001/gal **high:** $0.00001/gal

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: CDS
Technology Type: Hydrodynamic Separation

Treatment Notes

The Manasquan Savings Bank Stormwater Treatment System Field Evalutaion: CDS Unit (2010). Field, Peer-Reviewed, Composite.

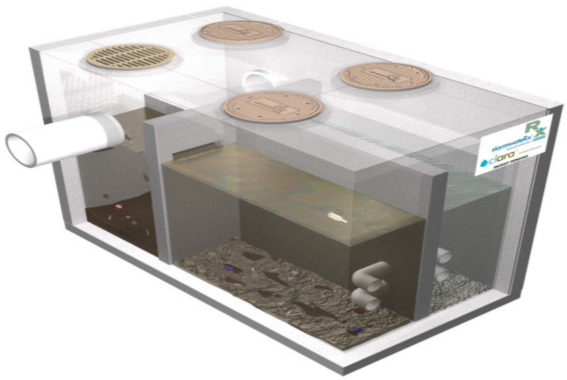
Additional Notes

Oil & Grease laboratory data using sorbents at flow rates of 25, 50, and 75% of design.

Treatment Technology Summary Report

Manufacturer/Vendor: StormwateRx LLC
Name of Technology: Clara Plug Flow Separator
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 5
high: 1120

System Footprint (sq. ft.): 0 - 150
Required Head Loss (ft): 0.5 - 1.5
Internal or External Bypass: Internal
Application Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	284.5							
Median Effluent (mg/L):	173.5							
Median Removal (%):	47		YES	YES				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	0.516	0.088	2.82			
Median Effluent (mg/L):	0.078	0.072	1.21			
Median Removal (%):	30	26	32			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 2

Estimated Costs

Estimated Installation Cost: **low:** $20,000 **high:** $52,000
Estimated Annual O&M Cost: **low:** $0.0005/gal **high:** $0.001/gal

Treatment Technology Summary Report

Manufacturer/Vendor: StormwateRx LLC
Name of Technology: Clara Plug Flow Separator
Technology Type: Hydrodynamic Separation

Treatment Notes

These samples were collected as grab samples by StormwateRx, consulting engineers, and facility treatment system operators. All analytical data is from a third party certified analytical lab. Non-detects were assumed to have the value of one half the detection limit.

Additional Notes

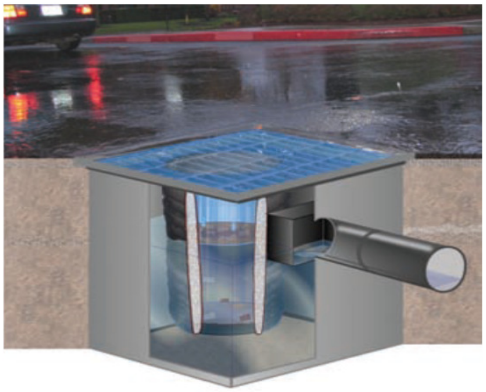
The Clara uses four pre-engineered chambers with an internal high-flow bypass to trap pollutants such as heavy solids and oil and grease.

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: Clean Way
Name of Technology: Clean Way Downspout Filtration Unit
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: Clean Way
Name of Technology: Clean Way Downspout Filtration Unit
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: ClearWater Solutions, Inc. *
Name of Technology: ClearWater BMP
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 200
high: 200

System Footprint (sq. ft.): 5,6

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

Treatment Technology Summary Report

Manufacturer/Vendor: ClearWater Solutions, Inc. *
Name of Technology: ClearWater BMP
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Coanda, Inc.
Name of Technology: Curb Inlet
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 50
high: 360,000

System Footprint (sq. ft.):
2-2000

Required Head Loss (ft):
1.5-3

Internal or External Bypass:
Internal

Application
Stormwater/Wastewater/
Process Water

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	1500							
Median Effluent (mg/L):	1376							
Median Removal (%):	8							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			48			
Median Effluent (mg/L):			15			
Median Removal (%):			69			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: A handful of private downspouts and area drains.

Estimated Costs

Estimated Installation Cost: low: $2,000 high: $3,500
Estimated Annual O&M Cost: low: $-0- high: $-0-

Treatment Technology Summary Report

Manufacturer/Vendor: Coanda, Inc.
Name of Technology: Curb Inlet
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Treatment Notes

USC (University of Southern California) obtained trash from Los Angeles Sanitation Services and United Stormwater. The Coanda BMP was filled with trash to evaluate the hydraulic performance. The test was conducted by running water from water trucks onto the street. The water then entered the BMP at approximately 635 gallons per minute (gpm). The BMP was evaluated for pollutant removal potential by collecting water quality samples before it reached the BMP and then from under the BMP at different time intervals. The samples were evaluated by USC using chemical analysis to determine the water quality.

Additional Notes

A summary of the USC report can be found at: http://www.coanda.com/products/documents/usc_research_project.pdf.

Other case studies have been performed, demonstrating removal of trash, nutrients, metals, pesticides, and bacteria: http://www.coanda.com/products/documents/Rowlett_Case_Study_I.pdf

Treatment Technology Summary Report

Manufacturer/Vendor: Coanda, Inc.
Name of Technology: Downspouts
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 50
high: 360,000

System Footprint (sq. ft.):
2-2000

Required Head Loss (ft):
1.5-3

Internal or External Bypass:
Internal

Application
Stormwater/Wastewater/
Process water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	1500							
Median Effluent (mg/L):	1376							
Median Removal (%):	8							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			48			
Median Effluent (mg/L):			15			
Median Removal (%):			69			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: A handful of private downspouts and area drains.

Estimated Costs

Estimated Installation Cost: **low:** $2,000 **high:** $3,500
Estimated Annual O&M Cost: **low:** $-0- **high:** $-0-

Treatment Technology Summary Report

Manufacturer/Vendor: Coanda, Inc.
Name of Technology: Downspouts
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Treatment Notes

USC (University of Southern California) obtained trash from Los Angeles Sanitation Services and United Stormwater. The Coanda BMP was filled with trash to evaluate the hydraulic performance. The test was conducted by running water from water trucks onto the street. The water then entered the BMP at approximately 635 gallons per minute (gpm). The BMP was evaluated for pollutant removal potential by collecting water quality samples before it reached the BMP and then from under the BMP at different time intervals. The samples were evaluated by USC using chemical analysis to determine the water quality.

Additional Notes

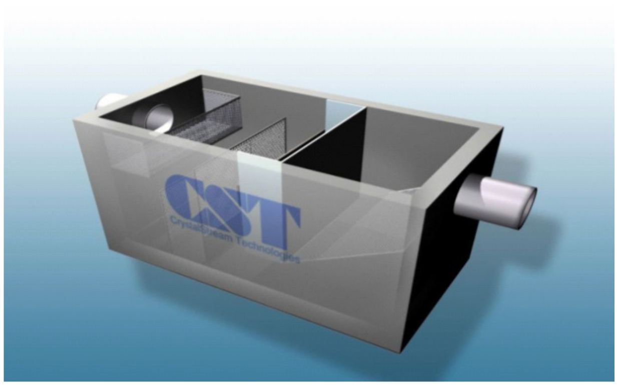
A summary of the USC report can be found at: http://www.coanda.com/products/documents/usc_research_project.pdf.

Other case studies have been performed, demonstrating removal of trash, nutrients, metals, pesticides, and bacteria:
http://www.coanda.com/products/documents/Rowlett_Case_Study_I.pdf

Treatment Technology Summary Report

Manufacturer/Vendor: CrystalStream Technologies
Name of Technology: CrystalClean Separator
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: CrystalStream Technologies
Name of Technology: CrystalClean Separator
Technology Type: Oil/Water Separator

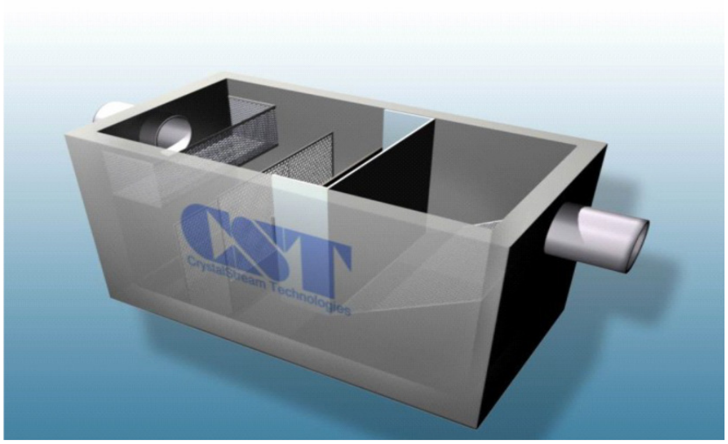
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: CrystalStream Technologies
Name of Technology: CrystalCombo Hybrid Polisher
Technology Type: Media Filtration(Combination System (with Oil/Water Separator))

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: CrystalStream Technologies
Name of Technology: CrystalCombo Hybrid Polisher
Technology Type: Media Filtration(Combination System (with Oil/Water Separator))

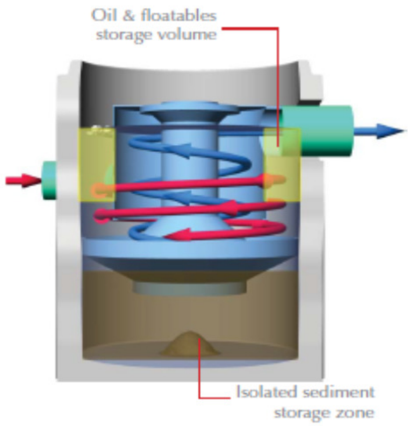
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Hydro International, Inc.
Name of Technology: Downstream Defender
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 500
high: 7800

System Footprint (sq. ft.): 0

Required Head Loss (ft): 0.5-0.9

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND							
Median Effluent (mg/L):	ND							
Median Removal (%):	50							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE	GULD				

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Hydro International, Inc.
Name of Technology:	Downstream Defender
Technology Type:	Hydrodynamic Separation

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: United Storm Water, Inc.
Name of Technology: DrainPac™
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ____________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: United Storm Water, Inc.
Name of Technology: DrainPac™
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems
Name of Technology: ecoLine a
Technology Type: Oil/Water Separator

Schematic

System Design Information

Design Flow Rate (gpm):
low: 25
high: 626

System Footprint (sq. ft.): 12-70

Required Head Loss (ft): 6.00" with clean coalescer

Internal or External Bypass: Site specific design required

Application
Stormwater/Process Water/ Wastewater/Groundwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	(b)		(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)		(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)		(b)	(b)	(b)	(b)	(b)	(b)

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)	(b)	(b)	(b)	(b)	(b)

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 6

Estimated Costs

Estimated Installation Cost: low: $ 6,700 high: $ 44,250
Estimated Annual O&M Cost: low: (a) high: (a)

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems
Name of Technology: ecoLine a
Technology Type: Oil/Water Separator

Treatment Notes

CEN EN 858-1 Test Method for Class I Coalescing Separator
Light liquid: Fuel oil, per ISO 8217, designation ISO-F-DMA with density of 0.85 g/cm3* (Solubility of light liquid nil, unsaponifiable)
Water: Potable or purified surface water
Water turn over: Minimum four volumes of test units
Liquid flux: 25-40 m^3/m^2-h (10-15 gpm/ft^2)
Max. residual light liquid: 5 mg/L (Hydrocarbon content analysis by prescribed infrared spectroscopy procedure)

Additional Notes

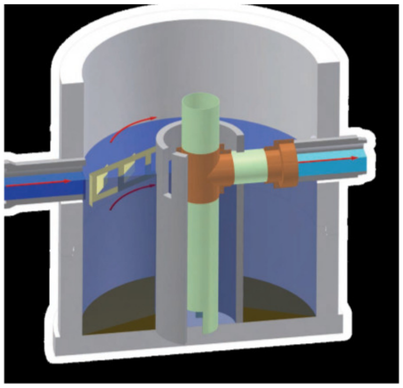
(a) Gravity flow system has no moving parts or power requirement. Oil coalescing media pack can be removed, rinsed, and replaced. In the event of damage to the coalescing media, new coalescing panels can be purchased for a low cost.

(b) Report Form's System performance data fields are not applicable. Product removes free-phase fluids such as floating oil and other petroleum hydrocarbon products (LNAPL - Light Non-Aqueous Phase Liquids).

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems
Name of Technology: ecoLine b
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: 50
high: 1110

System Footprint (sq. ft.):
N/A

Required Head Loss (ft):
6.00" with clean coalescer

Internal or External Bypass:
Site specific design required

Application
Stormwater/Process Water/Wastewater/Ground Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	(b)		(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)		(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)		(b)	(b)	(b)	(b)	(b)	(b)

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)	(b)	(b)	(b)	(b)	(b)

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 7

Estimated Costs

Estimated Installation Cost: **low:** $ 8,200 **high:** $ 81,900
Estimated Annual O&M Cost: **low:** (a) **high:** (a)

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems
Name of Technology: ecoLine b
Technology Type: Oil/Water Separator

Treatment Notes

CEN EN 858-1 Test Method for Class I Coalescing Separator
Light liquid: Fuel oil, per ISO 8217, designation ISO-F-DMA with density of 0.85 g/cm3* (Solubility of light liquid nil, unsaponifiable)
Water: Potable or purified surface water
Water turn over: Minimum four volumes of test units
Liquid flux: 25-40 m^3/m^2-h (10-15 gpm/ft^2)
Max. residual light liquid: 5 mg/L (Hydrocarbon content analysis by prescribed infrared spectroscopy procedure)

Additional Notes

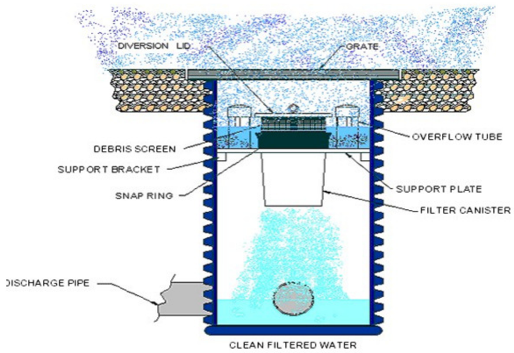
(a) Gravity flow system has no moving parts or power requirement. Oil coalescing media pack can be removed, rinsed, and replaced. In the event of damage to the coalescing media, new coalescing panels can be purchased for a low cost.

(b) Report Form's System performance data fields are not applicable. Product removes free-phase fluids such as floating oil and other petroleum hydrocarbon products (LNAPL - Light Non-Aqueous Phase Liquids).

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSense International Inc.
Name of Technology: EcoSense Stormwater Filtertration systems, Catch basin inserts
Technology Type: Media Filtration(Cartridge)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 25
high: 1,662*

System Footprint (sq. ft.):

Required Head Loss (ft):
Varies*

Internal or External Bypass:
Internal, Hooded

Application
Stormwater/Process Water/
Wastewater/Groundwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $400 **high:** $2,000
Estimated Annual O&M Cost: **low:** $100 **high:** $500

Treatment Technology Summary Report

Manufacturer/Vendor:	EcoSense International Inc.
Name of Technology:	EcoSense Stormwater Filtertration systems, Catch basin inserts
Technology Type:	Media Filtration(Cartridge)

Treatment Notes

Third party lab and simulated field studies have been done in US, Italy, New Zealand and Canada on filters loaded with Melt Blown Polypropylene only. One study performed Grab samples on canisters loaded with surfactant modified zeolite and impregnated polyester pads. Results will be included with this submittal.

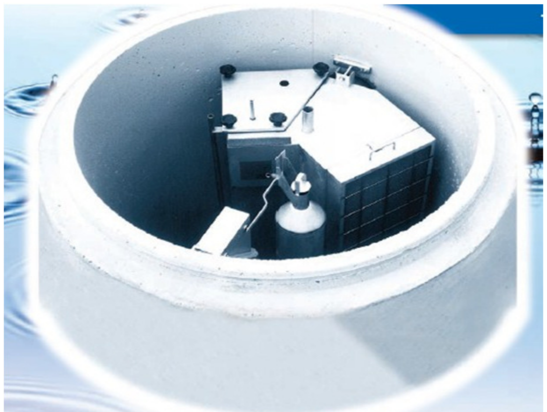
Additional Notes

EcoSense offers two media types for canister filters, but other media may be easily loaded. The system incorporates media filter canisters for low flows and "clean pass" hooded over-flows pipes. Multiple filters and over-flows may be installed depending on space available. Hooded over-flow effectively prevent floatables from bypassing canister filters. Debris, sediment, oils and grease (and contaminant associated) are effectively captured by the system. Debris collection baskets are also available especially designed to remove organic debris and trash. These systems are modular so that depending on catch basin sizes multiple baskets or filters or both may be installed.

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems, Inc./Water Tectonics, Inc.
Name of Technology: ecoSep®
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					PULD

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ____________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Royal Environmental Systems, Inc./Water Tectonics, Inc.
Name of Technology:	ecoSep®
Technology Type:	Oil/Water Separator

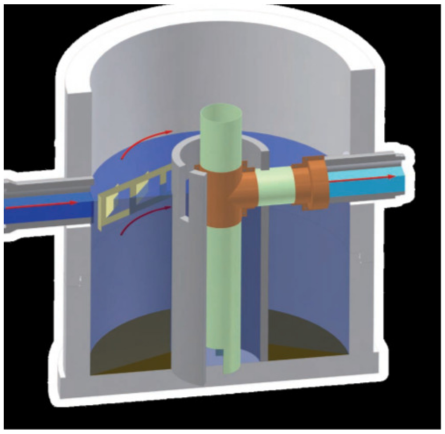
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems
Name of Technology: ecoStorm & ecoStorm Plus
Technology Type: Media Filtration(Combination System (with Hydrodyanamic Separation))

Schematic



System Design Information

Design Flow Rate (gpm):
low: No Min
high: 180

System Footprint (sq. ft.):
N/A

Required Head Loss (ft):
0.41' (c)

Internal or External Bypass:
Internal &/or External

Application
Stormwater/Process Water/
Wastewater/Ground Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	200							
Median Effluent (mg/L):	26							
Median Removal (%):	87							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	0.019	0.005	0.17			0.066
Median Effluent (mg/L):	0.009	0.002	0.073			0.042
Median Removal (%):	53	60	57			36

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		CULD			

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 9

Estimated Costs

Estimated Installation Cost: **low:** $8,900 (a) **high:** $37,500 (a)
Estimated Annual O&M Cost: **low:** (b) **high:** (b)

Treatment Technology Summary Report

Manufacturer/Vendor:	Royal Environmental Systems
Name of Technology:	ecoStorm & ecoStorm Plus
Technology Type:	Media Filtration(Combination System (with Hydrodyanamic Separation))

Treatment Notes

Field monitoring at the McRedmond Park site located in Redmond, WA.   Auto sampler for flow-portional composite and time-based discrete collections. Independent analytical laboratory, and 3rd party data validation/statistical analysis of data points and sets.

Additional Notes

ecoStorm and ecoStorm plus can be utilized as separate stand-alone technologies or combined in serial component installation. Combined technologies are currently under TAPE evaluation through WADOE for stormwater. Performance data reflects both stormwater and non-stormwater installations.

(a) Cost varies based on combination of units, number of units, and final design requirements.

(b) $500 - $1000 per cleaning/backflush event; Minimum of 1x per yr. to monthly for stormwater.

(c) Headloss based on:

- Current monitoring configuration: 1 ecoStorm upstream of 2 ecoStorm plus units.
- 360 gpm through the system, 180 gpm per filter.
- Site specific model calibrated onsite at known flow rates.
- Headloss negating effects of drop structure were neglected (located between the ecoStorm and ecoStorm plus units).
- Filters assumed to be at the point of required maintenance (twice the headloss measured for new filters).

System Performance Data results shown are for qualifying events only, per Washington State TAPE requirements:

- Per TAPE requirements, removal requirements for influent concentration less than 100 mg/l are that effluent must be less than or equal to 20 mg/l.
- For parameters with no results presented above, they are not being monitored or were present at concentrations are below measurable thresholds.

Treatment Technology Summary Report

Manufacturer/Vendor: Royal Environmental Systems, Inc./Water Tectonics, Inc.
Name of Technology: ecoTop®
Technology Type: Oil/Water Separator

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ____________________

Estimated Costs

Estimated Installation Cost: low: __________ high: ________
Estimated Annual O&M Cost: low: __________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Royal Environmental Systems, Inc./Water Tectonics, Inc.
Name of Technology:	ecoTop®
Technology Type:	Oil/Water Separator

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSense International Inc.
Name of Technology: EcoVault
Technology Type: Drain Inlet Insert(Media Filtration)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 1,346
high: 48,000

System Footprint (sq. ft.):
NA

Required Head Loss (ft):
Varies*

Internal or External Bypass:
Either or Both

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $25,000 **high:** $125,000
Estimated Annual O&M Cost: **low:** $200 **high:** $1,800

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSense International Inc.
Name of Technology: EcoVault
Technology Type: Drain Inlet Insert(Media Filtration)

Treatment Notes

A study has not been completed on this specific system. Studies have been performed on other manufactures version of the Type II Baffle Box. Minimum Performance claims are based on model studies performed at the Florida Institute of Technology: Pandit and Gopatakrishnan, 1996. The study mentioned was performed with a scale model Type 1 Baffle Box. Improvements such as media filtration and horizontal debris collection system were subsequently added.

Additional Notes

The EcoVault is unique among Type II baffle boxes. The standard model incorporates a high performance media filter into the last internal weir which treats low flows and remove a wide variety of contaminants including bacteria, mobile phosphate, ammonia, dissolved heavy metals and orgainics. TSS removal is expect to be 80% at the flows mentioned above. Course organic materials are captured and stored above the static WL greatly increasing overall nutrient removal. * Head Loss varies depending on the media filter's top elevation and is directly proportional. Debris loading also effects head loss.

Treatment Technology Summary Report

Manufacturer/Vendor: Enviro-Drain, Inc.
Name of Technology: Enviro-Drain®
Technology Type: Drain Inlet Insert(Absorbent Boom/Fabric)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 2
high: 71

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: Enviro-Drain, Inc.
Name of Technology: Enviro-Drain®
Technology Type: Drain Inlet Insert(Absorbent Boom/Fabric)

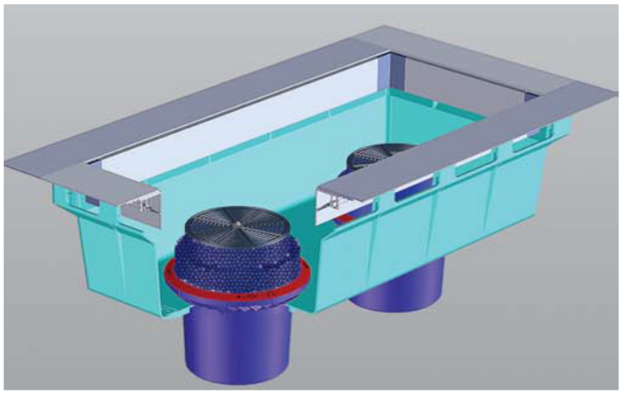
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Transpo Industries, Inc.
Name of Technology: EnviroSafe™
Technology Type: Drain Inlet Insert(Media Filtration)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 115
high: 230

System Footprint (sq. ft.): 0

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	Transpo Industries, Inc.
Name of Technology:	EnviroSafe™
Technology Type:	Drain Inlet Insert(Media Filtration)

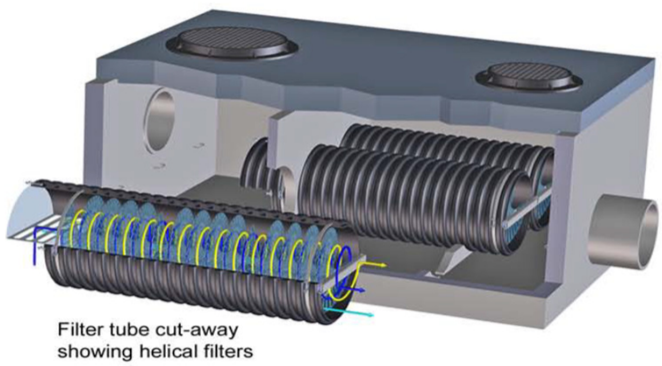
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Transpo Industries, Inc.
Name of Technology: EnviroSafe™ Storm Safe HF10
Technology Type: Drain Inlet Insert(Absorbent Boom/Fabric)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 900
high: 9000

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	Transpo Industries, Inc.
Name of Technology:	EnviroSafe™ Storm Safe HF10
Technology Type:	Drain Inlet Insert(Absorbent Boom/Fabric)

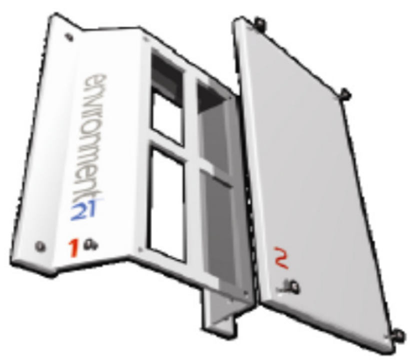
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: EnviroTrap Catch Basin Insert
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 0
high: 2700

System Footprint (sq. ft.): NA

Required Head Loss (ft): 0-0.5

Internal or External Bypass: NA

Application Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	*250		**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175		**150	**150	**150	**150	**150	**150
Median Removal (%):	*30		**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.07	***0.68	***0.24	NA	NA	NA
Median Removal (%):	***9	***13.6	***20	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: low: $200 high: $1,000
Estimated Annual O&M Cost: low: 0 high: $1,000

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: EnviroTrap Catch Basin Insert
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 180 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Filterra, DBA Americast, Inc.
Name of Technology: Filterra Curb Inlet System
Technology Type: Bioretention/Filtration

Schematic

System Design Information

Design Flow Rate (gpm):
low: 8.5
high: 50+

System Footprint (sq. ft.):

Required Head Loss (ft): 2.5

Internal or External Bypass: Can be either

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	10	12	12					
Median Influent (mg/L):	27.5	0.15	43.4					
Median Effluent (mg/L):	4.2	0.14	1.2					
Median Removal (%):	84.7	6.7	97.2					

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:				29		29
Median Influent (mg/L):				0.0056		0.194
Median Effluent (mg/L):				0.0033		0.082
Median Removal (%):				44		54

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		GULD	GULD		GULD

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 186

Estimated Costs

Estimated Installation Cost: **low:** $1,200 **high:** $7,500
Estimated Annual O&M Cost: **low:** $300 **high:** $3,000

Treatment Technology Summary Report

Manufacturer/Vendor:	Filterra, DBA Americast, Inc.
Name of Technology:	Filterra Curb Inlet System
Technology Type:	Bioretention/Filtration

Treatment Notes

For third party field monitoring at the Port of Tacoma Industrial site in WA, samples were collected via automatic flow-weighted composite samplers. Trapezoidal flumes and V-notch weirs with associated bubbler systems were installed to intercept influent and effluent stormwater, respectively, for flow measurements. Water levels within flumes were recorded using 5-minute intervals. A rain guage was installed in association with the units locations to continuously monitor precipitation totals in the drainage areas, and was interfaced with the autosampler and bubbler equipment.

Additional Notes

Data from Technical Evaluation Report (2009) produced by Herrera Environmental Consultants for Washington Department of Ecology. TSS data in the influent range accepted by Ecology(20 mg/L and greater). TP data in the influent range accepted by Ecology (0.1 to 0.5 mg/L). Low TP removal due to anomalous phosphorus data collected at the Port of Tacoma included very low TP influent concentrations and a high fraction of soluble reactive phosphorus. Dissolved copper data in the influent range accepted by Ecology (0.0029 to 0.02 mg/L). Dissolved zinc data in the influent range accepted by Ecology (0.02 to 0.6 mg/L). TPH data in the influent range accepted by Ecology (10 mg/L or greater).

Treatment Technology Summary Report

Manufacturer/Vendor: Filterra, DBA Americast, Inc.
Name of Technology: Filterra Roof Drain System
Technology Type: Bioretention/Filtration

Schematic

System Design Information

Design Flow Rate (gpm):
low: 8.5
high: 50+

System Footprint (sq. ft.):

Required Head Loss (ft):
2.5

Internal or External Bypass:
Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	10	12	12					
Median Influent (mg/L):	27.5	0.15	43.4					
Median Effluent (mg/L):	4.2	0.14	1.2					
Median Removal (%):	84.7	6.7	97.2					

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:				29		29
Median Influent (mg/L):				0.0056		0.194
Median Effluent (mg/L):				0.0033		0.082
Median Removal (%):				44		54

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		GULD	GULD		GULD

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 1

Estimated Costs

Estimated Installation Cost: **low:** $1,200 **high:** $7,500
Estimated Annual O&M Cost: **low:** $300 **high:** $3,000

Treatment Technology Summary Report

Manufacturer/Vendor:	Filterra, DBA Americast, Inc.
Name of Technology:	Filterra Roof Drain System
Technology Type:	Bioretention/Filtration

Treatment Notes

For third party field monitoring at the Port of Tacoma Industrial site in WA, samples were collected via automatic flow-weighted composite samplers. Trapezoidal flumes and V-notch weirs with associated bubbler systems were installed to intercept influent and effluent stormwater, respectively, for flow measurements. Water levels within flumes were recorded using 5-minute intervals. A rain guage was installed in association with the units locations to continuously monitor precipitation totals in the drainage areas, and was interfaced with the autosampler and bubbler equipment.

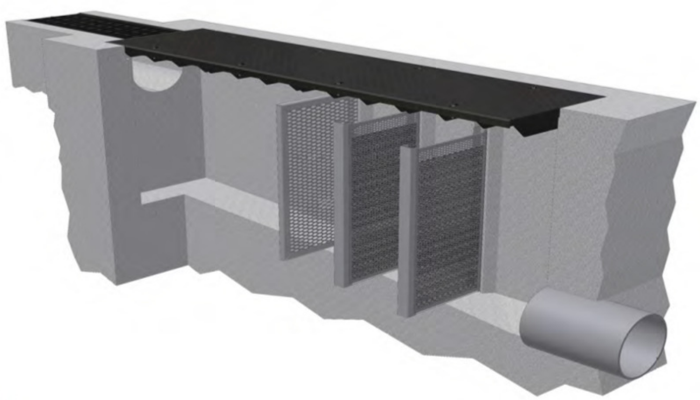
Additional Notes

Data from Technical Evaluation Report (2009) produced by Herrera Environmental Consultants for Washington Department of Ecology. TSS data in the influent range accepted by Ecology(20 mg/L and greater). TP data in the influent range accepted by Ecology (0.1 to 0.5 mg/L). Low TP removal due to anomalous phosphorus data collected at the Port of Tacoma included very low TP influent concentrations and a high fraction of soluble reactive phosphorus. Dissolved copper data in the influent range accepted by Ecology (0.0029 to 0.02 mg/L). Dissolved zinc data in the influent range accepted by Ecology (0.02 to 0.6 mg/L). TPH data in the influent range accepted by Ecology (10 mg/L or greater).

Treatment Technology Summary Report

Manufacturer/Vendor: ABT, Inc.
Name of Technology: First Flush
Technology Type: Oil/water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: 449
high: 538

System Footprint (sq. ft.): NA
Required Head Loss (ft): NA
Internal or External Bypass:

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $5,000 **high:** $10,000
Estimated Annual O&M Cost: **low:** $500 **high:** $3,000

Treatment Technology Summary Report

Manufacturer/Vendor: ABT, Inc.
Name of Technology: First Flush
Technology Type: Oil/water Separator

Treatment Notes

Lab test results are provided on the filter media performance and system hydraulic performace based on design capabilites. The installation cost if factoring material and cost of installation together...or an installed cost.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard Plus
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 100
high: 2000

System Footprint (sq. ft.):
1,10

Required Head Loss (ft):
0,0.25

Internal or External Bypass:
Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	100		35	35				35
Median Effluent (mg/L):	20		7	7				
Median Removal (%):	80		80	80				7

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 100

Estimated Costs

Estimated Installation Cost: **low:** $250 **high:** $1800
Estimated Annual O&M Cost: **low:** $75 **high:** $350

Treatment Technology Summary Report

Manufacturer/Vendor:	Kristar Enterprises, Inc.
Name of Technology:	FloGard Plus
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

Additional Notes

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard Downspout Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 30
high: 325

System Footprint (sq. ft.): 0.5,1

Required Head Loss (ft): 0,1.5

Internal or External Bypass: Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	100		35	35				35
Median Effluent (mg/L):	20		7	7				
Median Removal (%):	80		80	80				7

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $1500 **high:** $3500
Estimated Annual O&M Cost: **low:** $75 **high:** $250

Treatment Technology Summary Report

Manufacturer/Vendor:	Kristar Enterprises, Inc.
Name of Technology:	FloGard Downspout Filter
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard Dual Vortex Seperator
Technology Type: Hydrodynamic Separation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 150
high: 6,500

System Footprint (sq. ft.): 7 - 113
Required Head Loss (ft): 0 - 3
Internal or External Bypass: Internal
Application: Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	202							
Median Effluent (mg/L):	80							
Median Removal (%):	60							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: 10

Estimated Costs

Estimated Installation Cost: **low:** $10,000 **high:** $100,000
Estimated Annual O&M Cost: **low:** $300 **high:** $3,500

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard Dual Vortex Seperator
Technology Type: Hydrodynamic Separation

Treatment Notes

Internal lab testing performed by Kristar. Third party lab testing was performed by Alden Research laboratories based in Holden Massachussets. No field studies have been completed at this date.

