7/14/2014

State Water Resources Control Board
Division of Water Quality
Victoria A. Whitney, Deputy Director
P.O. Box 100
Sacramento, CA 95812

Dear Ms. Whitney:

EXTERNAL PEER REVIEW OF PROPOSED AMENDMENTS TO STATEWIDE WATER QUALITY CONTROL PLANS FOR TRASH

This letter responds to the attached March 10, 2014 request for external scientific peer review for the subject noted above. The review process is described below. All steps were conducted in confidence. Reviewers' identities were not disclosed.

To begin the process for selecting reviewers, I contacted the University of California, Berkeley (University) and requested recommendations for candidates considered qualified to perform the assignment. The University was provided with the March 10, 2014 request letter to me, and attachments, and no additional material was asked for, nor forwarded to augment the request. This service by the University includes interviews of each promising candidate and is supported through an Interagency Agreement co-signed by Cal/EPA and the University.

Each candidate who was both interested and available for the review period was asked to complete a Conflict of Interest (COI) Disclosure form and send it to me for review, with Curriculum Vitae. The cover letter for the COI form describes the context for COI concerns that must be taken into consideration when completing the form. "As noted, staff will use this information to evaluate whether a reasonable member of the public would have a serious concern about [the candidate's] ability to provide a neutral and objective review of the work product."

In subsequent letters to candidates approved as reviewers, I provided the attached January 7, 2009 Supplement to the Cal/EPA Peer Review Guidelines, which, in part serves two purposes: a) it provides guidance to ensure confidentiality through the course of the external review, and, b) it notes reviewers are under no obligation to discuss their comments with third-parties after reviews have been submitted. We recommend they do not. All outside parties are provided opportunities to address a proposed regulatory action, or potential basis for such, through a well-defined rulemaking process.

Later, I sent each reviewer the material to be reviewed and a detailed cover letter to initiate the review (Copies attached).

Also attached to the cover letter was the March 10, 2014 request for reviewers to me. Its Attachment 2 was highlighted as the focus for the review. Each reviewer was asked to address each topic, as expertise allows, in the order given. Thirty days were provided for the review. I also asked reviewers to direct enquiring third-parties to me after they have submitted their reviews.

Reviewers' names, affiliations, curriculum vitae, and reviews are being sent to you now with this letter. All attachments can be electronically accessed through the bookmark icon at the left of the screen. Professor Detlef Knappe sent 12 of the references used in his review separately through email. I will email you the 12 attachments separately. The selected papers and reports present information beyond that contained in papers and reports already cited in the Draft Staff Report.

Approved reviewers are as follows:

1) Tamara Galloway, Ph.D.
   Professor of Exotoxicology
   College of Life & Environmental Sciences
   University of Exeter
   314 Geoffrey Pope Bldg., Stocker Road
   Exeter, EX4 4QD, UK

   Telephone: 011-44-1392-263436
   Facsimile: 011-440-1392-263700
   Email: T.S.Galloway@exeter.ac.uk

2) David Barnes, Ph.D.
   Professor, Civil & Environmental Engineering
   College of Engineering and Mines
   University of Alaska
   Duckering 263, 306 Tanana Drive
   Fairbanks, AK 99775-5960

   Telephone: (907) 474-6126
   Facsimile: (907) 474-6087
   Email: dlbarnes@alaska.edu

3) Detlef Knappe, Ph.D.
   Professor
   Department of Civil, Construction, & Environmental Engineering
   North Carolina State University
   319 Mann Hall-E
   Campus Box 7908
   Raleigh, NC, 27695-7908

   Telephone: (919) 515-8791
   Facsimile: (919) 515-7908
   Email: knappe@ncsu.edu

If you have questions, or require clarification from the reviewers, please contact me directly.

Regards,

Gerald W. Bowes, Ph.D.
Manager, Cal/EPA Scientific Peer Review Program
Office of Research, Planning and Performance
State Water Resources Control Board
1001 “I” Street, 16th Floor
Sacramento, California 95814

Telephone: (916) 341-5567
Fax: (916) 341-5284
Email: Gerald.Bowes@waterboards.ca.gov

Attachments

1) March 10, 2014 Request by Victoria A. Whitney for Scientific Peer Review
2) Letters to Reviewers Initiating the Review
   a) Tamara Galloway, Ph.D., University of Exeter
   b) David Barnes, Ph.D., University of Alaska Fairbanks
   c) Detlef Knappe, Ph.D., North Carolina State University
3) January 7, 2009 Supplement to Cal/EPA Peer Review Guidelines
4) Curriculum Vitae:
   a) Tamara Galloway, Ph.D., University of Exeter
   b) David Barnes, Ph.D., University of Alaska Fairbanks
   c) Detlef Knappe, Ph.D., North Carolina State University
5) Reviews:
   a) Tamara Galloway, Ph.D., University of Exeter
   b) David Barnes, Ph.D., University of Alaska Fairbanks
   c) Detlef Knappe, Ph.D., North Carolina State University

ec:

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

State Water Resources Control Board

To: Gerald W. Bowes, Ph.D., Manager
Office of Research, Planning and Performance

Victoria A. Whitney

From: Victoria A. Whitney, Deputy Director
Division of Water Quality

Date: March 10, 2014

Re: AMENDMENT REQUEST FOR EXTERNAL PEER REVIEW OF PROPOSED AMENDMENTS TO STATEWIDE WATER QUALITY CONTROL PLANS FOR TRASH

This request amends the Feb 25, 2014 request by re-defining expertise requirements for reviewers.

The Division of Water Quality of the State Water Resources Control Board (State Water Board) requests by transmittal of this memo that reviewers be identified and assigned to provide external peer review of the proposed Amendments to Statewide Water Quality Control Plans for Trash (Trash Amendment) per the requirements of Health and Safety Code section 57004.

Currently, 73 water bodies are listed as impaired due to trash. There is a need for statewide consistency in regulation of trash in waters of the state. The State Water Board is proposing a statewide control program to reduce the amount of trash that accumulates in waters of the state, adversely affects beneficial uses and causes nuisance. The Trash Amendments would be adopted into the Inland Surface Water, Enclosed Bays and Estuaries Plan (ISWEBE Plan) and the California Ocean Plan. The proposed Trash Amendments would establish a narrative water quality objective for trash, a prohibition of discharge, and implementation provisions. The implementation focuses on a two track framework to reduce trash from the areas with high rates of trash generation.

We recommend reviewers be solicited with expertise in aquatic or marine ecotoxicology, solid waste/trash management, and wastewater engineering.

The title of the document we request to be reviewed is the "Proposed Amendments to Statewide Water Quality Control Plans for Trash (Trash Amendments)" and the supporting draft Staff Report. Documents will be available via hard copy and CD on Friday March 21, 2014.

A summary of the proposed Trash Amendments is provided in Attachment 1. Scientific issues, assumptions, and conclusions to be addressed by peer reviewers are listed in Attachment 2. The names of participants involved in developing the proposed Trash Amendment are listed in Attachment 3.

If you have further questions, please feel free to contact, Dr. Maria de la Paz Carpio-Obeso, Ocean Unit Chief, at (916) 341-5858 or MarielaPaz.Carpio-Obeso@waterboards.ca.gov, or to Ms. Johanna Weston at (916) 327-8117 or johanna.weston@waterboards.ca.gov.

Summary of the Proposed Amendments to Statewide Water Quality Control Plans for Trash

Summary

The State Water Board is proposing a statewide control program to reduce the amount of trash that accumulates in state waters, adversely affects identified beneficial uses, and causes nuisance. The Trash Amendments would be adopted into the Inland Surface Water, Enclosed Bays and Estuaries (ISWEBE) Plan and the California Ocean Plan. The proposed Trash Amendments include six elements: (1) a water quality objective for trash, (2) a prohibition of discharge, (3) implementation provisions, (4) a time schedule, (5) time extension options, and (6) monitoring and reporting requirements. The water quality objective would be implemented through permits and permit waivers. Permittees would comply with the water quality objective and the prohibition of discharge through a multiple track implementation framework that focuses on reducing trash from the areas with high rates of trash generation.

Rationale

The presence of trash in surface waters, specifically coastal and marine waters, is a prevalent issue in California. According to California's 2008-2010 Integrated Report[1], there are 73 water bodies listed as having impaired water quality due to the presence of large amounts of trash. Trash discarded on land is frequently transported through storm drains and to waterways and the ocean. Aquatic and marine life can be threatened from ingestion, entanglement, and habitat degradation from trash. Trash jeopardizes public health and safety and poses hindrance to recreational, navigational, and commercial activities. Additionally, trash, particularly plastic trash, can serve as a transport medium for pollutants, absorb persistent organic pollutants, and act as a vector for invasive species.

There is a need for a statewide consistency in regulation of trash in State waters. Regional approaches are not entirely consistent, and there are ongoing trash problems across the state. In the Colorado Basin Region, there is one adopted Total Maximum Daily Load (TMDL) for trash at the New River. In the Los Angeles Region, fifteen TMDLs were adopted for trash, which includes lakes, rivers, estuaries, and the ocean. The San Francisco Regional Water Quality Control Board uses a municipal storm water permit to address trash in 27 surface waters listed as impaired due to trash.

Project Goals

- Amend the California Ocean Plan and the ISWEBE Plan to include the following:
    a. A narrative water quality objective for trash.
    b. A prohibition of discharge of trash and preproduction plastics to waters of the State.
    c. Requirements that permitting authorities require NPDES permitees with permitted storm water discharges to comply with the prohibition of discharge.
        - Track 1: Network of full capture systems in priority land uses.
        - Track 2: Implement a plan of treatment and institutional controls.
    d. A time schedule for compliance based on the effective date of the first implementing permit.

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[1] State Water Board. 2010a. 2010 Integrated Report (Clean Water Act Section 3030(d) List/305(b) Report). Available at: http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml.

e. A framework for monitoring and reporting requirements in the implementing permit.

