Bay Area-wide Trash Capture Demonstration Project

Final Project Report

May 8, 2014

SAN FRANCISCO

ESTUARY
PARTNERSHIP

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Executive Summary

The Bay Area-wide Trash Capture Demonstration Project was conceived in early 2009, in anticipation of the San Francisco Bay Regional Water Quality Control Board's adoption of a new and innovative municipal regional stormwater National Pollutant Discharge Elimination System (NPDES) permit for Bay Area municipalities and municipal separate storm sewer system operators serving populations of at least 100,000 (NPDES "Phase I communities"). The San Francisco Estuary Partnership (SFEP), a program of the Association of Bay Area Governments (ABAG), applied for funds allocated to California under the American Recovery and Reinvestment Act of 2009. Thanks to the rules governing this federal stimulus funding, no match was required – a boon to the Bay Area's municipal stormwater programs, which are chronically resource-limited.

SFEP's intention in designing the project was to use grant funds to enhance and accelerate Phase II municipalities' ability to meet requirements for "full trash capture" in the new permit (the "MRP"). Because $5 million is only a fraction of the investment that will eventually be required for full compliance with the permit (100 percent reduction of trash-related impacts by 2022, with interim benchmarks), we opted for a demonstration project that would help municipal staff understand what types of devices would be effective in different infrastructure and land use scenarios, in order to make future investment more cost-efficient.

To this end, SFEP/ABAG released two requests for proposals for provision of trash capture devices of varied types, and contracted with 12 vendors. We then contracted with 64 of the 76 Phase I MRP permittees and three Phase II jurisdictions (population less than 100,000; not required to capture trash when the Demonstration Project began), allowing them to order devices through ABAG.

By the construction deadline, 4003 devices were installed in all but one of the contracted jurisdictions.

In addition to provision of devices, the project also developed the Bay Area Trash Tracker, a password-protected, online resource for municipalities, which maps device installations and allows local staff to upload and download maintenance data. As the project concludes, the Tracker has been used by more than 30 municipalities. The Bay Area Stormwater Management Association has been awarded a Proposition 84 grant, "Tracking California's Trash," which will continue development of the Tracker to include layers showing high trash generation areas, trash hotspots, and on-land disposal sites, and a public interface in the form of a "My Water Quality" Portal overseen by the California Water Quality Monitoring Council.

Throughout the project, SFEP has been gratified by the support of the State Water Quality Control Board's (State Water Board's) Division of Financial Assistance. Division staff have made funding available for this project from a number of grant sources, as circumstances changed and construction of this "shovel ready" project took many months longer than we anticipated initially. We appreciate the Division's support and understanding over the past four years.

Total funding $5 million

American Recovery and Reinvestment Act of 2009, through the California Clean Water State Revolving Fund: $734,938.75

Coastal Nonpoint Source (Propositions 13 & 50): $4,265,061.25

Urban Stormwater (Proposition 40): $107,792.78

Problem Statement

Trash in our local streams, creeks, and San Francisco Bay is an obvious and significant water pollution problem. A 2004 study found an average of three pieces of trash along every foot of stream leading to the Bay.[1] On Coastal Cleanup Day in 2012, volunteers in the nine Bay Area counties collected more than 290,000 pounds of trash and debris, including more than 19 tons of recyclables.[2]

Non-biodegradable plastic and expanded polystyrene ("Styrofoam"), including bags, bottles, and the fiberglass filters in cigarette butts, comprise most of our region's trash. This material is toxic to fish and wildlife; it clogs creeks and sloughs, degrades wetland habitat, creates blight, and deters recreation in our creeks and along our shoreline. Studies show that plastic debris in the water column binds to a range of toxic compounds, including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and chlorinated pesticides; and carry these pollutants into the food web when even tiny particles of plastic are ingested by fish, birds, and marine mammals.[3] In other words, trash compromises numerous beneficial uses, including

- Areas of special biological significance
- Estuarine habitat
- Marine habitat
- Fish migration
- Preservation of rare and endangered species
- Water contact recreation
- Noncontact water recreation
- Wildlife habitat

The San Francisco Estuary is designated an Estuary of National Significance in the federal Clean Water Act. The San Francisco Estuary Partnership is one of 28 National Estuary Programs, authorized under Section 320 of the Act. Reducing trash in San Francisco Bay and tributary creeks implements estuary enhancement actions in the Comprehensive Conservation and Management Plan (CCMP) for the San Francisco Estuary, which calls for reduction of trash pollution and marine debris in San Francisco Bay:

- CCMP action PO-1.8, "Develop and implement programs to prevent pollution of the Estuary by…harmful pollutants like trash, bacteria, sediments, nutrients"

- CCMP action AR-9.2, "Expand existing marine debris prevention and cleanup programs and develop new initiatives to reduce discharge of debris to waterways"

Reducing trash is also consistent with the 2007 [Resolution of the California Ocean Protection Council on Reducing and Preventing Marine Debris](#)[4] and the related Implementation Strategy.