Additional Notes

No field studies have been completed at this time. Correlation of TSS removal with other POCs would indicate similar removal of Total metals.

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard LoPro Matrix Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 45
high: 800

System Footprint (sq. ft.):
0.75,16

Required Head Loss (ft):
0,0.5

Internal or External Bypass:
Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	100		35	35				35
Median Effluent (mg/L):	20		7	7				
Median Removal (%):	80		80	80				7

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 10

Estimated Costs

Estimated Installation Cost: **low:** $400 **high:** $1000
Estimated Annual O&M Cost: **low:** $75 **high:** $300

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard LoPro Matrix Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard LoPro Trench Drain Filter
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 200
high: 500

System Footprint (sq. ft.): 1,20

Required Head Loss (ft): 0,0.25

Internal or External Bypass: Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	100		35	35				35
Median Effluent (mg/L):	20		7	7				
Median Removal (%):	80		80	80				7

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $600 **high:** $3000
Estimated Annual O&M Cost: **low:** $75 **high:** $350

Treatment Technology Summary Report

Manufacturer/Vendor:	Kristar Enterprises, Inc.
Name of Technology:	FloGard LoPro Trench Drain Filter
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard Trash & Debris Guard
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 50
high: 500

System Footprint (sq. ft.): 0.5 - 4
Required Head Loss (ft): 0 - 0.25
Internal or External Bypass: Internal
Application Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $450 **high:** $1,500
Estimated Annual O&M Cost: **low:** $50 **high:** $200

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: FloGard Trash & Debris Guard
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

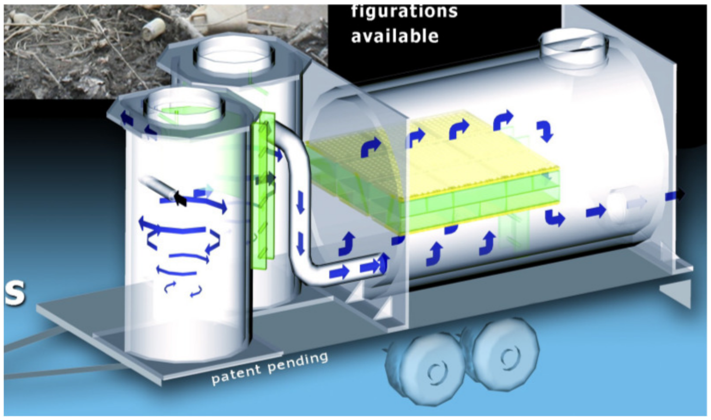
No Data Available

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: AquaShield, Inc.
Name of Technology: Go-Filter
Technology Type: Media Filtration(Combination System (with Hydrodyanamic Separation))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 50
high: 675

System Footprint (sq. ft.):

Required Head Loss (ft): 0.5

Internal or External Bypass: Both

Application
Stormwater/Process water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost:	**low:** Site-specific	**high:** Site-specific
Estimated Annual O&M Cost:	**low:** Site-specific	**high:** Site-specific

Treatment Technology Summary Report

Manufacturer/Vendor:	AquaShield, Inc.
Name of Technology:	Go-Filter
Technology Type:	Media Filtration(Combination System (with Hydrodyanamic Separation))

Treatment Notes

See Aqua-Filter for lab and field testing.

Additional Notes

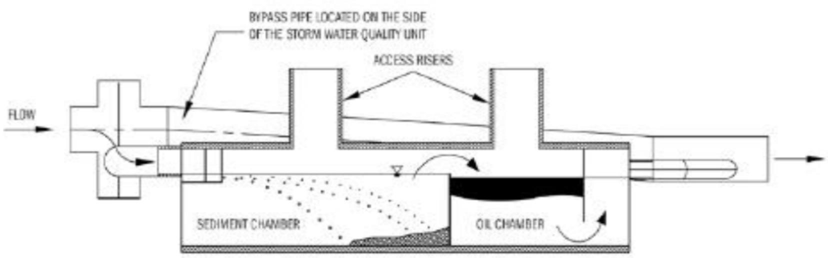
Mobile device works on same principle as Aqua-Filter. Useful on construction sites for turbidity reduction in addition to sediment removal. Device components have been verified by NJCAT.

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Hancor, Inc.
Name of Technology: Hancor Storm Water Quality Unit
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: Hancor, Inc.
Name of Technology: Hancor Storm Water Quality Unit
Technology Type: Oil/Water Separator

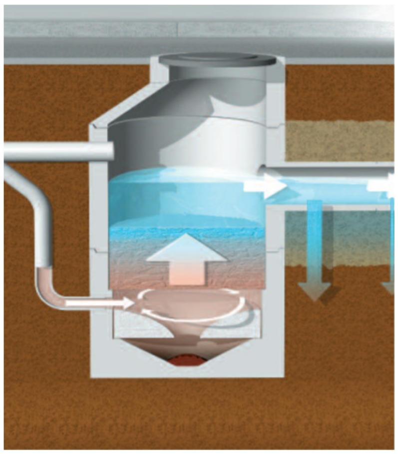
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Huber Technology, Inc.
Name of Technology: HUBER Hydro Filt
Technology Type: Drain Inlet Insert(Media Filtration)

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):
0

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: Huber Technology, Inc.
Name of Technology: HUBER Hydro Filt
Technology Type: Drain Inlet Insert(Media Filtration)

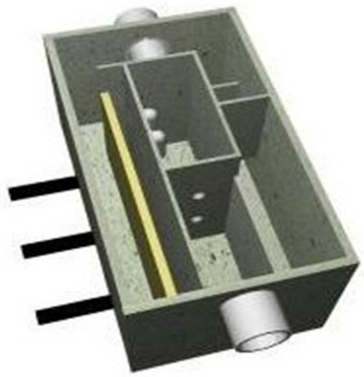
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Hydroworks
Name of Technology: HydroFilter
Technology Type: Media Filtration(Combination System (with Oil/Water Separator))

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Hydroworks
Name of Technology:	HydroFilter
Technology Type:	Media Filtration(Combination System (with Oil/Water Separator))

Treatment Notes

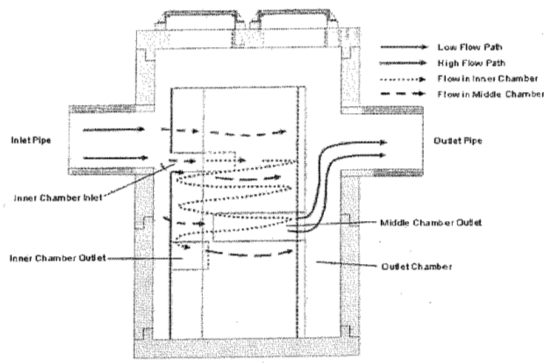
Additional Notes

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: Hydroworks
Name of Technology: HydroGuard
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 360
high: 3232

System Footprint (sq. ft.): 0

Required Head Loss (ft): 0-2

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND							
Median Effluent (mg/L):	ND							
Median Removal (%):	70							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

Treatment Technology Summary Report

Manufacturer/Vendor: Hydroworks
Name of Technology: HydroGuard
Technology Type: Hydrodynamic Separation

Treatment Notes

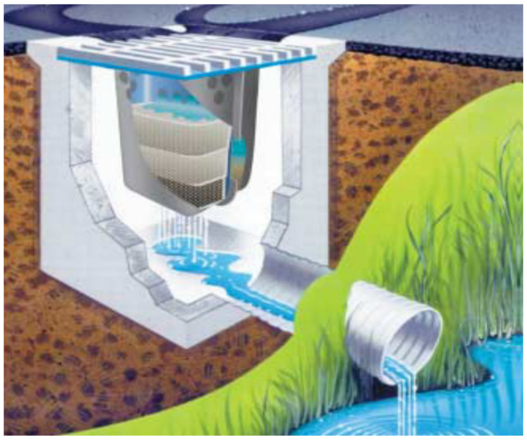
Additional Notes

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: ACF Environmental, Inc.
Name of Technology: Hydro-Kleen™
Technology Type: Drain Inlet Insert(Media Filtration)

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	ACF Environmental, Inc.
Name of Technology:	Hydro-Kleen™
Technology Type:	Drain Inlet Insert(Media Filtration)

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Stormdrain Solutions
Name of Technology: Inceptor®
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ____________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Stormdrain Solutions
Name of Technology:	Inceptor®
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

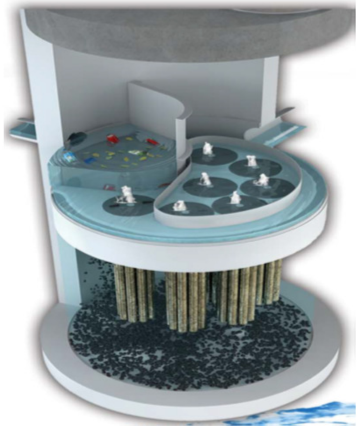
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Imbrium Systems
Name of Technology: Jellyfish Filter
Technology Type: Media Filtration(Up-Flow)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 60
high: 2300

System Footprint (sq. ft.):
12 - 113

Required Head Loss (ft):
1,2

Internal or External Bypass:
Internal or External Bypass

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	74							
Median Effluent (mg/L):	8							
Median Removal (%):	89							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	78	35	1.45			
Median Effluent (mg/L):	0.3	5	0.6			
Median Removal (%):	99	86	59			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		PULD			

	50% TSS Removal	80% TSS Removal
NJCAT		X

Other Approvals:

Local Installations

# of Installations in Washington: 1

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

Treatment Technology Summary Report

Manufacturer/Vendor: Imbrium Systems
Name of Technology: Jellyfish Filter
Technology Type: Media Filtration(Up-Flow)

Treatment Notes

Performance data is from third-party field study at University of Florida conducted according to the TARP protocol. Samples collected were grab samples of the entire crossection of flow. Twenty-one storm events have been monitored to date.

Additional Notes

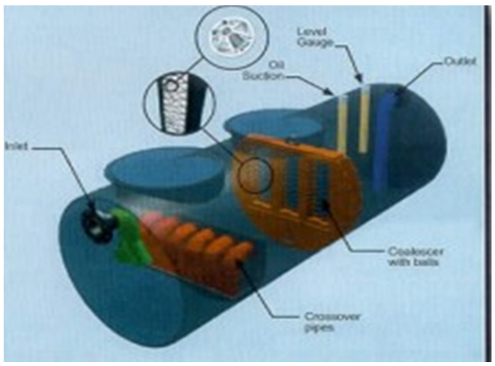
Copper concentrations are in micrograms per liter. Zinc concentrations are in milligrams per liter. Lead concentraions are in micrograms per liter. The O&M cost ranges from $0.001/gal to $0.003/gal. Installation costs range from $8000 to $125,000.

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Brown Minneapolis Tank
Name of Technology: Kleerwater
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: 25
high: 10,000

System Footprint (sq. ft.):

Required Head Loss (ft):
Gravity

Internal or External Bypass:
External

Application
Stormwater/Wastewater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: **low:** Varies **high:** Varies
Estimated Annual O&M Cost: **low:** Varies **high:** Varies

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Brown Minneapolis Tank
Name of Technology: Kleerwater
Technology Type: Oil/Water Separator

Treatment Notes

All data collected and verified by third party inspectors and Underwriters Laboratories (UL).

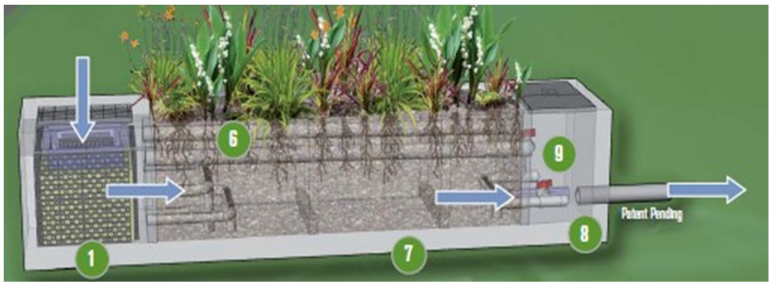
Additional Notes

• Underwriters Laboratories tested and listed per UL-2215
• Designed for no internal or confined space entry when performing routine maintenance.
• Kleerwater™ can handle larger influent flows, allowing for smaller separator tanks. With smaller separation tanks, less installation costs.
• Kleerwater™ separators utilizes Stokes Law for defining rates of rise of oil spheres in a liquid medium
• Unique patented oil separation process enhances oil from water separation efficiencies
• Separation efficiencies down to 5 ppm & lower. Note: Kleerwater™will not remove oils with a specific gravity of less than 0.95, dissolved hydrocarbons, or volatile organic compounds.
For additional information, please visit www.kleerwater.net

Treatment Technology Summary Report

Manufacturer/Vendor: Modular Wetland Systems, Inc.
Name of Technology: Modular Wetland Systems - Linear
Technology Type: Bioretention/Filtration

Schematic



System Design Information

Design Flow Rate (gpm):
low: 22
high: 120

System Footprint (sq. ft.):
16-84

Required Head Loss (ft):
2,4

Internal or External Bypass:
Internal (External in Some Situations)

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	270		19	4	NA	NA	NA	NA
Median Effluent (mg/L):	3		0	ND	NA	NA	NA	NA
Median Removal (%):	98		>99	>99	NA	NA	NA	NA

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	0.04	ND	0.24	0.757	0.543	0.95
Median Effluent (mg/L):	ND	ND	ND	0.0552	0.1	0.185
Median Removal (%):	>50		>79	93	81	80

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $12,000 **high:** $25,000
Estimated Annual O&M Cost: **low:** $8.26/gal **high:** $10.50/gal

Treatment Technology Summary Report

Manufacturer/Vendor: Modular Wetland Systems, Inc.
Name of Technology: Modular Wetland Systems - Linear
Technology Type: Bioretention/Filtration

Treatment Notes

The Modular Wetland System Linear has been used in the field since 2008. The system has be independently tested in the laboratory and field under various conditions. A series of composite grab samples were used in the field and laboratory provide performance analysis on the system.
--Quarter Scale Independent Lab Testing
--Full Scale Independent Field Testing

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Bio Clean Environmental
Name of Technology: Nutrient Separating Baffle Box
Technology Type: Hydrodynamic Separation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 148
high: 8,858

System Footprint (sq. ft.): 0

Required Head Loss (ft): 0

Internal or External Bypass: Internal (External in Some Situations)

Application Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	2	4	NA	2	NA			NA
Median Influent (mg/L):	366	1.49	NA	4	NA			NA
Median Effluent (mg/L):	48	0.44	NA	n/d	NA			NA
Median Removal (%):	86.8	70	NA	>99	NA			NA

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:	2	NA	0	NA	NA	NA
Median Influent (mg/L):	0.07	NA	0.318	NA	NA	NA
Median Effluent (mg/L):	0.042	NA	0.222	NA	NA	NA
Median Removal (%):	40	NA	30.25	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: 0 WA, 4 UT, 3 OR

Estimated Costs

Estimated Installation Cost: **low:** $10,000 **high:** $200,000
Estimated Annual O&M Cost: **low:** $0.33/gal **high:** $0.84/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	Bio Clean Environmental
Name of Technology:	Nutrient Separating Baffle Box
Technology Type:	Hydrodynamic Separation

Treatment Notes

The Nutrient Separating Baffle Box has been in use since for over 10 years. Several field and laboratory studies have been performed on the system. For this reason several reports are being listed below. N/A stands for information not available - pollutant not tested in the report
--City of Santa Monica field data is independent and was performed over the course of 1 year.
--Brevard County field testing is independent and was peformed over 4 storm events - Micco & Indiatlantic
-- NJ CAT Full Scale Labratory Testing Tier 1

Additional Notes

The Nutrient Separating Baffle Box employees screening, three chambered hydrodynamic spearation and absoptive polymer media for the removal of gorss solids, TSS, particulate pollutants and hydrocarbons.

Treatment Technology Summary Report

Manufacturer/Vendor: Rotondo Environmental Solutions, LLC
Name of Technology: Perimeter Sandfilter (Delaware Sandfilter)
Technology Type: Media Filtration (Sand Filter)

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):
0

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: Rotondo Environmental Solutions, LLC
Name of Technology: Perimeter Sandfilter (Delaware Sandfilter)
Technology Type: Media Filtration (Sand Filter)

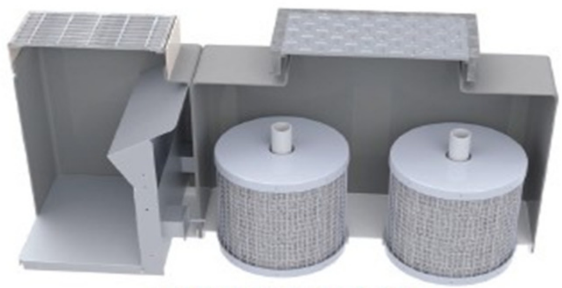
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: Perk Filter
Technology Type: Media Filtration(Cartridge)

Schematic



POD SYSTEM CONFIGURATION

System Design Information

Design Flow Rate (gpm):
low: 12
high: 1000

System Footprint (sq. ft.): 10,150

Required Head Loss (ft): 1.7,3.5

Internal or External Bypass: Internal

Application
Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	70		20	20				20
Median Effluent (mg/L):	11		5	5				5
Median Removal (%):	82		75	75				75

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	0.052	0.15	0.25			
Median Effluent (mg/L):	0.02	0.05	0.1			
Median Removal (%):	62	68	61			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		GULD		GULD	

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 15

Estimated Costs

Estimated Installation Cost: **low:** $10000 **high:** $200000
Estimated Annual O&M Cost: **low:** $1200 **high:** $10000

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Kristar Enterprises, Inc.
Name of Technology:	Perk Filter
Technology Type:	Media Filtration(Cartridge)

Treatment Notes

Internal lab testing performed by Kristar. Third party lab testing was performed by CSUS - OWP for TSS and subsequent "street Sweeipings" testing for metals and nutrients. Third Party field testing for GULD by Herrera.

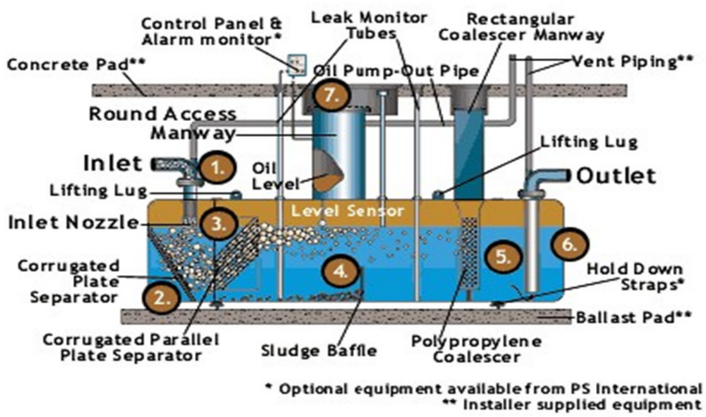
Additional Notes

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: PSI International, Inc.
Name of Technology: PSI Separator
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ____________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: PSI International, Inc.
Name of Technology: PSI Separator
Technology Type: Oil/Water Separator

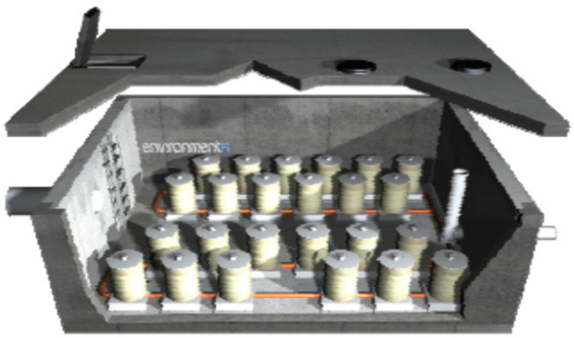
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: PuriStorm
Technology Type: Media Filtration(Cartridge)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 0
high: 2000

System Footprint (sq. ft.): 9-600
Required Head Loss (ft): 0-0.5
Internal or External Bypass: Both
Application: Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	*250		**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175		**80	**80	**80	**80	**80	**80
Median Removal (%):	*80		**80	**80	**80	**80	**80	**80

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.04	***0.28	***0.06	NA	NA	NA
Median Removal (%):	***50	***65	***80	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: $3,000 high: $25,000
Estimated Annual O&M Cost: low: 0 high: $10,000

HERRENA

Treatment Technology Summary Report

Manufacturer/Vendor:	Environment 21
Name of Technology:	PuriStorm
Technology Type:	Media Filtration(Cartridge)

Treatment Notes

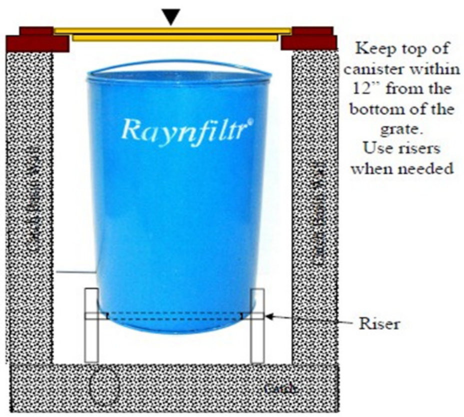
*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 60 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Environmental Filtration Inc.
Name of Technology: Raynfiltr
Technology Type: Drain Inlet Insert(Media Filtration

Schematic



System Design Information

Design Flow Rate (gpm):
low: 0
high: 900

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 1 (airport)

Estimated Costs

Estimated Installation Cost: **low:** $531 **high:** $554
Estimated Annual O&M Cost: **low:** **high:**

Treatment Technology Summary Report

Manufacturer/Vendor: Environmental Filtration Inc.
Name of Technology: Raynfiltr
Technology Type: Drain Inlet Insert(Media Filtration

Treatment Notes

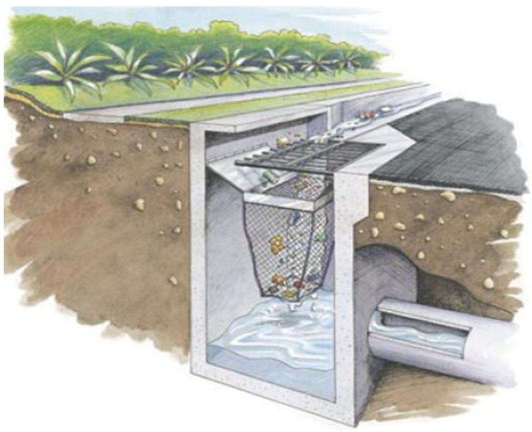
Additional Notes

Costs per catch basin

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSol Wastewater Filtration Systems
Name of Technology: RSF (Rapid Stormwater Filtration) 100
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 1784
high: 7000

System Footprint (sq. ft.):

Required Head Loss (ft): 0.5

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	NA						
Median Effluent (mg/L):	ND	NA						
Median Removal (%):	65	40						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSol Wastewater Filtration Systems
Name of Technology: RSF (Rapid Stormwater Filtration) 100
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

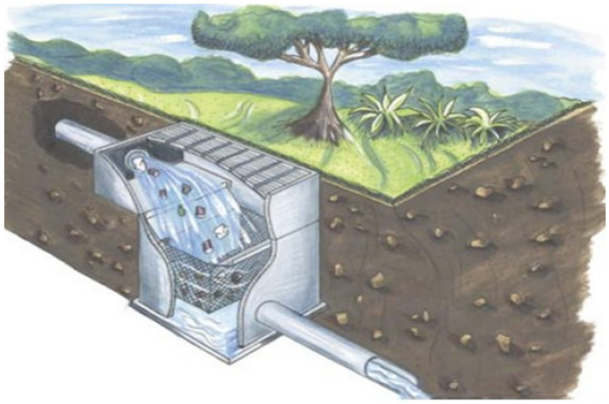
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSol Wastewater Filtration Systems
Name of Technology: RSF (Rapid Stormwater Filtration) 1000
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 12000
high: 18162

System Footprint (sq. ft.): 0
Required Head Loss (ft): 0.5
Internal or External Bypass:
Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	NA						
Median Effluent (mg/L):	ND	NA						
Median Removal (%):	49	30						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSol Wastewater Filtration Systems
Name of Technology: RSF (Rapid Stormwater Filtration) 1000
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

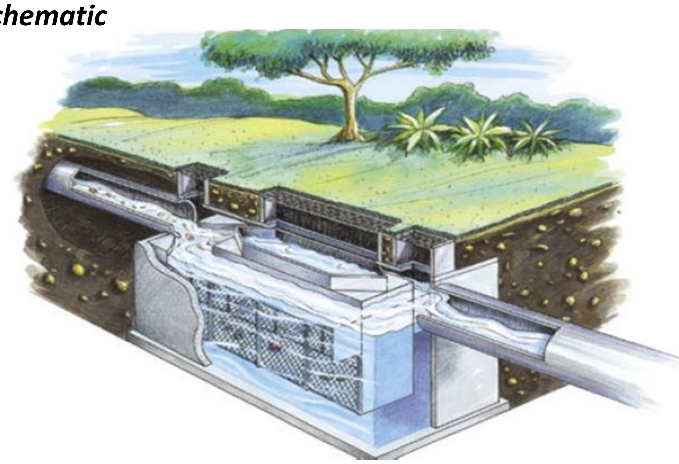
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSol Wastewater Filtration Systems
Name of Technology: RSF (Rapid Stormwater Filtration) 4000
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 837
high: 68270

System Footprint (sq. ft.): 0

Required Head Loss (ft): 0.5

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	NA						
Median Effluent (mg/L):	ND	NA						
Median Removal (%):	91	30						

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: EcoSol Wastewater Filtration Systems
Name of Technology: RSF (Rapid Stormwater Filtration) 4000
Technology Type: Drain Inlet Insert(Combination System (Screen and Media Filtration))

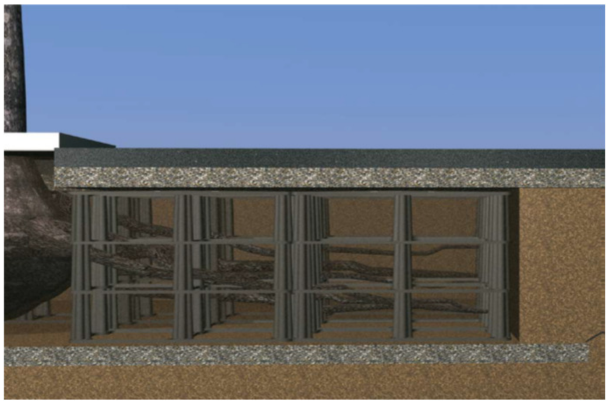
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Deep Root Partners, L.P.
Name of Technology: Silva Cell
Technology Type: Bioretention/Filtration

Schematic



System Design Information

Design Flow Rate (gpm):
low: 20"/hour
high: 3"/hour

System Footprint (sq. ft.):

Required Head Loss (ft):
n/a

Internal or External Bypass:
Optional

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):	80	68						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):				90+		90+

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		GULD	GULD		

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 7

Estimated Costs

Estimated Installation Cost: **low:** $4,000-$5,600 **high:** $10,000-$14,000
Estimated Annual O&M Cost: **low:** $100-$200 **high:** $100-$200

Treatment Technology Summary Report

Manufacturer/Vendor:	Deep Root Partners, L.P.
Name of Technology:	Silva Cell
Technology Type:	Bioretention/Filtration

Treatment Notes

Data is based on a literature search. The water quality filtering values are based on research by Davis at University of Maryland and Hunt at the University of North Carolina.

Additional Notes

Prince Georges County Stormwater Manual, British Columbia Stormwater Manual, State of Washington Department of Ecology

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: Nyloplast/Hancor, Inc.
Name of Technology: SNOUT®
Technology Type: Oil/Water Separator

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Nyloplast/Hancor, Inc.
Name of Technology:	SNOUT®
Technology Type:	Oil/Water Separator

Treatment Notes

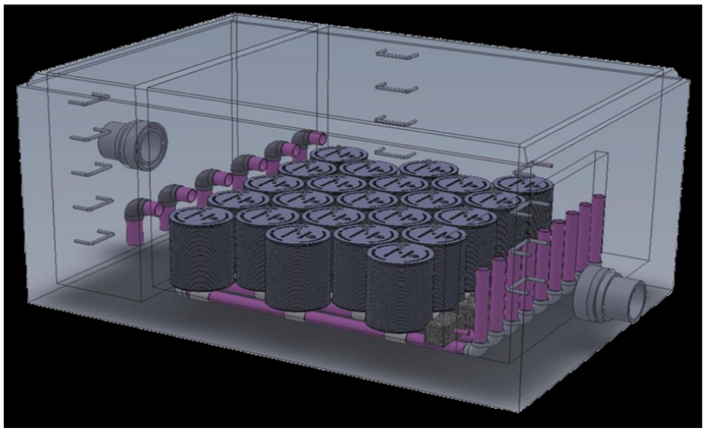
Additional Notes

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Imbrium Systems Corp
Name of Technology: Sorbtive™ FILTER
Technology Type: Media Filtration(Cartridge)

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND	ND						
Median Effluent (mg/L):	ND	ND						
Median Removal (%):	84	>77						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ____________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor: Imbrium Systems Corp
Name of Technology: Sorbtive™ FILTER
Technology Type: Media Filtration(Cartridge)

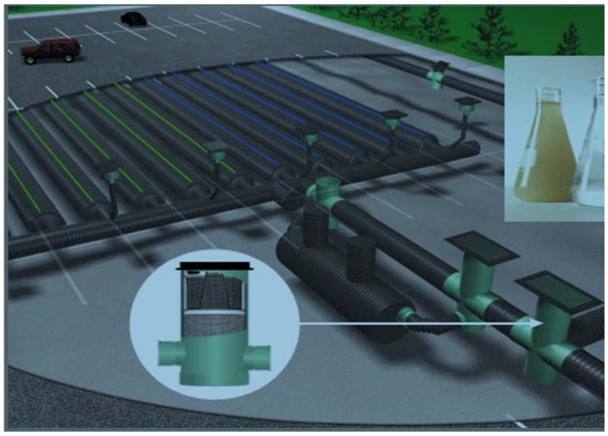
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Nyloplast/Hancor, Inc.
Name of Technology: Storm PURE™
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):
____

Required Head Loss (ft):
____

Internal or External Bypass:
____

Application
____

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:
____
____
____
____

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Nyloplast/Hancor, Inc.
Name of Technology:	Storm PURE™
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

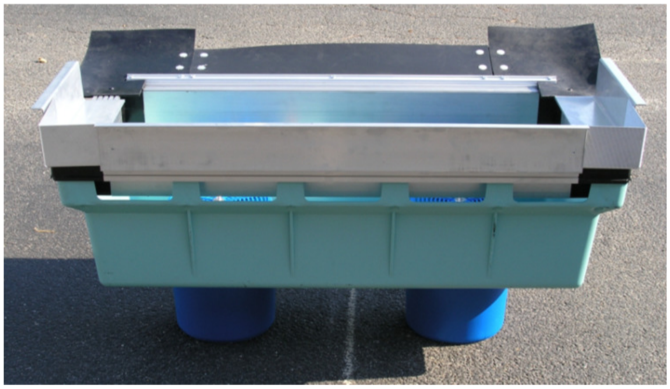
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: FABCO industries
Name of Technology: Stormbasin/Stormpod
Technology Type: Drain Inlet Insert(Media Filtration (Cartridge))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 50
high: >2500

System Footprint (sq. ft.): 4 - 200

Required Head Loss (ft): 1.25 - 2.5

Internal or External Bypass: Both

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	111.9	0.57		59.5				
Median Effluent (mg/L):	2.7	0.3		<5				
Median Removal (%):	97.8	47		>90				

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):		0.018	0.335			
Median Effluent (mg/L):		0.0049	0.175			
Median Removal (%):		73	48			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: <20

Estimated Costs

Estimated Installation Cost: **low:** $750 **high:** $2,000
Estimated Annual O&M Cost: **low:** $200 **high:** $800

Treatment Technology Summary Report

Manufacturer/Vendor:	FABCO industries
Name of Technology:	Stormbasin/Stormpod
Technology Type:	Drain Inlet Insert(Media Filtration (Cartridge))

Treatment Notes

FABCO stormbasin/stormpod has been tested in the lab and the field by 1st+3rd party's data was collected according to established protocols and consisted of barious methods including grab, auto, semi-auto and single event or composite samples

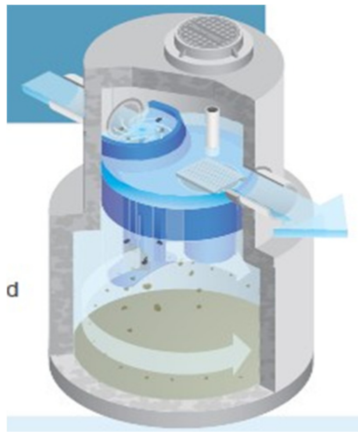
Additional Notes

FABCO was awarded a competition bid-soil source spec for large scale municupal deployment in the urban/ms4 stormdrain system of nassau county, long island, ny. Since 2009 FABCO was installed over 2000 stormbasins. Our performance approval as part of this spec-sediment TSS removal> 50% d50: 110 um. Hydrocarbons/oil&grease: >80%. .Phosphorus: >50%. Nitrogen >40%. Bacteria. >70%. Stormbasin is a great retrofit device for industrial facilities and is considered a structural BMP for pretreatment, source control or in spcc + swpp plans.