Methodology

The Trash Amendments propose a narrative water quality objective and prohibition of discharge specific to trash. Storm water transport is a dominant pathway of trash to receiving water bodies. The goal of reducing trash in receiving waters would focus on the areas of high trash generation rates within the jurisdiction of permitted dischargers. Discharges with trash requirements would need to utilize a combination of controls, such as full capture systems[2], institutional controls, and multi-benefit projects. For urban areas, the proposed amendments would focus trash control efforts on priority land uses with the highest rates of trash generation, which consist of high density residential, industrial, commercial, and mixed urban areas, and public transportation stations[3]. Caltrans, as a linear system, differs from a municipality with regard to trash generation. Based on Caltrans studies, the Adopt-A-Highway program, and the Keep California Beautiful program, the significant trash generating areas for Caltrans include areas such as: 1) highway on- and off- ramps in high-density residential, commercial, mixed urban, and industrial land use areas, 2) rest areas and park-and-rides, and 3) state highways in commercial and industrial land use areas.

Specific Expertise Requirements

- Aquatic or Marine Ecotoxicology
  The ecotoxicologist should have expertise in aquatic species and communities and their relationship with the physical environment, as well as the knowledge in the ability of plastics to be transport medium for pollutants and absorb persistent organic pollutants with aquatic environments

- Solid Waste/Trash Management
  The reviewer should have expertise in the relationship between land use and trash generation, prevention, characterization, monitoring and handling of trash, as well as waste minimization

- Wastewater Engineering
  The engineer should have expertise in stormwater and how to protect water quality from discharges of trash.

Three reviewers, at a minimum, will be adequate.

[2] Full capture systems for storm drains are defined in the Trash Amendments as treatment controls that trap all particles 5mm or larger. Each full capture system must be appropriately sized to, and designed to carry at least the same flows as, the corresponding storm drain.

[3] The Trash Amendments specifically define each of these five regulated land uses for purposes of implementation of the water quality objective and the prohibition of discharge; so, these definitions may differ substantially from an MS4's own local definition of those land uses in its ordinances, general plan, etc.

Description of Scientific Conclusions to be Address by Peer Reviewers

The statute mandating external scientific peer review (Health and Safety Code Section 57004) states that the reviewer's responsibility is to determine whether the scientific portion of the proposed rule is based up sound scientific knowledge, methods, and practices.

We request this determination be made for each of the following topics that constitute the scientific portion of the proposed regulatory action. An explanatory statement is provided for each scientific conclusion to focus the review, which includes a reference to the full discussion in the Staff Report.

Reviewers are not limited to addressing only the specific scientific conclusions presented below, and are asked to contemplate the following as well:

(a) In reading the Staff Report for the Trash Amendments, are there any additional scientific assumptions, finding, and conclusions that are part of the scientific basis of the proposed standard not described above? If so, please comment.

(b) Taken as a whole, is the scientific portion of the Trash Amendments based upon sound scientific knowledge, methods, and practices?

Reviewers should also note that some proposed actions may rely significantly on professional judgment, where available scientific data are not as extensive as desired to support the statutory requirement for absolute scientific rigor. In these situations, the proposed course of action is favored over no action.

The preceding guidance will ensure that reviewers have an opportunity to comment on all aspects of the scientific basis of the propose Board action. At the same time, reviewers also should recognize that the Board has a legal obligation to consider and respond to all feedback on the scientific portions of the proposed rule. Because of this obligation, reviewers are encouraged to focus feedback on the scientific conclusions that are relevant to the central regulatory element being proposed.

1. **Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats, and endangers wildlife in surface waters.**

   Trash is a pollutant that frequently enters our waterways through a diverse set of sources. Numerous studies, monitoring programs, and clean-up events have documented the presence of trash in streams, river, lakes, estuaries, wetlands, the ocean, and along the beaches. Trash poses health and safety hazards for fishermen, recreational boaters, and children playing on the beaches and in the water. Trash interferes with normal ecosystem functions through dispersal and settlement, which can have immediate and long-term effects on the aquatic habitat. In particular, trash presents a fatal threat through ingestion and entanglement for many aquatic and marine species of invertebrates, fish, seabirds, turtles, and mammals. In addition to ingestion and entanglement, there is a growing body of evidence documenting that trash, specifically microplastics, are a mechanism for the transport of persistent organic pollutants in animal tissues and throughout the food web. For the substantial evidence of the negative impacts of trash to public and wildlife health, a narrative water quality objective for trash should be established and consistently applied to all surface water bodies across California. See Chapters 1.2 and 1.3 in the Staff Report for the Trash Amendments for the scientific assumptions, findings, and conclusions.

2. **Different land uses have different rates of trash generation.**

   Approximately 80 percent of trash in the world's oceans originates from land-based sources. The primary transport mechanism of the land-based trash is through storm water and urban runoff (National Research Council 2008). Studies have determined that land use plays a role in trash generation rates, and permittees with existing trash controls prioritize trash reduction strategies by land use. Thus, land use should be used as part of the compliance strategy to reduce the discharge of trash to waterways and beaches across California. See Chapters 1.2 and 1.3 in the Staff Report for the Trash Amendments for the scientific assumptions, findings, and conclusions.

3. **A full capture system is an effective method for capturing trash greater than 5 mm from entering a surface water body via storm water.**

   The storm water system is a dominant transport pathway for trash to surface water bodies. The Trash Amendments propose the use of full capture systems as a preferred method for controlling trash. A full capture system is a treatment control that traps trash measuring 5 mm or greater, such as cigarette butts, bags (paper and plastic), food wrappers and containers, beverage bottles and cans, and building materials. Full capture systems can include individual catch basin inserts, vortex separation systems, trash nets, and gross solids removal devices. Properly functioning full capture systems should be a feasible method to capture trash in the storm water and divert trash in the areas of high trash generation from the waterways and beaches. See Chapter 5 in the Staff Report for the Trash Amendments for the scientific assumptions, findings, and conclusions.

Names of Participants Involved in Developing the Proposed Trash Amendment

From 2011 to 2013, the State Water Board convened a Statewide Public Working Group to assist staff in the development of the Trash Amendments. The Public Working Group members were selected to represent the diverse set of stakeholders of trash regulations.

Public Advisory Group Members:

- Sean Bothwell, California Coastkeeper Alliance
- Geoff Brosseau, The California Stormwater Quality Association
- Miriam Gordon, Clean Water Action
- Gary Hildebrand, Los Angeles County
- Kirsten James, Heal the Bay
- Scott McGowen, California Department of Transportation
- Charles Moore, Algalita Marine Research Institute
- Tom Reeves, City of Monterey
- Tim Shestek, American Chemistry Council
- Leslie Tamminen, Seventh Generation Advisors

May 28, 2014

Tamara Galloway, Ph.D.
Professor of Exotoxicology
College of Life & Environmental sciences
University of Exeter
314 Geoffrey Pope Bldg., Stocker Road
Exeter, EX4 4QD, UK
T.S.Galloway@exeter.ac.uk

Dear Professor Galloway,

REQUEST FOR EXTERNAL SCIENTIFIC PEER REVIEW: STATE WATER RESOURCES CONTROL BOARD STAFF REPORT FOR PROPOSED AMENDMENTS TO STATEWIDE WATER QUALITY CONTROL PLANS FOR TRASH

My letter today is intended to initiate the next phase of the external review – the actual review itself.

The State Water Board will receive reviewers' comments and curriculum vitae from me after the review has concluded, and not be a party to the process.

The following documents are provided through a secure FTP site. Access instructions are given at the end of this letter.

a) **March 10, 2014 memorandum signed by Victoria Whitney: "Request for External Peer Review of Proposed Amendments to Statewide Water Quality Control Plans for Trash".**

Three attachments are included in the memorandum:

Attachment 1: Summary of the Proposed Amendments to Statewide Water Quality Control Plans for Trash.

Attachment 2: Description of Scientific Conclusions to be addressed by Peer Reviewers. Clear guidance for the review is provided in the preamble. **Please address all conclusions, as expertise allows, in the order listed.** Once conclusions have been addressed, as necessary respond to latitude given reviewers in preamble (a) and (b).

Through this (May 28) letter, I am updating Attachment 2, specifically for locations in the Draft Staff Report where supporting text can be found for the three Conclusions to be addressed by reviewers.

Conclusion 1 : Revised Directive : **See Section 1.4, Section 1.5, and Appendix A**
Conclusion 2 : Revised Directive : **See Section 1.5 and Appendix A**

Conclusion 3 : Revised Directive : **See Chapter 5**

Attachment 3: Names of Participants Involved in Developing the Proposed Trash Amendments

b) Draft Staff Report for Draft Amendments to Statewide Water Quality Control Plans for Trash

c) References. Draft Staff Report

d) January 7, 2009 Supplement to the Cal/EPA Peer Review Guidelines.
In part, this provides guidance to ensure the review is kept confidential through its course. The Supplement notes reviewers are under no obligation to discuss their comments with third-parties after reviews have been submitted. **We recommend they do not.** All outside parties are provided opportunities to address a proposed regulatory action through a well-defined regulatory process. Please direct enquiring parties to me.

Please download all information within one week of receiving this letter. It will no longer be available after one week's time. The URL, username and password are as follows:

username:

password:

Return your comments directly to me, on Monday, June 30, 2014, and not before. Questions about the review should be for clarification, in writing – email is fine, and addressed to me. My responses will be in writing also. I subsequently will forward all reviews together to Ms. Victoria Whitney with reviewers' Curriculum Vitae. All this information will be posted at the appropriate State Water Board program web site, and at the State and Regional Water Boards' Scientific Peer Review web site.

Your acceptance of this review assignment is most appreciated.