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[1] S. Moore, M.R. Cover, and A. Senter, "A Rapid Trash Assessment Method Applied to the San Francisco Bay Region: Trash Measurement in Streams," poster presented at the State of the Estuary Conference, Oakland, CA, 2004. Available at http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/trash_poster.pps. Visited 11/24/2013.

[2] California Coastal Commission, http://www.coastal.ca.gov/publiced/ccd/stats/2012.html

[3] U.S. Environmental Protection Agency Region 9 (Pacific Southwest), "Marine Debris in the North Pacific: A Summary of Existing Information and Identification of Data Gaps," 2013. Available at http://www.epa.gov/region9/marine-debris/pdf/MarineDebris-NPacFinalAprvd.pdf. Retrieved October 31, 2013.

[4] http://www.opc.ca.gov/webmaster/ftp/pdf/docs/Documents_Page/Resolutio ns/MarineDebris_Resolution.pdf

In 2009 the San Francisco Bay Regional Water Quality Control Board (Water Board) adopted the 2008 303(d) list of impaired waters for our region[5]. The list incorporated 26 new listings for trash impairment, two of which are for extensive segments of shoreline in Central and Lower San Francisco Bay. Consequently, trash capture requirements for the majority of Bay Area municipalities are included in the Municipal Regional Stormwater Permit (National Pollutant Discharge Elimination System Phase I permit, or MRP[6]), which the Water Board adopted in December 2009. Phase I cities that joined SFEP's trash capture Demonstration Project recognized that participation in the project would provide resources that would aid in compliance with the permit. A number of Phase II communities used the project to meet anticipated trash reduction requirements in the Phase II "small MS4" statewide permit (adopted in 2013).

Demonstration Project Goals

- Provide a significant number of Bay Area municipalities with trash capture devices that fulfill permit requirements[7]

- Structure the project so that municipal staff can gain knowledge of different device types and their appropriateness to different land use scenarios

- Work with a group of municipalities within the project to collect and report on estimates of trash reduction as a result of device installations

Project Description and Approach

Project type: Demonstration Project implementing the Comprehensive Conservation and Management Plan of an "estuary of national significance"

Project cost and funding sources:

The project was initially awarded $5 million from the American Recovery and Reinvestment Act of 2009 (federal stimulus bill, ARRA), with funds passed through the federal Environmental Protection Agency (USEPA) to the State Water Resources Control Board's Clean Water State Revolving Fund. No match was required.

In May 2011, due to a policy change at USEPA, the original ARRA award was reduced. Thanks to the commitment of the Division of Financial Assistance to this project, trash capture device procurement and construction funds were transferred to Coastal Nonpoint Source Program bond funds from Propositions 13 and 50. In April 2013 a further amendment assigned all remaining project funding to Urban Stormwater Program bond funds (Proposition 40).

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[5] http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/303dlist.shtml
[6] http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/Municipal/index.shtml
[7] The Municipal Regional Stormwater Permit requires "full-capture" devices; and the Water Board defines "full capture" as capturing all trash and debris larger than 5mm in a given catchbasin (for small inserts) or catchment (for high-flow capacity devices).

Approach

Key elements of the Demonstration Project were contracting, construction, development of the Bay Area Trash Tracker website, and outreach and education.

Initiation of the project involved a sequence of steps and milestones, many of them driven by contract requirements. Work proceeded on two semi-sequential and overlapping tracks: contracting, and construction.

A. Contracting

Contracting between SFEP/ABAG and the State Water Board's Clean Water State Revolving Fund (Division of Financial Assistance) was necessarily complete before the project could commence. We then needed to contract with full trash capture device suppliers and installers – in order to determine prices – before we could answer municipalities' questions about the cost and value of the program, and begin to contract with them. Each municipality was required to have an executed contract with ABAG in place before construction could begin in its jurisdiction.

1. In early October 2009, SFEP/ABAG contracted with the State Water Board for the $5 million project. Many of the terms of the contract were driven by the "shovel-ready project" requirements of the American Recovery and Reinvestment Act of 2009 (ARRA, the federal stimulus bill).

2. On October 19, 2009, we hosted the first meeting of the project's Trash Advisory Group of municipal representatives affected by the trash capture requirements in the Municipal Regional Stormwater NPDES Permit. This group continued to work with us on issues including the contents of the Requests for Proposals from trash capture device vendors; reference checking for applying vendors; allocation of project funds among municipalities; and the agenda for the Kickoff Meeting and subsequent trainings.

3. In response to an ARRA requirement that construction be under contract within a few months of the contract award, the City of Dublin agreed to install a number of devices in November 2009. Revel Environmental Manufacturing, Inc., a device vendor already under contract to Dublin, was able to meet the construction deadline. (We are grateful to both Dublin and REM for moving quickly and enabling the rest of the Bay Area to benefit from the Demonstration Project.)

4. Beginning in fall 2009, SFEP/ABAG developed and released, sequentially, two Requests for Proposals from vendors of trash capture devices. We held a pre-proposal meeting to answer potential questions from proposers after each release.