Treatment Technology Summary Report

Manufacturer/Vendor: Imbrium Systems
Name of Technology: Stormceptor
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 0
high: 11000

System Footprint (sq. ft.):

Required Head Loss (ft):
0.22

Internal or External Bypass:
Internal

Application
Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:	57	38	15					
Median Influent (mg/L):	159	0.275	29					
Median Effluent (mg/L):	59	0.175	4					
Median Removal (%):	53	21.8	73					

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):				27.5	41.8	35.3

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: 510+

Estimated Costs

Estimated Installation Cost: **low:** $3,000 **high:** $15,000
Estimated Annual O&M Cost: **low:** $500 **high:** $5,000

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Imbrium Systems
Name of Technology:	Stormceptor
Technology Type:	Hydrodynamic Separation

Treatment Notes

The data detailed below is aggregate of many field studies (8) as well as lab studies (2) including the NJCAT TARP program. Most studies were conducted 3rd party with both automatic and grab samplers. Individual test reports are available upon request.

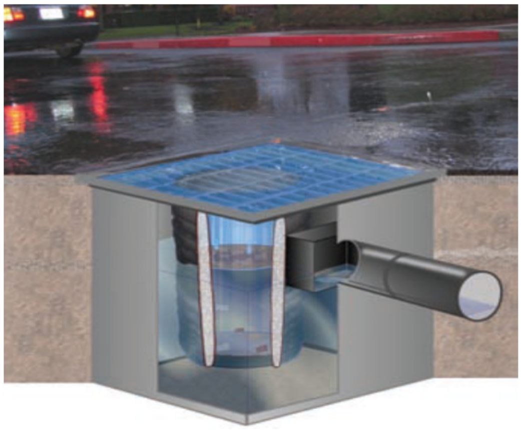
Additional Notes

Despite the above averages, the Stormceptor system, when sized with PCSWMM for Stormceptor has a 0.94 correlation (r-squared regression value) with field performance when an accurate PSD is used to size the unit. Therefore the Stormceptor can be confidently and accurately sized for TSS removal goals on the order of 80% TSS, if the proper consideration like a true PSD are taken into account. Furthermore, the laboratory evaluation indicates that the Stormceptor unit can achieve DOE level performance at flow rates larger than the indicated treatment flow rate on the DOE GULD. The flow rates listed in the DOE GULD are merely a hydraulic marker within the system that indicates when the unit begins to inhibit scour from the unit.

Treatment Technology Summary Report

Manufacturer/Vendor: Clean Way
Name of Technology: StormClean Catch Basin Insert
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ________________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Clean Way
Name of Technology:	StormClean Catch Basin Insert
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

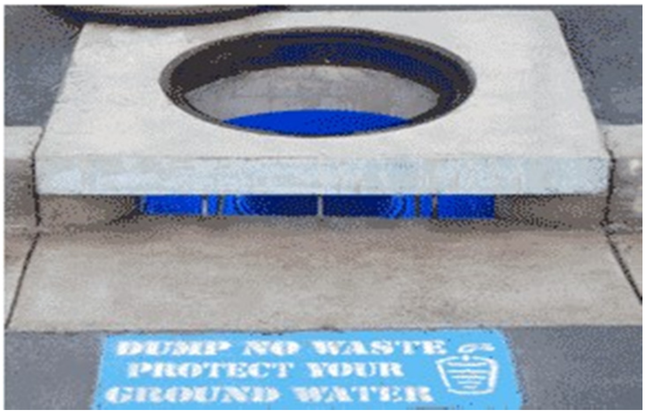
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Clean Way
Name of Technology: StormClean Curb Inlet Insert
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Clean Way
Name of Technology:	StormClean Curb Inlet Insert
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Clean Way
Name of Technology: StormClean Wall Mount Filtration Unit
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Clean Way
Name of Technology:	StormClean Wall Mount Filtration Unit
Technology Type:	Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

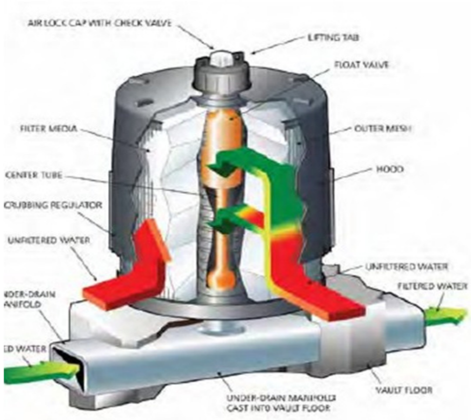
Additional Notes

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: CONTECH Construction Products Inc.
Name of Technology: StormFilter - ZPG
Technology Type: Media Filtration(Cartridge)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 2
high: 44900

System Footprint (sq. ft.):
8 - 6,050

Required Head Loss (ft):
1.8 - 12

Internal or External Bypass:
Both available

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	83							0.12
Median Effluent (mg/L):	23							0.062
Median Removal (%):	82							42

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	0.0425	0.12	0.225	0.00464		0.0599
Median Effluent (mg/L):	0.0335	0.0435	0.12767	0.00423		0.0532
Median Removal (%):	47	24	62	11		15

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		GULD			

	50% TSS Removal	80% TSS Removal
NJCAT		X

Other Approvals:

Local Installations

# of Installations in Washington: > 500

Estimated Costs

Estimated Installation Cost: **low:** $10K **high:** $2.5 M
Estimated Annual O&M Cost: **low:** $0.00008/gal **high:** $0.00024/gal

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Construction Products Inc.
Name of Technology: StormFilter - ZPG
Technology Type: Media Filtration(Cartridge)

Treatment Notes

a) Stormwater Management StormFilter Basic Treatment Application for General Use Level Designation (2005): field,flow-weighted, peer reviewed, composite samples; b) Milwaukee Riverwalk ETV; Third Party, Field, Flow weighted. c) Heritage Marketplace Field Evalution (2004): field, flow-weighted, peer reviewed, composite samples; d) EvTec Lake Union Ultra-Urban Stormwater Technology Evaluation Stormwater Management StormFilter (2008): field, third party, composite.

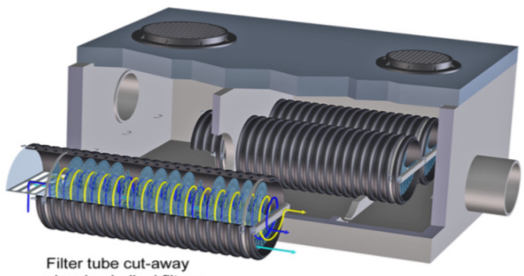
Additional Notes

TSS reference a; Metals references b & c; cPAHs reference d. cPAHs used Chrysene as the parameter as it was the median performance for the suite of requested analytes. Ranges were 33% to 47% for the entire suite. cPAH data contained 10% more GAC (by volume) than standard ZPG.

Treatment Technology Summary Report

Manufacturer/Vendor: Fabco Industries
Name of Technology: Stormsafe-helix
Technology Type: Media Filtration(Cartridge)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 3
high: 9

System Footprint (sq. ft.): 160 - 250

Required Head Loss (ft): 0 - 3

Internal or External Bypass: both

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: none

Estimated Costs

Estimated Installation Cost: **low:** $20,000 **high:** $60,000
Estimated Annual O&M Cost: **low:** $2,000 **high:** $6,000

HERRENA

Treatment Technology Summary Report

Manufacturer/Vendor:	Fabco Industries
Name of Technology:	Stormsafe-helix
Technology Type:	Media Filtration(Cartridge)

Treatment Notes

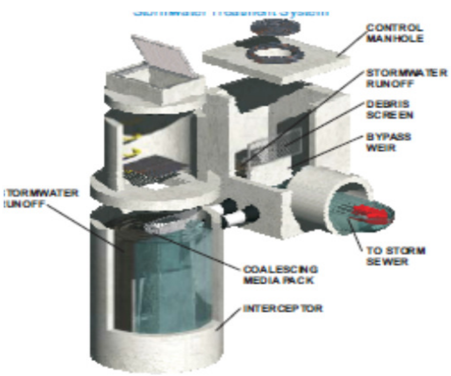
We have conducted lab and field studies as descried in our online reports, we are currently undergoing 3rd party field testing at a wastewater treatment plant, treating 10 acres of stormwater runoff.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Park USA
Name of Technology: StormTrooper®
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 0
high: 11000

System Footprint (sq. ft.):

Required Head Loss (ft): 0.22

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor:	Park USA
Name of Technology:	StormTrooper®
Technology Type:	Hydrodynamic Separation

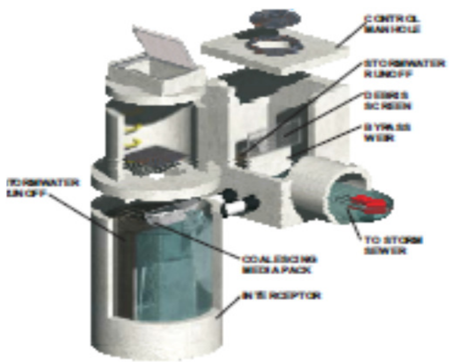
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Park USA
Name of Technology: StormTrooper® EX Extra-Duty
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.): ________

Required Head Loss (ft): ________

Internal or External Bypass: ________

Application ________

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals: ________

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

Treatment Technology Summary Report

Manufacturer/Vendor:	Park USA
Name of Technology:	StormTrooper® EX Extra-Duty
Technology Type:	Hydrodynamic Separation

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: SwaleGard
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Schematic

System Design Information

Design Flow Rate (gpm):
low: 100
high: 800

System Footprint (sq. ft.): 4 - 16

Required Head Loss (ft): 0 - 0.5

Internal or External Bypass: Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	100		35	35				35
Median Effluent (mg/L):	20		7	7				
Median Removal (%):	80		80	80				7

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 2

Estimated Costs

Estimated Installation Cost: **low:** $4,500 **high:** $4,500
Estimated Annual O&M Cost: **low:** $75 **high:** $300

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: SwaleGard
Technology Type: Drain Inlet Insert(Combination System (Screen and Absorbent Boom/Fabric))

Treatment Notes

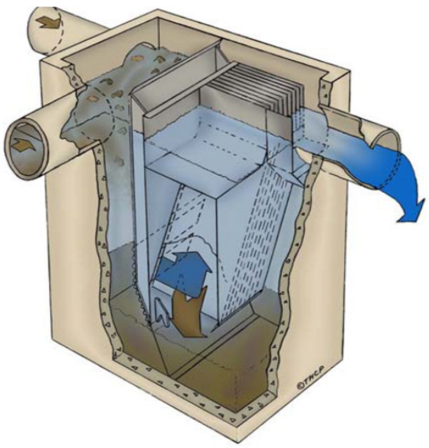
Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Terre Hill Concrete Products
Name of Technology: Terre Kleen™
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 1.5
high: 100

System Footprint (sq. ft.): 0

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND							
Median Effluent (mg/L):	ND							
Median Removal (%):	78							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor: Terre Hill Concrete Products
Name of Technology: Terre Kleen™
Technology Type: Hydrodynamic Separation

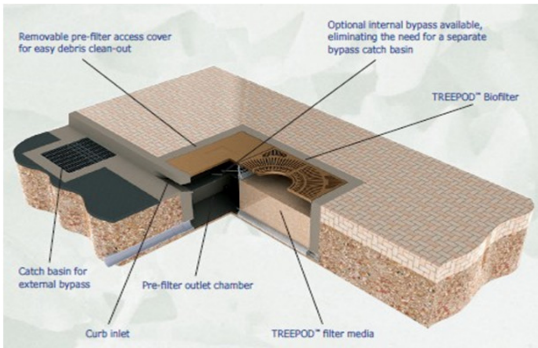
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Kristar Enterprises, Inc.
Name of Technology: TreePod Biofilter
Technology Type: Bioretention/Filtration

Schematic



System Design Information

Design Flow Rate (gpm):
low: 16
high: 72

System Footprint (sq. ft.):
24 - 84

Required Head Loss (ft):
0 - 0.5

Internal or External Bypass:
Internal

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	TBD		TBD	TBD				TBD
Median Effluent (mg/L):	TBD		TBD	TBD				TBD
Median Removal (%):	TBD		TBD	TBD				TBD

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	TBD	TBD	TBD	TBD	TBD	TBD
Median Effluent (mg/L):	TBD	TBD	TBD	TBD	TBD	TBD
Median Removal (%):	TBD	TBD	TBD	TBD	TBD	TBD

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $10,000 **high:** $50,000
Estimated Annual O&M Cost: **low:** $400 **high:** $750

Treatment Technology Summary Report

Manufacturer/Vendor:	Kristar Enterprises, Inc.
Name of Technology:	TreePod Biofilter
Technology Type:	Bioretention/Filtration

Treatment Notes

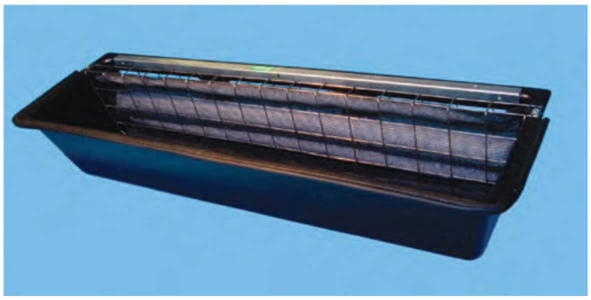
Internal Hydraulic testing only completed at this time. UNH field study for performance currently under way.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: Triton Drop Inserts
Technology Type: Drain Inlet Insert(Media Filtration (Cartridge))

Schematic



System Design Information

Design Flow Rate (gpm):
low: 100
high: 5404

System Footprint (sq. ft.):

Required Head Loss (ft):

Internal or External Bypass:
Both available

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: > 100

Estimated Costs

Estimated Installation Cost: **low:** $300 **high:** $2,500
Estimated Annual O&M Cost: **low:** $0.000002/gal **high:** $0.00008/gal

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: Triton Drop Inserts
Technology Type: Drain Inlet Insert(Media Filtration (Cartridge))

Treatment Notes

Additional Notes

Treatment Technology Summary Report

HERRERA

Manufacturer/Vendor: AbTech Industries
Name of Technology: Ultra Urban Filter
Technology Type: Drain Inlet Inset (Absorbent Boom/Fabric)

Schematic

System Design Information

Design Flow Rate (gpm):
low: 190
high: 500

System Footprint (sq. ft.):
0

Required Head Loss (ft):
0.5 - 1.5

Internal or External Bypass:
Internal Bypass

Application
Stormwater/Process Water

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):			>100	>100	180			>100
Median Effluent (mg/L):			<10	<10	>4.4			>10
Median Removal (%):	*80		90	85	**40			**60

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: **low:** $400 **high:** $1,700
Estimated Annual O&M Cost: **low:** NA **high:** NA

Treatment Technology Summary Report

Manufacturer/Vendor:	AbTech Industries
Name of Technology:	Ultra Urban Filter
Technology Type:	Drain Inlet Inset (Absorbent Boom/Fabric)

Treatment Notes

Primary analysis of AbTech Industries Ultra Urban Filter (UUF) was conducted in laboratory studies conducted by third parties using grab samples from established test protocols developed by federal and state regulatory entities. Field data was collected during studies conducted by municipalities to evaluate the effectiviness of the UUFs for deployment in the localized watershed. The testing methods used by the municipalities were governed by the state regulatory body, in which that municipality was located.

Additional Notes

* Data based on Particle Size Distribution (PSD) and not on mg/L. Samples tested were evaluated using a medium sand in the 0.355-0.300 mm range.

**Reduction of soluble dissolved hydrocarbons occurs when they become partitioned in the dispersed hydrocarbons and are removed simultaneously. Filtration of dissolved phase hydrocarbons through AbTech's UUFs will not occur, in substantial percent volumes, without the presence of dispersed hydrocarbons. Bench scale testing can be conducted on field samples to establish viability in a specific environment or to meet a specific discharge standard.

Total Metals Removal: Based on TSS testing the UUF has the ability to physically separate Total Metals from the water column, but AbTech products have no Chemical or Biological exchange during the filtration of Total Metals.

Treatment Technology Summary Report

Manufacturer/Vendor: Rotondo Environmental Solutions, LLC
Name of Technology: Underground Sandfilter (DC Sandfilter)
Technology Type: Media Filtration (Sand Filter)

Schematic

System Design Information

Design Flow Rate (gpm):
low: ________
high: ________

System Footprint (sq. ft.):
0

Required Head Loss (ft):

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: ________

Estimated Costs

Estimated Installation Cost: low: ________ high: ________
Estimated Annual O&M Cost: low: ________ high: ________

HERRERA

Treatment Technology Summary Report

Manufacturer/Vendor:	Rotondo Environmental Solutions, LLC
Name of Technology:	Underground Sandfilter (DC Sandfilter)
Technology Type:	Media Filtration (Sand Filter)

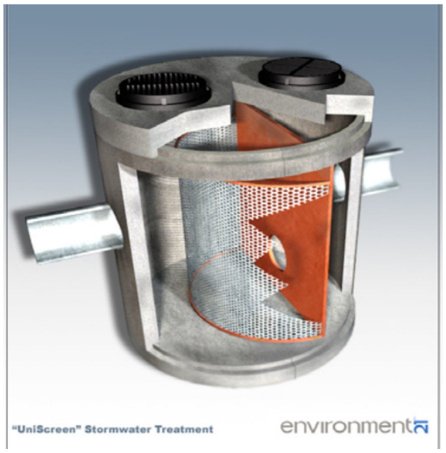
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: UniScreen
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 0
high: 15,700

System Footprint (sq. ft.): 20-135

Required Head Loss (ft): 0-0.5

Internal or External Bypass: Both

Application Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	*250		**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175		**150	**150	**150	**150	**150	**150
Median Removal (%):	*80		**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.06	***0.56	***0.18	NA	NA	NA
Median Removal (%):	***20	***27	***40	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: low: $2,000 high: $15,000
Estimated Annual O&M Cost: low: 0 high: $2,000

Treatment Technology Summary Report

Manufacturer/Vendor:	Environment 21
Name of Technology:	UniScreen
Technology Type:	Hydrodynamic Separation

Treatment Notes

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 150 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: UniStorm
Technology Type: Hydrodynamic Separation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 0
high: 15,700

System Footprint (sq. ft.): 20-135

Required Head Loss (ft): 0-0.5

Internal or External Bypass: NA

Application
Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	*250	ND	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	ND	**150	**150	**150	**150	**150	**150
Median Removal (%):	*80	80	**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.06	***0.56	***0.18	NA	NA	NA
Median Removal (%):	***20	***27	***40	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: **low:** $2,000 **high:** $15,000
Estimated Annual O&M Cost: **low:** 0 **high:** $2,000

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: UniStorm
Technology Type: Hydrodynamic Separation

Treatment Notes

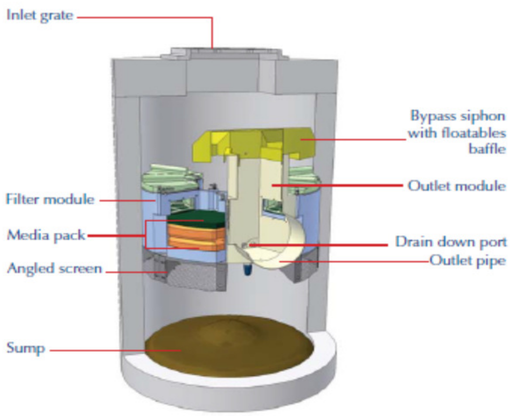
*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 150 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Hydro International, Inc.
Name of Technology: Up-Flo™ Filter
Technology Type: Media Filtration(up flow)

Schematic



System Design Information

Design Flow Rate (gpm):
low: 147
high: 448

System Footprint (sq. ft.): 0

Required Head Loss (ft): 1.7-2.5

Internal or External Bypass:

Application

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	ND							
Median Effluent (mg/L):	ND							
Median Removal (%):	91							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE		PULD			

	50% TSS Removal	80% TSS Removal
NJCAT		X

Other Approvals:

Local Installations

# of Installations in Washington:

Estimated Costs

Estimated Installation Cost: low: high:
Estimated Annual O&M Cost: low: high:

Treatment Technology Summary Report

Manufacturer/Vendor: Hydro International, Inc.
Name of Technology: Up-Flo™ Filter
Technology Type: Media Filtration(up flow)

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: UrbanGreen BioFilter
Technology Type: Bioretention/Filtration

Schematic

System Design Information

Design Flow Rate (gpm):
low: 4
high: 600

System Footprint (sq. ft.):

Required Head Loss (ft):
3,6

Internal or External Bypass:
Both available

Application
Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: > 25

Estimated Costs

Estimated Installation Cost: **low:** $10k **high:** $250K
Estimated Annual O&M Cost: **low:** $0.0001/gal **high:** $0.0003/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	CONTECH Stormwater Solutions, Inc.
Name of Technology:	UrbanGreen BioFilter
Technology Type:	Bioretention/Filtration

Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: V2B1 Treatment System
Technology Type: Hydrodynamic Separation

Schematic

System Design Information

Design Flow Rate (gpm):
low: 0
high: 63000

System Footprint (sq. ft.): 20-800
Required Head Loss (ft): 0-0.5
Internal or External Bypass: Both
Application: Stormwater

Treatment Performance

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	*250	ND	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	ND	**150	**150	**150	**150	**150	**150
Median Removal (%):	*80	40	**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Number of samples:						
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.05	***0.35	***0.09	NA	NA	NA
Median Removal (%):	***40	***55	***70	NA	NA	NA

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE	PULD				

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: 0

Estimated Costs

Estimated Installation Cost: low: $2,000 high: $15,000
Estimated Annual O&M Cost: low: 0 high: $2,000

Treatment Technology Summary Report

Manufacturer/Vendor: Environment 21
Name of Technology: V2B1 Treatment System
Technology Type: Hydrodynamic Separation

Treatment Notes

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d50 of 110 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

Additional Notes

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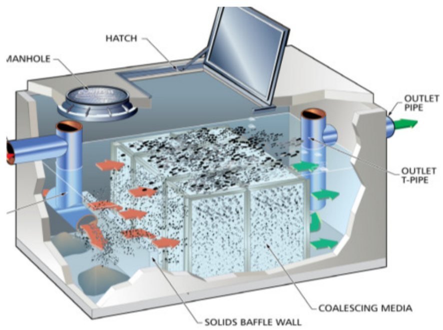
Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: VortClarex
Technology Type: Oil/Water Separator

Schematic



System Design Information

Design Flow Rate (gpm):
low: 100
high: 2000

System Footprint (sq. ft.):

Required Head Loss (ft):
0.1

Internal or External Bypass:
Both available

Application
Stormwater

Treatment Performance *

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):								
Median Effluent (mg/L):								
Median Removal (%):								

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE					

	50% TSS Removal	80% TSS Removal
NJCAT		

Other Approvals:

Local Installations

# of Installations in Washington: >25

Estimated Costs

Estimated Installation Cost: **low:** $10K **high:** $300K
Estimated Annual O&M Cost: **low:** $0.00008/gal **high:** $0.001/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	CONTECH Stormwater Solutions, Inc.
Name of Technology:	VortClarex
Technology Type:	Oil/Water Separator

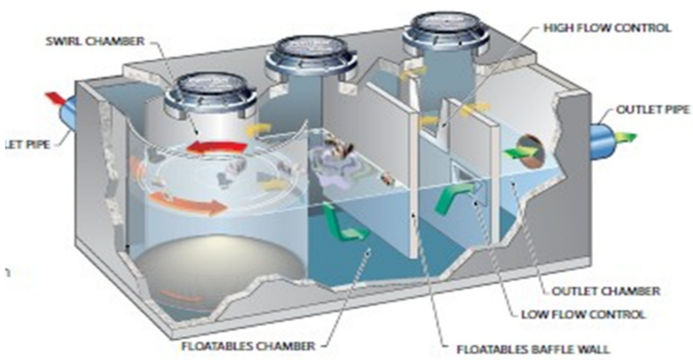
Treatment Notes

Additional Notes

Treatment Technology Summary Report

Manufacturer/Vendor: CONTECH Stormwater Solutions, Inc.
Name of Technology: Vortechs
Technology Type: Hydrodynamic Separation

Schematic



System Design Information

Design Flow Rate (gpm):
low: 50
high: 22450

System Footprint (sq. ft.): NA
Required Head Loss (ft): 0.1
Internal or External Bypass: Both Available
Application: Stormwater

*Treatment Performance **

	TSS	TP	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Number of samples:								
Median Influent (mg/L):	108							
Median Effluent (mg/L):	28							
Median Removal (%):	93							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Number of samples:						
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

* blank cells indicate no information was received from vendor

Approvals

	Pretreatment	Basic	Enhanced	Phosphorus	Oil
TAPE	GULD				

	50% TSS Removal	80% TSS Removal
NJCAT	X	

Other Approvals:

Local Installations

# of Installations in Washington: > 100

Estimated Costs

Estimated Installation Cost: **low:** $20K **high:** $500K
Estimated Annual O&M Cost: **low:** $0.000001/gal **high:** $0.00004/gal

Treatment Technology Summary Report

Manufacturer/Vendor:	CONTECH Stormwater Solutions, Inc.
Name of Technology:	Vortechs
Technology Type:	Hydrodynamic Separation

Treatment Notes

The WAWA Route 37 Stormwater Treatment System TARP TIER II Field Evalaution: Vortechs (2010). Field, Peer Reviewed, Composite.

Additional Notes

APPENDIX B

Technology Questionnaire Responses

Appendix B Index (by Treatment System Name)

Appendix B Index (by Treatment System Name)

Appendix B Index (by Manufacturer/Vendor Name)

Appendix B Index (by Manufacturer/Vendor Name)

Active

Manufacturer Technology Report

Manufacturer:	WaterTectonics	**Contact Name:**	Jim Mothersbaugh
Name of Technology:	ACISTBox	**Contact Email:**	jim@watertectonics.com
# of Installations in Washington:	5	**Contact Phone:**	866-402-2298
		Contact Website:	www.watertectonics.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [x] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [x] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** $ 25,000 **high:** $ 400,000
Estimated Annual O&M Cost ($/gallon treated): **low:** ______ **high:** ______

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	100	>1000
System aboveground footprint (sq ft):	200	>2000
Required head loss (ft):	N/A	N/A

Internal or External Bypass: None - auto recirculation

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Field by operator; in-line real-time with sensors/data loggers for turbidity and pH; in-house and independent party grab/composite sampling; in-house and 3rd party independent analytical laboratory testing.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):		3.12		0.0199			0.00028
Median Effluent (mg/L):		0.38		0.00002			0.00002
Median Removal (%):		88%		99.9%			93%

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	0.341	0.25	2.12			0.817
Median Effluent (mg/L):	0.0179	0.05	1.04			0.744
Median Removal (%):	95%	80%	51%			9%

Notes, Comments, Additional References

Provided under DOE issued GULD as Chitosan-Enhanced Sandfiltration (CESF), a stand alone system. Water Tectonics expands CESF application for removal of LNAPL, NWTPH, cPAH/PAH's, and metals by system modification to include oil/water separation, enhanced pre-treatment, post SF micron filtration, and granular activated carbon and/or other media adsorption. As a stand-alone technology it is designated for turbidity and pH. If raw water turbidity is >600 NTU, pretreatment is required. CESF has limited to no ability to remove turbidity consisting of rock dust, rock flour, or other rock source fines that have not been geochemically weathered over time. Chitosan performance is typically compromised by acidic or alkaline pH conditions out side the neutral range. Performance data presented is from from full-scale use at temporary projects where RSA CESF technology was used in accordance with GULD specifications with modifications for enhanced removal components (e.g., granular activated carbon). Untreated construction water ranging from >25 NTU to > 5000 NTU (with pretreatment if over 600 NTU) have all been reduced to <10 NTU, but typically to <5 NTU. Flow ranges for various conventional system sizes range from 100 to over 1000 gpm for 24/7 continuous operations.

HERRERA

Manufacturer Technology Report

Manufacturer:	BakerCorp	**Contact Name:**	Tim Ferris
Name of Technology:	Baker Tank with Chitosan Enhanced Sand Filtration	**Contact Email:**	tferris@bakercorp.com
# of Installations in Washington:	1	**Contact Phone:**	206-793-6136
		Contact Website:	bakercorp.com

Treatment Type/Application *(check all that apply)*

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separation
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☑ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☑ Filtration (chemically enhanced)
- ☑ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☑ Chemical Treatment
- ☑ Stormwater
- ☑ Groundwater
- ☑ Wastewater
- ☑ Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** ________ **high:** ________

Estimated Annual O&M Cost ($/gallon treated): **low:** ________ **high:** ________

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	15gpm	1,000gpm+
System aboveground footprint (sq ft):	1,000sq ft	2,500sq ft
Required head loss (ft):		

Internal or External Bypass: ____________________

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	200						
Median Effluent (mg/L):	10						
Median Removal (%):	95						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	150	500	2500	20	40	400
Median Effluent (mg/L):	75	200	1000	10	20	40
Median Removal (%):	50	40	50	50	50	90

Notes, Comments, Additional References

TSS, total metals, and dissolved metals removal will depend upon the degree that they will absorb to particulate matter. The values provided for these parameters are based upon a study done by Dungeness Environmental during 2009-2010. Dungeness Environmental does not have relevant data for the organics listed in this table. For any questions, please contact Chris Palczewski at Dungeness Environmental: 425-481-0600 or cpalczewski@dungenessenviro.com. Thank you.

Manufacturer Technology Report

Manufacturer: Clear Creek Systems, Inc.
Name of Technology: Multiple Technologies
# of Installations in Washington: > 15 on the West Coast

Contact Name: Jason Ziemer
Contact Email: jziemer@clearcreeksystems.com
Contact Phone: 253 670 4054
Contact Website: www.clearcreeksystems.com

Treatment Type/Application *(check all that apply)*

- [x] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separation
- [x] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [x] Filtration (chemically enhanced)
- [x] Ion exchange column
- [x] Reverse osmosis
- [ ] Electrocoagulation
- [x] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: 15,000 high: >250,000
Estimated Annual O&M Cost ($/gallon treated): low: < 0.001 high: > 0.003

System Hydraulics/Design

Design Flow Rate (gpm): low: < 25 high: > 2,000
System aboveground footprint (sq ft): low: < 25 high: > 2,000
Required head loss (ft): low: NA high: NA
Internal or External Bypass: External - Offline Facility

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Attached data was collected from grab samples that were analyzed by an accredited laboratory.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Clear Creek Systems, Inc. (CCS) provides a wide variety of water treatment equipment including particulate filtration, mixed media absorption, ion exchange, oil/water seperators, UV, RO, chemical treatment and chemically enhanced sand filtration. Our treatment systems are sized for specific site requirements using the Western Washington Hydrology Model 3. We select the appropriate treatment technology for a specific site by conducting either laboratory or field treatability and pilot testing. For this reason we have included a broad range of flow rates, costs and footprint requirements. We have attached some data and a Power Point presentation that further explains our approach and capabilities. In addition, much more information about CCS can be found at www.clearcreeksystems.com. We have attached some data for your review, but most of our clients have not released us to share the data that has been collected at their sites.

Manufacturer Technology Report

Manufacturer:	Schreiber LLC	**Contact Name:**	William Kunzman
Name of Technology:	Fuzzy Filter	**Contact Email:**	billk@schreiberwater.com
Technology Category:		**Contact Phone:**	205-655-7466
Technology Process:		**Contact Website:**	www.schreiberwater.com

# of Installations in Washington: 0

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☐ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☑ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☑ Groundwater
- ☑ Wastewater
- ☑ Process water

Estimated Costs

Estimated Installation Cost: low: ______ high: ______
Estimated Annual O&M Cost: low: ______ high: ______

System Hydraulics

Design Flow Rate (gpm): low: 70 high: unlimited
Required head loss (ft): 3.5
Internal or External Bypass: external

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Fuzzy Filter removes suspende solids 4 microns and above. The media is compressible so that pore size can be adjusted thru changes in compressioon of the media via the integral actuator connected to a perforated compression plate. Influent solids should be less than 100 mg/l with many typical applications processing water streams containing 20 mg/l and less. Attached is a particle distribution analysis for removal of suspended solids from river water. Two recent projects under contruction include filtration of contaminated storm water collected within chemical plants. We also have several CSO installations, one of which can process 85 MGD for the city of Atlanta.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):	10								
Median Effluent (mg/L):	2								
% Removal:	70-95%								

Notes, Comments, Additional References

Fuzzy Filter removes suspende solids 4 microns and above. The media is compressible so that pore size can be adjusted thru changes in compressioon of the media via the integral actuator connected to a perforated compression plate. Influent solids should be less than 100 mg/l with many typical applications processing water streams containing 20 mg/l and less. Attached is a particle distribution analysis for removal of suspended solids from river water. Two recent projects under contruction include filtration of contaminated storm water collected within chemical plants. We also have several CSO installations, one of which can process 85 MGD for the city of Atlanta.