Sincerely,

Gerald W. Bowes

Gerald W. Bowes, Ph.D.
Manager, Cal/EPA Scientific Peer Review Program
Office of Research, Planning and Performance
State Water Resources Control Board
1001 "I" Street, MS-16B
Sacramento, California 95814

Telephone: (916) 341-5567
Facsimile: (916) 341-5284
Email: GBowes@waterboards.ca.gov

May 28, 2014

David Barnes, Ph.D.
Professor, Civil & Environmental Engineering
College of Engineering and Mines
University of Alaska
Duckering 263, 306 Tanana Drive
Fairbanks, AK 99775-5960
dlbarnes@alaska.edu

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May 28, 2014

Detlef Knappe, Ph.D.
Professor
Department of Civil, Construction, & Environmental Engineering
North Carolina State University
319 Mann Hall-E
Campus Box 7908
Raleigh, NC, 27695-7908
knappe@ncsu.edu

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Email: GBowes@waterboards.ca.gov

January 7, 2009

Supplement to Cal/EPA External Scientific Peer Review Guidelines – "Exhibit F" in Cal/EPA Interagency Agreement with University of California Gerald W. Bowes, Ph.D.

Guidance to Staff:

1. Revisions. If you have revised any part of the initial request, please stamp "Revised" on each page where a change has been made, and the date of the change. Clearly describe the revision in the cover letter to reviewers, which transmits the material to be reviewed. The approved reviewers have seen your original request letter and attachments during the solicitation process, and must be made aware of changes.

2. Documents requiring review. All important scientific underpinnings of a proposed science-based rule must be submitted for external peer review. The underpinnings would include all publications (including conference proceedings), reports, and raw data upon which the proposal is based. If there is a question about the value of a particular document, or parts of a document, I should be contacted.

3. Documents not requiring review. The Cal/EPA External Peer Review Guidelines note that there are circumstances where external peer review of supporting scientific documents is not required. An example would be "A particular work product that has been peer reviewed with a known record by a recognized expert or expert body." I would treat this allowance with caution. If you have any doubt about the quality of such external review, or of the reviewers' independence and objectivity, that work product – which could be a component of the proposal - should be provided to the reviewers.

4. Implementation review. Publications which have a solid peer review record, such as a US EPA Criteria document, do not always include an implementation strategy. The Cal/EPA Guidelines require that the implementation of the scientific components of a proposal, or other initiative, must be submitted for external review.

5. Identity of external reviewers. External reviewers should not be informed about the identity of other external reviewers. Our goal has always been to solicit truly independent comments from each reviewer. Allowing the reviewers to know the identity of others sets up the potential for discussions between them that could devalue the independence of the reviews.

6. Panel Formation. Formation of reviewer panels is not appropriate. Panels can take on the appearance of scientific advisory committees and the external reviewers identified through the Cal/EPA process are not to be used as scientific advisors.

7. Conference calls with reviewers. Conference calls with one or more reviewers can be interpreted as seeking collaborative scientific input instead of critical review. Conference calls with reviewers are not allowed.

Guidance to Reviewers from Staff:

1. Discussion of review.

   Reviewers are not allowed to discuss the proposal with individuals who participated in development of the proposal. These individuals are listed in Attachment 3 of the review request.

   Discussions between staff and reviewers are not permitted. Reviewers may request clarification of certain aspects of the review process or the documents sent to them.

   Clarification questions and responses must be in writing. Clarification questions about reviewers' comments by staff and others affiliated with the organization requesting the review, and the responses to them, also must be in writing. These communications will become part of the administrative record.

   The organization requesting independent review should be careful that organization-reviewer communications do not become collaboration, or are perceived by others to have become so. The reviewers are not technical advisors. As such, they would be considered participants in the development of the proposal, and would not be considered by the University of California as external reviewers for future revisions of this or related proposals. The statute requiring external review of science-based rules proposed by Cal/EPA organizations prohibits participants serving as peer reviewers..

2. Disclosure of reviewer Identity and release of review comments.

   Confidentiality begins at the point a potential candidate is contacted by the University of California. Candidates who agree to complete the conflict of interest disclosure form should keep this matter confidential, and should not inform others about their possible role as reviewer.

   Reviewer identity may be kept confidential until review comments are received by the organization that requested the review. After the comments are received, reviewer identity and comments must be made available to anyone requesting them.

   Reviewers are under no obligation to disclose their identity to anyone enquiring. It is recommended reviewers keep their role confidential until after their reviews have been submitted.

3. Requests to reviewers by third parties to discuss comments.

   After they have submitted their reviews, reviewers may be approached by third parties representing special interests, the press, or by colleagues. Reviewers are under no obligation to discuss their comments with them, and we recommend that they do not.

   All outside parties are provided an opportunity to address a proposed regulatory action during the public comment period and at the Cal/EPA organization meeting where the proposal is considered for adoption. Discussions outside these provided avenues for comment could seriously impede the orderly process for vetting the proposal under consideration.

4. Reviewer contact information.

The reviewer's name and professional affiliation should accompany each review. Home address and other personal contact information are considered confidential and should not be part of the comment submittal.

Curriculum vitae: Tamara Galloway

Position: Professor of Ecotoxicology, College of Life and Environmental Sciences, University of Exeter, Exeter, EX4 4PS, t.s.galloway@exeter.ac.uk

Educational history

1979-1983 University of Glasgow
BSc (1st Class Honours) in Biochemistry 1983
Norman Davidson Memorial Gold Medallist 1983

1983-1986 University of Edinburgh
PhD in Biochemistry, SERC CASE award winner

Professional experience

2005 -2007 Reader in Ecotoxicology (Principal lecturer, 2001-2005, Senior Lecturer (0.5 FTE 1997-2001), Department of Biological Sciences, University of Plymouth

1994-1997 Research Fellow (0.5 FTE), Department of Medicine, University of Plymouth

1992-1993 Research Assistant to the Director (0.2 FTE), Peter Mitchell, FRS, Nobel Laureate, Glynn Research Institute, Bodmin

1986-1990 Project Leader, Clinical Reagents Research and Development, Amersham International PLC, Bucks

Recent esteem factors

- Nominated for UK Queen's Anniversary Prize for Outstanding Research, 2013
- Research with Impact award finalist for Outstanding Contribution to Policy and Public Services, University of Exeter, 2011
- Honorary Chair in Ecotoxicology, University of Exeter Medical School, 2008-
- UK Research Assessment Exercise (RAE 2008), expert advisor

Activities relevant to the current application

- Expert member of the Organisation for Economic Cooperation and Development (OECD) Working Party on Manufactured Nanoparticles, 2008- and Dosimetry Subcommittee
- Regional Environmental Protection Advisory Committee, UK Environment Agency, 2009- 2012
- Invited witness to FDA Congressional Review on Bisphenol A, Washington, Sep 2007
- Contributing author to the Royal Commission on Environmental Pollution , Report on Novel Materials 2008 www.rcep.org.uk

Selected peer reviewed publications (from >150 since 2001) h index 28

1. Wright, S., Rowe, D., Thompson, R and **Galloway T.S (**2013) Microplastic ingestion decreases energy reserves in marine worms. *Current Biology 23*(23), R1031-R1033
    a. This was a front page featured article
2. Browne M.A, Niven S, **Galloway T.S**, Rowland S, Richard C. Thompson. Microplastic moves pollutants and additives to worms reducing functions linked to health and biodiversity. *Current Biology 23*(23), 2388-2392
3. Cole, M., Lindeque, P., Halsband-Lenk, C., **Galloway, T. S.,** (2011) Microplastic as a contaminant in the marine environment: a review. *Mar Poll Bull* 62(12):2588-97,(highly accessed)
4. Cole, M., Lindeque, P., Goodhead, R, Moger J, Halsband-Lenk, C., Galloway, T. S.,

Microplastic Ingestion by Zooplankton *Environ. Sci. Technol.*, *47*(12), 6646-6655

5. Melzer, D., Osborne, N.J., Henley, W.E., Cipelli, R., Young, A., Money, C., McCormack, P., Luben, R., Khaw, K.T., Wareham, N.J., **Galloway TS** (2012). Urinary bisphenol A concentration and risk of future coronary artery disease in apparently healthy men and women. *Circulation*, *125*(12), 1482-1490.
6. Melzer, D. and **Galloway, T.S**. (2011) Bisphenol A and adult disease: making sense of fragementary data and competing inferences. *Annals Internal Med 155:392-394*
7. Melzer, D., Harries, L., Cipelli, R., Henley,W., Money, C., McCormack, P., Young, A., Guralnik,J., Ferrucci, L., Bandinelli, S., Corsi, AM.,**Galloway, T.** (2011) Bisphenol A Exposure is Associated with In-Vivo Estrogenic Gene Expression in Adults *Environ Health Perspect* 119:1788-1793. Accompanying editorial p a524 Faculty of 1000 highly commended
8. Browne, M, Crump, P., Niven, S., Teuten, E., Tonkin, A., **Galloway, T.S.,** Thompson, R. C. (2011) Accumulations of microplastic on shorelines worldwide: sources and sinks. *Environ. Sci. Technol.* 45:9175-9179
11. Browne, M. A., **Galloway, T. S**. and Thompson, R. C. (2010) Spatial patterns of plastic debris along estuarine shorelines, *Environ. Sci. Technol*. *44*(9):3404-3409
12. Lang, I., **Galloway, T. S**., Depledge, M. Bowman, R and Melzer, D. (2008) Association of urinary bisphenol A concentration with medical disorders and laboratory abnormalities in adults, *J. Amer. Med. Assoc.* 300:1303-1310, editorial, p1353 Faculty of 1000 highly commended
13. Browne, M. A., Dissanayake, A., **Galloway, T. S.,** Lowe, D. M. and Thompson, R. C. (2008) Ingested microscopic plastic translocates to the circulatory system of the mussel, *Mytilus edulis* (L) Environ. Sci. Technol. 42:5026-5031
14. Teuten, E. L., Rowland, S., **Galloway, T. S**. and Thompson, R. C. (2007) Potential for plastics to transport hydrophobic contaminants, *Environ. Sci. Technol.* 41:7759-7764

Some recent research grants

Total external grant income since 2001(as principal or co-applicant) = >£7 million

- **Galloway TS**, Lewis CL and Tyler CR (2013) CLEANSEA: Towards a Clean, Litter Free European Marine Environment through Scientific Evidence, Innovative Tools and Good Governance *European Union*, 2010-2013 €3 million, £390K to Exeter
- **Galloway TS** and Tyler CR (2011) Ecotoxicology of cerium oxide nanoparticles in the aquatic environment *NERC FENAC access grant* 2011 £24K
- **Galloway TS** (2011) Ecotoxicology in the benthic zone: Investigating the life history factors that influence species sensitivity. *BBSRC CASE with Astrazeneca PLC* 2011-2015 £91K
- Mathews, F, **Galloway TS** and Bailey T (2011) Gender inequalities in early life health outcomes, *Wellcome Trust*, 2011-2013, £87,900
- **Galloway TS,** Thompson R, Rowland S (2010) Microplastics in the marine environment and their effects on biota *DEFRA* 2011-2014 £400K
- **Galloway TS**, Tyler CR, Moger J (2010) QNANO: Nanotechnology consortium Infrastructure grant, *European Union*, 2010-2013 €7 million, £300K to Exeter
- Tyler CR and **Galloway TS** (2010) NanoBEE: Consortium for manufactured nanomaterials bioavailability and environmental exposure, *USEPA/ NERC* 2010-2013 , £3.5 million, UK lead Birmingham, £215K to Exeter
- Melzer, D and **Galloway TS** (2009) CARDIS: Chemical exposure and risk of cardiovascular disease in adults, *British Heart Foundation*, £104K 2009-2011
- **Galloway, T. S**., Tyler, C. R. and Shaw, A. (2008) Prospect: Ecotoxicology of manufactured metal oxide nanoparticles, *EPSRC/DEFRA/Industry LINK award*, 2009-2012 £3.8 million, £671K to Exeter

Curriculum Vita of David L. Barnes, Ph.D., P.E.

Contact Information

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Professional Preparation

1985 B.S., Civil Engineering, New Mexico State University
1987 M.S., Environmental Engineering, New Mexico State University
1997 Ph.D., Chemical and Bioresource Engineering (Emphasis on Contaminant Fate and Transport), Colorado State University.

Current Position

2012 – Present	University of Alaska Fairbanks	Professor

Previous Positions

2008 – 2012	University of Alaska Fairbanks	Professor and Department Chair
2006 – 2008	University of Alaska Fairbanks	Associate Professor and Department Chair
2004 – 2006	University of Alaska Fairbanks	Associate Professor
1999 – 2004	University of Alaska Fairbanks	Assistant Professor
1997 – 1999	University of Texas	Research Program Manager
1987 – 1992	Geoscience Consultants, Ltd.	Engineer

Five Most Recent Publications

1. Tamabayeva, D., L Duffy, P. Loring, D. Barnes. 2013. Mitigation History of the Industrial Hg Contamination in Nura River Watershed of the Republic of Kazakhstan: Evaluation of an Adaptive Management Approach. *Environmental Management and Sustainable Development*, 2(1): 183-194.
2. *Seefeldt, S.S., R.A. Boydston, P.N. Kaspari, M. Zhang, E. Carr, J. Smeenk, D.L. Barnes.* 2013. *Aminopyralid Residue Impacts on Potatoes and Weeds. American Journal of Potato Research, 90(3): 239-244.*
3. Schnabel, W.E., J. Munk, D.L. Barnes, W. Lee. 2012. Four-Year Performance Evaluation of a Pilot-Scale Evapotranspiration Landfill Cover in Southcentral Alaska. *Cold Regions Science and Technology,* 82: 1-7.
4. Schnabel, W.E., T. Abichou, D. Barnes, W. Lee, J. Munk, B. Pape. *2012.* Assessing the Performance of a Cold Region Evaportranspiration Landfill Cover Using Lysimetry and Electrical Resistivity Tomography. *Journal of Phytoremediation*, 14, sup1: 61-75
5. Munk, J., W.E. Schnabel, D.L. Barnes, and W. Lee. 2011. Atomospheric Loading Effects on Free Draining Lysimeters. *Water Resources Research*, 47, Wo5541, doi:10.1029/2010WR009784.

Five Other Significant Publications

1. Carlson, A.E. and D.L. Barnes. 2011. Movement of Trichloroethene in a Discontinuous Permafrost Zone. *Journal of Contaminant Hydrology*, 124, no.1-4: 1-13.
2. Benning, J.L. and D.L. Barnes. 2009. Comparison of Methods for the Determination of Diffusion Coefficients and Effective Porosities in Through-Diffusion Tests. *Water Resources Research*. 45,no 9.
3. Benning J.L. and D.L. Barnes. 2009. The Effects of Scale and Spatial Heterogeneities on Diffusion in Volcanic Breccias and Basalts: Amchitka Island, Alaska. *Journal of Contaminant Hydrology*, 106, no. 3-4: 150-165.

4. Chambers, M.K., M.R. Ford, D.M. White, D.L. Barnes, and S. Schiewer. 2009. Transport of Fecal Bacteria by Boots and Vehicle Tires in a Rural Alaskan Community. *Journal of Environmental Management,* 90, no. 2: 961-966.
5. Chambers, M.K., M.R. Ford, D.M. White, D.L. Barnes, S. Schiewer. 2008. Distribution and Transport of Fecal Bacteria at Spring Thaw in a Rural Alaskan Community. *Journal of Cold Regions Engineering,* 22, no 1: 16-37.

Synergistic Activities

- Associate Editor of *Cold Regions Science and Technology* (2010-2013).
- Recipient of the Robert Piacenza Award for Excellence in Teaching (2013)
- US Delegate to the Arctic Council Emergency Prevention, Preparedness and Response Working Group Meeting, 2004, 2007, 2009, 2010.
- Australian Antarctic Division Visiting Scientist, January 2008.
- Contaminants in Freezing Ground International Steering Committee 2002 - 2012 (Co-Chair 2002-2004)
- Registered Professional Engineer, New Mexico

Collaborators & Other Affiliations

Brad Authier of ERM, Joanna Burger of Rutgers, Billy Connor of University of Alaska Fairbanks (UAF), Larry Duffy of UAF, Patrick Haas of Haas and Associates, Mary Beth Leigh of UAF, David Kosson of Vanderbilt, Jane Paris of ERM, William Schnabel of UAF, Max Schwanne of ERM, Steve Seefeldt of UAF, Yuri Shur of UAF, Silke Schiewer of UAF, Dan White of UAF, Ian Snape of Australian Antarctic Division.

Graduate Advisors: David McWhorter, Colorado State University (retired), Fernando Cadena, New Mexico State University (retired).

26 Total Graduate Students Advised:

- 3 former, completed Doctoral students: Jennifer Benning, Anna Wagner, Walter Fourier.
- 21 former completed Masters students: Hrishikesh Adhikari, Cornellia Ballou, Andrea Carlson, Neil D'Cunha, Travis Eckhoff, David Fish, Walter Fourier, Stacey Fruitiger, Stephanie Gould, Ben Hostetler, Karin Johansson, Ekaterina Matveeva, Amber Mandt, Lisa Minnear, Ameet Pinto, Srinivan Rao Raghupatruni, William Rhodes, Stina Stjarnstrom, Dinara Tamabayeva, Susan Underbakke, Trevor White,
- 2 Masters students in progress: Michelle Barnes, Sara Janda

Detlef R.U. Knappe

Department of Civil, Construction, and Environmental Engineering
North Carolina State University

Professional Preparation

University of Illinois, Urbana, IL	Civil Engineering	B.S., May 1989
University of Illinois, Urbana, IL	Environmental Engineering	M.S., May 1991
University of Illinois, Urbana, IL	Environmental Engineering	Ph.D., January 1996

Appointments

2008 – present	Professor, Dept. of Civil, Construction, and Environmental Engineering, NC State University
2013 (1/1-6/30)	Visiting Scholar, US EPA, Research Triangle Park, NC
2002 – 2008	Associate Professor, Dept. of Civil, Construction, and Environmental Engineering, NC State University
2005 (7/1-12/31)	Visiting Scholar, EAWAG, Swiss Federal Institute of Technology (ETH), Zürich, Switzerland
1996 - 2002	Assistant Professor, Department of Civil Engineering, NC State University

Recent/Representative Publications

1. Kovalova, L.; Knappe, D.R.U.; Lehnberg, K., Kazner, K., and Hollender, J. "Removal of highly polar micropollutants from wastewater by powdered activated carbon." *Environ. Sci. Poll. Res.*, 20(6): 3607-3615, 2013.
2. Chen, Y.; D.R.U. Knappe; and M.A. Barlaz. "The Effect of Aging on the Bioavailability of Toluene Sorbed to Municipal Solid Waste Components." *Chemosphere*, 90(2): 251-259, 2013.
3. Dunn, S.E. and D.R.U. Knappe. *Disinfection By-Product Precursor and Micropollutant Removal by Powdered Activated Carbon*. Water Research Foundation: Denver, Colorado, 2013.
4. Matsui, Y.; T. Yoshida; S. Nakao; D.R.U. Knappe; and T. Matsushita. "Characteristics of competitive adsorption between 2-methylisoborneol and natural organic matter on superfine and conventionally sized powdered activated carbons." *Water Research*, 45(16): 4741-4749, 2012.
5. Baeza, A.C. and D.R.U. Knappe. "Transformation Kinetics of Biochemically Active Compounds in Low-Pressure UV Photolysis and UV/H_2O_2 Advanced Oxidation Processes." *Water Research*, 45(15): 4531-4543, 2011.
6. Summers, R.S.; D.R.U. Knappe; and V.L. Snoeyink. 2011. "Adsorption of Organic Compounds." In *Water Quality & Treatment*, 6th ed., J.K. Edzwald (Ed.), McGraw-Hill: New York, NY.
7. Velten, S.; D.R.U. Knappe; J. Traber; H.P. Kaiser; U. von Gunten; M. Boller; and S. Meylan. "Characterization of natural organic matter adsorption in granular activated carbon adsorbers." *Water Research*, 45(13): 3951-3959, 2011.
8. Alpert, S.M.; D.R.U. Knappe; and J.J. Ducoste. "Modeling the UV/hydrogen peroxide advanced oxidation process using computational fluid dynamics." *Water Research*, 44(6): 1797-1808, 2010.
9. Saquing, J.M.; C.D. Saquing; D.R.U. Knappe; and M.A. Barlaz. "Impact of Plastics on Fate and Transport of Organic Contaminants in Landfills." *Environmental Science and Technology* 44(16): 6396-6402, 2010.
10. Saquing, J.M.; L.A. Mitchell; Wu, B.; T.B. Wagner; D.R.U. Knappe; and M.A. Barlaz. "Factors controlling alkylbenzene and tetrachloroethene desorption from municipal solid waste components." *Environmental Science and Technology* 44(3): 1123-1129, 2010.