Manufacturer Technology Report

HERRERA

Manufacturer: KASELCO, LLC
Name of Technology: High-Flo Electocoagulation
# of Installations in Washington: 0 in WA, 2 in Vancouver

Contact Name: Douglas Herber
Contact Email: dherber@kaselco.com
Contact Phone: 361-594-3327
Contact Website: www.kaselco.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [x] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** $25,000 **high:** $2,200,000
Estimated Annual O&M Cost ($/gallon treated): **low:** $0.0005 **high:** $0.01

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 2.5 **high:** 1,200+ Can link systems in parallel for larger capacity
System aboveground footprint (sq ft): **low:** 40 **high:** 4000
Required head loss (ft): **low:** 2 **high:** 20
Internal or External Bypass: External

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

System Performance has been evaluated in lab as well as in field research applications and existing installations. Grab samples are analyzed both internally as well as by a third party lab.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Have attached actual test result parameters. We are currently in the process of having detailed third party test evaluations and will supply those results as available.

Manufacturer Technology Report

Manufacturer: OilTrap Environmental Prd.
Name of Technology: OilTrap ElectroPulse
# of Installations in Washington: 33

Contact Name: Mike Davis
Contact Email: mike@oiltrap.com
Contact Phone: 360.943.6495
Contact Website: www.oiltrap.com

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [x] Electrocoagulation
- [ ] Chemical Treatment
- [ ] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

	low	high
Estimated Installation Cost (unit cost and construction cost):	25,000	500000
Estimated Annual O&M Cost ($/gallon treated):	$0.002	0.005

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	5	500
System aboveground footprint (sq ft):	40	1500
Required head loss (ft):	5	15

Internal or External Bypass: either

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Samples were collected as routine grab samples and tested by an EPA certified laboratory.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	600	78	136	28	Unknown	Unknown	Unknown
Median Effluent (mg/L):	10	0.27	<5.0	0.43	Unknown	Unknown	Unknown
Median Removal (%):	98.3	99.6	>96.3	98.4	Unknown	Unknown	Unknown

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	12.1	14.1	151	8.2	10.9	78.6
Median Effluent (mg/L):	0.072	0.039	0.34	0.072	0.039	0.34
Median Removal (%):	99.4	99.7	99.9	99.1	99.6	99.9

Notes, Comments, Additional References

I have not worked with wastewater with PCB or dioxins. We generally see 90%+ in reduction of pesticides also.

Manufacturer Technology Report

HERRERA

Manufacturer: WaterTectonics
Name of Technology: pHATBox
# of Installations in Washington: 40 +

Contact Name: Jim Mothersbaugh
Contact Email: jim@watertectonics.com
Contact Phone: 866-402-2298
Contact Website: www.watertectonics.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [x] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: $ 19,500 high: $ 28,500
Estimated Annual O&M Cost ($/gallon treated): low: (a) high: (a)

System Hydraulics/Design

Design Flow Rate (gpm): low: 250 high: 350
System aboveground footprint (sq ft): low: 10 (b) high: 24 (b)
Required head loss (ft): low: N/A high: N/A
Internal or External Bypass: N/A

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Field. Real-time with in-line probes. 2-point buffer calibration.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Median Effluent (mg/L):	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Median Removal (%):	(c)	(c)	(c)	(c)	(c)	(c)	(c)

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	(c)	(c)	(c)	(c)	(c)	(c)
Median Effluent (mg/L):	(c)	(c)	(c)	(c)	(c)	(c)
Median Removal (%):	(c)	(c)	(c)	(c)	(c)	(c)

Notes, Comments, Additional References

(a) Depends on buffering capacity of waterstream, flow rate, total volume processed, specific pH adjustment additive selected, and final pH point required.
(b) Packaged in 4' -6' (w) x 2.5' (d) x 4' (t) industrial steel box w/hinged top opening lid. Additional storage space for addtive will depend on volume of additive storage (up to 35-gal drums in box, larger must go external) - plus secondary containment). Unit has in-line pH probe for real time monitoring and data logger expandable for dual pH adjustment (multi injection/mixing loops), and flow recording. pH set-point(s) programmable into controller.
(c) Adjusts pH. System performance data - not applicable.

Additional Notes:
-Effective for controlling alkaline waters from cement/concrete operations using carbon dioxide.
-Suitable for inclusion as pH adustment component in variety of water treatment systems.
-pH set-points (high/low) variable for application.

HERRERA

Manufacturer Technology Report

Manufacturer:	StormwateRx LLC	**Contact Name:**	Ayn Generes
Name of Technology:	Purus Polishing System	**Contact Email:**	ayng@stormwaterx.com
# of Installations in Washington:	YES	**Contact Phone:**	800.680.3543
		Contact Website:	www.stormwaterx.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [x] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost):	**low:**	10000	**high:**	140000
Estimated Annual O&M Cost ($/gallon treated):	**low:**	0.0024	**high:**	0.0047

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	5	**high:**	210
System aboveground footprint (sq ft):	**low:**	10	**high:**	90
Required head loss (ft):	**low:**	70	**high:**	120

Internal or External Bypass: External

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

These samples were collected as grab samples by StormwateRx, consulting engineers, and facility treatment system operators. All analytical data is from a third party certified analytical lab. Non-detects were assumed to have the value of one half the detection limit.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):		YES		YES	YES		YES

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):			0.28			.060
Median Effluent (mg/L):			0.083			0.0074
Median Removal (%):			86			88

Notes, Comments, Additional References

Additional pollutant removal includes bacteria (>99%), PCBs, PAHs and toxic organics.

HERRERA

Manufacturer Technology Report

Manufacturer:	Morselt Borne BV	**Contact Name:**	Harry Assink
Name of Technology:	Redbox	**Contact Email:**	info@morselt.com
Technology Category:		**Contact Phone:**	31742661166
Technology Process:		**Contact Website:**	www.morselt.com

# of Installations in Washington:

Treatment Type/Application *(check all that apply)*

☐ Downspout	☐ Oil/Water Separartion	☐ Filtration (media)	☐ Ion exchange column	☐ Stormwater
☐ Drain Inlet Insert	☐ Settling	☐ Filtration (fabric)	☐ Reverse osmosis	☐ Groundwater
☐ Below Ground Vault	☐ Hydrodynamic Separation	☐ Filtration (biofiltration)	☑ Electrocoagulation	☑ Wastewater
☐ Above Ground Vault	☐ Floatables Baffle	☐ Filtration (chemically enhanced)	☐ Chemical Treatment	☑ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$42,000	**high:**	$1,000,000
Estimated Annual O&M Cost:	**low:**	$1,000	**high:**	$20,000

System Hydraulics

Design Flow Rate (gpm):	**low:**	0.5	**high:**	150
Required head loss (ft):	n.a.			
Internal or External Bypass:	n.a.			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Third part analysis has been performed in many cases. Results show very high removal rates, especially for heavy metals.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:	99		99	99	99	99			

Notes, Comments, Additional References

The RedBox purifies industrial wastewater for many industries such as plating, paper, printing, paint manufacturing.

HERRERA

Manufacturer Technology Report

Manufacturer: Siemens
Name of Technology: WWIX
Technology Category:
Technology Process: Regulated Metals Removal
# of Installations in Washington: >500

Contact Name: Adam Szczesniak
Contact Email: adam.szczesniak@siemens.com
Contact Phone: 860-593-2063
Contact Website: siemens.com/water

Treatment Type/Application *(check all that apply)*

- [x] Downspout
- [x] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [x] Filtration (chemically enhanced)
- [x] Ion exchange column
- [x] Reverse osmosis
- [ ] Electrocoagulation
- [x] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

	low	high
Estimated Installation Cost:	3,000	250,000
Estimated Annual O&M Cost:	3,000	500,000

System Hydraulics

Design Flow Rate (gpm): low: 1gpm high: 5000gpm
Required head loss (ft): 20psi
Internal or External Bypass: None

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Siemens manufactures an extensive line of water treatment equipment from mobile clarification, precipitation, membrane technologies and ion excahnge or adsorptive systems. For stormwater treatment systems Siemens has media tailored to achieve low discharge levels as low as 1ppb and 12ppt for mercury. Siemens systems are typically sampled by customer and checked with on site test kits or samples shipped to local certified laboratories for evaluation.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

Manufacturer Technology Report

HERRERA

Manufacturer:	WaterTectonics	**Contact Name:**	Jim Mothersbaugh
Name of Technology:	WaveIonics	**Contact Email:**	jim@watertectonics.com
# of Installations in Washington:	35+	**Contact Phone:**	866-402-2298
		Contact Website:	www.watertectonics.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☑ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☑ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☑ Groundwater
- ☑ Wastewater
- ☑ Process water

Estimated Costs

	low:		high:	
Estimated Installation Cost:	low:	60000	high:	850000
Estimated Annual O&M Cost:	low:	0.0008	high:	0.008

System Hydraulics/Design

Design Flow Rate (gpm):	low:	50	high:	>1000
System footprint (sq ft):	low:	200	high:	>4000
Required head loss (ft):	low:	NA	high:	NA
Internal or External Bypass:	NONE-auto recirculation for retreat			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Field via hand-held instruments, Technology's in-line and real-time water quality monitoring system, Oversight Engineers/Project Owners, 3rd party analytical testing laboratories using both instantaneous grab and composting methods (manual and automated). System performance "Median" data presented below does not accommodate analytical data results for parameters report as ND (<MDL's, or <MCL's). All ND data was utilized in the calculations as the value of the MDL or MCL. Influent data is limited in that our Clients typically do not incur cost expenditure to evaluate raw water characteristics once the system has been designed, installed, and made operational. They focus on monitoring effluent quality. Further, effluent data generated by our Clients/System Owners do not typically provide us with DMR's they submit to Ecology or other regulatory agencies. Effluent data points do not reflect technology ability to achieve lower than reported results. Permit discharge limitations have historically varied from site to site, permit to permit , and therefore data reflect treatment efforts and not technology limitations.

	NTU's	TSS	TPH0	O&G	SVOCs	PCBs	Dioxins
Median Influent (mg/L):	830	200	45.6	197	2.34	0.0024	
Median Effluent (mg/L):	0.4	5	0.25	4.76	0.00002	0.00011	
Median Removal (%):	100	98	99	98	100	9505	

	Total Metals			Dissolved Metals			
	Cu	Pb	Zn	Cu	Pb	Zn	CPAHs
Median Influent (mg/L):	4.8	0.253	0.516	0.0235	0.0157	0.12	0.081
Median Effluent (mg/L):	0.0074	0.003	0.0315	0.005	0.0031	0.02	0.00002
Median Removal (%):	100	99	94	79	80	83	99.98

Notes, Comments, Additional References

WaveIonics electrocoagulation (EC) technology can be stand-alone, or part of a treatment train with supplemental components (see Treatment Type/Application, above) utilized for pre-treatment and/or polishing. EC facilitates the coagulation of suspended solids fines and/or dissolved species that are suitable for removal by conventional precipitation settling and/or filtration process steps. EC reactions will depend on the nature of constituents present, their reaction chemistry, pH sensitivity, and water conductivity. Bacteria disinfection has been demonstrated at laboratory and full-scale applications. Technology viability and optimization is recommended for non-conventional constituents of concern, or for complex matrices where interferences and competing conditions are problematic to conventional advanced treatment processes. Although a technology for application to a broad-spectrum of constituents, EC does not rely on treatment chemicals (e.g. polymers), it generates low solids volumes, is full-automated to reduce O&M labor, and cost-effectively converts AC power to DC. Power consumption is driven primarily by demand and loads of pumps, common to any mechanical water conveyance system plus optional control area HVAC. System Performance data fields (above) call for "Median" data points that do not allow for presentation of worst-case conditions, nor do they adequately reflect "mean" conditions, both of which are more elevated than the "Median" data presented for influent characteristics. Effluent "median" data do not reflect <MDL or <MCL data as reported by laboratories. However, ND results utilized in the calculation were the numeric value of the actual MDL or MCL. SVOC and cPAH data reflect a summation of all individual constituents in SVOC or cPAH parameter suites as totals. PCB's are totals of all Arochlor congeners. Oil and Grease data reflect both Freon and Hexane extraction analytical methods. Technology has not been used to specifically remove Dioxins and when technology was utilized, Dioxins were not targeted for analytical testing. Other data available upon request for: bacteria; other heavy metals; color from humics, etc.

HERRERA

Manufacturer Technology Report

Manufacturer:	Waste & Environmental Technologies Ltd.	**Contact Name:**	Dr. Alvin Ip
Name of Technology:	WetSep	**Contact Email:**	alvin@wastech.com.hk
Technology Category:	Above Ground Vault	**Contact Phone:**	(852) 2602-0308
Technology Process:	Water Treatment	**Contact Website:**	www.wastech.com.hk
# of Installations in Washington:	1		

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [x] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [x] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [x] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [x] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$1000	**high:**	$2500
Estimated Annual O&M Cost:	**low:**	$100/day	**high:**	$250/day

System Hydraulics

Design Flow Rate (gpm):	**low:**	20	**high:**	260
Required head loss (ft):	40 feet			
Internal or External Bypass:	External Bypass			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

The data can be stored and downloaded from data logger for flowrate, pH and Turbidity. Grab samples can also be taken at various points in the system to be varified by a third party (i.e. laboratory).
Please also find the Field Study for the WetSep filtration System

Parameter:	**SS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):	112	13.4	7 µg/L		0.3 µg/L	18 µg/L			
Median Effluent (mg/L):	<2	1.9	1 µg/L		<0.2 µg/L	<1 µg/L			
% Removal:	98%	86%	86%		50%	94%			

Notes, Comments, Additional References

The WetSep system was used in the State of Washington at the Canada/US border crossing. The main Contractor for this job was JE Dunn Construction. The main use of the unit was for treatment of construction waste runoff.

Passive

Manufacturer Technology Report

Manufacturer:	Eco-Tec, Inc	**Contact Name:**	Herb Pearse
Name of Technology:	ADsorb-it	**Contact Email:**	herb@eco-tec-inc.com
# of Installations in Washington:	61	**Contact Phone:**	253-884-6804
		Contact Website:	www.eco-tec-inc.com

Treatment Type/Application (check all that apply)

- [x] Downspout
- [x] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

	low:	high:
Estimated Installation Cost (unit cost and construction cost):	$0.91/SF	$0.91/SF
Estimated Annual O&M Cost ($/gallon treated):	$0.91/SF	$0.91/SF

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	80/SF	100/SF
System aboveground footprint (sq ft):	Varies	Varies
Required head loss (ft):	NA	NA

Internal or External Bypass: Per individual application

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

A variety of sampling methods have been implemented over the years based on specific installations of the ADsorb-it Filtration Fabric and associated application specific product configurations manufactured from the ADsorb-it Fabric. ADsorb-it is designed to be versatile in its installation for diverse filtration applications, thus it can be configured for Downspout, Drain Inlet Inset, Below Ground Vault, Above Ground Vault, Shoreline, Oil Water Separator, and General Stormwater applications. ADsorb-it is approved by the Department of Ecology (Ecology) for use as a Catch Basin Insert and is used by Ecology for spill response and general oil/water related issues.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	Varies	Varies	Varies				
Median Effluent (mg/L):	Varies	Varies	Varies				
Median Removal (%):	80-99	99-100	99-100				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):	Varies	Varies	Varies	Varies	Varies	Varies

Notes, Comments, Additional References

Please see the attached report from the City of Tacoma as well as the VMS Full Scale and Field Tests for TSS removal. The 'filter blanket" referred to in the City of Tacoma Report is the ADsorb-it Fabric Product #EDB24-5, Contour Ditch Boom. Attached to this email is additional testing / application data and photographs to present a general spectrum of possible applications. As can be seen on our web site at www.eco-tec-inc.com, miles of ADsorb-it Fabric were deployed along the Gulf Coast Shoreline as an Oil Fence to provide effective removal of advancing oils from the BP Deepwater Horizon Release. Additional testing data can be accessed on our web site simply by clicking on "Test Data" in the left hand column. As a note, ADsorb-it is highly effective at removing hydrocarbons, including fats, oils and greases (FOG) from water, thus any other contaminants that would be attached to the hydrocarbon such as PCBs would be removed in conjuncton with hydrocarbon / FOG removal. ADsorb-it is an environmentally compatible product in that it is: Made from waste fibers from the textile manufacturing industry, it effectively removes hydrocarbons and associated / attached contaminants from the environment, it can be cleaned and reused indefinitely, it can be disposed of as a fuel source with a higher BTU per pound value than coal and less than 1% residual ash.

Manufacturer Technology Report

Manufacturer:	AquaShield, Inc.	**Contact Name:**	Mark Miller
Name of Technology:	Aqua-Filter	**Contact Email:**	mmiller@aquashieldinc.com
Technology Category:	Below Ground Vault	**Contact Phone:**	888-344-9044
Technology Process:	Vortex + Filtration	**Contact Website:**	www.aquashieldinc.com

# of Installations in Washington: 13

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [ ] Settling
- [x] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [x] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost:	**low:**	Site-specific	**high:**	Site-specific
Estimated Annual O&M Cost:	**low:**	Site-specific	**high:**	Site-specific

System Hydraulics

Design Flow Rate (gpm): **low:** 25 **high:** 960+

Required head loss (ft): 0.8

Internal or External Bypass: Both

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Independent lab by grab samples. Field by auto-composite sampling, 6 sample pairs per TARP qualifying storm.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:	160								
Median Influent (mg/L):	43								
Median Effluent (mg/L):	5								
% Removal:	80								

Notes, Comments, Additional References

Aqua-Filter filtration cartridge has been verified by NJCAT. AF--5.3 model is currently undergoing independent TARP Tier II field testing in Maryland averaging 96% TSS removal. Anticipate completion in 2012. AF-4.2 model field tested at Univeristy of New Hampshire Stormwater Center, 80% TSS removal efficiency (see above parameters).

Manufacturer Technology Report

Manufacturer: AquaShield, Inc.
Name of Technology: Aqua-Guardian
Technology Category: Drain Inlet Insert
Technology Process: Filtration
# of Installations in Washington: 15

Contact Name: Mark Miller
Contact Email: mmiller@aquashieldinc.com
Contact Phone: 888-344-9044
Contact Website: www.aquashieldinc.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process wate

Estimated Costs

Estimated Installation Cost: **low:** Site-specific **high:** Site-specific
Estimated Annual O&M Cost: **low:** Site-specific **high:** Site-specific

System Hydraulics

Design Flow Rate (gpm): **low:** 5/400* **high:** 100/940*
Required head loss (ft): 0
Internal or External Bypass: Both

* x/x = flow thru perlite/flow thru perlite + filter cloth

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

See Aqua-Filter, since this device uses same media. Independent lab by grab samples. Field by auto-composite sampling, 6 sample pairs per TARP qualifying storm.

Parameter:	TSS	TP	Dis. Cu	Dis. Zn	Dis. Cd	Dis. Pb	TPH	cPAHs	PCBs
# of sample:	160								
Median Influent (mg/L):	43								
Median Effluent (mg/L):	5								
% Removal:	80								

Notes, Comments, Additional References

See Aqua-Filter since this device uses same filter media. Aqua-Filter filtration cartridge has been verified by NJCAT. AF-5.3 model is currently undergoing independent TARP Tier II field testing in Maryland averaging 96% TSS removal. Anticipate completion in 2012. AF-4.2 model field tested at Univeristy of New Hampshire Stormwater Center, 80% TSS removal efficiency (see above parameters).

Manufacturer Technology Report

Manufacturer:	AquaShield, Inc.	**Contact Name:**	Mark Miller
Name of Technology:	Aqua-Swirl	**Contact Email:**	mmiller@aquashieldinc.com
Technology Category:	Below Ground Vault	**Contact Phone:**	888-344-9044
Technology Process:	Hydrodynamic Sep.	**Contact Website:**	www.aquashieldinc.com

# of Installations in Washington: 82

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☐ Settling
- ☑ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☑ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	Site-specific	**high:**	Site-specific
Estimated Annual O&M Cost:	**low:**	Site-specific	**high:**	Site-specific

System Hydraulics

Design Flow Rate (gpm): **low:** 100 **high:** 2600

Required head loss (ft): 0.25

Internal or External Bypass: Both

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab tested by Tennessee Tech University using autosamplers. Field by auto-composite sampling, 6 sample pairs per TARP.

Parameter:	TSS	TP	Dis. Cu	Dis. Zn	Dis. Cd	Dis. Pb	TPH	cPAHs	PCBs
# of sample:	192								
Median Influent (mg/L):	137								
Median Effluent (mg/L):	12								
% Removal:	86								

Notes, Comments, Additional References

Independent field testing underway per TARP Tier II in Maryland, anticipate completion in 2011. 16 storms and 14 inches of rain sampled to date. Sample parameters above are for field test. Lab testing verified by NJCAT.

Manufacturer Technology Report

HERRERA

Manufacturer:	StormwateRx LLC	**Contact Name:**	Ayn Generes
Name of Technology:	Aquip Enhanced Filtration Sys.	**Contact Email:**	ayng@stormwaterx.com
# of Installations in Washington:	30	**Contact Phone:**	800.680.3543
		Contact Website:	www.stormwaterx.com

Treatment Type/Application (check all that apply)

- [x] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separation
- [x] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [x] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost):	**low:**	5000	**high:**	150000
Estimated Annual O&M Cost ($/gallon treated):	**low:**	0.0003	**high:**	0.003

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	10	**high:**	350
System aboveground footprint (sq ft):	**low:**	14	**high:**	320
Required head loss (ft):	**low:**	4	**high:**	7

Internal or External Bypass: External

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

These samples were collected as grab samples by StormwateRx, consulting engineers, and facility treatment system operators. All analytical data is from a third party certified analytical lab. Non-detects were assumed to have the value of one half the detection limit.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	30		9.9				
Median Effluent (mg/L):	3.39		3				
Median Removal (%):	83	YES	70	YES	YES		YES

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):	0.152	0.03	0.425	0.084	0.008	0.196
Median Effluent (mg/L):	0.008	0.006	0.061	0.006	0.007	0.06
Median Removal (%):	94	79	85	93	51	73

Notes, Comments, Additional References

Non-detects were assumed to have the value of one half the detection limit.

Aquip removes PCBs, PAHs and other toxic organics through particle filtration and absorption to one of the filtration media in the bed. VOC and SVOC removal is through absorption and biological degradation.

The Aquip is a secondary defense against oil and grease and removes TPH and soluble oils through biodegredataion, absorption and bio-mechanical means.

Manufacturer Technology Report

Manufacturer: Bio Clean Environmental
Name of Technology: Bio Clean Curb Inlet Basket
# of Installations in Washington: 0 WA

Contact Name: Greg Kent
Contact Email: gkent@biocleanenvironmental.net
Contact Phone: 760-433-7640
Contact Website: www.biocleanenvironmental.net

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** 445 **high:** 1,600
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate): **low:** $ 0.20 **high:** $ 0.40

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 381 **high:** 898
System aboveground footprint (sq ft): **low:** 0 **high:** 0
Required head loss (ft): **low:** 0.5 **high:** 2

Internal or External Bypass: External - Installed in Catch Basin - Does Not Affect Basin Hydraulics

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Curb Inlet Basket has been in use since the mid 90's. Several field and laboratory studies have been performed on the system. For this reason several reports are being listed below.
--Univerisity of Southern California Independent Field Testing (Turbidity in NTUs)
--Suspended Solids Retention Testing Full Scale Lab Testing

University of Southern California

	Turbidity	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	42	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	12.75	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	70	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	24.3	not tested	not tested	not tested	85.8
Median Effluent (mg/L):	not tested	not tested	10.4	not tested	not tested	not tested	73.4
Median Removal (%):	not tested	not tested	79	not tested	not tested	not tested	14

Suspended Solids Retention Test

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	n/a	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	n/a	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	93*	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

Notes, Comments, Additional References

*Mass Balance was used for the Suspended Solids Retention Test and therefore mg/L and number of samples does not apply. An OK-90 Sand gradation was used for the testing. The Bio Clean Curb Inlet Basket is available with the patented Easy Maintenance Shelf System which reduces maintenance time and slows down water velocity for added settling and pollutant removal. To see this system in action visit: http://www.biocleanenvironmental.com/product/video/?path=content/product/curb_inlet_baskets/Curb_Inlet_Basket-Product_Video.flv&w=768&h=576

Manufacturer Technology Report

Manufacturer: Bio Clean Environmental
Name of Technology: Bio Clean Downspout Filter
# of Installations in Washington: 17 Port of Olympia (Upcoming 2011)

Contact Name: Greg Kent
Contact Email: gkent@biocleanenvironmental.net
Contact Phone: 760-433-7640
Contact Website: www.biocleanenvironmental.net

Treatment Type/Application (check all that apply)

- [x] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** 1,035 **high:** 1,200
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate): **low:** $ 0.16 **high:** $ 0.22

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 249 **high:** 1,145
System aboveground footprint (sq ft): **low:** .31 (cu ft) **high:** 1.57 (cu ft)
Required head loss (ft): **low:** 1 **high:** 2

Internal or External Bypass: Internal Bypass - High Flow Unimpeded - UPC Approved and Tested

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Bio Clean Downspout Filter has been used since 2003. It has been tested and approved by IAMPO. The downspout filter has UPC certification. The filter has been tested under the IAMPO to verify treatment and bypass flow rates. The filter also meets the protocol's minimum pollutant removal specification of at least 60% TSS at a concentration of 150 mg/L over a several hour period up to the storage capacity of the product. The filter has also been tested in full scale labratory testing.
--Full Scale Laboratory Testing D-Tek Analytical --X-Tex-Z-200 Testing for Metals - From Xextex Corporation, USA

Full Scale Laboratory Testing

	TSS	Turbidity (Sil-Co-Sil 106)	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	n/a	429	223.5	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	n/a	251	29.5	not tested	not tested	not tested	not tested
Median Removal (%):	93*	41	87	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

X-TEX FABRIC TESTING - For Metals Removal

	TSS	Turbidity (Sil-Co-Sil 106)	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not kwonw	not kwonw	not kwonw	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not kwonw	not kwonw	not kwonw	not tested	not tested	not tested	not tested
Median Removal (%):	76	96	69	not tested	not tested	not tested	not tested

Notes, Comments, Additional References

*Mass Balance was used for the TSS Tesing and therefore mg/L and number of samples does not apply. Turbidity in NTUs. This filter is made of all stainless steel and is istalled inline with new or existing downspouts. The Bio Clean Downspout Filter is also available with added for ion exchange embedded filter fabric for enhanced removal of metals. The filter is adaptable to downspout sizes 4" to 12".

Manufacturer Technology Report

HERRERA

Manufacturer:	Bio Clean Environmental	**Contact Name:**	Greg Kent
Name of Technology:	Bio Clean Flume Filter	**Contact Email:**	gkent@biocleanenvironmental.net
# of Installations in Washington:	0 WA	**Contact Phone:**	760-433-7640
		Contact Website:	www.biocleanenvironmental.net

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [x] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost):	**low:**	660	**high:**	1,302
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate	**low:**	$ 0.23	**high:**	$ 0.74

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	116	**high:**	583
System aboveground footprint (sq ft):	**low:**	1	**high:**	6
Required head loss (ft):	**low:**	0.083	**high:**	0.5

Internal or External Bypass: Internal Bypass Up to Specific Flow - Configured to Allow for High Flow External Bypass

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Bio Clean Flume Filter has been tested indepedently in a full scale laboratory setting.. A series of 5 composite influent and effluent samples were collcted over a period of two days. The Flume Filter Tested utilized a series of three BioSorb Hydrocarbon Booms.
--Full Scale Laboratory Testing D-Tek Analytical

Full Scale Laboratory Testing

	TSS (Sil-Co-Sil 106)	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	73	223	360	NA	NA	NA	NA
Median Effluent (mg/L):	51.6	29.5	62	NA	NA	NA	NA
Median Removal (%):	29	87	83	NA	NA	NA	NA

	Total Metals			Dissolved Metals			Nutrients
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**	**TP**
Median Influent (mg/L):	NA	NA	NA	NA	NA	NA	NA
Median Effluent (mg/L):	NA	NA	NA	NA	NA	NA	NA
Median Removal (%):	NA	17	NA	NA	NA	NA	NA

Notes, Comments, Additional References

The Bio Clean Flume Filter comes standard with BioSorb Hydrocarbon booms. The filter is designed to utilize varoius media based upon pollutants of concern. The Flume Filter is designed to be used in unique conditions in which sheet flow needs to be treated and no fall is available for other types of technologies.

Manufacturer Technology Report

Manufacturer: Bio Clean Environmental
Name of Technology: Bio Clean Grate Inlet Skimmer Box
# of Installations in Washington: 0 WA, 123 OR

Contact Name: Greg Kent
Contact Email: gkent@biocleanenvironmental.net
Contact Phone: 760-433-7640
Contact Website: www.biocleanenvironmental.net

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

	low	high
Estimated Installation Cost (unit cost and construction cost):	635	1,800
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate):	$ 0.15	$ 0.40

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	224	8,980
System aboveground footprint (sq ft):	0	0
Required head loss (ft):	0.5	2

Internal or External Bypass: Internal - High Flow Rate

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Grate Inlet Skimmer Basket has been in use since the mid 90's. Several field and laboratory studies have been performed on the system. For this reason several reports are being listed below.
--Longo Toyota - Independent Field Testing
--Suspended Solids Retention Testing Full Scale Lab Testing
--Reedy Creek Improvement District Independent Field Testing
--UC Irvine Independent Testing
--Whitman's Pond
--Creech Engineering

Longo Toyota - Independent Field Testing

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	not tested	not tested	189	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	10.43	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	95	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	1.9	1.5	13.7	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	0.1	0.2	0.73	not tested	not tested	not tested	not tested
Median Removal (%):	95	87	95	not tested	not tested	not tested	not tested

Suspended Solids Retention Test

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	n/a	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	n/a	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	86*	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

Reedy Creek Improvement District

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	not known	not tested	not known	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not known	not tested	not known	not tested	not tested	not tested	not tested
Median Removal (%):	74	not tested	54	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not known
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not known
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	57

UC Irvine							
	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	not known	not tested	not known	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not known	not tested	not known	not tested	not tested	not tested	not tested
Median Removal (%):	53	not tested	90	not tested	not tested	not tested	not tested
	Total Metals			**Dissolved Metals**			**Nutrients**
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not known	not known	not known	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not known	not known	not known	not tested	not tested	not tested	not tested
Median Removal (%):	7	98	11	not tested	not tested	not tested	not tested

Whitman's Pond							
	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	978	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	329	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	66	not tested	not tested	not tested	not tested	not tested	not tested
	Total Metals			**Dissolved Metals**			**Nutrients**
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	18.6
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	0.452
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	98

Creech Engineering							
	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	not known	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not known	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	73	not tested	not tested	not tested	not tested	not tested	not tested
	Total Metals			**Dissolved Metals**			**Nutrients**
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not known
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not known
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	79

Notes, Comments, Additional References

*Mass Balance was used for the Suspended Solids Retention Test and therefore mg/L and number of samples does not apply. An OK-90 Sand gradation was used for the testing. The Bio Clean Grate Inlet Skimmer Basket is backed by a 5 year unlimited warranty. It's the only catch basin filter to utilize multiple levels of screens to maxmize performance and treatment flow rate. The product is manufactured from marine grade fiberglass and stainless steel. It contains no cheap net, plastics or fabrics which can rip, tare and break under field conditions. For more information visit: http://www.biocleanenvironmental.com/product/grate_inlet_skimmer_box

HERRERA

Manufacturer Technology Report

Manufacturer:	Bio Clean Environmental	**Contact Name:**	Greg Kent
Name of Technology:	Bio Clean Trench Drain Filter	**Contact Email:**	gkent@biocleanenvironmental.net
# of Installations in Washington:	0 WA	**Contact Phone:**	760-433-7640
		Contact Website:	www.biocleanenvironmental.net

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost):	**low:** 660	**high:** 1,302
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate):	**low:** $ 0.23	**high:** $ 0.74

System Hydraulics/Design

Design Flow Rate (gpm) Per Linear Foot:	**low:** 28	**high:** 86
System aboveground footprint (sq ft):	**low:** 0	**high:** 0
Required head loss (ft):	**low:** 4	**high:** 12

Internal or External Bypass: Internal Bypass Up to Specific Flow - Configured to Allow for High Flow External Bypass

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

No testing has been done on the trench drain filter.

Full Scale Laboratory Testing

	TSS (Sil-Co-Sil 106)	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

Notes, Comments, Additional References

The Bio Clean Trench Drain Filter comes standard with BioSorb Hydrocarbon booms or can use BioMediaGREEN. The filter is designed to utilize varoius media based upon pollutants of concern. The Trench Drain Filter can be used in various size trench drains.