Synergistic Activities:

- Meeting/Symposium/Committee Leadership:
  - Organizer for special topic session on activated carbon, AWWA Annual Conf., 2013
  - AWWA Activated Carbon Standards Committee Member, 2003-present
  - AWWA Organic Contaminants Research Committee Member, 2000-2005, 2007-present
  - Co-organizer of ACS Symposium "Advances in Adsorption Processes," Fall 2007-Spring 2008.
  - Technical Advisory Committee member and research advisor for the NCSU Student Chapter of Engineers Without Borders, Fall 2006-present.
  - Project Advisory Committee Member for AwwaRF/Water RF research projects, 1997-present
- Editorships
  - Associate Editor for Water Science & Technology, 2009-2013
  - Topical Editor for Open Access journal Drinking Water Engineering and Science, 2011-present
- Representative Scholarly and Professional Honors
  - Thesis advisor for the 1st place winner in the American Water Works Association Academic Achievement Award competition for the best Master's Thesis, 2013
  - Outstanding Teacher, NC State University, 2011
  - Thesis advisor for the 2nd place winner in the American Water Works Association Academic Achievement Award competition for the best Master's Thesis, 2007
  - AWWA Water Science & Research Division Best Poster Award, 2006
  - Bill Horn Kimley-Horn Faculty Award, NC State University, 2003
  - AWWA Water Science & Research Division Best Paper Award, 2001

Collaborators and Co-Editors:

Morton A. Barlaz, NCSU
Joel J. Ducoste, NCSU
Francis L. de los Reyes, NCSU
Howard Weinberg, UNC-Chapel Hill
Mark A. Nanny, University of Oklahoma
Steven Shannon, NCSU
Karl Linden, University of Colorado-Boulder
R. Scott Summers, University of Colorado-Boulder
Andrew Lindstrom, US EPA, RTP, NC
Thomas Speth, US EPA, Cincinnati, OH

Graduate Advisors and Postdoctoral Sponsors:

Vernon L. Snoeyink (University of Illinois, MS and PhD)

Thesis Advisor & Postgraduate-Scholar Sponsor:

(38 total, 23 MS, 9 PhD, 6 post-graduate scholars)

MS: Andrew Rike, 1998, Rike Consulting, AR; David Briley, 1999, Hazen & Sawyer Engineers, NC; Robert Belk, 1999 Hazen & Sawyer Engineers, NC; Neerja Rastogi, 1999, Camp Dresser & McKee, NC; Caleb Taylor, 2000; Steven Gandy, 2000, Municipal Engineering Services Company, NC; Patricia Quinlivan, 2001, URS Corporation, NC; Travis Wagner, 2003, Pure Technologies, MD; Alfred Rossner, 2004, continued for PhD; Lisa Mitchell, 2005, GHD Professional, NC; Isabella Mezzari, 2006, GSI Environmental, TX; Venkata Mandapaka, 2008, CalTrans; Anjali Viswakumar, 2010, US EPA, NC; Qianru Deng, 2010, MWH, WA; Angela Mastropole, 2010, Dewberry, NC; Susan Dunn, 2011, Black & Veatch, MD; Leigh-Ann Dudley, 2012, Dewberry, NC; Meredith Fotta, CDM-Smith, NC; Allison Reinert, Hazen&Sawyer, NC. *Current*: Elisa Arevalo, Amber Greune, Viking Edeback, Rachel Ingham.

PhD: B. Wu, PhD 2002, Rho Inc., NC; L. Li, PhD 2002, California Department of Public Health, CA; Y. Chen, PhD 2003, Novozymes, NC; C. Chun, PhD 2007, VDOT, VA; A. C. Baeza, PhD 2008, Universidad de Concepcion, Chile; A. A. Rossner, PhD 2008, Universidad de Concepcion, Chile; J. M. Saquing, PhD 2009; B. Yuncu, Solutions IES, NC. *Current*: Josh Kearns (Scott Summers, chair).

Postgraduate Scholars: Shannon Bartelt-Hunt, UNebraska; Erik Rosenfeldt, Hazen & Sawyer, VA; Koichi Ohno, Osaka University (Japan), Qingdong Qing, Southeast University (China), Zhang Hua, Tongji University (China). *Current*: Mei Sun.

Review prepared by
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26th June 2014

Proposed amendments to stateside water quality control plans for trash

This document constitutes an external scientific review of the Draft Amendments to Stateside Water Quality Control Plans for Trash, prepared by the Division of Water Quality, State Water Resources Control Board, California Environmental Protection Board, May 2014

The question being addressed by the reviewer is:

Is the scientific portion of the proposed rule based upon sound scientific knowledge, methods and practise? This question is directed towards all aspects of the document, but in particular to the following scientific conclusions

1. Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats and endangers wildlife in surface waters.
2. Different land uses have different rates of trash generation.

Overview

The Draft Staff Report provides a detailed analysis of the need for a proposed Trash Amendment to the Stateside Water Quality Control Plans for Trash and also serves as the State Water Board's Substitute Environmental Document (SED) that is required to meet the needs of the California Environmental Quality Act. The report aims to present an analysis of why such an amendment is needed, centred on the achievement of the highest water quality consistent with maximum benefit to the people of the state. According to definitions provided by Porter-Cologne section 13050, beneficial uses requiring protection from pollution and nuisance involve both surface waters and ground waters. The Water Board is charged with protecting surface and ground waters, marshes and wetlands through a system of water quality objectives and discharge prohibitions. These are described in the document for the various basin plans and the ocean plan for the state.

The scientific rationale presented in the document provides a detailed analysis of the beneficial uses that can be affected by trash, associated with aquatic life and public health. It discusses the evidence linking land use with trash generation rates and provides an analysis of the various methods that might be implemented to achieve improved water quality through capturing trash. Here, the quality of that scientific evidence is reviewed, with an emphasis on the impacts of trash on aquatic life and public health.

General comments

The document is thoroughly researched and clearly presented. A wide range of scientific reports, government and organisational reports and publications from the international peer reviewed and publically available literature have been used to provide evidence for each section and conclusion and in general these are well placed within the text and accurately cited.

The following section of the review discusses the first conclusion 'Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats and endangers wildlife in surface waters' and concentrates on the evidence presented in Appendix A Trash Background

Appendix A Trash background

The first point to make about this section is in relation to its organisation. The conclusion being made from this evidence is that 'Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats and endangers wildlife in surface waters', yet the emphasis of the Appendix and supporting documents is in the reverse order, with excellent emphasis given to aquatic life beneficial uses, wildlife, freshwater, estuarine and marine habitats and organisms and evidence for these effects, yet less attention given to providing evidence for the human health aspect.

'Trash threatens public health' pA-196

The evidence presented to support the adverse effects of trash on public health presents a reasonable picture of the likely effects, yet is limited in the literature that is cited to support the claims being made. Only one reference is provided, an internal document from Los Angeles Water Board, 2010. Detailed inspection of this reference does not provide a good body of evidence supporting the influence of trash on human health, other than anecdotally. There exists, however, an extensive body of research covering this topic, exploring and describing the links between exposure to anthropogenic litter, human waste and adverse health effects. My recommendation would be that to maintain the high standard of scientific evidence supporting the document as a whole, some additional effort is put into strengthening the evidence here. There are a number of relevant documents that could be used to support this, and a couple of suggestions are listed below, or these could be replaced with a more USA focused example.

1. DG Europe (2011), Plastic Waste: Ecological and Human Health Impacts. Science for Environment Policy In-depth Report November 2011, available from http://ec.europa.eu/environment/integration/research/newsalert/pdf/IR1.pdf

This document provides an in depth analysis of the human and ecological health effects that might be predicted from plastic litter, with a lengthy section discussing human health effects.

2. Musmeci et al., 2010. The impact measurement of solid waste management on health: the hazard index. *Ann Ist Super Sanità* 46: 293-298

This document discussed various methods for assessing the risk to human health associated with exposure to emissions (chemical, physical, infectious) arising from solid waste disposal.

Despite these limitations in the extent of scientific evidence and supporting documentation cited, the section is well laid out and the conclusions and content provide a plausible and convincing rationale for concluding that trash poses public health and safety hazards.

Beneficial uses impacted by trash A-188

This section outlines the many beneficial uses specific to California that are listed in the basin plans for the regional water boards, and in the Ocean plan, that may be impacted by trash. It is reasonable to conclude, as this section does, that the trash related impacts to aquatic life beneficial uses are substantiated and that there is sufficient evidence documenting ingestion, entanglement, habitat alteration and degradation due to trash to lead to adverse effects on spawning, migration and survival of aquatic life including mammals, turtles, birds, fish, amphibians and invertebrates.

Effects of trash on aquatic habitats A-190

In this section the potential impacts of trash on different aquatic habitats is reviewed, from the potential to impact on the function of the soft bottomed benthos to the presence of trash items in deep-sea canyons. The evidence to support the conclusion that trash can be found in these locations and has the potential to impact these habitats is strong.

The potential for trash to contribute to the wider distribution of invasive species is discussed (page A-191). This section is well written and discussed except for the discussion relating to the paper by Barnes (2002). The statement 'In fact, trash is found to more than double the rafting opportunities for biota'… needs to be qualified with a bit more detail. What Barnes actually found was that when debris was examined from 30 remote island shores from across the globe, there was a relationship between the extent of rafting organisms and latitude. Anthropogenic litter had roughly doubled the propagation of fauna in the subtropics locations and this figure was even higher at higher latitudes. Hence floating litter increases the opportunities for alien invasions, as shown by this example. We don't yet know if this applies universally.

Whether trash can serve as a *transport medium for pollutants* is discussed in some detail (page A-192). Whilst there are some very recent additions to this literature that are not included, they do not change the overall conclusion made, which is that the extent to which plastic debris act as vectors for pollutants is likely to be strongly influenced by local conditions and by the nature of the contaminant and of the plastic. It is unlikely that microplastics (defined as plastic debris of <5mm in diameter) represent an important global reservoir of persistent organic pollutants, but they may well influence the movement and distribution of these pollutants in the wider environment.

The review of scientific evidence on the effects of trash ingestion on wildlife is thorough and provides relevant examples, especially for sea turtles, where a significant body of evidence has been assembled of the often fatal consequences of plastics ingestion and gut abrasion and blockage.

Regarding the propensity of plastics to act to transport toxic substances to organisms following ingestion, the evidence presented provides a good overview of current literature up until 2011. There are some more recent references that have since appeared in the literature, and a selection of the most recent is summarised briefly below. Their inclusion in the draft

report would further strengthen the conclusions that have been made regarding the transport of toxic substances to organisms following ingestion.

1. Koelmans et al., (2014) Leaching of plastics additives to marine organisms, *Environmental Pollution* 187: p49-54.

This article explores the transfer of adhered plastics additives into the tissues of marine organisms, using lugworms and fish as exemplar species. The conclusions drawn are that plastics ingestion will make a negligible contribution to the transfer of the additives nonylphenol and bisphenol A to the animal's body tissues compared with other routes of exposure.

2. Velzeboer et al., 2014, Strong sorption of PCBs to nanoplastics, microplastics, carbon nanotubes and fullerenes, *Environmental Science and Technology*, 48: p4869-4876.

This article highlights the influence of salinity on sorption of contaminants, especially to polymers. The authors note that polychlorinated biphenols, which are priority organic pollutants in the marine environment with many adverse human and ecological health effects, bind exceptionally strongly to all particles tested.

3. Bakir et al., 2014. Transport of persistent organic pollutants by microplastics in estuarine conditions, *Estuarine Coastal and Shelf Science*, 140: 14-21.

This paper confirms that transport and movement of contaminants by plastic particles in the aquatic environment are greatly influenced by local conditions. The likely direction of transport for the organochlorine pesticide DDT and the polyaromatic hydrocarbon phenanthrene, both common aquatic pollutants, is predicted to be from freshwater and estuarine to fully marine conditions.

Collectively, these articles confirm the overall conclusion made in the draft staff report that the uptake and bioaccumulation of toxic substances from plastics has been shown to occur, but that it is not yet possible to fully describe the extent to which this is significant in comparison with other modes of toxicant transfer (via atmosphere or ocean currents) in the environment.

The effects of trash entanglement (A-193) are well discussed and illustrated with relevant recent examples, supporting the conclusions made in the report that trash entanglement can lead to fatalities for many different species.

Different land uses have different rates of trash generation.

The second conclusion to be addressed in this review is that different land uses have different rates of trash generation (A-198).

Scientific evidence is presented to document the composition of trash collected from beaches, inland waterways, coastal waters and subsurface waters. The data on which these descriptions are based is extensive (>850K pieces of litter collected in 2012 alone), and it is comparable to similar data

assembled for other global sites by organisations, academics and government funded studies. These support the top ten items of trash collected from coastal clean-up sites to be: cigarette butts, bags, food wrappers and containers, caps and lids, crockery and cutlery, glass beverage bottles, plastic beverage bottles, beverage cans and building materials. This dominance of consumer products associated with food consumption is useful since it helps in directing remedial efforts towards the most pollution sites and activities.

The factors influencing the movement of trash in the environment in a downstream direction are well reviewed and supported with data (A-199), allowing for identification of five primary transport mechanisms: littering, storm events, wind-blown trash, illegal dumping and direct disposal into water bodies. Credible and detailed studies are presented documenting assessments of the types of trash items found in different water bodies, and highlighting affected areas (high foot and car transport

areas, transition points, special sports and entertainment events, fast food and shopping outlets). This evidence supports the conclusion that different rates of trash generation are associated with different land uses.

A useful additional section deals in detail with outfall and storm drain monitoring. A key aspect of the successful implementation of the amendment will be in applying a system of monitoring to judge compliance ad success in remediating water quality. The information presented is in agreement with California State's position as a leader in implementing local ordinances with goals of reducing trash, and specifically plastics, including single-use disposable items: expanded polystyrene foam and single use plastcic bags.

Again, there are recent peer reviewed references that support these conclusions, but which are based on studies of waters in the UK and Europe. This highlights the global nature of the problems being addressed.

1. Lechner et al., 2014. The Danube so colourful, a potpourri of plastic litter outnumbers fish larvae in Europe's second largest river. *Environmental pollution*, 188: p1770181.

This 2 year survey of the Austrian Danube reported a net flow rate of 4.2 tonnes per day, with industrial raw materials (flakes, spheres and pellets) accounting for >70% the reported items

2. Sadri et al., 2014. On the quantity and composition of floating plastic debris entering and leaving the Tamar estuary, Southwest England. *Marine Pollution Bulletin*, 81: 55-60.

This paper confirmed the net movement of land based litter and debris into marine waters. A study of the effects of tide noted that spring tides were associated with larger plastics items than were neap tides. The estuary could not be identified as either a net source or sink of litter.

Collectively, these additional references reinforce the conclusion made in the draft staff report that a major proportion of marine litter originates on land and that different land based uses lead to the generation of different rates of trash generation.

end

Draft Amendments to Statewide Water Quality Control Plans for Trash July 9, 2014

External Peer Review by Dr. David L. Barnes, P.E.
Professor of Civil and Environmental Engineering
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General Comments

The Draft Amendment to Statewide Water Quality Control Plans for Trash (*Draft Staff Report*) details regulatory method that is focused on reducing the amount of trash discharged to surface water by amending existing discharge permits and prohibiting the discharge of preproduction plastics by manufacturers and transports. These steps seem to be necessary in that exiting laws, regulations, and permitting processes are not successfully reducing the amount of trash and preproduction plastics being discharged to surface waters.

I found this *Draft Staff Report* to be very well written. A thorough case was made as to why action to address the discharge of trash is needed at this time. Methods that can be used to comply with the amendment were adequately discussed. Moreover, the authors cited pertinent literature throughout the document. This review addresses three scientific conclusions from the *Draft Staff Report*:

1) Trash threatens public health and safety, reduces appeal, degrades aquatic habitats, and endangers wildlife in surface water.
2) Different land uses have different rates of trash generation.
3) A full capture system is an effective method for capturing trash greater than 5 mm from entering a surface water body via storm water.

In addition I have included some general comments on the *Draft Staff Report* in my review.

Conclusion 1 – Trash threatens public health and safety, reduces appeal, degrades aquatic habitats, and endangers wildlife in surface water

My expertise only allows me to address the public health and safety aspects related to this conclusion. A reasonable definition of pollutant is a species that has some undesired consequence associated with its presence (Nazaroff and Cohen, 2001). With this definition it is easy to see that trash can be defined as a pollutant. Discharges of trash and preproduction plastics to streams, rivers, lakes, and oceans are an immense and global problem (Leous and Parry, 2005). Numerous studies have documented the presence of trash, in particular plastics owing to its predominance among marine trash (Gregory and Ryan, 1997; Derraik, 2002; Thompson et al., 2004). The ultimate impact these discharges have on aquatic life and wildlife is well documented and well cited in the *Draft Staff Report*.

The human health and safety risks resulting from improperly discarded solid waste have been understood since the 19th century (Tchobanoglous et al., 1993). The main health impact is disease caused by rats, flies, and other disease vectors breeding in trash-impacted areas and then spreading disease to humans. Hanks (1967) details the relationship between solid waste and human disease, tracing the connection between improper solid waste management and 22 human diseases. Though high amounts of putrescible organic wastes are generally not contained in common trash (litter), discarded fast food bags containing unfinished food, diapers, improperly disposed household wastes, among other items will contain waste that will degrade attracting rodents and flies. Since the study conducted by Hanks (1967) additional public health concerns have come into focus concerning improperly discarded trash, in particular hypodermic needles and plastics (Phillip, 1993; Halden, 2010). It is well understood that trash can impact human health and public safety.

Conclusion 2 - Different land uses have different rates of trash generation.

Limited studies have been reported in the refereed literature on waste generation rates classified by land use. A study conducted by Cutter et al. (1991) in New Jersey shows a difference in trash generation rates depending upon land use. In this study the authors divided land use into the following categories

- Residential
    - Urban
    - Suburban
    - Rural
- Commercial
    - Urban
    - Suburban
    - Rural
- Industrial
- Roads
    - Rural/county
    - State/federal highway
    - Interstate/toll road
- Beaches
    - Undeveloped bay
    - Developed bay
    - Developed Ocean
- Watercourses
- State Parks
- Landfills

The authors sampled at two-week intervals over a four-week period during the summer of 1989. Each site was visited three times. In their study, the only collected litter larger than one inch (~2.5 cm).