HERRERA

Manufacturer Technology Report

Manufacturer: Bio Clean Environmental
Name of Technology: Bio Clean Water Polisher - Up Flow Filter
# of Installations in Washington: 0

Contact Name: Greg Kent
Contact Email: gkent@biocleanenvironmental.net
Contact Phone: 760-433-7640
Contact Website: www.biocleanenvironmental.net

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separation
- [x] Settling
- [x] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** 25,000 **high:** 125,000
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate): **low:** $ 5.24 **high:** $ 7.85

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 191 **high:** 528
System aboveground footprint (sq ft): **low:** 0 **high:** 0
Required head loss (ft): **low:** 1 **high:** 2
Internal or External Bypass: Internal Bypass - High Flow Unimpeded

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Bio Clean Water Polisher is a unique upflow media filter designed as a stand alone treatment unit or incorporated with the Nutrient Separating Baffle Box to form a complete treatment train. The Bio Clean Water Polisher utilizes the revolutionary filter media, BioMediaGREEN. The BioMediaGREEN has been independently tested in full scale labaratory testing. Media surface loading rate during the testing averaged 2-5 gpm with minimal head. A series of 8 composite influent and effluent grab samples we collected over a perioud of two days.
--BioMediaGREEN Performance Testing by Waves Environmental - Independent Full Scale Lab Testing

Full Scale Laboratory Testing

	TSS (Sil-Co-Sil 106)	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	84.6	1.4	69.8	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	12.4	0	6.5	not tested	not tested	not tested	not tested
Median Removal (%):	85	>99	91	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	0.57	0.38	0.75	2.07
Median Effluent (mg/L):	not tested	not tested	not tested	0.12	0.01	0.16	0.63
Median Removal (%):	not tested	not tested	not tested	79	98	78	70

Notes, Comments, Additional References

The Bio Clean Water Polisher utilizes the revolutionary filter media, BioMediaGREEN. This material is made of billions of small fibers formed into solid blocks. The media composition consists of various oxides to allow for ion exchange and precipitation of dissolved pollutants. The physical structure of the media provides high peformance for the entrapment of particulate pollutants. The media has 80% void space which allows for double the hydraulic retention time when compared to granular media which leads to better overall performance. Another result of the void space is a high hydraulic conductivity. The media surface area loading rate for the media is approximately 7 gpm/sq ft surface area at a head pressure of 18".

Manufacturer Technology Report

HERRERA

Manufacturer: Bio-Microbics, Inc.
Name of Technology: BioSTORM
# of Installations in Washington: 0

Contact Name: Lucas Staus
Contact Email: sales@biomicrobics.com
Contact Phone: 800-753-3278
Contact Website: www.biomicrobics.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	500	2000
Estimated Annual O&M Cost:	400	4000

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	225	4800
System footprint (sq ft):	45	162
Required head loss (ft):	0.5	0.17

Internal or External Bypass: external

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

TSS results are from grab samples done in a lab setting. Unit was tested from 50% of design flow up to 125%. Numbers reported below are at 100% of design flow.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	227						
Median Effluent (mg/L):	7.9						
Median Removal (%):	95.3						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Installation costs and O&M costs are estimates for the Washington area and do not include equipment or tank costs. Drawings and further information on the product can be obtained on our website at the following url: http://biomicrobics.com/?p=77

Manufacturer Technology Report

HERRERA

Manufacturer:	CONTECH Construction Products,	**Contact Name:**	Sean Darcy
Name of Technology:	CDS	**Contact Email:**	darcys@contech-cpi.cc
# of Installations in Washington:	> 250	**Contact Phone:**	503-258-3105
		Contact Website:	contech-cpi.com

Treatment Type/Application (check all that apply)

- ☑ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separation
- ☑ Settling
- ☑ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** $10K **high:** $2.5M

Estimated Annual O&M Cost ($/gallon treated): **low:** $0.00001 **high:** $0.00001

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 20 **high:** 44900

System aboveground footprint (sq ft): **low:** NA **high:** NA

Required head loss (ft): **low:** 0.1 **high:**

Internal or External Bypass: Both Available

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Manasquan Savings Bank Stormwater Treatment System Field Evalutaion: CDS Unit (2010). Field, Peer-Reviewed, Composite.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs	SSC<50 um
Median Influent (mg/L):	154		22					35
Median Effluent (mg/L):	26		5					9
Median Removal (%):	95		64					65

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Oil & Grease laboratory data using sorbents at flow rates of 25,50, and 75% of design.

Manufacturer Technology Report

Manufacturer: StormwateRx LLC
Name of Technology: Clara Gravity Stormwater Separator
# of Installations in Washington: 2

Contact Name: Ayn Generes
Contact Email: ayng@stormwaterx.com
Contact Phone: 800.680.3543
Contact Website: www.stormwaterx.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☑ Above Ground Vault
- ☑ Oil/Water Separation
- ☑ Settling
- ☑ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: 20000 high: 52000
Estimated Annual O&M Cost ($/gallon treated): low: 0.0005 high: 0.001

System Hydraulics/Design

Design Flow Rate (gpm): low: 5 high: 1120
System aboveground footprint (sq ft): low: 0 high: 150
Required head loss (ft): low: 0.5 high: 1.5
Internal or External Bypass: Internal

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

These samples were collected as grab samples by StormwateRx, consulting engineers, and facility treatment system operators. All analytical data is from a third party certified analytical lab. Non-detects were assumed to have the value of one half the detection limit.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	284.5						
Median Effluent (mg/L):	173.5						
Median Removal (%):	47.0	YES	YES				

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	0.516	0.088	2.82			
Median Effluent (mg/L):	0.078	0.072	1.21			
Median Removal (%):	29.5	25.8	32.0			

Notes, Comments, Additional References

The Clara uses four pre-engineered chambers with an internal high-flow bypass to trap pollutants such as heavy solids and oil and grease.

Manufacturer Technology Report

HERRERA

Manufacturer: Coanda, Inc.
Name of Technology: Coanda Effect
# of Installations in Washington: A handful of private downspouts and area drains.

Contact Name: Steve Esmond
Contact Email: sesmond@coanda.com
Contact Phone: (714) 272-1997
Contact Website: http://www.coanda.com/

Treatment Type/Application *(check all that apply)*

- [x] Downspout
- [x] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

	low:		high:		
Estimated Installation Cost:	low:	$2,000	high:	$3,500	
Estimated Annual O&M Cost:	low:	$-0-	high:	$-0-	No installation has required maintenance to dat

System Hydraulics/Design

Design Flow Rate (gpm):	low:	50	high:	360,000
System footprint (sq ft):	low:	2	high:	2,000
Required head loss (ft):	low:	1.5	high:	3

Internal or External Bypass: Optional internal bypass is provided.

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

USC (University of Southern California) obtained trash from Los Angeles Sanitation Services and United Stormwater. The Coanda BMP was filled with trash to evaluate the hydraulic performance. The test was conducted by running water from water trucks onto the street. The water then entered the BMP at approximately 635 gallons per minute (gpm). The BMP was evaluated for pollutant removal potential by collecting water quality samples before it reached the BMP and then from under the BMP at different time intervals. The samples were evaluated by USC using chemical analysis to determine the water quality.

	TS	COD	TOC	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	1500	1262	1137				
Median Effluent (mg/L):	1376	1081	996				
Median Removal (%):	8%	14%	12%				

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):			48			
Median Effluent (mg/L):			15			
Median Removal (%):			69%			

Notes, Comments, Additional References

A summary of the USC report can be found at: http://www.coanda.com/products/documents/usc_research_project.pdf.

Other case studies have been performed, demonstrating removal of trash, nutrients, metals, pesticides, and bacteria:
http://www.coanda.com/products/documents/Rowlett_Case_Study_I.pdf

Manufacturer Technology Report

HERRERA

Manufacturer:	Hydro International	**Contact Name:**	Fred Kraekel
Name of Technology:	Downstream Defender®	**Contact Email:**	fkraekel@hil-tech.com
Technology Category:	Below Ground Vault	**Contact Phone:**	207-321-3733
Technology Process:	Filter	**Contact Website:**	www.hydro-international.biz

# of Installations in Washington: ____________

Treatment Type/Application *(check all that apply)*

☐ Downspout	☑ Oil/Water Separartion	☐ Filtration (media)	☐ Ion exchange column	☑ Stormwater
☐ Drain Inlet Insert	☑ Settling	☐ Filtration (fabric)	☐ Reverse osmosis	☐ Groundwater
☑ Below Ground Vault	☐ Hydrodynamic Separation	☐ Filtration (biofiltration)	☐ Electrocoagulation	☐ Wastewater
☐ Above Ground Vault	☑ Floatables Baffle	☐ Filtration (chemically enhanced)	☐ Chemical Treatment	☐ Process water

Estimated Costs

Estimated Installation Cost: **low:** ________ **high:** ________
Estimated Annual O&M Cost: **low:** ________ **high:** ________

System Hydraulics

Design Flow Rate (gpm): **low:** ________ **high:** ________
Required head loss (ft): ________
Internal or External Bypass: ________

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Contact Hydro International for details.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

The Downstream Defender® is an advanced Hydrodynamic Vortex Separator that is specifically designed to provide high removal efficiencies of urban runoff pollutants over a wide range of flow rates. It is commonly used in stormwater applications as either pretreatment or as a stand-alone treatment system. The unique flow-modifying internal components distinguish the Downstream Defender from simple swirl-type devices and conventional oil/grit separators by minimizing turbulence and head losses, enhancing separation, and preventing washout of previously stored pollutants. The high removal efficiencies and inherent low head losses of the Downstream Defender allow for a small footprint, making it a compact and economical solution for non-point source pollution. Contact Hydro International at 1-800-848-2706 or visit the website www. hydro-international.biz for more information.

HERRERA

Manufacturer Technology Report

Manufacturer:	Royal Environmental Systems	**Contact Name:**	Jim Mothersbaugh
Name of Technology:	ecoLine A	**Contact Email:**	jim@watertectonics.com
# of Installations in Washington:	6	**Contact Phone:**	866-402-2298
		Contact Website:	www.watertectonics.com

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** $ 6,700 **high:** $ 44,250

Estimated Annual O&M Cost ($/gallon treated): **low:** (a) **high:** (a)

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 25 **high:** 626

System aboveground footprint (sq ft): **low:** 12 **high:** 70

Required head loss (ft): **low:** 6.00" with clean coalescer

Internal or External Bypass: Site specific design required

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

CEN EN 858-1 Test Method for Class I Coalescing Separator
Light liquid: Fuel oil, per ISO 8217, designation ISO-F-DMA with density of 0.85 g/cm3* (Solubility of light liquid nil, unsaponifiable)
Water: Potable or purified surface water
Water turn over: Minimum four volumes of test units
Liquid flux: 25-40 m^3/m^2-h (10-15 gpm/ft^2)
Max. residual light liquid: 5 mg/L (Hydrocarbon content analysis by prescribed infrared spectroscopy procedure)

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)	(b)	(b)	(b)	(b)	(b)	(b)

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)	(b)	(b)	(b)	(b)	(b)

Notes, Comments, Additional References

(a) Gravity flow system has no moving parts or power requirement. Oil coalescing media pack can be removed, rinsed, and replaced. In the event of damage to the coalescing media, new coalescing panels can be purchased for a low cost.

(b) Report Form's System performance data fields are not applicable. Product removes free-phase fluids such as floating oil and other petroleum hydrocarbon products (LNAPL - Light Non-Aqueous Phase Liquids).

HERRERA

Manufacturer Technology Report

Manufacturer:	Royal Environmental Systems	**Contact Name:**	Jim Mothersbaugh
Name of Technology:	ecoLine B	**Contact Email:**	jim@watertectonics.com
# of Installations in Washington:	7	**Contact Phone:**	866-402-2298
		Contact Website:	www.watertectonics.com

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

	low:	high:
Estimated Installation Cost (unit cost and construction cost):	$ 8,200	$ 81,900
Estimated Annual O&M Cost ($/gallon treated):	(a)	(a)

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	50	1110
System aboveground footprint (sq ft):	N/A	N/A
Required head loss (ft):	6.00" with clean coalescer	N/A

Internal or External Bypass: Site specific design required

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

CEN EN 858-1 Test Method for Class I Coalescing Separator
Light liquid: Fuel oil, per ISO 8217, designation ISO-F-DMA with density of 0.85 g/cm3* (Solubility of light liquid nil, unsaponifiable)
Water: Potable or purified surface water
Water turn over: Minimum four volumes of test units
Liquid flux: 25-40 m^3/m^2-h (10-15 gpm/ft^2)
Max. residual light liquid: 5 mg/L (Hydrocarbon content analysis by prescribed infrared spectroscopy procedure)

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)	(b)	(b)	(b)	(b)	(b)	(b)

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Effluent (mg/L):	(b)	(b)	(b)	(b)	(b)	(b)
Median Removal (%):	(b)	(b)	(b)	(b)	(b)	(b)

Notes, Comments, Additional References

(a) Gravity flow system has no moving parts or power requirement. Oil coalescing media pack can be removed, rinsed, and replaced. In the event of damage to the coalescing media, new coalescing panels can be purchased for a low cost.

(b) Report Form's System performance data fields are not applicable. Product removes free-phase fluids such as floating oil and other petroleum hydrocarbon products (LNAPL - Light Non-Aqueous Phase Liquids).

Manufacturer Technology Report

HERRERA

Manufacturer:	EcoSense International Inc.	**Contact Name:**	Randy Burden
Name of Technology:	EcoSense Stormwater Filtration systems, Catc	**Contact Email:**	randy.burden@ecosenseint.com
Technology Category:		**Contact Phone:**	321-449-0324 / 321-5
Technology Process:	Oil/ Grease / sediment / debris removal	**Contact Website:**	www.ecosenseint.com

# of Installations in Washington: 0

Treatment Type/Application (check all that apply)

- [x] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	\$400.00	\$2,000
Estimated Annual O&M Cost:	\$100.00	\$500.00

System Hydraulics

Design Flow Rate (gpm): low: 25 high: 1662*

Required head loss (ft): Varies*

Internal or External Bypass: Internal, Hooded

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Third party Lab and simulated field studies have been done in US, Italy, New Zealand and Canada on filters loaded with Melt Blown Polypropylene only. One study performed Grab samples on canisters loaded with surfactant modified zeolite and impregnated polyester pads. Results will be included with this submittal.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

EcoSense offers two media types for canister filters, but other media may be easily loaded. The system incorporates media filter canisters for low flows and "clean pass" hooded over-flows pipes. Multiple filters and over-flows may be installed depending on space available. Hooded over-flow effectively prevent floatables from bypassing canister filters. Debris, sediment, oils and grease (and contaminant associated) are effectively captured by the system. Debris collection baskets are also available especially designed to remove organic debris and trash. These systems are modular so that depending on catch basin sizes multiple baskets or filters or both may be installed.

HERRERA

Manufacturer Technology Report

Manufacturer:	Royal Environmental Systems	**Contact Name:**	Jim Mothersbaugh
Name of Technology:	ecoStorm & ecoStorm Plus	**Contact Email:**	jim@watertectonics.com
# of Installations in Washington:	9	**Contact Phone:**	866-402-2298
		Contact Website:	www.watertectonics.com

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separation
- [x] Settling
- [x] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [x] Groundwater
- [x] Wastewater
- [x] Process water

Estimated Costs

	low	high
Estimated Installation Cost (unit cost and construction cost):	8900 (a)	37500 (a)
Estimated Annual O&M Cost ($/gallon treated):	(b)	(b)

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	No Min	180
System aboveground footprint (sq ft):	N/A	N/A
Required head loss (ft):	0.41' (c)	

Internal or External Bypass: Internal &/or External

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Field monitoring at the McRedmond Park site located in Redmond, WA. Auto sampler for flow-portional composite and time-based discrete collections. Independent analytical laboratory, and 3rd party data validation/statistical analysis of data points and sets.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	200						
Median Effluent (mg/L):	26						
Median Removal (%):	87%						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	0.019	0.005	0.17			0.066
Median Effluent (mg/L):	0.009	0.002	0.073			0.042
Median Removal (%):	53%	60%	57%			36%

Notes, Comments, Additional References

ecoStorm and ecoStorm plus can be utilized as separate stand-alone technologies or combined in serial component installation. Combined technologies are currently under TAPE evaluation through WADOE for stormwater. Performance data reflects both stormwater and non-stormwater installations.

(a) Cost varies based on combination of units, number of units, and final design requirements.

(b) $500 - $1000 per cleaning/backflush event; Minimum of 1x per yr. to monthly for stormwater.

(c) Headloss based on:

- Current monitoring configuration: 1 ecoStorm upstream of 2 ecoStorm plus units.
- 360 gpm through the system, 180 gpm per filter.
- Site specific model calibrated onsite at known flow rates.
- Headloss negating effects of drop structure were neglected (located between the ecoStorm and ecoStorm plus units).
- Filters assumed to be at the point of required maintenance (twice the headloss measured for new filters).

System Performance Data results shown are for qualifying events only, per Washington State TAPE requirements:

- Per TAPE requirements, removal requirements for influent concentration less than 100 mg/l are that effluent must be less than or equal to 20 mg/l.
- For parameters with no results presented above, they are not being monitored or were present at concentrations are below measurable thresholds.

Manufacturer Technology Report

Manufacturer:	EcoSense International Ir	**Contact Name:**	Randy Burden
Name of Technology:	EcoVault Baffle Box	**Contact Email:**	/.burden@ecosenseint
Technology Category:	Below Ground Vault	**Contact Phone:**	-449-0324 / 321-544-9
Technology Process:	Type II Baffle Box	**Contact Website:**	www.ecosenseint.com

# of Installations in Washington: 0

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☑ Above Ground Vault
- ☑ Oil/Water Separartion
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☑ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☑ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$25,000.00	**high:**	$125,000
Estimated Annual O&M Cost:	**low:**	$200.00	**high:**	$1,800.00

System Hydraulics

Design Flow Rate (gpm): **low:** 1346 **high:** 48,000

Required head loss (ft): Varies*

Internal or External Bypass: Either or Both

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

A study has not been completed on this specific system. Studies have been performed on other manufactures version of the Type II Baffle Box. Minimum Performance claims are based on model studies performed at the Florida Institute of Technology: Pandit and Gopatakrishnan, 1996. The study mentioned was performed with a scale model Type 1 Baffle Box. Improvements such as media filtration and horizontal debris collection system were subsequently added.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

The EcoVault is unique among Type II baffle boxes. The standard model incorporates a high performance media filter into the last internal weir which treats low flows and remove a wide variety of contaminants including bacteria, mobile phosphate, ammonia, dissolved heavy metals and orgainics. TSS removal is expect to be 80% at the flows mentioned above. Course organic materials are captured and stored above the static WL greatly increasing overall nutrient removal. The cassette style media filter contains three filter components including surfactant modified zeolite, hydrophobic meltblown polypropylene and polyester fiber pads impregnated with Granulated Ferric Hydroxide, Natural Zeolite and select grade acid washed Activated Carbon. * Head Loss varies depending on the media filter's top elevation and is directly proportional. Debris loading also effects head loss.

HERRERA

Manufacturer Technology Report

Manufacturer:	Environment 21, LLC	**Contact Name:**	Dino Pezzimenti
Name of Technology:	EnviroTrap	**Contact Email:**	dino@env21.com
# of Installations in Washington:	0	**Contact Phone:**	585-815-4714
		Contact Website:	www.env21.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$200	**high:**	$1,000
Estimated Annual O&M Cost:	**low:**	0	**high:**	$1,000

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	0	**high:**	2,700
System footprint (sq ft):	**low:**	NA	**high:**	NA
Required head loss (ft):	**low:**	0	**high:**	0.5
Internal or External Bypass:	NA			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Field studies are incomplete at this time and are still under evaluation.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	*250	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	**150	**150	**150	**150	**150	**150
Median Removal (%):	*30	**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.07	***0.68	***0.24	NA	NA	NA
Median Removal (%):	***9	***13.6	***20	NA	NA	NA

Notes, Comments, Additional References

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d_{50} of 180 microns was used.

**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.

***Testing is not complete for metals; therefore, these values are estimated.

Manufacturer Technology Report

HERRERA

Manufacturer:	Filterra, DBA Americast, Inc.	**Contact Name:**	Will Harris
Name of Technology:	Filterra Curb Inlet System	**Contact Email:**	wharris@filterra.com
Technology Category:	Below Ground Vault	**Contact Phone:**	909-790-5239
Technology Process:	biofiltration	**Contact Website:**	www.filterra.com

# of Installations in Washington: 186

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☐ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☑ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	$1,200	$7,500
Estimated Annual O&M Cost:	$300	$3,000

System Hydraulics

Design Flow Rate (gpm): low: 8.5 high: 50+

Required head loss (ft): 2.5

Internal or External Bypass: Can be either

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

For third party field monitoring at the Port of Tacoma Industrial site in WA, samples were collected via automatic flow-weighted composite samplers. Trapezoidal flumes and V-notch weirs with associated bubbler systems were installed to intercept influent and effluent stormwater, respectively, for flow measurements. Water levels within flumes were recorded using 5-minute intervals. A rain guage was installed in association with the units locations to continuously monitor precipitation totals in the drainage areas, and was interfaced with the autosampler and bubbler equipment.

Parameter:	TSS	TP	Dis. Cu	Dis. Zn	Dis. Cd	Dis. Pb	TPH	cPAHs	PCBs
# of sample:	10	12	29	29			12		
Median Influent (mg/L):	27.5	0.15	0.0056	0.194			43.4		
Median Effluent (mg/L):	4.2	0.14	0.0033	0.082			1.2		
% Removal:	84.7	6.7	44	54			97		

Notes, Comments, Additional References

Please refer to the attached Filterra Curb Inlet Model Overview Sheet for further information. Please note that the Filterra Curb Inlet Model can be designed and built with or without an internal high flow bypass compartment. Data from Technical Evaluation Report (2009) produced by Herrera Environmental Consultants for Washington Department of Ecology. TSS data in the influent range accepted by Ecology(20 mg/L and greater). TP data in the influent range accepted by Ecology (0.1 to 0.5 mg/L). Low TP removal due to anomalous phosphorus data collected at the Port of Tacoma included very low TP influent concentrations and a high fraction of soluble reactive phosphorus. Dissolved copper data in the influent range accepted by Ecology (0.0029 to 0.02 mg/L). Dissolved zinc data in the influent range accepted by Ecology (0.02 to 0.6 mg/L). TPH data in the influent range accepted by Ecology (10 mg/L or greater).

Manufacturer Technology Report

Manufacturer: Filterra, DBA Americast, Inc.
Name of Technology: Filterra Roof Drain System
Technology Category: Downspout
Technology Process: Biofiltration
# of Installations in Washington: 1

Contact Name: Will Harris
Contact Email: wharris@filterra.com
Contact Phone: 909-790-5239
Contact Website:

Treatment Type/Application (check all that apply)

- [x] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [x] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost: **low:** $1,200 **high:** $7,500
Estimated Annual O&M Cost: **low:** $300 **high:** $3,000

System Hydraulics

Design Flow Rate (gpm): **low:** 8.5 **high:** 50+
Required head loss (ft): 2.5
Internal or External Bypass: Internal

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

For third party field monitoring at the Port of Tacoma Industrial site in WA, samples were collected via automatic flow-weighted composite samplers. Trapezoidal flumes and V-notch weirs with associated bubbler systems were installed to intercept influent and effluent stormwater, respectively, for flow measurements. Water levels within flumes were recorded using 5-minute intervals. A rain guage was installed in association with the units locations to continuously monitor precipitation totals in the drainage areas, and was interfaced with the autosampler and bubbler equipment.

Parameter:	TSS	TP	Dis. Cu	Dis. Zn	Dis. Cd	Dis. Pb	TPH	cPAHs	PCBs
# of sample:	10	12	29	29			12		
Median Influent (mg/L):	27.5	0.15	0.0056	0.194			43.4		
Median Effluent (mg/L):	4.2	0.14	0.0033	0.082			1.2		
% Removal:	84.7	6.7	44	54			97.2		

Notes, Comments, Additional References

Please refer to the attached Filterra Roof Drain System Model Overview Sheet for further information. Please note that the Filterra Roof Drain System can be designed and built with or without an internal high flow bypass compartment. System can be also designed and built for either above ground or below ground applications. Data from Technical Evaluation Report (2009) produced by Herrera Environmental Consultants for Washington Department of Ecology. TSS data in the influent range accepted by Ecology(20 mg/L and greater). TP data in the influent range accepted by Ecology (0.1 to 0.5 mg/L). Low TP removal due to anomalous phosphorus data collected at the Port of Tacoma included very low TP influent concentrations and a high fraction of soluble reactive phosphorus. Dissolved copper data in the influent range accepted by Ecology (0.0029 to 0.02 mg/L). Dissolved zinc data in the influent range accepted by Ecology (0.02 to 0.6 mg/L). TPH data in the influent range accepted by Ecology (10 mg/L or greater).

Manufacturer Technology Report

Manufacturer:	ABT, Inc.	**Contact Name:**	Brad Short
Name of Technology:	First Flush 1640FF	**Contact Email:**	bshort@abtdrains.com
Technology Category:	Below Ground Vault	**Contact Phone:**	949-633-6111
Technology Process:	Gravity-Flow through	**Contact Website:**	www.abtdrains.com

# of Installations in Washington: 0

Treatment Type/Application *(check all that apply)*

- ☐ Downspout
- ☑ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☐ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☐ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$5,000	**high:**	10,000
Estimated Annual O&M Cost:	**low:**	$500	**high:**	$3,000

System Hydraulics

Design Flow Rate (gpm):	**low:**	449	**high:**	538
Required head loss (ft):				
Internal or External Bypass:	See detail for bypass.			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab test results are provide on the filter media performance and system hydraulic performace based on design capabilites. The installation cost if factoring material and cost of installation together...or an installed cost. See attached detail of the larger unit available from ABT. Installation in several states including CA.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

Manufacturer Technology Report

HERRERA

Manufacturer: Kristar Enterprises, Inc.
Name of Technology: FloGard Downspout Filter
# of Installations in Washington: 0
Contact Name: Michael Kimberlain
Contact Email: mkimberlain@kristar.com
Contact Phone: (800) 579-8819
Contact Website: www.kristar.com

Treatment Type/Application (check all that apply)

- [x] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	$1,500	$3,500
Estimated Annual O&M Cost:	$75	$250

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	30	325
System footprint (sq ft):	0.5	1
Required head loss (ft):	0	0.5

Internal or External Bypass: Internal

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	100	35	35				35
Median Effluent (mg/L):	20	7	7				
Median Removal (%):	80	80	80				7

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

Notes, Comments, Additional References

HERRERA

Manufacturer Technology Report

Manufacturer: Kristar Enterprises, Inc.
Name of Technology: Flo Gard Dual Vortex Separator
# of Installations in Washington: 10

Contact Name: Michael Kimberlain
Contact Email: mkimberlain@kristar.com
Contact Phone: (800) 579-8819
Contact Website: www.kristar.com

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [x] Hydrodynamic Separation
- [x] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [x] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

	low	high
Estimated Installation Cost:	$10,000	$100,000
Estimated Annual O&M Cost:	$300	$3,500

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	150	6,500
System footprint (sq ft):	7	113
Required head loss (ft):	0	3

Internal or External Bypass: Internal

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Internal lab testing performed by Kristar. Third party lab testing was performed by Alden Research laboratories based in Holden Massachussets. No field studies have been completed at this date.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	202						
Median Effluent (mg/L):	80						
Median Removal (%):	60						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

No field studies have been completed at this time. Correlation of TSS removal with other POCs would indicate similar removal of Total metals.

HERRERA

Manufacturer Technology Report

Manufacturer:	Kristar Enterprises, Inc.	**Contact Name:**	Michael Kimberlain
Name of Technology:	FloGard LoPro Matrix Filter	**Contact Email:**	mkimberlain@kristar.com
# of Installations in Washington:	10	**Contact Phone:**	(800) 579-8819
		Contact Website:	www.kristar.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☑ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$400	**high:**	$1,000
Estimated Annual O&M Cost:	**low:**	$75	**high:**	$300

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	45	**high:**	800
System footprint (sq ft):	**low:**	0.75	**high:**	16
Required head loss (ft):	**low:**	0	**high:**	0.5
Internal or External Bypass:	Internal			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	100	35	35				35
Median Effluent (mg/L):	20	7	7				
Median Removal (%):	80	80	80				7

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

Notes, Comments, Additional References

HERRERA

Manufacturer Technology Report

Manufacturer: Kristar Enterprises, Inc.
Name of Technology: FloGard LoPro Trench Drain Filter
# of Installations in Washington: 0

Contact Name: Michael Kimberlain
Contact Email: mkimberlain@kristar.com
Contact Phone: (800) 579-8819
Contact Website: www.kristar.com

Treatment Type/Application *(check all that apply)*

- ☐ Downspout
- ☑ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:		high:	
Estimated Installation Cost:	low:	$600	high:	$3,000
Estimated Annual O&M Cost:	low:	$75	high:	$350

System Hydraulics/Design

Design Flow Rate (gpm):	low:	200	high:	500
System footprint (sq ft):	low:	1	high:	20
Required head loss (ft):	low:	0	high:	0.25
Internal or External Bypass:	Internal			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	100	35	35				35
Median Effluent (mg/L):	20	7	7				
Median Removal (%):	80	80	80				7

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

Notes, Comments, Additional References

Manufacturer Technology Report

HERRERA

Manufacturer:	Kristar Enterprises, Inc.	**Contact Name:**	Michael Kimberlain
Name of Technology:	FloGard+Plus	**Contact Email:**	mkimberlain@kristar.com
# of Installations in Washington:	100	**Contact Phone:**	(800) 579-8819
		Contact Website:	www.kristar.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☑ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☐ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:		high:	
Estimated Installation Cost:	low:	$250	high:	$1,800
Estimated Annual O&M Cost:	low:	$75	high:	$350

System Hydraulics/Design

Design Flow Rate (gpm):	low:	100	high:	2,000
System footprint (sq ft):	low:	1	high:	10
Required head loss (ft):	low:	0	high:	0.25
Internal or External Bypass:	Internal			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	100	35	35				35
Median Effluent (mg/L):	20	7	7				
Median Removal (%):	80	80	80				7

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

Notes, Comments, Additional References

Manufacturer Technology Report

Manufacturer:	Kristar Enterprises, Inc.	**Contact Name:**	Michael Kimberlain
Name of Technology:	FloGard Trash & Debris Guard	**Contact Email:**	mkimberlain@kristar.com
# of Installations in Washington:	0	**Contact Phone:**	(800) 579-8819
		Contact Website:	www.kristar.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☑ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:		high:	
Estimated Installation Cost:	**low:**	$450	**high:**	$1,500
Estimated Annual O&M Cost:	**low:**	$50	**high:**	$200

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	50	**high:**	500
System footprint (sq ft):	**low:**	0.5	**high:**	4
Required head loss (ft):	**low:**	0	**high:**	0.25
Internal or External Bypass:	Internal			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

No Data Available

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Manufacturer Technology Report

Manufacturer:	AquaShield, Inc.	**Contact Name:**	Mark Miller
Name of Technology:	Go-Filter	**Contact Email:**	mmiller@aquashieldinc.com
Technology Category:	Above Ground Vault	**Contact Phone:**	888-344-9044
Technology Process:	Vortex + Filtration	**Contact Website:**	www.aquashieldinc.com

# of Installations in Washington: 0

Treatment Type/Application *(check all that apply)*

☐ Downspout	☑ Oil/Water Separartion	☑ Filtration (media)	☐ Ion exchange column	☑ Stormwater
☐ Drain Inlet Insert	☐ Settling	☐ Filtration (fabric)	☐ Reverse osmosis	☐ Groundwater
☐ Below Ground Vault	☑ Hydrodynamic Separation	☐ Filtration (biofiltration)	☐ Electrocoagulation	☐ Wastewater
☐ Above Ground Vault	☑ Floatables Baffle	☑ Filtration (chemically enhanced)	☐ Chemical Treatment	☑ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	Site-specific	**high:**	Site-specific
Estimated Annual O&M Cost:	**low:**	Site-specific	**high:**	Site-specific

System Hydraulics

Design Flow Rate (gpm):	**low:**	50	**high:**	675
Required head loss (ft):		0.5		
Internal or External Bypass:		Both		

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

See Aqua-Filter for lab and field testing.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

Mobile device works on same principle as Aqua-Filter. Useful on construction sites for turbidity reduction in addition to sediment removal. Device components have been verified by NJCAT.

Manufacturer Technology Report

HERRERA

Manufacturer:	Imbrium Systems	**Contact Name:**	Joel Garbon
Name of Technology:	Jellyfish Filter	**Contact Email:**	jgarbon@imbriumsystms.com
# of Installations in Washington:	1	**Contact Phone:**	503-706-6193
		Contact Website:	www.imbriumsystems.com

Treatment Type/Application *(check all that apply)*

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☑ Above Ground Vault
- ☑ Oil/Water Separation
- ☑ Settling
- ☑ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☑ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: ________ high: ________

Estimated Annual O&M Cost ($/gallon treated): low: ________ high: ________

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	60	2300
System aboveground footprint (sq ft):	12	113
Required head loss (ft):	1	2

Internal or External Bypass: Internal or External Bypass

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Performance data is from third-party field study at University of Florida conducted according to the TARP protocol. Samples collected were grab samples of the entire crossection of flow. Twenty-one storm events have been monitored to date.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	74						
Median Effluent (mg/L):	8						
Median Removal (%):	89						

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	78	35	1.45			
Median Effluent (mg/L):	0.3	5	0.6			
Median Removal (%):	99	86	59			

Notes, Comments, Additional References

Copper concentrations are in micrograms per liter. Zinc concentrations are in milligrams per liter. Lead concentraions are in micrograms per liter. The O&M cost ranges from $0.001/gal to $0.003/gal. Installation costs range from $8000 to $125,000.