Results from this study show a clear difference in generation rates according to the land uses the authors defined. Commercial sites were the most littered. The next most littered land use areas (in order of generation rate) are as follows: state parks, roads, landfills, beaches, industrial areas, residential areas, and finally watercourses. The authors also found that there was not statistical difference between the overall generation rates in rural areas in comparison to suburban areas. However, there was a clear statistical difference between the generation rates in urban areas in comparison to suburban and rural areas. This result makes intuitive sense since the overall solid waste generation rates are high in populated urban areas in comparison to relatively less populated suburban and rural areas.

Stein and Syrek (2005) conducted a litter survey for the New Jersey Clean Communities Council. In this study the authors divided the land use into the following categories:

- Rural freeways and tollways,
- Other state rural highways,
- Rural and local roads,
- Urban freeways and tollways,
- Vacant, industrial or un-maintained street frontages,
- Commercial street frontages,
- Public facility street frontage, and
- Residential street frontage.

The authors performed litter counts in each land use category with each site been visited once. Results from their study show that the category "other state rural highways" had the greatest amount of litter. The authors attributed this result to the frequency of cleaning up litter. As the authors state, "the street in front of the courthouse is cleaned more often than a Rural Local Road." The next highest litter accumulation was found in the category "vacant, industrial or un-maintained street frontages" followed by the category "rural freeways and tollways."

One difference between the study by Stein and Syrek (2005) and Cutter et al. (1991) is Cutter et al. (1991) removed the litter they counted so that in subsequent visits the authors were collecting litter that had accumulated over the previous two week period (during the survey litter was not removed by road or maintenance crews at any of the sites). In the study by Stein and Syrek (2005) each site was visited only once. Hence, the influence of the difference between active litter cleanup activities between the different land use categories on litter generation rates (litter quantity/time) was most likely not as great in the study performed by Cutter et al. (1991). This difference in study methodology means that the results from Cutter et al. (1991) are most likely more reflective of litter generation rates as a function of land use category than the study by Stein and Syrek (2005).

Results from a study performed by Black and Veatch (2012), which is cited in the *Draft Staff Report*, indicates that litter generation rates is a function of land use area. In this study the authors divided the entire study area into five land use categories: open space/parks, low density single family residential, commercial, industrial, and high density single family residential. Each site was visited once per week

for eight weeks. The authors selected a consecutive four week period from the eight week study to be representative of typical litter generation over a 30 day period. The authors found that commercial land use category had the greatest litter accumulation rate over the representative 30 day period followed by industrial areas. As in the study performed by Cutter et al. (1991) these authors collected and removed the litter. Following this methodology the litter collected and counted during the next sampling period was most likely not greatly impacted by litter cleanup activities performed by maintenance crews.

Results from these three studies strongly indicate that trash generation rates are a function of land use. Further, according to the results from the study performed by Cutter et al. (1991) and by Black and Veatch (2012), commercial areas have the greatest trash generation rates.

Conclusion 3 - A full capture system is an effective method for capturing trash greater than 5 mm from entering a surface water body via storm water.

Processes for the separation of solids from liquids are well known and used in many different industries. Removing trash from storm water is just another application of the fundamentals of separation. The challenges in the development of these type of capture systems are the system should have no moving parts or require external power source. Moreover, the system must be reliable, economic, have minimal water head requirements, and have high removal efficiency. Most importantly, the system most not increase the flood levels in the vicinity of the structure (Armitage, 1998).

Given the complexity of capturing trash down to a size of 5 mm, most likely no trap will be 100% effective under all conditions (Armitage, 2003). However, many systems will be effective under defined conditions. An example of a defined condition in which the full capture system is evaluated against is provided by the Los Angeles Regional Water Quality Control Board for Ballona Creek (State of California, 2004). Several likely systems were evaluated by the County of Los Angeles (2004), hence it is my belief that full capture systems will be effective under defined conditions. Further, if the NPDES process is amended to include trash as detailed in this *Draft Staff Report*, then more about these systems will be learned and improvements to existing full capture systems will most likely occur as well.

Specific Comments on the *Draft Staff Report*

Comment on Section 1.6 – Current Efforts to Address Concerns Related to Trash in California Waters

In this section the authors discuss current laws, ordinances, and permitting processes directed at trash. The authors included in this section short discussions on the existing NPDES permitting processes adopted by the Los Angeles Water Board and the permitting process adopted by the San Francisco Water Board. I believe it would be beneficial to include in this section (or a different section) an expanded discussion on these two attempts to control the discharge of trash. How successful have these attempts been? What has been the associated implementation cost? Most importantly, is the proposed process of eliminating trash discharges feasible? It seems that much can be (and already has

been) learned from these case studies. I believe it would be beneficial to include a detailed discussion of the knowledge gained from these case studies in this report.

Comment on Section 2.4.2 - Nonpoint Source Dischargers

In this subsection the authors address the requirements for nonpoint source (NPS) dischargers who are subject to Waste Discharge Requirements (WDRs) or waivers to WDRs. Does this cover all the NPS dischargers? If not, how will the Water Board regulate and enforce NPS dischargers who are not subject to these requirements or waivers?

Comment on Section 4.10 – Issue 10: How should the Trash Amendments structure monitoring and reporting of trash control efforts?

In this section the authors discusses different options for monitoring requirements for MS4 permittees complying under Track 2 and for Caltrans. MS4 permittees will be required to conduct baseline and annual monitoring to demonstrate the effectiveness of their selected controls. I recommend a statewide standard method for developing the baseline be established to provide consistency among the different Water Boards. I also recommend that a statewide standard method for annual monitoring be developed. I recommend that the monitoring programs be constructed such that the conclusions derived from these monitoring events be statistically defensible. To illustrate why I believe such a standard method is required we can use the following references that were cited in the *Draft Staff Report*:

- Los Angeles Water Board. 2007f. *Trash Total Maximum Daily Load for the Los Angeles River Watershed*. Revised Draft. July 27, 2007.
- Black and Veatch. 2012. *Quantification study of institutional measures for Trash TMDL compliance – Interim Report: Year 1 – 2012*. Prepared for by the City of Los Angeles.

The Los Angeles Water Board has classified land use into 13 different categories. Baseline waste load allocations developed for each jurisdiction in the Los Angeles River watershed is reported in Los Angeles Water Board (2007). Table 1 provides the volumes of trash collected in the baseline study for each land use category and the area measured for each land use category reported in Los Angeles Water Board (2007). The total baseline trash volume resulting from this study is 1,374,845 gallons.

Black and Veatch (2012) conducted an extensive assessment of performance of institutional measures employed by the City of Los Angeles to reduce discharges of trash. These authors measured trash volumes in representative land use category areas over a representative 30-day period. They report the litter generation rates generated for the following land use categories: Open Space/Parks, Low Density Residential, Commercial, Industrial, and High Density Residential (Table 2). We can determine the representative trash volumes for each of the reported land use categories be multiplying each 2012

measured litter generation rate by their respective area reported by Los Angeles Water Board (2007). Table 2 provides these values.

Table 1. Land Use Areas and Baseline Volumes for Los Angeles

Land Use Category	Land Area[1] (acre)	Volume[1] (gallons)	Litter Generation Rate[2] (gallons/acre)
Open Space	29,344	170494	5.81
Low Density Residential	4,390	13302	3.03
Commercial Services	10,906	161072	14.77
Industrial	10,758	164951	15.33
High Density Residential	94,048	523851	5.57
Public Facilities	5,651	86603	15.32
Educational Institutions	4,941	72974	14.77
Military Institutions	83	0	0
Transportation	7,462	114426	15.33
Mixed Urban	1,382	21170	15.31
Agriculture	1,670	9692	5.802
Water	3,270	0	0
Recreational	6,253	36310	5.807
	Total	1,374,845	

[1] From Appendix II, Los Angeles Water Board (2007)
[2] terminology used in Black and Veatch (2012)

Table 2. Measured Litter Generation Rates and Calculated Trash Volumes for Los Angeles Measured in 2012

Land Use Category	Land Area[1] (acre)	Litter Generation Rate (gallons/acre)	Volume (gallons)
Open Space[2]	29,344	1.90	55,754
Low Density Residential[2]	4,390	0.98	4,302
Commercial Services[2]	10,906	18.52	201,979
Industrial[2]	10,758	7.65	82,299
High Density Residential[2]	94,048	2.86	268,977
Public Facilities[3]	5,651	7.65	43,230
Educational Institutions[3]	4,941	18.52	91,507
Military Institutions	83	0.00	0
Transportation[3]	7,462	7.65	57,084
Mixed Urban[3]	1,382	7.65	10,572
Agriculture[3]	1,670	1.90	3,173
Water	3,270	0.00	0
Recreational[3]	6,253	1.90	11,881
		Total	832,771

[1] From Appendix II, Los Angeles Water Board (2007)
[2] From Black and Veatch (2012)
[3] Estimated using the assumptions provided in Los Angeles Water Board (2007)

Using assumptions for litter generation rates provided in Los Angeles Water Board (2007), we can determine the representative trash volumes for the remaining land use categories (Table 2). A

summation of the volumes for each land use category results in the total volume of trash generated over a 30-day period in 2012 equal to 832,771 gallons.

The authors of the Black and Veatch (2012) study calculated the total volume differently from the method described above. In their study they present a representative litter generation rate as the ratio of the total trash volume measured at each of their representative land use category sites to the total area of all of the sites. Using this method they calculate a representative land use generation rate equal to 6.80 gallons/acre. They then determine the representative trash volume for each land use category in Los Angeles by multiplying this ratio by the land area for each category. Summing these trash volumes results in a total volume of trash generated over a 30-day period equal to 1,203,031 gallons, which is over 40% greater than the value determined by the first method described above.