Manufacturer Technology Report

Manufacturer:	Brown Minneapolis Tank	**Contact Name:**	Allan McComas
Name of Technology:	Kleerwater	**Contact Email:**	amccomas@bmt-tank.com
Technology Category:	Below Ground Vault	**Contact Phone:**	(360) 482-1724
Technology Process:		**Contact Website:**	bmt-tank.com

# of Installations in Washington:

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☐ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☑ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost: **low:** Varies by size **high:** Varies by installation size
Estimated Annual O&M Cost: **low:** Nominal **high:** Nominal

System Hydraulics

Design Flow Rate (gpm): **low:** 25 gpm **high:** 10,000 gpm
Required head loss (ft): Gravity
Internal or External Bypass: External

System Performance

Breifly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

All data collected and verified by third party inspectors and Underwriters Laboratories (UL).

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

- Underwriters Laboratories tested and listed per UL-2215
- Designed for no internal or confined space entry when performing routine maintenance.
- Kleerwater™ can handle larger influent flows, allowing for smaller separator tanks. With smaller separation tanks, less installation costs.
- Kleerwater™ separators utilizes Stokes Law for defining rates of rise of oil spheres in a liquid medium
- Unique patented oil separation process enhances oil from water separation efficiencies
- Separation efficiencies down to 5 ppm & lower.
- Electronic audible and visual alarms available for preset level alarm notifications
- Separator material of construction: carbon steel.
- Single or double wall steel configurations available
- Handle continuous or intermittent influent flow rates.

Note: Kleerwater™will not remove oils with a specific gravity of less than 0.95, dissolved hydrocarbons, or volatile organic compounds.
For additional information, please visit www.kleerwater.net

Manufacturer Technology Report

Manufacturer: Modular Wetland Systems, Inc.
Name of Technology: Modular Wetland System - Linear
# of Installations in Washington: 0 WA

Contact Name: Greg Kent
Contact Email: gkent@biocleanenvironmental.net
Contact Phone: 760-433-7640
Contact Website: www.biocleanenvironmental.net

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [x] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separation
- [x] Settling
- [x] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [x] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: 12,000 high: 25,000
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate): low: $ 8.26 high: $ 10.50

System Hydraulics/Design

Design Flow Rate (gpm): low: 22 high: 120
System aboveground footprint (sq ft): low: 16 high: 84
Required head loss (ft): low: 2 high: 4
Internal or External Bypass: Internal (External in Some Situations)

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Modular Wetland System Linear has been used in the field since 2008. The system has be independently tested in the laboratory and field under various conditions. A series of composite grab samples were used in the field and laboratory provide performance analysis on the system. --Quarter Scale Independent Lab Testing
--Full Scale Independent Field Testing

Quarter Scale Lab Testing

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	270	19	4	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	3	0	n/d	not tested	not tested	not tested	not tested
Median Removal (%):	98	>99	>99%	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	not tested	not tested	not tested	0.757	0.543	0.95
Median Effluent (mg/L):	not tested	not tested	not tested	0.0552	0.1	0.185
Median Removal (%):	not tested	not tested	not tested	93	81	80

Full Scale Field Testing

	TSS	TPH - Motor Oil	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	45.67	0.83	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	8.24	0	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	82	>99	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	
Median Influent (mg/L):	0.04	n/d	0.24	not tested	not tested	not tested	
Median Effluent (mg/L):	n/d	n/d	n/d	not tested	not tested	not tested	
Median Removal (%):	>50		>79	not tested	not tested	not tested	

Notes, Comments, Additional References

The Modular Wetland System Linear is a 4 stage treatment train that includes screening, separation, media filtration and biofiltration. This combination of treatment processes offers the most comprehensive range of stormwater treatment available. The treatment train concept employed helps to minimize overall maintenance costs.

Manufacturer Technology Report

Manufacturer:	Bio Clean Environmental	**Contact Name:**	Greg Kent
Name of Technology:	Nutrient Separating Baffle Box	**Contact Email:**	gkent@biocleanenvironmental.net
# of Installations in Washington:	0 WA, 4 UT, 3 OR	**Contact Phone:**	760-433-7640
		Contact Website:	www.biocleanenvironmental.net

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separation
- [x] Settling
- [x] Hydrodynamic Separation
- [x] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost):	**low:** 10,000	**high:** 200,000
Estimated Annual O&M Cost ($/gallon treated - based on peak treatment flow rate):	**low:** $ 0.33	**high:** $ 0.84

System Hydraulics/Design

Design Flow Rate (gpm):	**low:** 148	**high:** 8,858
System aboveground footprint (sq ft):	**low:** 0	**high:** 0
Required head loss (ft):	**low:** 0	**high:** 0

Internal or External Bypass: Internal (External in Some Situations)

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The Nutrient Separating Baffle Box has been in use since for over 10 years. Several field and laboratory studies have been performed on the system. For this reason several reports are being listed below.
--City of Santa Monica field data is independent and was performed over the course of 1 year.
--Brevard County field testing is independent and was peformed over 4 storm events - Micco & Indiatlantic
-- NJ CAT Full Scale Labratory Testing Tier 1

Santa Monica Independent Field Data

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	366	not tested	4	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	48	not tested	n/d	not tested	not tested	not tested	not tested
Median Removal (%):	86.8	not tested	>99%	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	0.07	not tested	0.318	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	0.042	not tested	0.222	not tested	not tested	not tested	not tested
Median Removal (%):	40	not tested	30.25	not tested	not tested	not tested	not tested

Brevard County Stormwater Monitoring - Micco Basin

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	16.55	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	8.63	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	47.9	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	0.055
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	0.0425
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	23

Brevard County Storwater Monitoring - Indiatlantic

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	32.9	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	7.6	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	76.9	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	1.49
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	0.44
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	70

NJ CAT Testing - Tier 1 - 63 Micron Mean Particle Size PSD

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	varies	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	varies	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	67.3	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	not tested	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	not tested	not tested	not tested	not tested	not tested	not tested	not tested

Atlantic Beach Baffle Box Teasting - 5th St

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	85	not tested	not tested	not tested	not tested	not tested	not tested
Median Effluent (mg/L):	27	not tested	not tested	not tested	not tested	not tested	not tested
Median Removal (%):	68	not tested	not tested	not tested	not tested	not tested	not tested

	Total Metals			Dissolved Metals			Nutrients
	Cu	Pb	Zn	Cu	Pb	Zn	TP
Median Influent (mg/L):	0.017	0.014	0.088	not tested	not tested	not tested	0.31
Median Effluent (mg/L):	0.01	0.0065	0.038	not tested	not tested	not tested	0.21
Median Removal (%):	41	54	57	not tested	not tested	not tested	32

Notes, Comments, Additional References

The Nutrient Separating Baffle Box employees screening, three chambered hydrodynamic spearation and absoptive polymer media for the removal of gross solids, TSS, particulate pollutants and hydrocarbons. To see how the system operates visit:
http://www.biocleanenvironmental.com/video/?path=/content/product/ns_baffle_box/NS_Baffle_Box-Product_Video.flv&w=768&h=576
THE PATENTED SEPARATION AND DRY STATE STORAGE OF GROSS SOLIDS SUCH AS LEAVES AND GRASS CLIPPINGS MINIMIZES NUTRIENT LOADS SEE FOLLOWING ARTICLE
http://www.biocleanenvironmental.com/content/product/ns_baffle_box/Brochure%20-%20Leaching%20Article%20-%20NSBB.pdf

Manufacturer Technology Report

HERRERA

Manufacturer: Kristar Enterprises, Inc.
Name of Technology: Perk Filter
# of Installations in Washington: 15
Contact Name: Michael Kimberlain
Contact Email: mkimberlain@kristar.com
Contact Phone: (800) 579-8819
Contact Website: www.kristar.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	$10,000	$200,000
Estimated Annual O&M Cost:	$1,200	$10,000

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	12	1,000
System footprint (sq ft):	10	150
Required head loss (ft):	1.7	3.5

Internal or External Bypass: Internal

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Internal lab testing performed by Kristar. Third party lab testing was performed by CSUS - OWP for TSS and subsequent "street Sweeipings" testing for metals and nutrients. Third Party field testing for GULD by Herrera.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	70	20	20				20
Median Effluent (mg/L):	11	5	5				5
Median Removal (%):	82	75	75				75

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	0.052	0.15	0.25			
Median Effluent (mg/L):	0.02	0.05	0.1			
Median Removal (%):	62	68	61			

Notes, Comments, Additional References

Manufacturer Technology Report

HERRERA

Manufacturer:	Environment 21, LLC	**Contact Name:**	Dino Pezzimenti
Name of Technology:	PuriStorm	**Contact Email:**	dino@env21.com
# of Installations in Washington:	0	**Contact Phone:**	585-815-4714
		Contact Website:	www.env21.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [ ] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$3,000	**high:**	$25,000
Estimated Annual O&M Cost:	**low:**	0	**high:**	$10,000

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	0	**high:**	2,000
System footprint (sq ft):	**low:**	9	**high:**	600
Required head loss (ft):	**low:**	0	**high:**	0.5
Internal or External Bypass:	Both			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Field studies are not in progress at this time. Future studies are planned.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	*250	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	**80	**80	**80	**80	**80	**80
Median Removal (%):	*80	**80	**80	**80	**80	**80	**80

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.04	***0.28	***0.06	NA	NA	NA
Median Removal (%):	***50	***65	***80	NA	NA	NA

Notes, Comments, Additional References

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d_{50} of 60 microns was used.

**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.

***Testing is not complete for metals; therefore, these values are estimated.

Manufacturer Technology Report

Manufacturer: Environmental Filtration, Inc.
Contact Name: Lyle Clemenson
Name of Technology: Raynfiltr
Contact Email: cei@pconline.com
# of Installations in Washington: 1 (airport)
Contact Phone: 763-425-1167
Contact Website: www.raynfiltr.org

Treatment Type/Application (check all that apply)

- [x] Downspout
- [x] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [ ] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost: low: 531 high: 554
Estimated Annual O&M Cost: low: high:

System Hydraulics/Design

Design Flow Rate (gpm): low: 0 high: 900
System footprint (sq ft): low: high:
Required head loss (ft): low: high:
Internal or External Bypass:

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Costs per catch basin

Manufacturer Technology Report

HERRERA

Manufacturer:	Deep Root Partners, L.P.	**Contact Name:**	Brenda Guglielmina
Name of Technology:	Silva Cell	**Contact Email:**	ɔrenda@deeproot.con
Technology Category:	Below Ground Vault	**Contact Phone:**	
Technology Process:		**Contact Website:**	

# of Installations in Washington: 7

Treatment Type/Application *(check all that apply)*

- [x] Downspout
- [ ] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [ ] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [x] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost:	**low:** ‡,000-$5,6(	**high:**),000-$14,000
Estimated Annual O&M Cost:	**low:** $100-$200	**high:** $100-$200

System Hydraulics

Design Flow Rate (gpm):	**low:** 20"/hour	**high:** 3"/hour
Required head loss (ft):	n/a	
Internal or External Bypass:	Optional	

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

ꜱerature search. The water quality filtering values are based on research by Davis at University of Maryland and Hunt at the Universi

Parameter:	TSS	TP	Dis. Cu	Dis. Zn	Dis. Cd	Dis. Pb	TPH	cPAHs	PCBs
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:	80%	68%	90%+	90%+	90%+				

Notes, Comments, Additional References

Prince Georges County Stormwater Manual, British Columbia Stormwater Manual, State of Washington Department of Ecology

HERRERA

Manufacturer Technology Report

Manufacturer: FABCO industries
Name of Technology: Stormbasin/Stormpod
# of Installations in Washington: <20

Contact Name: Scott Gorneau
Contact Email: Sgorneau@fabco-industries.com
Contact Phone: 207.831.2795
Contact Website: www.fabco-industries.com

Treatment Type/Application (check all that apply)

- ☑ Downspout
- ☑ Drain Inlet Insert
- ☑ Below Ground Vault
- ☑ Above Ground Vault
- ☐ Oil/Water Separartion
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☑ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☑ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	750	2000
Estimated Annual O&M Cost:	200	800

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	50	>2500
System footprint (sq ft):	4	200
Required head loss (ft):	1.25	2.5

Internal or External Bypass: both

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

FABCO stormbasin/stormpod has been tested in the lab and the field by 1st+3rd party's data was collected according to established protocols and consisted of barious methods including grab, auto, semi-auto and single event or composite samples

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs	Total P	Total N
Median Influent (mg/L):	111.9		59.5					0.57	4
Median Effluent (mg/L):	2.7		<5					0.3	1.5
Median Removal (%):	97.8		>90					47	63

	Total Metals			Dissolved Metals			Bacteria		
	Cu	Pb	Zn	Cu	Pb	Zn	ECOLI	Fecal	Enter
Median Influent (mg/L):		0.018	0.335				1550	1600	430
Median Effluent (mg/L):		0.0049	0.175				270	430	230
Median Removal (%):		73	48				83	73	47

Notes, Comments, Additional References

FABCO was awarded a competition bid-soil source spec for large scale municupal deployment in the urban/ms4 stormdrain system of nassau county, long island, ny. Since 2009 FABCO was installed over 2000 stormbasins. Our performance approval as part of this spec-sediment TSS removal> 50% d50: 110 um. Hydrocarbons/oil&grease: >80%. .Phosphorus: >50%. Nitrogen >40%. Bacteria. >70%. Stormbasin is a great retrofit device for industrial facilities and is considered a structural BMP for pretreatment, source control or in spcc + swpp plans.

Manufacturer Technology Report

Manufacturer:	Imbrium Systems	**Contact Name:**	Justin Arnott
Name of Technology:	Stormceptor	**Contact Email:**	Jarnott@ImbriumSystems.com
Technology Category:	Below Ground Vault	**Contact Phone:**	(403) 389-9593
Technology Process:	Sedimentation	**Contact Website:**	www.imbriumsystems.com

# of Installations in Washington: 510+

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [x] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [x] Hydrodynamic Separation
- [ ] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost: **low:** $3,000 **high:** $15,000
Estimated Annual O&M Cost: **low:** $500 **high:** $5,000

System Hydraulics

Design Flow Rate (gpm): **low:** 0 **high:** 11000
Required head loss (ft): 0.22
Internal or External Bypass: Internal

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

The data detailed below is aggregate of many field studies (8) as well as lab studies (2) including the NJCAT TARP program. Most studies were conducted 3rd party with both automatic and grab samplers. Individual test reports are available upon request.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:	57	38					15		
Median Influent (mg/L):	159	0.275					29		
Median Effluent (mg/L):	59	0.175					4		
% Removal:	53	21.8	27.5	35.3		41.8	73		

Notes, Comments, Additional References

Despite the above averages, the Stormceptor system, when sized with PCSWMM for Stormceptor has a 0.94 correlation (r-squared regression value) with field performance when an accurate PSD is used to size the unit. Therefore the Stormceptor can be confidently and accurately sized for TSS removal goals on the order of 80% TSS, if the proper consideration like a true PSD are taken into account. Furthermore, the laboratory evaluation indicates that the Stormceptor unit can achieve DOE level performance at flow rates larger than the indicated treatment flow rate on the DOE GULD. The flow rates listed in the DOE GULD are merely a hydraulic marker within the system that indicates when the unit begins to inhibit scour from the unit.

Manufacturer Technology Report

HERRERA

Manufacturer:	CONTECH Construction Products Inc.	**Contact Name:**	Sean Darcy
Name of Technology:	StormFilter - ZPG	**Contact Email:**	darcys@contech-cpi.com
# of Installations in Washington:	> 500	**Contact Phone:**	503-258-3105
		Contact Website:	contech-cpi.com

Treatment Type/Application (check all that apply)

- [x] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [ ] Oil/Water Separation
- [x] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [x] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): **low:** $10K **high:** $2.5 M
Estimated Annual O&M Cost ($/gallon treated): **low:** 0.00008 **high:** 0.00024

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	2	44900
System aboveground footprint (sq ft):	8	6050
Required head loss (ft):	1.8	12

Internal or External Bypass: Both available

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

a) Stormwater Management StormFilter Basic Treatment Application for General Use Level Designation (2005): field,flow-weighted, peer reviewed, composite samples; b) Milwaukee Riverwalk ETV; Third Party, Field, Flow weighted. c) Heritage Marketplace Field Evalution (2004): field, flow-weighted, peer reviewed, composite samples; d) EvTec Lake Union Ultra-Urban Stormwater Technology Evaluation Stormwater Management StormFilter (2008): field, third party, composite.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	83						**0.12**
Median Effluent (mg/L):	23						**0.062**
Median Removal (%):	82						**42**

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):	0.0425	0.12	0.225	0.00464		0.0599
Median Effluent (mg/L):	0.0335	0.0435	0.12767	0.00423		0.0532
Median Removal (%):	47	24	62	11		15

Notes, Comments, Additional References

TSS reference a; Metals references b & c; cPAHs reference d. cPAHs used Chrysene as the parameter as it was the median performance for the suite of requested analytes. Ranges were 33% to 47% for the entire suite. cPAH data contained 10% more GAC (by volume) than standard ZPG.

Manufacturer Technology Report

HERRERA

Manufacturer:	Fabco Industries	**Contact Name:**	Scott Gornean
Name of Technology:	Stormsafe-Helix	**Contact Email:**	Sgorneau@fabco-industries.com
# of Installations in Washington:	none	**Contact Phone:**	207-831-2795
		Contact Website:	www.fabco-industries.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☐ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☑ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☑ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☐ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:		high:	
Estimated Installation Cost:	**low:**	20000	**high:**	60000
Estimated Annual O&M Cost:	**low:**	2000	**high:**	6000

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	3	**high:**	9
System footprint (sq ft):	**low:**	160	**high:**	250
Required head loss (ft):	**low:**	0	**high:**	3
Internal or External Bypass:		both		

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

We have conducted lab and field studies as descried in our online reports, we are currently undergoing 3rd party field testing at a wastewater treatment plant, treating 10 acres of stormwater runoff.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals			Bateria	
	Cu	Pb	Zn	Cu	Pb	Zn	Total coli	Fecal
Median Influent (mg/L):							4388	3948
Median Effluent (mg/L):							1360	934
Median Removal (%):							69	76

Notes, Comments, Additional References

The Stormsafe-helix technology was released in 2010. The system is designed to treat high flow rates and is generally preceeded by a pretreatment device like a hydrodynamic separator. We offer two configurations of filters that target pathogen or oil&grease, applications include: pathogen/bacteria impaired water bodies. wastewater treatment palnts w/ stormwater discharges. beach outfalls, industrial discharges.

Manufacturer Technology Report

Manufacturer:	Kristar Enterprises, Inc.	**Contact Name:**	Michael Kimberlain
Name of Technology:	SwaleGard Pre-filter	**Contact Email:**	mkimberlain@kristar.com
# of Installations in Washington:	2	**Contact Phone:**	(800) 579-8819
		Contact Website:	www.kristar.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [ ] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [ ] Filtration (media)
- [x] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$4,500	**high:**	$4,500
Estimated Annual O&M Cost:	**low:**	$75	**high:**	$300

System Hydraulics/Design

Design Flow Rate (gpm):	**low:**	100	**high:**	800
System footprint (sq ft):	**low:**	4	**high:**	16
Required head loss (ft):	**low:**	0	**high:**	0.5
Internal or External Bypass:	Internal			

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Lab - UCLA, Univeristy of Hawaii, City of Auckland, NZ, CSUS - OWP. Field Study - University of Hawaii and City of Auckland

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	100	35	35				35
Median Effluent (mg/L):	20	7	7				
Median Removal (%):	80	80	80				7

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):			10			
Median Effluent (mg/L):			6			
Median Removal (%):			60			

Notes, Comments, Additional References

Manufacturer Technology Report

Manufacturer: Kristar Enterprises, Inc.
Name of Technology: TreePod Biofilter
# of Installations in Washington: 0

Contact Name: Michael Kimberlain
Contact Email: mkimberlain@kristar.com
Contact Phone: (800) 579-8819
Contact Website: www.kristar.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [x] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [ ] Hydrodynamic Separation
- [x] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [x] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost: **low:** $10,000 **high:** $50,000
Estimated Annual O&M Cost: **low:** $400 **high:** $750

System Hydraulics/Design

Design Flow Rate (gpm): **low:** 16 **high:** 72
System footprint (sq ft): **low:** 24 **high:** 84
Required head loss (ft): **low:** 0 **high:** 0.5
Internal or External Bypass: Internal

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Internal Hydraulic testing only completed at this time. UNH field study for performance currently under way.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	TBD	TBD	TBD				TBD
Median Effluent (mg/L):	TBD	TBD	TBD				TBD
Median Removal (%):	TBD	TBD	TBD				TBD

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	TBD	TBD	TBD	TBD	TBD	TBD
Median Effluent (mg/L):	TBD	TBD	TBD	TBD	TBD	TBD
Median Removal (%):	TBD	TBD	TBD	TBD	TBD	TBD

Notes, Comments, Additional References

Manufacturer Technology Report

HERRERA

Manufacturer:	REM, Inc. (Revel Environmental Manufacturing)	**Contact Name:**	Marcel Sloane
Name of Technology:	TRITON Drop Inlet Insert	**Contact Email:**	marcel@remfilters.com
Technology Category:		**Contact Phone:**	(925) 858-8005
Technology Process:		**Contact Website:**	remfilters.com

# of Installations in Washington: Estimated: 100

Treatment Type/Application *(check all that apply)*

☐ Downspout	☐ Oil/Water Separartion	☑ Filtration (media)	☐ Ion exchange column	☑ Stormwater
☑ Drain Inlet Insert	☐ Settling	☑ Filtration (fabric)	☐ Reverse osmosis	☐ Groundwater
☐ Below Ground Vault	☐ Hydrodynamic Separation	☐ Filtration (biofiltration)	☐ Electrocoagulation	☐ Wastewater
☐ Above Ground Vault	☐ Floatables Baffle	☐ Filtration (chemically enhanced)	☐ Chemical Treatment	☐ Process water

Estimated Costs

Estimated Installation Cost:	**low:**	$100	**high:**	$700
Estimated Annual O&M Cost:	**low:**	$40	**high:**	$120

System Hydraulics

Design Flow Rate (gpm): **low:** 76 **high:** 9233

Required head loss (ft): .5"

Internal or External Bypass: Internal 721 gpm to 23,000 gpm

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Treatment flow rates will vary depending on the filter cartridge & media configuration which is dependent upon the size and shape of the specific catch basin. See attached treatment flow rate matrix for the most common filter cartridge and media configurations.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

See attached University of California, Irvine Testing Protocols and Results

HERRERA

Manufacturer Technology Report

Manufacturer: AbTech Industries
Name of Technology: Ultra Urban Filter
# of Installations in Washington:
Contact Name: Jonathan Thatcher
Contact Email: jthatcher@abtechindustries.com
Contact Phone: (480) 874-4000
Contact Website: abtechindustries.com

Treatment Type/Application (check all that apply)

- [ ] Downspout
- [x] Drain Inlet Insert
- [ ] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separation
- [ ] Settling
- [ ] Hydrodynamic Separation
- [ ] Floatables Baffle
- [x] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [x] Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: $400 high: $1,700
Estimated Annual O&M Cost ($/gallon treated): low: high:

System Hydraulics/Design

Design Flow Rate (gpm): low: 190 high: 500
System aboveground footprint (sq ft): low: 0 high:
Required head loss (ft): low: 0.5 high: 1.5
Internal or External Bypass: Internal Bypass

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Primary analysis of AbTech Industries Ultra Urban Filter (UUF) was conducted in laboratory studies conducted by third parties using grab samples from established test protocols developed by federal and state regulatory entities. Field data was collected during studies conducted by municipalities to evaluate the effectiveness of the UUFs for deployment in the localized watershed. The testing methods used by the municipalities were governed by the state regulatory body, in which that municipality was located.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):		>100	>100	180			>100
Median Effluent (mg/L):		<10	<10	>4.4			>10
Median Removal (%):	*80%	90%	85%	**40%			**60%

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

* Data based on Particle Size Distribution (PSD) and not on mg/L. Samples tested were evaluated using a medium sand in the 0.355-0.300 mm range.
**Reduction of soluble dissolved hydrocarbons occurs when they become partitioned in the dispersed hydrocarbons and are removed simultaneously. Filtration of dissolved phase hydrocarbons through AbTech's UUFs will not occur, in substantial percent volumes, without the presence of dispersed hydrocarbons. Bench scale testing can be conducted on field samples to establish viability in a specific environment or to meet a specific discharge standard.

Total Metals Removal: Based on TSS testing the UUF has the ability to physically separate Total Metals from the water column, but AbTech products have no Chemical or Biological exchange during the filtration of Total Metals.

HERRERA

Manufacturer Technology Report

Manufacturer: Environment 21, LLC
Name of Technology: UniScreen
# of Installations in Washington: 0
Contact Name: Dino Pezzimenti
Contact Email: dino@env21.com
Contact Phone: 585-815-4714
Contact Website: www.env21.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	$2,000	$15,000
Estimated Annual O&M Cost:	0	$2,000

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	0	15,700
System footprint (sq ft):	20	135
Required head loss (ft):	0	0.5

Internal or External Bypass: Both

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Field studies are not in progress at this time. Future studies are planned.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	*250	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	**150	**150	**150	**150	**150	**150
Median Removal (%):	*80	**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	**Pb**	**Zn**	**Cu**	**Pb**	**Zn**
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.06	***0.56	***0.18	NA	NA	NA
Median Removal (%):	***20	***27	***40	NA	NA	NA

Notes, Comments, Additional References

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d_{50} of 150 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

HERRERA

Manufacturer Technology Report

Manufacturer:	Environment 21, LLC	**Contact Name:**	Dino Pezzimenti
Name of Technology:	UniStorm	**Contact Email:**	dino@env21.com
# of Installations in Washington:	0	**Contact Phone:**	585-815-4714
		Contact Website:	www.env21.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:	high:
Estimated Installation Cost:	$2,000	$15,000
Estimated Annual O&M Cost:	0	$2,000

System Hydraulics/Design

	low:	high:
Design Flow Rate (gpm):	0	15,700
System footprint (sq ft):	20	135
Required head loss (ft):	0	0.5
Internal or External Bypass:	NA	

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Field studies are not in progress at this time. Future studies are planned.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	*250	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	**150	**150	**150	**150	**150	**150
Median Removal (%):	*80	**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.06	***0.56	***0.18	NA	NA	NA
Median Removal (%):	***20	***27	***40	NA	NA	NA

Notes, Comments, Additional References

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d_{50} of 150 microns was used.

**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.

***Testing is not complete for metals; therefore, these values are estimated.

Manufacturer Technology Report

Manufacturer:	Hydro International	**Contact Name:**	Fred Kraekel
Name of Technology:	Up-Flo Filter®	**Contact Email:**	fkraekel@hil-tech.com
Technology Category:	Below Ground Vault	**Contact Phone:**	207-321-3733
Technology Process:	Filter	**Contact Website:**	www.hydro-international.biz

# of Installations in Washington: __________

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separartion
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost: **low:** ______ **high:** ______
Estimated Annual O&M Cost: **low:** ______ **high:** ______

System Hydraulics

Design Flow Rate (gpm): **low:** ______ **high:** ______
Required head loss (ft): ______
Internal or External Bypass: ______

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

Contact Hydro International for details.

Parameter:	**TSS**	**TP**	**Dis. Cu**	**Dis. Zn**	**Dis. Cd**	**Dis. Pb**	**TPH**	**cPAHs**	**PCBs**
# of sample:									
Median Influent (mg/L):									
Median Effluent (mg/L):									
% Removal:									

Notes, Comments, Additional References

The Up-Flo Filter® is a a high rate, upflow filtration system designed to remove fine suspended sediment and associated pollutants like nutrients and heavy metals, depending on the type of media used. The modular, subsurface filtration system is housed in a 4-ft diameter manhole or precast vault that can be retrofitted into an existing storm drain manhole or supplied as a complete system. The design incorporates gravitational separation of floating and settling materials, screening, and filtration of stormwater flows. A siphon-activated bypass conveys flows larger than the design filtration rate for on-line installations. Pollutant removals include TSS, nutrients (i.e. phophorus), synthetic organics, pesticides, herbicides and heavy metals (iron, chromium, copper and lead). The Up-Flo FIlter was issued a PULD by Washington DOE. Contact Hydro International at 1-800-848-2706 or visit the website www. hydro-international.biz for more information.

Manufacturer Technology Report

Manufacturer:	CONTECH Construction Products Inc.	**Contact Name:**	Sean Darcy
Name of Technology:	UrbanGreen BioFilter	**Contact Email:**	darcys@contech-cpi.com
# of Installations in Pacific Northwest:	> 25	**Contact Phone:**	503-258-3105
		Contact Website:	contech-cpi.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☐ Oil/Water Separation
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☑ Filtration (media)
- ☐ Filtration (fabric)
- ☑ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☑ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low	high
Estimated Installation Cost (unit cost and construction cost):	$10k	$250K
Estimated Annual O&M Cost ($/gallon treated):	0.0001	0.0003

System Hydraulics/Design

	low	high
Design Flow Rate (gpm):	4	600
System aboveground footprint (sq ft):		
Required head loss (ft):	3	6

Internal or External Bypass: Both available

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Manufacturer Technology Report

HERRERA

Manufacturer:	Environment 21, LLC	**Contact Name:**	Dino Pezzimenti
Name of Technology:	V2B1	**Contact Email:**	dino@env21.com
# of Installations in Washington:	0	**Contact Phone:**	585-815-4714
		Contact Website:	www.env21.com

Treatment Type/Application *(check all that apply)*

- [ ] Downspout
- [ ] Drain Inlet Insert
- [x] Below Ground Vault
- [ ] Above Ground Vault
- [x] Oil/Water Separartion
- [x] Settling
- [x] Hydrodynamic Separation
- [x] Floatables Baffle
- [ ] Filtration (media)
- [ ] Filtration (fabric)
- [ ] Filtration (biofiltration)
- [ ] Filtration (chemically enhanced)
- [ ] Ion exchange column
- [ ] Reverse osmosis
- [ ] Electrocoagulation
- [ ] Chemical Treatment
- [x] Stormwater
- [ ] Groundwater
- [ ] Wastewater
- [ ] Process water

Estimated Costs

Estimated Installation Cost:	**low:** $2,000	**high:** $15,000
Estimated Annual O&M Cost:	**low:** 0	**high:** $2,000

System Hydraulics/Design

Design Flow Rate (gpm):	**low:** 0	**high:** 63,000
System footprint (sq ft):	**low:** 20	**high:** 800
Required head loss (ft):	**low:** 0	**high:** 0.5
Internal or External Bypass:	Both	

System Performance

Breifly describe how data were colected (field, lab, third party, grab sample, auto-composite, etc.)

Third party lab studies are complete and the field studies are planned to begin within one year.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):	*250	**400	**400	**400	**400	**400	**400
Median Effluent (mg/L):	*175	**150	**150	**150	**150	**150	**150
Median Removal (%):	*80	**62.5	**62.5	**62.5	**62.5	**62.5	**62.5

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):	***0.08	***0.79	***0.3	NA	NA	NA
Median Effluent (mg/L):	***0.05	***0.35	***0.09	NA	NA	NA
Median Removal (%):	***40	***55	***70	NA	NA	NA

Notes, Comments, Additional References

*The TSS removal efficiency is also dependent upon the Particle Size Distribution (PSD). For this product, the assumption of a PSD with a d_{50} of 110 microns was used.
**Any oil based removal depends on the droplet size and specific gravity of the oil. For this product, accurate, analyzed data is unavailable; therefore a mean oil droplet size of 100 micron and a spgr of 0.89 are used. The removal efficiencies are estimated.
***Testing is not complete for metals; therefore, these values are estimated.

Manufacturer Technology Report

HERRERA

Manufacturer:	CONTECH Construction Products Inc.	**Contact Name:**	Sean Darcy
Name of Technology:	VortClarex	**Contact Email:**	darcys@contech-cpi.com
# of Installations in Pacific Northwest:	>25	**Contact Phone:**	503-258-3105
		Contact Website:	contech-cpi.com

Treatment Type/Application (check all that apply)

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separation
- ☑ Settling
- ☐ Hydrodynamic Separation
- ☐ Floatables Baffle
- ☑ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

	low:		high:	
Estimated Installation Cost (unit cost and construction cost):	low:	$10K	high:	$300K
Estimated Annual O&M Cost ($/gallon treated):	low:	0.00008	high:	0.001

System Hydraulics/Design

Design Flow Rate (gpm):	low:	100	high:	2000
System aboveground footprint (sq ft):	low:		high:	
Required head loss (ft):	low:	0.1	high:	
Internal or External Bypass:	Both available			

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs
Median Influent (mg/L):							
Median Effluent (mg/L):							
Median Removal (%):							

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

Manufacturer Technology Report

Manufacturer: CONTECH Construction Products, Inc.
Name of Technology: Vortechs System
# of Installations in Washington: > 100

Contact Name: Sean Darcy
Contact Email: darcys@contech-cpi.com
Contact Phone: 503-258-3105
Contact Website: contech-cpi.com

Treatment Type/Application *(check all that apply)*

- ☐ Downspout
- ☐ Drain Inlet Insert
- ☑ Below Ground Vault
- ☐ Above Ground Vault
- ☑ Oil/Water Separation
- ☑ Settling
- ☑ Hydrodynamic Separation
- ☑ Floatables Baffle
- ☐ Filtration (media)
- ☐ Filtration (fabric)
- ☐ Filtration (biofiltration)
- ☐ Filtration (chemically enhanced)
- ☐ Ion exchange column
- ☐ Reverse osmosis
- ☐ Electrocoagulation
- ☐ Chemical Treatment
- ☑ Stormwater
- ☐ Groundwater
- ☐ Wastewater
- ☐ Process water

Estimated Costs

Estimated Installation Cost (unit cost and construction cost): low: $20K high: $500K
Estimated Annual O&M Cost ($/gallon treated): low: $0.00001 high: $0.00004

System Hydraulics/Design

Design Flow Rate (gpm): low: 50 high: 22450
System aboveground footprint (sq ft): low: NA high: NA
Required head loss (ft): low: 0.1 high:
Internal or External Bypass: Both Available

System Performance

Briefly describe how data were collected (field, lab, third party, grab sample, auto-composite, etc.)