Each analysis method is a valid approach to comparing the volume of trash generated in comparison to the baseline. However, the results are greatly different between the two methods. At the extreme, one calculation method may show that a jurisdiction is out of compliance, while the other method may indicate otherwise. Hence, I believe a standard monitoring (and analysis) method is required for both the development of the baseline and for annual monitoring. Furthermore, given the heterogeneous nature of trash generation, a comparison of generated trash volumes to a baseline value needs to be statistically defensible. I believe that to be truly successful in eliminating trash discharges very close attention needs to be paid to the monitoring and analysis procedures used to track progress towards this goal and eventual attainment of this goal.

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Review of scientific conclusions that serve as basis for the proposed California Trash Amendments.

Conclusion #1: Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats, and endangers wildlife in surface waters

The need for the proposed Trash Amendments is based on a number of claims. The first claim is that trash is present in streams, rivers, lakes, estuaries, wetlands, the ocean, and along beaches. This claim is supported by data in peer-reviewed publications cited in the Draft Staff Report (e.g. EPA 2002, Moore et al. 2001). Additional supporting evidence is provided by Ribic et al. (2012), who provide a 10-year perspective on debris quantities at locations on the US Pacific Coast. Furthermore, Smith and Markic (2013) suggest that quantitative estimates of trash deposition along marine shorelines are likely low because of the low sampling frequencies employed in most studies.

The second claim is that trash interferes with beneficial uses of surface waters by adversely affecting public health and safety as well as aquatic habitat and life. Examples of public health and safety effects include health and safety hazards for fishermen, recreational boaters, and children playing on beaches and in the water. Examples of effect on aquatic habitat and life include fatalities of mammals, turtles, birds, fish, and crustaceans as a result of trash ingestion or entanglement by trash. Harmful effects of trash on aquatic habitat and life are well supported by the peer-reviewed literature cited in the Draft Staff Report (e.g., Bjorndahl et al. 1994, EPA 1992, 2002, Gramenetz 1988, Jacobsen et al. 2010, Tomas et al. 2002). The 2008 National Research Council Report "Tackling Marine Debris in the 21st Century," which was mentioned in the March 10 memo, as well as the paper by Gregory (2009) could be added to further support the claim that trash interferes with beneficial uses of surface water. Both sources include additional examples and citations regarding trash impacts on aquatic life and habitat. Other claims associated with the degradation of aquatic habitat made in Appendix A of the Draft Staff Report (trash is a transport medium for invasive species, trash inhibits gas exchange at the sediment/water interface and promotes hypoxia/anoxia) are based on sound scientific knowledge and documented through appropriate citations. Claims associated with the adverse effects of trash on public health and safety are primarily supported through examples provided in a 2010 report prepared by the Los Angeles Water Quality Control Board. The 2008 National Research Council Report "Tackling Marine Debris in the 21st Century" as well as papers by Gregory (2009) and Hastings and Potts (2013) provide additional support that could be incorporated in the Draft Staff Report if needed.

Persistent organic pollutants (POPs) sorbed to microplastics may pose another hazard for aquatic life. The Draft Staff Report appropriately points out that limited research exists on the biological uptake and bioaccumulation of toxics from plastics (p. A-193); however, the conclusion that plastic trash is therefore not a significant vector of toxics relative to other exposure processes (p. A-193) does not necessarily follow from the recognized data scarcity. The Draft Staff Report

correctly points out that some studies have suggested that plastic trash may not be an important vector for wildlife exposure to POPs (Gouin et al. 2011, which is cited in the Draft Staff Report). In addition, a recent paper arrived at a similar conclusion for bisphenol A and nonylphenol (Koelmans et al. 2014). On the other hand, Besseling et al. (2013) showed that the internal PCB105 concentration in lugworms increased upon microplastic ingestion from sediment containing ~0.1-1% microplastic; however, the study also concluded that the microplastic contents tested in the sediments were not representative of those found in affected aquatic habitats. Data gaps are still too large to draw conclusions about the importance of POP exposure via ingestion of microplastics. It also needs to be pointed out that trash is defined as particles >5 mm in diameter/size while a substantial fraction of microplastics is <5 mm in size (Moore et al. 2011). As a result, trash removal from stormwater will reduce but not eliminate the exposure of aquatic organisms to microplastics and POPs sorbed to microplastics.

Related claims in Appendix A of the Draft Staff Report (Effects of Trash on Contact and Non-Contact Water Recreation, Commercial and Sport Fishing, and Navigation as well as Effects of Trash on Native American Culture [and subsistence fishers]) are reasonable and can be further supported, at least in part, by the information presented by National Research Council (2008), Gregory (2009), Hastings and Potts (2013) and references therein. Both National Research Council (2008) and Hastings and Potts (2013) address economic implications of trash on tourism and fisheries.

Based on the above analysis, conclusion #1 is based on sound scientific knowledge and warrants the development of a narrative water quality objective for trash.

Conclusion #2: Different land uses have different rates of trash generation

Both the March 10 memo and Appendix A (p. A-200) suggest that 80% of marine debris is derived from land-based sources, and this figure is based on a 1999 NOAA publication. This claim could be further substantiated with the data of Ribic et al. (2012), who illustrate that at least 60% of debris on Southern California beaches is derived from land-based sources while at least 8% is derived from ocean-based sources; the balance could not be assigned to either origin. Ribic et al. (2012) also report data for other Pacific Coast locations.

The March 10 memo states that “the primary transport mechanism of land-based trash is through storm water and urban runoff” and references National Research Council 2008. I could not verify the use of “primary” in National Research Council (2008), which states “stormwater runoff, which is recognized as a major source of the marine debris along U.S. coasts and waterways, is regulated as a point source under the National Pollutant Discharge Elimination System.” However, the Draft Staff Report takes a more global approach to defining important sources and transport mechanisms for trash, which is more appropriate. Through appropriate citations, the Draft Staff Report also appropriately supports the argument that runoff during storm events is an important transport mechanism for land-based trash (p. A-200). National Research Council (2008) could be added to the list of references for additional support.

The March 10 memo and the Draft Staff Report appropriately state that land use plays a role in trash generation rates. In addition to the cited studies in the Draft Staff Report (pp. A-201 -

A-204), the paper by Hipp et al. (2006) could be cited. While not focusing directly on trash, Hipp et al. (2006) illustrate that total suspended solids (TSS) inputs vary by land use and that placement of treatment devices can be optimized based on knowledge of TSS sources. Hipp et al. (2006, Supplementary Information) identified vacant lots as an important TSS source term.

Based on the above analysis, conclusion #2 is based on sound scientific knowledge and has important implications for the development of cost-effective strategies compliance strategies.

Conclusion #3: A full capture system is an effective method for capturing trash greater than 5 mm from entering a surface water body via storm water

Based on the importance of storm water as an importance conveyance mechanism for land-based trash, it is claimed that properly functioning full capture systems (defined as treatment controls capable of capturing trash that is 5 mm or greater in size) are an effective way to capture trash and divert trash in areas of high trash generation from the waterways and beaches. Full capture systems can include catch basin inserts, vortex separation systems, trash nets, and gross solids removal devices. While there is little information on the performance of full capture systems in the peer-reviewed literature, an undated report by the California Coastal Commission and the Algalita Marine Research Foundation (http://plasticdebris.org/Trash_BMPs_for_Munis.pdf) provides a useful summary of the performance, maintenance needs, and costs of full capture systems. I will refer to this report as the CCC report.

When assessing the effectiveness of a full capture system, its performance during storm events is important. For example, the CCC Report points out that catch basin inserts of the box and tray kind have limited volume capacity and cannot be considered full capture systems because trash escapes the catch basin inserts during storm events. Also, accumulated material can lead to loss of drainage capacity and local flooding. Some catch basin inserts are also vulnerable to damage by lit cigarette butts (Kostarelos et al. 2011). Nonetheless, catch basin inserts, when properly designed and maintained, offer the possibility to function as a full capture system

Some vortex separation systems can be problematic because they impart additional head loss that cannot be accommodated by some existing storm drains, and upstream flooding can be a result (CCR Report).

End-of-pipe nets can quickly clog when net openings of 5 mm are used (CCR Report). As a result, inspection is needed after every storm >0.25 in. This inspection frequency is also recommended for other netting systems, such as in-line netting and floating systems. A study conducted by the US Environmental Protection Agency and Fresh Creek Technologies illustrated that the Netting Trash Trap system was 93-97% effective for trash removal from a combined sewer overflow (US EPA 1999). Mesh openings of 6.5 and 13 mm were tested and yielded similar trash removal efficiencies; however, no information about the size of non-retained particles was reported.

According to the CCR report, gross solids removal devices are effective to very effective for removing litter from discharges of highway storm water runoff (linear radial device: 98%

removal by weight, 92% removal by volume; inclined screen device: 100% removal). Annual maintenance of gross removal devices at the end of the wet season appears to be sufficient.

Overall, conclusion #3 is based on sound scientific knowledge, and a number of studies and reports illustrate that full capture treatment options are available that effectively remove trash from storm water. Because storm water is an important trash conveyance mechanism, trash removal by full capture devices is expected to lead to substantial reductions in trash introduction to surface waters, including coastal waters. I recommend that the Draft Staff Report be updated with information presented in the CCR Report to more completely capture the pros and cons associated with each of the presented full capture treatment options.

Additional comments/questions:

1. Table 13 (p. A-189-190): What is meant by "biological compounds"? See entries for Estuarine Habitat, Marine Habitat, Wetland Habitat.
2. Last 4 lines on p. A-198: Fit? Needed?
3. Page A-199: "five primary transport mechanisms" should be changed to five primary sources and transport mechanisms"
4. Define dry season runoff. Dry season streamflow?
5. Use "sorb" instead of "adsorb" or "absorb" when discussing POP sorption to plastics. Depending on the type of plastic and the POP concentration, adsorption or absorption can dominate. Sorb is a more general term that encompasses both mechanisms.

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