The WAWA Route 37 Stormwater Treatment System TARP TIER II Field Evalaution: Vortechs (2010). Field, Peer Reviewed, Composite.

	TSS	TPH	Oil & grease	SVOCs	PCBs	Dioxins	CPAHs	SSC<50 um
Median Influent (mg/L):	108							24
Median Effluent (mg/L):	28							8
Median Removal (%):	93							70

	Total Metals			Dissolved Metals		
	Cu	Pb	Zn	Cu	Pb	Zn
Median Influent (mg/L):						
Median Effluent (mg/L):						
Median Removal (%):						

Notes, Comments, Additional References

APPENDIX C

Technology Product Information

Appendix C Index (by Treatment System Name)

Treatment System Name	Manufacturer/Vendor Name	Brochure	Drawings	Specs	Graphic/ Schematic	O&M Manual	Testing	Other
Active Treatment Systems								
ACISTBox®	Water Tectonics, Inc.	X						
Arkal Filter (Spin Klin System)	Arkal Filtration Systems/PEP (U.S. Distributor)					X		
Arkal Media Filter	Arkal Filtration Systems/PEP (U.S. Distributor)	X						
Baker Tank with Sand Filter	BakerCorp	X		X				
Chitosan-Enhanced Sand Filtration Using FlocClear™	Clear Creek Systems					X	X	
Fuzzy Filter	Schreiber	X		X	X		X	
High-Flo Electrocoagulation	Kaselco			X			X	
OilTrap ElectroPulse Water Treatment System	OilTrap Environmental	X		X			X	
pHATBox®	Water Tectonics, Inc.	X						
Purus® Stormwater Polishing System	StormwateRx	X						
Redbox	Morselt Borne BV	X						
Wastewater Ion Exchange System (WWIX)	Siemens Water Technologies Inc.	X						
WaterTrak Ion Exchange	Aquatech	X				X		
WaterTrak Pressurized Media Filter	Aquatech	X				X		
WaterTrak Reverse Osmosis	Aquatech	X				X		
WaterTrak Ultrafiltration	Aquatech	X				X		
WaveIonics™	Water Tectonics, Inc.	X					X	
Wetsep	Waste & Environmental Technologies Ltd.	X		X	X			
Passive Treatment Systems								
ADS® Water Quality Unit	Advanced Drainage Systems, Inc	X	X			X	X	X
Adsorb-It	Eco-Tec, Inc.	X	X				X	X
Aqua Shield Aqua-Filter System	AquaShieldTM, Inc.	X		X		X		X
Aqua Shield Aqua-Swirl Concentrator	AquaShieldTM, Inc.	X			X	X		X
Aqua-Guardian™ Catch Basin Insert	AquaShieldTM, Inc.	X				X		X
Aquip® Enhanced Stormwater Filtration System	StormwateRx	X			X			
BayFilter®	BaySaver Technologies, Inc.		X	X			X	X
BaySeparator®	BaySaver Technologies, Inc.		X	X			X	X
Bio Clean Curb Inlet Basket	BioClean Environmental Services, Inc.	X	X	X			X	
Bio Clean Downspout Filter	BioClean Environmental Services, Inc.	X	X				X	
Bio Clean Flume Filter	BioClean Environmental Services, Inc.	X						X
Bio Clean Grate Inlet Skimmer Box	BioClean Environmental Services, Inc.	X						X
Bio Clean Trench Drain Filter	BioClean Environmental Services, Inc.	X						X
Bio Clean Water Polisher	BioClean Environmental Services, Inc.	X	X					
BioSTORM	Bio-Microbics, Inc.	X	X			X		X
CDS™ Stormwater Treatment System	CONTECH Stormwater Solutions Inc.	X	X	X		X		
Clara® Gravity Stormwater Separator Vault	StormwateRx	X			X			
Clean Way Downspout Filtration Unit	Clean Way	X						X
ClearWater BMP	ClearWater Solutions, Inc.	X	X			X		
Coanda Curb Inlet Filter	Coanda, Inc.	X	X	X			X	
Coanda Downspout Filter	Coanda, Inc.	X						

Appendix C Index (by Treatment System Name)

Treatment System Name	Manufacturer/Vendor Name	Brochure	Drawings	Specs	Graphic/ Schematic	O&M Manual	Testing	Other
Passive Treatment Systems (cont.)								
CrystalClean Separator	CrystalStream Technologies	X	X				X	X
CrystalCombo Hybrid Polisher	CrystalStream Technologies	X			X		X	X
Downstream Defender	Hydro International, Inc.	X	X	X		X		X
DrainPac™	United Storm Water, Inc.		X	X		X	X	X
ecoLine A®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	X	X					
ecoLine B®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	X	X		X	X		X
EcoSense™ Stormwater Filtration Systems	EcoSense International	X			X		X	
ecoSep®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	X	X	X		X		X
ecoStorm ®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	X	X	X	X	X		X
ecoStorm Plus®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	X	X	X	X	X		X
ecoTop®	Royal Environmental Systems, Inc./Water Tectonics, Inc.	X	X	X				
EcoVault™ Baffle Box	EcoSense International	X					X	
Enviro-Drain®	Enviro-Drain, Inc.	X	X					
EnviroSafe™	Transpo Industries, Inc.	X						
EnviroSafe™ Storm Safe HF10	Transpo Industries, Inc.	X				X		
EnviroTrap Catch Basin Insert	Environment 21	X	X	X			X	
Filterra® Roofdrain System	Filterra, DBAAmericast, Inc.		X		X	X		X
Filterra® System	Filterra, DBAAmericast, Inc.		X		X	X		X
First Flush 1640FF	ABT, Inc.	X	X					
FloGard+PLUS®	Kristar Enterprises, Inc.	X	X			X		X
FloGard® Downspout Filter	Kristar Enterprises, Inc.	X	X			X		
FloGard® Dual-Vortex Hydrodynamic Separator	Kristar Enterprises, Inc.	X	X			X		
FloGard® LoPro Matrix Filter	Kristar Enterprises, Inc.	X	X			X		
FloGard® LoPro Trench Drain Filter	Kristar Enterprises, Inc.	X	X			X		
Flo-Gard® Trash & Debris Guard	Kristar Enterprises, Inc.	X	X			X		
Go-Filter	AquaShieldTM, Inc.	X						X
Hancor Storm Water Quality Unit	Hancor, Inc.	X		X		X	X	X
HUBER Hydro Filt	Huber Technology, Inc.	X			X			
HydroFilter	Hydroworks				X			
HydroGuard	Hydroworks	X	X			X	X	X
Hydro-Kleen™	ACF Environmental, Inc.	X			X			X
Inceptor®	Stormdrain Solutions	X					X	X
Jellyfish™ Filter	Imbrium Systems Corp	X	X	X		X		X
Kleerwater™	Brown-Minneapolis Tank Co./ Kleerwater Technologies, LLC	X		X	X			X
Modular Wetland System – Linear	Modular Wetland Systems, Inc./ BioClean Environmental Services, Inc.	X	X	X		X	X	X
Nutrient Separating Baffle Box	BioClean Environmental Services, Inc.	X	X	X			X	
Perimeter Sandfilter (Delaware Sandfilter)	Rotondo Environmental Solutions, LLC		X					
Perk Filter™	Kristar Enterprises, Inc.	X	X			X		
PSI Separator	PSI International, Inc.				X	X		X

Appendix C Index (by Treatment System Name)

Treatment System Name	Manufacturer/Vendor Name	Brochure	Drawings	Specs	Graphic/ Schematic	O&M Manual	Testing	Other
Passive Treatment Systems (cont.)								
PuriStorm	Environment 21	X	X					
Raynfiltr™	Environmental Filtration, Inc.	X	X					
RSF (Rapid Stormwater Filtration) 100	EcoSol Wastewater Filtration Systems	X	X	X			X	X
RSF (Rapid Stormwater Filtration) 1000	EcoSol Wastewater Filtration Systems	X	X	X			X	X
RSF (Rapid Stormwater Filtration) 4000	EcoSol Wastewater Filtration Systems	X	X	X			X	X
Silva Cell	DeepRoot Partners	X		X	X	X		X
SNOUT®	Nyloplast/Hancor, Inc.	X						
Sorbtive™ FILTER	Imbrium Systems Corp	X	X			X	X	X
Storm PURE™	Nyloplast/Hancor, Inc.	X						
StormBasin™	Fabco Industries, Inc.	X	X			X	X	X
Stormceptor®	Imbrium Systems Corp	X	X	X		X		X
StormClean Catch Basin Insert	Clean Way	X	X					X
StormClean Curb Inlet Insert	Clean Way	X						X
StormClean Wall Mount Filtration Unit	Clean Way	X						X
Stormfilter using ZPG Media	CONTECH Stormwater Solutions Inc.	X	X	X		X	X	
StormPod™	Fabco Industries, Inc.	X	X			X	X	X
StormSafe™ Helix	Fabco Industries, Inc.	X			X	X		
StormTrooper®	Park USA	X	X					X
StormTrooper® EX Extra-Duty	Park USA	X	X					X
SwaleGard® Pre-filter	Kristar Enterprises, Inc.	X	X			X		
Terre Kleen™	Terre Hill Concrete Products		X	X				X
TREEPOD® Biofilter	Kristar Enterprises, Inc.	X	X			X		
Triton Drop Inlet Insert	Revel Environmental Manufacturing, Inc./ CONTECH Stormwater Solutions Inc.	X	X	X		X	X	
Ultra-Urban Filter™	Abtech Industries	X						
Underground Sandfilter (DC Sandfilter)	Rotondo Environmental Solutions, LLC		X					
UniScreen	Environment 21	X	X	X			X	
UniStorm	Environment 21	X	X	X		X	X	
Up-Flo™ Filter	Hydro International, Inc.	X	X	X		X	X	
UrbanGreen BioFilter	CONTECH Stormwater Solutions Inc.	X	X	X		X		X
V2B1 Treatment System	Environment 21	X	X	X			X	
VortClarex	CONTECH Stormwater Solutions Inc.	X	X	X		X		
Vortechs System	CONTECH Stormwater Solutions Inc.	X	X	X		X	X	X

Appendix C Index (by Manufacturer/Vendor Name)

Treatment System Name	Manufacturer/Vendor Name	Brochure	Drawings	Specs	Graphic/ Schematic	O&M Manual	Testing	Other
Active Treatment Systems								
Aquatech	WaterTrak Ion Exchange	X				X		
Aquatech	WaterTrak Pressurized Media Filter	X				X		
Aquatech	WaterTrak Reverse Osmosis	X				X		
Aquatech	WaterTrak Ultrafiltration	X				X		
Arkal Filtration Systems/PEP (U.S. Distributor)	Arkal Filter (Spin Klin System)					X		
Arkal Filtration Systems/PEP (U.S. Distributor)	Arkal Media Filter	X						
BakerCorp	Baker Tank with Sand Filter	X		X				
Clear Creek Systems	Chitosan-Enhanced Sand Filtration Using FlocClear™					X	X	
Kaselco	High-Flo Electrocoagulation			X			X	
Morselt Borne BV	Redbox	X						
OilTrap Environmental	OilTrap ElectroPulse Water Treatment System	X		X			X	
Schreiber	Fuzzy Filter	X		X	X		X	
Siemens Water Technologies Inc.	Wastewater Ion Exchange System (WWIX)	X						
StormwateRx	Purus® Stormwater Polishing System	X						
Waste & Environmental Technologies Ltd.	Wetsep	X		X	X			
Water Tectonics, Inc.	ACISTBox®	X						
Water Tectonics, Inc.	pHATBox®	X						
Water Tectonics, Inc.	WaveIonics™	X					X	
Passive Treatment Systems								
ABT, Inc.	First Flush 1640FF	X	X					
Abtech Industries	Ultra-Urban Filter™	X						
ACF Environmental, Inc.	Hydro-Kleen™	X			X			X
Advanced Drainage Systems, Inc	ADS® Water Quality Unit	X	X			X	X	X
AquaShieldTM, Inc.	Aqua Shield Aqua-Filter System	X		X		X		X
AquaShieldTM, Inc.	Aqua Shield Aqua-Swirl Concentrator	X			X	X		X
AquaShieldTM, Inc.	Aqua-Guardian™ Catch Basin Insert	X				X		X
AquaShieldTM, Inc.	Go-Filter	X						X
BaySaver Technologies, Inc.	BayFilter®		X	X			X	X
BaySaver Technologies, Inc.	BaySeparator®		X	X			X	X
BioClean Environmental Services, Inc.	Bio Clean Curb Inlet Basket	X	X	X			X	
BioClean Environmental Services, Inc.	Bio Clean Downspout Filter	X	X				X	
BioClean Environmental Services, Inc.	Bio Clean Flume Filter	X						X
BioClean Environmental Services, Inc.	Bio Clean Grate Inlet Skimmer Box	X						X
BioClean Environmental Services, Inc.	Bio Clean Trench Drain Filter	X						X
BioClean Environmental Services, Inc.	Bio Clean Water Polisher	X	X					
BioClean Environmental Services, Inc.	Nutrient Separating Baffle Box	X	X	X			X	
Bio-Microbics, Inc.	BioSTORM	X	X			X		X
Brown-Minneapolis Tank Co./ Kleerwater Technologies, LLC	Kleerwater™	X		X	X			X

Appendix C Index (by Manufacturer/Vendor Name)

Treatment System Name	Manufacturer/Vendor Name	Brochure	Drawings	Specs	Graphic/ Schematic	O&M Manual	Testing	Other
Passive Treatment Systems (cont.)								
Clean Way	Clean Way Downspout Filtration Unit	X						X
Clean Way	StormClean Catch Basin Insert	X	X					X
Clean Way	StormClean Curb Inlet Insert	X						X
Clean Way	StormClean Wall Mount Filtration Unit	X						X
ClearWater Solutions, Inc.	ClearWater BMP	X	X			X		
Coanda, Inc.	Coanda Curb Inlet Filter	X	X	X			X	
Coanda, Inc.	Coanda Downspout Filter	X						
CONTECH Stormwater Solutions Inc.	CDS™ Stormwater Treatment System	X	X	X		X		
CONTECH Stormwater Solutions Inc.	Stormfilter using ZPG Media	X	X	X		X	X	
CONTECH Stormwater Solutions Inc.	UrbanGreen BioFilter	X	X	X		X		X
CONTECH Stormwater Solutions Inc.	VortClarex	X	X	X		X		
CONTECH Stormwater Solutions Inc.	Vortechs System	X	X	X		X	X	X
CrystalStream Technologies	CrystalClean Separator	X	X				X	X
CrystalStream Technologies	CrystalCombo Hybrid Polisher	X			X		X	X
DeepRoot Partners	Silva Cell	X		X	X	X		X
EcoSense International	EcoSense™ Stormwater Filtration Systems	X			X		X	
EcoSense International	EcoVault™ Baffle Box	X					X	
EcoSol Wastewater Filtration Systems	RSF (Rapid Stormwater Filtration) 100	X	X	X			X	X
EcoSol Wastewater Filtration Systems	RSF (Rapid Stormwater Filtration) 1000	X	X	X			X	X
EcoSol Wastewater Filtration Systems	RSF (Rapid Stormwater Filtration) 4000	X	X	X			X	X
Eco-Tec, Inc.	Adsorb-It	X	X				X	X
Enviro-Drain, Inc.	Enviro-Drain®	X	X					
Environment 21	EnviroTrap Catch Basin Insert	X	X	X			X	
Environment 21	PuriStorm	X	X					
Environment 21	UniScreen	X	X	X			X	
Environment 21	UniStorm	X	X	X		X	X	
Environment 21	V2B1 Treatment System	X	X	X			X	
Environmental Filtration, Inc.	Raynfiltr™	X	X					
Fabco Industries, Inc.	StormBasin™	X	X			X	X	X
Fabco Industries, Inc.	StormPod™	X	X			X	X	X
Fabco Industries, Inc.	StormSafe™ Helix	X			X	X		
Filterra, DBAAmericast, Inc.	Filterra® Roofdrain System		X		X	X		X
Filterra, DBAAmericast, Inc.	Filterra® System		X		X	X		X
Hancor, Inc.	Hancor Storm Water Quality Unit	X		X		X	X	X
Huber Technology, Inc.	HUBER Hydro Filt	X			X			
Hydro International, Inc.	Downstream Defender	X	X	X		X		X
Hydro International, Inc.	Up-Flo™ Filter	X	X	X		X	X	
Hydroworks	HydroFilter				X			
Hydroworks	HydroGuard	X	X			X	X	X
Imbrium Systems Corp	Jellyfish™ Filter	X	X	X		X		X

Appendix C Index (by Manufacturer/Vendor Name)

Treatment System Name	Manufacturer/Vendor Name	Brochure	Drawings	Specs	Graphic/ Schematic	O&M Manual	Testing	Other
Passive Treatment Systems (cont.)								
Imbrium Systems Corp	Sorbtive™ FILTER	X	X			X	X	X
Imbrium Systems Corp	Stormceptor®	X	X	X		X		X
Kristar Enterprises, Inc.	FloGard+PLUS®	X	X			X		X
Kristar Enterprises, Inc.	FloGard® Downspout Filter	X	X			X		
Kristar Enterprises, Inc.	FloGard® Dual-Vortex Hydrodynamic Separator	X	X			X		
Kristar Enterprises, Inc.	FloGard® LoPro Matrix Filter	X	X			X		
Kristar Enterprises, Inc.	FloGard® LoPro Trench Drain Filter	X	X			X		
Kristar Enterprises, Inc.	Flo-Gard® Trash & Debris Guard	X	X			X		
Kristar Enterprises, Inc.	Perk Filter™	X	X			X		
Kristar Enterprises, Inc.	SwaleGard® Pre-filter	X	X			X		
Kristar Enterprises, Inc.	TREEPOD® Biofilter	X	X			X		
Modular Wetland Systems, Inc./ BioClean Environmental Services, Inc.	Modular Wetland System – Linear	X	X	X		X	X	X
Nyloplast/Hancor, Inc.	SNOUT®	X						
Nyloplast/Hancor, Inc.	Storm PURE™	X						
Park USA	StormTrooper®	X	X					X
Park USA	StormTrooper® EX Extra-Duty	X	X					X
PSI International, Inc.	PSI Separator				X	X		X
Revel Environmental Manufacturing, Inc./ CONTECH Stormwater Solutions Inc.	Triton Drop Inlet Insert	X	X	X		X	X	
Rotondo Environmental Solutions, LLC	Perimeter Sandfilter (Delaware Sandfilter)		X					
Rotondo Environmental Solutions, LLC	Underground Sandfilter (DC Sandfilter)		X					
Royal Environmental Systems, Inc./Water Tectonics, Inc.	ecoLine A®	X	X					
Royal Environmental Systems, Inc./Water Tectonics, Inc.	ecoLine B®	X	X		X	X		X
Royal Environmental Systems, Inc./Water Tectonics, Inc.	ecoSep®	X	X	X		X		X
Royal Environmental Systems, Inc./Water Tectonics, Inc.	ecoStorm ®	X	X	X	X	X		X
Royal Environmental Systems, Inc./Water Tectonics, Inc.	ecoStorm Plus®	X	X	X	X	X		X
Royal Environmental Systems, Inc./Water Tectonics, Inc.	ecoTop®	X	X	X				
Stormdrain Solutions	Inceptor®	X					X	X
StormwateRx	Aquip® Enhanced Stormwater Filtration System	X			X			
StormwateRx	Clara® Gravity Stormwater Separator Vault	X			X			
Terre Hill Concrete Products	Terre Kleen™		X	X				X
Transpo Industries, Inc.	EnviroSafe™	X						
Transpo Industries, Inc.	EnviroSafe™ Storm Safe HF10	X				X		
United Storm Water, Inc.	DrainPac™		X	X		X	X	X

The contents of this appendix are provided on a CD

APPENDIX D

Excel Versions of Tables 3 through 12

The contents of this appendix are provided on a CD

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
Napa River Sediment, R2-2009-0064 (adopted September 9, 2009)	WLAs apply to "Industrial Stormwater NPDES Permit No. CAS000001." Napa River Sediment TMDL, R2-2009-0064, Table 3b. WLAs for CAS000001 permittees: 500 metric tons/year; 0.3 percent of natural background.
Sonoma Creek Sediment, R2-2008-0103 (adopted October 10, 2008)	WLAs apply to "Industrial Stormwater – NPDES Permit No. CAS000001." Sonoma Creek Sediment TMDL, R2-2008-0103. WLAs for CAS000001 permittees: 100 metric tons/year; 0.2 percent natural background.
Santa Clara River Reach 3 Chloride, US EPA (established June 18, 2003)	"Wasteload allocations are established for the following chloride sources: discharges of construction or industrial site runoff or CalTrans facility discharges to Santa Clara River Reach 3 or to any tributaries that discharge to Reach 3 that are regulated through the ... Industrial Activities Stormwater General Permit Order No. 97-03-DWQ." Santa Clara River Reach 3 Chloride TMDL at 18. The WLAs for industrial permittees are 80 mg/L. *Id.* at 17.
Walker Creek Mercury, R2-2007-0010 (adopted January 23, 2007)	WLAs apply to "Gambonini Mine site NPDES Permit no. CAS000001." Walker Creek Mercury TMDL, R2-2007-0010, Table 7-x. WLAs for CAS000001 permittees: 5 mg mercury per kg suspended sediment.
Oxnard Drain No. 3 Pesticides, PCBs and Sediment Toxicity, US EPA (established October 6, 2011)	"All other permitted facilities also receive WLAs. Relevant permit numbers are . . . General Industrial Stormwater: Order No. 97-03-DWQ, CAS000001, or subsequent permits." Oxnard Drain No. 3 Pesticides, PCBs and Sediment Toxicity TMDL at 33.

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td></td><td>
Table 15. TMDL numeric targets used for wasteload and load allocations
<table>
<tr><th>Pollutant / Medium</th><th>Water Allocations, chronic (ug/L)</th><th>Sediment[1,2] Allocations (ug/dry kg)</th><th>Alternate Sediment[1,3] Allocations (ug/dry kg)</th></tr>
<tr><td>Bifenthrin[4]</td><td>0.0006</td><td>-</td><td>-</td></tr>
<tr><td>Chlordane, total</td><td>0.00059</td><td>0.5</td><td>3.3</td></tr>
<tr><td>Chlorpyrifos[4]</td><td>0.0056</td><td>-</td><td>-</td></tr>
<tr><td>4,4'-DDT</td><td>0.00059</td><td>1.0</td><td>0.3</td></tr>
<tr><td>4,4'-DDE</td><td>0.00059</td><td>2.2</td><td>2.2</td></tr>
<tr><td>4,4'-DDD</td><td>0.00084</td><td>2.0</td><td>2.0</td></tr>
<tr><td>Dieldrin</td><td>0.00014</td><td>0.02</td><td>4.3</td></tr>
<tr><td>PCBs, total</td><td>0.00017</td><td>22.7</td><td>180</td></tr>
<tr><td>Sediment Toxicity</td><td>-</td><td>No significant chronic sediment toxicity (See below and Section 3 for more details)</td><td>-</td></tr>
<tr><td>Toxaphene</td><td>0.0002</td><td>0.1</td><td>360</td></tr>
</table>
</td></tr>
<tr><td>Long Beach City Beaches and Los Angeles River Estuary Indicator Bacteria, US EPA (established March 26, 2012)</td><td>"… the Statewide Industrial Storm Water General Permit … [is] assigned WLAs of zero (0) days of allowable exceedances for all time periods for the single sample targets and no exceedances of the 30-day geometric mean targets because they are not expected to be a significant source of indicator bacteria."</td></tr>
<tr><td>Los Angeles Area Lakes Nitrogen, Phosphorus, Mercury, Trash, Organochlorine Pesticides and PCBs, US EPA (established March 26, 2012)</td><td>"The NPDES permits in the watersheds draining to impaired lakes include … general industrial stormwater permits, and a general NPDES permit."</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td></td><td>
Table 4-8. Wasteload Allocations of Phosphorus and Nitrogen Loading to Peck Road Park Lak
<table>
<tr><th>Subwatershed</th><th>Responsible Jurisdiction</th><th>Input</th><th>Wasteload Allocation Total Phosphorus (lb-P/yr)[4]</th><th>Wasteload Allocation Total Nitrogen (lb-N/yr)[4]</th></tr>
<tr><td>Eastern</td><td>General Industrial Stormwater Permittees[2] (in the city of Duarte)</td><td>General Industrial Stormwater[1]</td><td>55.1
(0.37 mg/L P)[2]</td><td>432
(3.61 mg/L N)[2]</td></tr>
<tr><td>Eastern</td><td>General Industrial Stormwater Permittees (in the city of Irwindale)[3]</td><td>General Industrial Stormwater[1]</td><td>32.5
(0.37 mg/L P)[2]</td><td>255
(3.61 mg/L N)[2]</td></tr>
<tr><td>Eastern</td><td>General Industrial Stormwater Permittees (in the city of Monrovia)[3]</td><td>General Industrial Stormwater[1]</td><td>223</td><td>1,748</td></tr>
<tr><td>Near Lake</td><td>General Industrial Stormwater Permittees (in the city of Arcadia)[3]</td><td>General Industrial Stormwater[1]</td><td>23.4
(0.37 mg/L P)[2]</td><td>183
(3.61 mg/L N)[2]</td></tr>
<tr><td>Western</td><td>General Industrial Stormwater Permittees (in the city of Arcadia)[3]</td><td>General Industrial Stormwater[1]</td><td>517
(0.37 mg/L P)[2]</td><td>4,058
(3.61 mg/L N)[2]</td></tr>
</table>
</td></tr>
<tr><td>Santa Monica Bay DDTs and PCBs, US EPA (established March 26, 2012)</td><td>
“In addition there are 18 minor discharges, 175 dischargers covered under general permits, 87 dischargers covered by an industrial stormwater permit…”

Table 6-4. Mass-based waste load allocations for the four major groups of stormwater permit discharging to Santa Monica Bay.
<table>
<tr><th>Permit Type</th><th>Area (m2)</th><th>% of Total Area</th><th>DDT (g/yr)</th><th>PCBs (g/yr)</th></tr>
<tr><td>Los Angeles County MS4</td><td>926,705,620</td><td>96.723</td><td>27.08</td><td>140.25</td></tr>
<tr><td>CalTrans</td><td>25,746,490</td><td>2.687</td><td>0.75</td><td>3.90</td></tr>
<tr><td>Construction</td><td>5,406,683</td><td>0.564</td><td>0.16</td><td>0.82</td></tr>
<tr><td>Industrial</td><td>241,245</td><td>0.025</td><td>0.01</td><td>0.04</td></tr>
<tr><td>Entire SMB WMA</td><td>958,100,038</td><td>100</td><td>28</td><td>145</td></tr>
</table>
</td></tr>
<tr><td>San Gabriel River Metals and Selenium, US EPA (established March 26, 2007)</td><td>“The combined storm water waste load allocation is further allocated to the general industrial, general construction, MS4 and Caltrans permits based on their percent area of the developed portion of the watershed.”</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Santa Monica Bay Nearshore Debris, R4-10-010 (adopted November 4, 2010)</td><td>“The WLA for plastic pellets is zero. Zero plastic pellets is defined as no discharge of plastic pellets from the premises of industrial facilities that import, manufacture, process, transport, store, recycle or otherwise handle plastic pellets. The WLA is consistent with Cal. Water Code § 13367 and 40 CFR 122.26(b)(12). WLAs for plastic pellets are assigned to permittees of the Industrial Storm Water General Permit (Order No. 97-03-DWQ, and NPDES Permit No. CAS 000001) within the Santa Monica Bay WMA.”</td></tr>
<tr><td>Machado Lake Toxics TMDL, R4-10-008, (adopted September 2, 20100</td><td>“As of the writing of the TMDL, there are approximately 47 dischargers enrolled under the general industrial stormwater permit in the Machado Lake subwatershed … Waste load allocations (WLAs) for contaminants associated with suspended sediment are assigned to stormwater dischargers (MS4, Caltrans, general construction and general industrial dischargers) in both wet and dry weather.”

<table>
<tr><th>Responsible Party</th><th>Pollutant</th><th>WLA for Suspended Sediment-Associated Contaminants (µg/kg dry weight)</th></tr>
<tr><td rowspan="7">MS4 Permittees[1], Caltrans, General Construction and Industrial Stormwater Permittees, Other Non-stormwater NPDES Permittees</td><td>Total PCBs</td><td>59.8</td></tr>
<tr><td>DDT (all congeners)</td><td>4.16</td></tr>
<tr><td>DDE (all congeners)</td><td>3.16</td></tr>
<tr><td>DDD (all congeners)</td><td>4.88</td></tr>
<tr><td>Total DDT</td><td>5.28</td></tr>
<tr><td>Chlordane</td><td>3.24</td></tr>
<tr><td>Dieldrin</td><td>1.9</td></tr>
<tr><td colspan="3">[1] WLAs are applied with a 3-year averaging period.</td></tr>
</table></td></tr>
<tr><td>Santa Clara River Bacteria, R4-10-006, (adopted July 8, 2010)</td><td>“…the Statewide Industrial Storm Water General Permit …[is] assigned WLAs of zero (0) days of allowable exceedances for all time periods for the single sample targets and no exceedances of the 30-day geometric mean targets because they are not expected to be significant source of indicator bacteria. Compliance with an effluent limit based on the bacteria water quality objectives will be used to demonstrate compliance with the WLA.”</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Los Angeles River Metals, R4-10-003 (adopted May 6, 2010)</td><td>
“The general industrial storm water permits shall achieve interim wet-weather waste load allocations, which shall be expressed as NPDES water quality-based effluent limitations. Effluent limitations may be expressed as permit conditions, such as the installation, maintenance, and monitoring of Regional Board-approved BMPs. Permittees shall begin an iterative BMP process including BMP effectiveness monitoring to achieve compliance with final waste load allocations.”

Interim WLAs:
<table>
<tr><th colspan="4">Interim wet-weather WLAs for general industrial storm water permittees (total recoverable metals)*</th></tr>
<tr><th>Cd (µg/L)</th><th>Cu(µg/L)</th><th>Pb(µg/L)</th><th>Zn(µg/L)</th></tr>
<tr><td>15.9</td><td>63.6</td><td>81.6</td><td>117</td></tr>
</table>

Final WLAs:
<u>Dry weather</u>: A zero waste load allocation is assigned to all industrial and construction storm water permittees during dry weather.

<u>Wet weather:</u>
<table>
<tr><th colspan="2">General Industrial wet-weather WLAs (total recoverable metals):</th></tr>
<tr><th>Metal</th><th>Waste Load Allocation (kg/day)</th></tr>
<tr><td>Cadmium</td><td>WER[1] x 1.6×10^{-10} x daily volume(L) – 0.11</td></tr>
<tr><td>Copper</td><td>WER[1] x 8.8×10^{-10} x daily volume (L) – 0.5</td></tr>
<tr><td>Lead</td><td>WER[1] x 3.3×10^{-9} x daily volume (L) – 0.22</td></tr>
<tr><td>Zinc</td><td>WER[1] x 8.3×10^{-9} x daily volume (L) – 4.8</td></tr>
</table>

Each storm water permittee under the general industrial and construction storm water permits will receive individual waste load allocations per acre based on the total acres of their facility.
</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Colorado Lagoon Pesticides, PAHs, PCB, Metals, R4-09-005 (adopted October 1, 2009)</td><td>“Concentration-based waste load allocations are assigned to minor NPDES permits, other stormwater, and non-stormwater permittees. Any future minor NPDES permits or enrollees under a general non-stormwater NPDES permit, general industrial stormwater permit or general construction permit will also be subject to concentration-based waste load allocations.”
<table>
<tr><th>Constituents</th><th>Waste Load Allocation (ug/dry kg)</th></tr>
<tr><td>Chlordane</td><td>0.50</td></tr>
<tr><td>Dieldrin</td><td>0.02</td></tr>
<tr><td>Lead</td><td>46,700.00</td></tr>
<tr><td>Zinc</td><td>150,000.00</td></tr>
<tr><td>PAHs</td><td>4,022.00</td></tr>
<tr><td>PCBs</td><td>22.70</td></tr>
<tr><td>DDT</td><td>1.58</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Machado Lake Nutrient, R4-2008-006 (adopted May 1, 2008)</td><td>
Interim WLAs are based on current in-lake concentrations. The effective date interim total nitrogen and total phosphorus waste load allocations are set as the 95th percentile of current concentrations in the lake. The 5 year interim total nitrogen WLAs are established as a 30 percent reduction from current in-lake concentrations. Concentration-based interim and final WLAs will be included in stormwater permits in accordance with NPDES guidance and requirements. The tables below present the interim and final waste load allocations for the stormwater discharges.
<table>
<tr><th>Waste Load Allocations</th><th>Total Phosphorus</th><th>Total Nitrogen ($TKN + NO_3-N + NO_2-N$)</th></tr>
<tr><td></td><td>Final WLA (mg/L)</td><td>Final WLA (mg/L)</td></tr>
<tr><td>MS4 Permittees[1] Caltrans, General Construction and Industrial stormwater permits</td><td>0.1</td><td>1.0</td></tr>
</table>
1. Municipal Separate Storm Sewer System (MS4) Permittees that are responsible for discharges to Machado Lake include: Los Angeles County, Los Angeles County Flood Control District, and the Cities of Carson, Lomita, Los Angeles, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, and Torrance.
<table>
<tr><th>Waste Load Allocations</th><th>Years After Effective Date</th><th>Interim Total Phosphorus WLAs (mg/L)</th><th>Interim Total Nitrogen (TKN + NO3-N + NO2-N) WLAs (mg/L)</th></tr>
<tr><td rowspan="3">MS4 Permittees, Caltrans, General Construction and Industrial Stormwater permits</td><td>At Effective Date[1]</td><td>1.25</td><td>3.50</td></tr>
<tr><td>5[2]</td><td>1.25</td><td>2.45</td></tr>
<tr><td>9.5 (Final WLAs[3])</td><td>0.10</td><td>1.00</td></tr>
</table>
</td></tr>
<tr><td>Harbor Beaches of Ventura County Bacteria, R4-2007-017 (adopted November 1, 2007)</td><td>“General NPDES permits, individual NPDES permits, the Statewide Industrial Storm Water General Permit, the Statewide Construction Activity Storm Water General Permit, and WDR permittees in the Channel Islands Harbor subwatershed are assigned WLAs of zero (0) days of allowable exceedances for all three time periods and for the single sample limits and the rolling 30-day geometric mean.”</td></tr>
</table>

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
Calleguas Creek Watershed Salts, R4-2007-016 (adopted October 4, 2007)	"A group mass-based dry weather WLA has been developed for all permitted stormwater discharges, including municipal separate storm sewer systems (MS4s), and general industrial and construction stormwater permits. . ." "Permitted stormwater dischargers that are responsible parties to this TMDL include the Municipal Stormwater Dischargers (MS4s) of the Cities of Camarillo, Moorpark, Thousand Oaks, County of Ventura, Ventura County Watershed Protection District, and general industrial and construction permittees. Permitted stormwater dischargers are assigned a dry weather wasteload allocation equal to the average dry weather critical condition flow rate multiplied by the numeric target for each constituent (Table 4). Waste load allocations apply in the receiving water at the base of each subwatershed. Because wet weather flows transport a large mass of salts at a typically low concentration, these dischargers should meet water quality objectives during wet weather. Dry weather allocations apply when instream flow rates are below the 86th percentile flow and there has been no measurable precipitation in the previous 24 hours."

Interim WLAs:

Table 7. Interim Dry Weather WLAs for Permitted Stormwater Dischargers

Constituent	Interim Limit (mg/L)
Boron Total	1.3
Chloride Total	230
Sulfate Total	1289
TDS Total	1720

Final WLAs:

Table 6. Final Dry Weather WLAs for Permitted Stormwater Dischargers

Subwatershed	Critical Condition Flow Rate (mgd)	Chloride (lb/day)	TDS (lb/day)	Sulfate (lb/day)	Boron (lb/day)
Simi	1.39	1,738	9,849	2,897	12
Las Posas	0.13	157	887	261	N/A
Conejo	1.26	1,576	8,931	2,627	N/A
Camarillo	0.06	72	406	119	N/A
Pleasant Valley (Calleguas)	0.12	150	850	250	N/A
Pleasant Valley (Revolon)	0.25	314	1,778	523	2

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
Ballona Creek Metals, R4-2007-015 (adopted September 6, 20070	"A grouped mass-based waste load allocation is developed for the storm water permittees (Los Angeles County MS4, Caltrans, General Construction and General Industrial) by subtracting the load allocation from the total loading capacity" **Dry Weather:** "…A waste load allocation of zero is assigned to all general construction and industrial storm water permits during dry weather. Therefore, the storm water waste load allocations are apportioned between the MS4 permittees and Caltrans, based on an areal weighting approach." **Wet Weather:** **Wet-weather Storm Water WLAs Apportioned Between Storm Water Permits (total recoverable metals)** Waste Load Allocation (grams/day) Copper MS4 Permittees 1.70E-05 x Daily storm volume (L) Caltrans 2.37E-07 x Daily storm volume (L) General Construction 4.94E-07 x Daily storm volume (L) General Industrial 1.24E-07 x Daily storm volume (L) Lead MS4 Permittees 5.58E-05 x Daily storm volume (L) Caltrans 7.78E-07 x Daily storm volume (L) General Construction 1.62E-06 x Daily storm volume (L) General Industrial 4.06E-07 x Daily storm volume (L) Selenium MS4 Permittees 4.73E-06 x Daily storm volume (L) Caltrans 6.59E-08 x Daily storm volume (L) General Construction 1.37E-07 x Daily storm volume (L) General Industrial 3.44E-08 x Daily storm volume (L) Zinc MS4 Permittees 1.13E-04 x Daily storm volume (L) Caltrans 1.57E-06 x Daily storm volume (L) General Construction 3.27E-06 x Daily storm volume (L) General Industrial 8.19E-07 x Daily storm volume (L)

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td></td><td>
Each storm water permittee enrolled under the general construction or industrial storm water permits will receive an individual waste load allocation on a per acre basis, based on the acreage of their facility.

Dry Weather

Dry-weather waste load allocation for storm water is equal to the dry-weather critical flow multiplied by the dry-weather numeric target minus the load allocation for direct atmospheric deposition.

Dry-weather Storm Water WLAs (grams total recoverable metals/day)
<table>
<tr><th></th><th>Copper</th><th>Lead</th><th>Selenium</th><th>Zinc</th></tr>
<tr><td>Ballona Creek</td><td>818.9</td><td>438.6</td><td>171</td><td>10,416.2</td></tr>
<tr><td>Sepulveda Channel</td><td>370.7</td><td>198.8</td><td>77</td><td>4,711.1</td></tr>
</table>
A waste load allocation of zero is assigned to all general construction and industrial storm water permits during dry weather. Therefore, the storm water waste load allocations are apportioned between the MS4 permittees and Caltrans, based on an areal weighting approach.

Dry-weather Storm Water WLAs Apportioned between Storm Water Permits (grams total recoverable metals/day)
<table>
<tr><th></th><th>Copper</th><th>Lead</th><th>Selenium</th><th>Zinc</th></tr>
<tr><td><u>Ballona Creek</u></td><td></td><td></td><td></td><td></td></tr>
<tr><td>MS4 permittees</td><td>807.7</td><td>432.6</td><td>169</td><td>10,273.1</td></tr>
<tr><td>Caltrans</td><td>11.2</td><td>6.0</td><td>2</td><td>143.1</td></tr>
<tr><td><u>Sepulveda Channel</u></td><td></td><td></td><td></td><td></td></tr>
<tr><td>MS4 Permittees</td><td>365.6</td><td>196.1</td><td>76</td><td>4646.4</td></tr>
<tr><td>Caltrans</td><td>5.1</td><td>2.7</td><td>1</td><td>64.7</td></tr>
</table>
Concentration-based dry-weather waste load allocations are assigned to the minor NPDES permits and general non-storm water NPDES permits that discharge to Ballona Creek or its tributaries. Any future minor NPDES permits or enrollees under a general non-storm water NPDES permit will also be subject to the concentration-based waste load allocations.

Dry-weather WLAs for other permits (total recoverable metals)
<table>
<tr><th>Copper (µg/L)</th><th>Lead (µg/L)</th><th>Selenium (µg/L)</th><th>Zinc (µg/L)</th></tr>
<tr><td>24</td><td>13</td><td>5</td><td>304</td></tr>
</table>
</td></tr>
<tr><td>Calleguas Creek Watershed Metals and Selenium, 2006-012, Adopted June 8, 2006</td><td>“In accordance with current practice, a group concentration-based WLA has been developed for all permitted stormwater discharges, including municipal separate storm sewer systems (MS4s), Caltrans, general industrial and construction stormwater permits, and Naval Air Weapons Station Point Mugu.”</td></tr>
</table>

TMDLs Applicable to Permittees	WLAs Applicable to Permittees

Interim WLAs:

A. Interim Limits

Constituents	Calleguas and Conejo Creek			Revolon Slough		
	Dry CMC (ug/L)	Dry CCC (ug/L)	Wet CMC (ug/L)	Dry CMC (ug/L)	Dry CCC (ug/L)	Wet CMC (ug/L)
Copper*	23	19	204	23	19	204
Nickel	15	13	(a)	15	13	(a)
Selenium	(b)	(b)	(b)	14	13	(a)

(a) The current loads do not exceed the TMDL under wet conditions; interim limits are not required.
(b) Selenium allocations have not been developed for this reach as it is not on the 303(d) list.
(c) Attainment of interim limits will be evaluated in consideration of background loading data, if available.

Final WLAs (dry weather):

Flow Range	Calleguas and Conejo Creek			Revolon Slough		
	Low Flow	Average Flow	Elevated Flow	Low Flow	Average Flow	Elevated Flow
Copper1 (lbs/day)	0.04*WER 0.02	0.12*WER 0.02	0.18*WER 0.03	0.03*WER - 0.01	0.06*WER - 0.03	0.13*WER 0.02
Nickel (lbs/day)	0.100	0.120	0.440	0.050	0.069	0.116
Selenium (lbs/day)	(a)	(a)	(a)	0.004	0.003	0.004

[1] If site-specific WERs are approved by the Regional Board, TMDL waste load allocations shall be implemented in accordance with the approved WERs using the equations set forth above. Regardless of the final WERs, total copper loading shall not exceed current loading.
(a) Selenium allocations have not been developed for this reach as it is not on the 303(d) list.

WLAs (wet weather) in Water Column:

Constituent	Calleguas Creek	Revolon Slough
Copper[1] (lbs/day)	(0.00054*Q^2*0.032*Q - 0.17)*WER - 0.06	(0.0002*Q2+0.0005*Q)*WER
Nickel[2] (lbs/day)	0.014*Q^2+0.82*Q	0.027*Q^2+0.47*Q
Selenium[2] (lbs/day)	(a)	0.027*Q^2+0.47*Q

[1] If site-specific WERs are approved by the Regional Board, TMDL waste load allocations shall be implemented in accordance with the approved WERs using the equations set forth above. Regardless of the final WERs, total copper loading shall not exceed current loading.
[2] Current loads do not exceed loading capacity during wet weather. Sum of all loads cannot exceed loads presented in the table
(a) Selenium allocations have not been developed for this reach as it is not on the 303(d) list.
Q: Daily storm volume.

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
	Interim Limits and Final WLAs for Mercury in Suspended Sediment: Final WLAs are set at 80% reduction of HSPF load estimates. Interim limits for mercury in suspended sediment are set equal to the highest annual load within each flow category, based on HSPF output for the years 1993-2003.

Flow Range	Calleguas Creek		Revolon Slough	
	Interim (lbs/yr)	Final (lbs/yr)	Interim (lbs/yr)	Final (lbs/yr)
0-15,000 MGY	3.3	0.4	1.7	0.1
15,000-25,000 MGY	10.5	1.6	4	0.7
Above 25,000 MGY	64.6	9.3	10.2	1.8

MGY: million gallons per year.

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria, R4-2006-011 (adopted June 8, 2006)</td><td>“Run-off to Ballona Creek is regulated as a point source under the Los Angeles County MS4 Permit, the Caltrans Storm Water Permit, and the General Construction and Industrial Storm Water Permits.”

Table 7.21.2b: Ballona Creek, Ballona Estuary and Sepulveda Channel Bacteria TMDL: WLAs and LAs for tributaries to the Impaired Reaches.
<table>
<tr><th>Tributary</th><th>Point of Application</th><th>Water Quality Objectives</th><th>Waste Load Allocation (No. exceedance days)</th></tr>
<tr><td>Ballona Creek Reach 1</td><td>At confluence with Reach 2</td><td>LREC-1
Freshwater</td><td>For single sample objectives:
(0) summer dry weather,
(3) winter dry weather
(17*) winter wet weather

For geometric mean objectives:
(0) for all periods</td></tr>
<tr><td>Benedict Canyon Channel</td><td>At confluence with Reach 2</td><td>LREC-1
Freshwater</td><td>For single sample objectives:
(0) summer dry weather,
(3) winter dry weather
(17*) winter wet weather

For geometric mean objectives:
(0) for all periods</td></tr>
<tr><td>Ballona Creek Reach 2</td><td>At confluence with Ballona Estuary</td><td>REC-1
Marine water</td><td>For single sample objectives:
(0) summer dry weather,
(3) winter dry weather
(17) winter wet weather

For geometric mean objectives:
(0) for all periods</td></tr>
<tr><td>Centinela Creek</td><td>At confluence with Ballona Estuary</td><td>REC-1
Marine water</td><td>For single sample objectives:
(0) summer dry weather,
(3) winter dry weather
(17) winter wet weather

For geometric mean objectives:
(0) for all periods</td></tr>
<tr><td>Del Rey Lagoon</td><td>At confluence with Ballona Estuary</td><td>REC-1
Marine water</td><td>For single sample objectives:
(0) summer dry weather,
(3)winter dry weather
(17) winter wet weather

For geometric mean objectives:
(0) for all periods</td></tr>
</table>
*At the confluence with Reach 2, the greater of the allowable exceedance days under the reference system approach or high flow suspension shall</td></tr>
<tr><td>Marina del Rey Harbor Toxics, R4-2005-012 (adopted October 6, 2005)</td><td>“Waste load allocations (WLA) are assigned to point sources for the Marina del Rey watershed. A grouped mass-based waste load allocation is developed for the storm water permittees (Los Angeles County MS4, Caltrans, General Construction and General Industrial) by subtracting the load allocations from the total loading capacity. Concentration-based waste load allocations are developed for other point sources in the watershed.”

The storm water waste load allocations are apportioned between the MS4 permittees, Caltrans, the general construction and the general industrial storm water permits based on an estimate of the percentage of land area</td></tr>
</table>

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
	covered under each permit.

Metals Storm Water WLAs Apportioned between Permits (kg/yr)

	Copper	Lead	Zinc
MS4 Permittees	2.01	2.75	8.85
Caltrans	0.022	0.03	0.096
General Construction	0.033	0.045	0.144
General Industrial	0.004	0.006	0.018

Organics Storm Water WLAs Apportioned between Permits (g/yr)

	Chlordane	Total PCBs
MS4 Permittees	0.0295	1.34
Caltrans	0.0003	0.015
General Construction	0.0005	0.022
General Industrial	0.0001	0.003

Each storm water permittee enrolled under the general construction or industrial storm water permits will receive an individual waste load allocation on a per acre basis, based on the acreage of their facility.

Metals Waste Load Allocations for Storm Water (kg/yr)

Copper	Lead	Zinc
2.06	2.83	9.11

Organics Waste Load Allocations for Storm Water (g/yr)

Chlordane	Total PCBs
0.03	1.38

Metals per Acre WLAs for Individual General Construction or Industrial Storm Water Permittees (g/yr/ac)

Copper	Lead	Zinc
2.3	3.1	10

Organics per acre WLAs for Individual General Construction or Industrial Storm Water Permittees (mg/yr/ac)

Chlordane	Total PCBs
0.03	1.5

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Ballona Creek Estuary Toxic Pollutants, 2005-008, Adopted July 7, 2005</td><td>“Waste load allocations (WLA) are assigned to point sources for the Ballona Creek watershed. A grouped mass-based wate load allocation is developed for the storm water permittees (Los Angeles County MS4, Caltrans, General Construction and General Industrial)…”
<table>
<tr><th colspan="5">Metals per Acre WLAs for Individual General Construction or Industrial Storm Water Permittees (g/yr/ac)</th></tr>
<tr><td>Cadmium</td><td>Copper</td><td>Lead</td><td>Silver</td><td>Zinc</td></tr>
<tr><td>0.1</td><td>3</td><td>4</td><td>0.1</td><td>13</td></tr>
</table>
<table>
<tr><th colspan="4">Organics per Acre WLAs for Individual General Construction or Industrial Storm Water Permittees (mg/yr/ac)</th></tr>
<tr><td>Chlordane</td><td>DDTs</td><td>Total PCBs</td><td>Total PAHs</td></tr>
<tr><td>0.04</td><td>0.14</td><td>2</td><td>350</td></tr>
</table>
Concentration-based waste load allocations are assigned to the minor NPDES permits and general non-storm water NPDES permits that discharge to Ballona Creek or its tributaries. Any future minor NPDES permits or enrollees under a general non-storm water NPDES permit will also be subject to the concentration-based waste load allocations.
<table>
<tr><th colspan="5">Metals Concentration-based Waste Load Allocations (mg/kg)</th></tr>
<tr><td>Cadmium</td><td>Copper</td><td>Lead</td><td>Silver</td><td>Zinc</td></tr>
<tr><td>1.2</td><td>34</td><td>46.7</td><td>1.0</td><td>150</td></tr>
</table>
<table>
<tr><th colspan="4">Organic Concentration-based Waste Load Allocations (μg/kg)</th></tr>
<tr><td>Chlordane</td><td>DDTs</td><td>Total PCBs</td><td>Total PAHs</td></tr>
<tr><td>0.5</td><td>1.58</td><td>22.7</td><td>4,022</td></tr>
</table>
</td></tr>
<tr><td>Los Angeles Harbor Bacteria, R4-2004-011, Adopted July 1, 2004</td><td>“Discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria. Therefore, the WLAs for these discharges are zero (0) days of allowable exceedances for all three time periods and for the single sample limits and the rolling 30-day geometric mean.”</td></tr>
<tr><td>Marina del Rey Back Basins Bacteria, R4-2003-012 (adopted August 7, 2003)</td><td>“As discussed in “Source Analysis”, discharges from general NPDES permits, general industrial storm water permits and general construction storm water permits are not expected to be a significant source of bacteria. Therefore, the WLAs for these discharges are zero (0) days of allowable exceedances for all three time periods and for the single sample limits and the rolling 30-day geometric mean. Any future enrollees under a general NPDES permit, general industrial storm water permit or general construction storm water permit within the MdR Watershed will also be subject to a WLA of zero days of allowable exceedances.”</td></tr>
</table>

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
Santa Clara River Nutrients, R4- 2003-011 (adopted August 7, 2003)	"Concentration-based wasteloads are allocated to municipal, industrial and construction stormwater sources regulated under NPDES permits." "For stormwater permittees discharging into Reach 7, the thirty-day WLA for ammonia as nitrogen is 1.75 mg/L and the one-hour WLA for ammonia as nitrogen is 5.2 mg/L; the thirty-day average WLA for nitrate plus nitrite as nitrogen is 6.8 mg/L. For stormwater permittees discharging into Reach 3, the thirty-day WLA for ammonia as nitrogen is 2.0 mg/L and the one-hour WLA for ammonia as nitrogen is 4.2 mg/L; the thirty-day average WLA for nitrate plus nitrite nitrogen is 8.1 mg/L"

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
Los Angeles River Nutrients, R4- 2003-009 (adopted July 10, 2003)	"Waste loads are allocated to minor point sources enrolled under NPDES or WDR permits including but not limited to Tapia WRP, Whittier Narrows WRP, Los Angeles Zoo WRP, industrial and construction stormwater…" a) Ammonia wasteload allocations (WLAs) for minor point sources are listed below by receiving waters: ***Water Body*** ***One-hour average WLA*** ***Thirty-day average WLA*** Los Angeles River above Los Angeles-Glendale WRP (LAG) 4.7 mg/L 1.6 mg/L Los Angeles River below LAG 8.7 mg/L 2.4 mg/L Los AngelesTributaries 10.1 mg/L 2.3 mg/L b) WLAs for nitrate-nitrogen, nitrite-nitrogen, and nitrate-nitrogen plus nitrite-nitrogen for minor discharges are listed below: ***Constituent*** ***Thirty-day average WLA*** NO_3-N 8.0 mg/L NO_2-N 1.0 mg/L NO_3-N + NO_2-N 8.0 mg/L
Ballona Creek Trash, R4-2004-023 (adopted March 4, 2004)	"As required by the Clean Water Act, discharges of pollutants to surface waters from storm water are prohibited, unless the discharges are in compliance with a National Pollutant Discharge Elimination System (NPDES) Permit…In addition, USEPA Phase II stormwater permits, general permits, and industrial permits may also be used to regulate discharges of trash to the river…"
Chollas Creek Diazinon, R9-2002-0123 (adopted	"The State Water Resources Control Board (State Board) has issued three additional NPDES storm water permits that regulate the discharge of pollutants including diazinon in the Chollas Creek watershed. These permits are the

TMDLs Applicable to Permittees	WLAs Applicable to Permittees
August 14, 2002)	statewide Caltrans Municipal Storm Water Permit (State Board Order No. 99-06-DWQ NPDES No. CAS 000003), the statewide General Industrial Storm Water Permit (State Board Order No. 97-03-DWQ NPDES No. CAS 000001), and the statewide General Construction Storm Water Permit (State Board Order No. 99-08-DWQ NPDES No. CAS 000002) which directly regulate discharges from Caltrans owned and operated facilities, and from industrial and construction sites respectively, located within the Chollas Creek watershed." "…The concentration-based Waste Load and Load allocations of this TMDL are applied equally to all diazinon discharge sources in the Chollas Creek watershed. All allocations are set at 90% of the Numeric Targets resulting in a diazinon allocation equal to 0.072 µg/L under acute exposure conditions and a diazinon allocation of 0.045 µg/L under chronic exposure conditions. These allocations include an explicit 10 % margin of safety to account for uncertainties in the TMDL analysis. This concentration-based TMDL and its allocations apply year-round and will be protective during all flow conditions and seasons. **Waste Load and Load Allocations for Diazinon in Chollas Creek** Exposure Duration / Numeric Targets / Margin of Safety / Waste Load and Load Allocations: Acute / 0.08 µg/L / 0.008 µg/L / 0.072 µg/L Chronic / 0.05 µg/L / 0.005 µg/L / 0.045 µg/L … Responsible Partie(s): As dischargers of diazinon in urban storm water flows to Chollas Creek, the City of San Diego, City of Lemon Grove, City of La Mesa, San Diego Unified Port District, County of San Diego, and the California Department of Transportation (CalTrans) are responsible for implementation of this TMDL. These entities are regulated as municipal Copermittees under the San Diego MS4 Permit or the statewide CalTrans MS4 Permit."

Waste Load and Load Allocations for Diazinon in Chollas Creek

Exposure Duration	Numeric Targets	Margin of Safety	Waste Load and Load Allocations
Acute	0.08 µg/L	0.008 µg/L	0.072 µg/L
Chronic	0.05 µg/L	0.005 µg/L	0.045 µg/L

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Chollas Creek Copper, Lead, and Zinc, R9-2007-0043 (adopted June 13, 2007)</td><td>"…the Industrial Storm Water General NPDES WDRs Order 97-0003-DWQ (General Industrial NPDES Requirements) is an order that regulates discharges in Chollas Creek that are associated with ten broad categories of industrial activities…All point source discharges to Chollas Creek are expected to achieve this WLA."

TABLE 11.1 The Wasteload Allocations for dissolved copper, lead, and zinc for acute and chronic conditions
<table>
<tr><th>Metal</th><th>WLA for Acute Conditions –
One-Hour Average
= Loading Capacity* MOS</th><th>WLA for Chronic Conditions –
Four-Day Average
=Loading Capacity*MOS</th></tr>
<tr><td>Copper</td><td>(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}*0.9</td><td>(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}*0.9</td></tr>
<tr><td>Lead</td><td>[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]} * 0.9</td><td>[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]} * 0.9</td></tr>
<tr><td>Zinc</td><td>(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]} * 0.9</td><td>(0.986) * {e^[0.8473 * ln (hardness) + 0.884]} * 0.9</td></tr>
</table></td></tr>
<tr><td>Revised Project I - Twenty Beaches and Creeks in San Diego Region (including Tecolote Creek), R9-2010-0001 (adopted February 10, 2010)</td><td>"…All 47 MSW landfills are regulated by WDRs (general or site specific) issued by the San Diego Water Board and via the statewide Industrial Stormwater NPDES requirements for landfills. Both are interrelated in that a change to the statewide WDRs are always reflected in the Regional WDRs, which are renewed in 5 or 10 year cycles depending on the perceived threat to water quality and complexity ranking of the facility (pursuant to CCR Title 23, section 2200)."</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Los Peñasquitos Lagoon Sediment, R9-2012-0033, June 13, 2012</td><td>
“Responsible parties include … general industrial storm water NPDES permittees…. As of March 2012, there were 81 industrial facilities enrolled under the general industrial storm water permit in the Los Peñasquitos watershed. Table 4 identifies the industrial facilities within the Peñasquitos watershed.”

Table 6. TMDL summary
<table>
<tr><th>Source</th><th>Critical Wet Period Load (tons)</th><th>Daily Load (tons)</th></tr>
<tr><td>Watershed contribution (WLA)</td><td>2,580</td><td>12.2</td></tr>
<tr><td>Ocean boundary (LA)</td><td>9,780</td><td>46.4</td></tr>
<tr><td>Margin of Safety (MOS)</td><td>implicit</td><td>implicit</td></tr>
<tr><td>TMDL</td><td>12,360</td><td>58.6</td></tr>
</table>
Table 7. Year 2000 vs. historical loads and percent reduction
<table>
<tr><th>Source</th><th>Year 2000 Load (tons)</th><th>Historical (mid-1970s) Load (tons)</th><th>Load Reduction (tons)</th><th>Percent Reduction Required</th></tr>
<tr><td>Watershed contribution (WLA)</td><td>7,719</td><td>2,580</td><td>5,139</td><td>67%</td></tr>
<tr><td>Ocean boundary (LA)</td><td>5,944</td><td>9,780</td><td>+3,836 (increase)</td><td>+39% (increase)</td></tr>
<tr><td>Total</td><td>13,663</td><td>12,360</td><td>1,303</td><td>10%</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>TMDLs Applicable to Permittees</th><th>WLAs Applicable to Permittees</th></tr>
<tr><td>Los Angeles and Long Beach Harbors Toxic and Metals, R11-008, Adopted March 23, 2012</td><td>
“The regulatory mechanisms to implement the TMDL include, but are not limited to … the Statewide Industrial Storm Water General Permit.”
Interim WLAs:
(1) Dominguez Channel Freshwater Interim Allocations
<u>A. Freshwater Toxicity Interim Allocation wet weather</u>: An interim allocation of 2 TUc applies to each source, including all point sources assigned a WLA and all nonpoint sources assigned a LA.
<u>B. Freshwater Metals Interim Allocations - wet weather only</u>: Interim water allocations are assigned to stormwater dischargers (MS4, Caltrans, general construction and general industrial stormwater dischargers) and other NPDES dischargers. Interim water allocations are based on the 95th percentile of total metals data collected from January 2006 to January 2010 using a log-normal distribution.
Concentration-based Dominguez Channel and Torrance Lateral freshwater interim metal allocations:
Concentration-based Dominguez Channel and Torrance Lateral freshwater interim metal allocations
<table>
<tr><th></th><th>Total Copper</th><th>Total Lead</th><th>Total Zinc</th></tr>
<tr><td>allocation (µg/L)</td><td>207.51</td><td>122.88</td><td>898.87</td></tr>
</table>
</td></tr>
</table>

TMDLs Applicable to Permittees	WLAs Applicable to Permittees

(2) Dominguez Channel Estuary and Greater Los Angeles and Long Beach Harbor Waters:

Interim sediment allocations are assigned to stormwater dischargers (MS4, Caltrans, general construction and general industrial stormwater dischargers) and other NPDES dischargers. Interim sediment allocations are based on the 95th percentile of sediment data collected from 1998-2006.

Sediment, interim concentration-based allocations

	Pollutant (mg/kg sediment)					
Waterbody	**Copper**	**Lead**	**Zinc**	**DDT**	**PAHs**	**PCBs**
Dominguez Channel Estuary	220.0	510.0	789.0	1.727	31.60	1.490
Long Beach Inner Harbor	142.3	50.4	240.6	0.070	4.58	0.060
Los Angeles Inner Harbor	154.1	145.5	362.0	0.341	90.30	2.107
Long Beach Outer Harbor (inside breakwater)	67.3	**46.7**	**150**	0.075	**4.022**	0.248
Los Angeles Outer Harbor (inside breakwater)	104.1	**46.7**	**150**	0.097	**4.022**	0.310
Los Angeles River Estuary	53.0	**46.7**	183.5	0.254	4.36	0.683
San Pedro Bay Near/Off Shore Zones	76.9	66.6	263.1	0.057	**4.022**	0.193
Los Angeles Harbor - Cabrillo Marina	367.6	72.6	281.8	0.186	36.12	0.199
Los Angeles Harbor - Consolidated Slip	1470.0	1100.0	1705.0	1.724	386.00	1.920
Los Angeles Harbor - Inner Cabrillo Beach Area	129.7	**46.7**	163.1	0.145	**4.022**	0.033
Fish Harbor	558.6	116.5	430.5	40.5	2102.7	36.6

Numbers in **bold** are also the final allocation.

Final WLAs:

(1) Dominguez Channel Freshwater Allocations

A. Freshwater Toxicity Allocation in wet weather: A final allocation of 1 TUc, or its equivalent based on any Statewide Toxicity Policy, applies to each source, including all point sources assigned a WLA and all nonpoint sources assigned a LA.

B. Freshwater Metals Allocations in wet weather: Wet-weather allocations are assigned to Dominguez Channel and all upstream reaches and tributaries of Dominguez Channel (above Vermont Avenue) … Concentration-based WLAs are assigned for the other point sources including but not limited to General Construction, General Industrial, Power Generating stations, minor permits and irregular dischargers, and other NPDES dischargers."

TMDLs Applicable to Permittees	WLAs Applicable to Permittees

Concentration-based Dominguez Channel Wet-weather Final Allocations (µg/L)

	Total **Copper**	Total **Lead**	Total **Zinc**
Other stormwater/NPDES	**9.7**	**42.7**	**69.7**

Based on hardness = 50 mg/L. Recalculated concentration-based allocations using ambient hardness at the time of sampling are considered consistent with the assumptions and requirements of these waste load allocations. In addition to the wasteload allocations above, samples collected during flow conditions less than the 90[th] percentile of annual flow rates must demonstrate that the acute and chronic hardness dependent water quality criteria provided in the CTR are achieved.

(2) Torrance Lateral Freshwater and Sediment Allocations

Torrance Lateral Wet-weather Waste Load Allocations and Sediment Waste Load Allocations, concentration-based

Media	Total Copper	Total Lead	Total Zinc
Water (unfiltered) (µg/L)	9.7	42.7	69.7
Sediment (mg/kg dry)	31.6	35.8	121

(3) Dominguez Channel Estuary and Greater Harbor Waters Allocations—Concentration-based WLAs for point sources in Dominguez Channel Estuary and Greater Harbor Waters (including refineries) for metals, PAHs, and bioaccumulative compounds in water.

Non-MS4 point sources such as General Construction, General Industrial, individual industrial permittees, including power generating stations, minor permits and irregular dischargers into Dominguez Channel Estuary and Greater Harbor Waters are assigned concentration-based allocations

Receiving (salt) Water Column Concentration-Based Waste Load Allocations

Constituents	Copper* (µg/L)	Lead* (µg/L)	Zinc* (µg/L)	PAHs (µg/L)	Chlordane (µg/L)	4,4'-DDT (µg/L)	Dieldrin (µg/L)	Total PCBs (µg/L)
Dominguez Channel Estuary	3.73	8.52	85.6	0.049**	0.00059	0.00059	0.00014	0.00017
Greater Harbor Waters	3.73	8.52	85.6			0.00059		0.00017

TMDL	**Expired Compliance Deadline**
Compliance with Final WLA Due	
Santa Clara River Reach 3 Chloride	June 18, 2003
Marina del Rey Harbor Back Basins Bacteria	March 18, 2007 (compliance deadline for summer and winter dry WLAs)
San Gabriel River Metals and Selenium	March 26, 2007
Los Angeles Harbor Bacteria	March 10, 2010
Oxnard Drain No. 3 Pesticides, PCBs and Sediment Toxicity, EPA Established	October 6, 2011
Long Beach City Beaches and Los Angeles River Estuary Indicator Bacteria	March 26, 2012
Los Angeles Area Lakes Nitrogen, Phosphorus, Mercury, Trash, Organochlorine Pesticides and PCBs	March 26, 2012
Santa Monica Bay DDTs and PCBs	March 26, 2012
Compliance with Interim WLA Due	
Calleguas Creek Watershed Metals and Selenium	June 8, 2006
Calleguas Creek Watershed Salts	December 2, 2008
Los Angeles River Metals	January 11, 2011
Ballona Creek Metals	January 11, 2011