   We received 12 proposals from small device vendors, and 5 proposals from large device fabricators/suppliers. Working with Water Board staff and after checking references, we accepted 11 small device proposals to provide "full trash capture" devices and inlet screens to be used in conjunction with full trash capture catchbasin inserts, and all of the large device proposals. The list of accepted vendors, and the devices initially on offer, was approved by the ABAG Board of Directors on March 18, 2010. (By the end of the project, during which time vendors made inevitable modifications to their project lines, 36 devices were on offer to municipalities.)

   Contracting between ABAG and selected vendors was time consuming, both for the vendors and for project staff – apparently due to the complexity of the legal requirements. Twelve vendors were under contract by the end of May 2010. Two selected small device vendors did not

complete the contracting process with ABAG, because they were unwilling to meet all of the contracting requirements of ARRA and the Clean Water State Revolving Fund.

5. While we negotiated contracts with device vendors, we began work on contracts between ABAG and the Bay Area's municipalities. This required extensive correspondence between ABAG's attorney and the attorney for the State Water Board Division of Financial Assistance, as well as input from city attorneys.

6. In order to draft municipal contracts, we had to determine how to allocate the portion of the $5 million total dedicated to construction funds ($4,245,030.00) among participating municipalities. Working with the project Advisory Group, we went through several scenarios and finally arrived at an allocation based on a combination of 1) population, and 2) the municipality's trash capture requirement in the MRP, which was based on number of acres of high-trash-generating zoning.

7. Once we had agreement on the funding allocation, we gave the municipalities until January 1, 2010 to tell us whether or not they would join the project, although contracting would continue after that date. The January 2010 deadline, which all but one municipality met, allowed us to finalize the funding allocation among participating entities, which in turn allowed us to prepare contracts that reflected actual amounts of project funding available to each municipality.

8. In July 2010 we mailed contracts with ABAG to 98 Bay Area towns, cities, and counties. Because members of the Advisory Group had told us in no uncertain terms that they would need many months to execute contracts (a process that includes staff review; review and approval by legal staff; and a city council or county board of supervisors resolution), we gave the cities until January 2011 to contract with ABAG.

This proved to be a highly unrealistic deadline. Municipal contracting was extremely time-intensive both for project staff and ABAG's attorneys. Many city attorneys had questions, and reservations, about the certifications required by the Division of Financial Assistance. In fact, due to such concerns and after much negotiation, the last contracts were not executed until June 2012.

Evaluation and Lessons Learned in the Contracting Process

We learned early in the process of developing, and executing, the municipal contracts that far more staff time would be required for this step than any of us at SFEP/ABAG had anticipated. Part of the problem was due to the fact that the Division of Financial Assistance was very familiar with contracting for construction of large one-off facilities such as wastewater treatment plants, but had relatively little experience contracting for a widely distributed "construction" project designed to install thousands of catch basin-scale, relatively ephemeral pieces of equipment. The standard certifications required by the Division made little sense to the majority of city and county attorneys reviewing their contracts, and it took a great amount of correspondence with both public works staff and attorneys to resolve their concerns.

That said, SFEP/ABAG staff have been gratified by the high level of cooperation and support we, and the project, received from our municipal partners in the Demonstration Project.

Recommendations for future projects:

The Division of Financial Assistance has made substantial revisions to the Policy for Implementing the Clean Water State Revolving Fund, which now better accommodates "expanded use" projects, including projects that control nonpoint source pollution and protect and enhance stormwater quality. We hope

that contracting for such projects in the future will be as well thought-through as recent amendments to the Policy.

Figure 1: Catchbasin retrofit devices

At left, a connector pipe screen installed in a catch basin. Above, a retractable inlet screen directs trash to street sweeping. The unit retracts during a storm event, preventing flooding. Below left, another type of connector pipe screen. Below right, a media filter designed for installation into a drop inlet.

B. Construction

The construction period extended from the City of Dublin's initial device installations in October 2009 until March 2013. Construction was slow to start due to contracting issues. SFEP, vendor, and city staff all collaborated in our efforts to meet the construction deadline and spend all of the construction budget on device procurement and installation.

Many aspects of the construction process needed to occur sequentially, in order to ensure municipal control over the process.

Project forms. Both vendor and municipal contracts needed to clearly explain the mechanisms for ordering and accepting trash capture devices to be purchased by the Demonstration Project. The project team, working with ABAG's attorney and financial staff, began developing these forms as soon as the contract between the State Water Board and ABAG was signed.

1. We developed a system of Purchase Order forms, pre-populated with vendor- and device-specific information, to be filled out online and submitted electronically to SFEP. Electronic submittal facilitated automated mapping of device types and locations. Because these forms were, essentially, binding contracts between the ordering municipality and the device vendor, both entities' signatures, in addition to the SFEP project manager's, were also required in hard copy for an order to be complete. (See Appendix III for an example purchase order package.)

2. Following construction, ABAG needed a way to pass ownership and responsibility for each installed device to the municipality where it was installed. This was accomplished with a Notice of Acceptance form, also co-signed by the municipality, the vendor, and SFEP. (See Appendix IV for an example Notice of Acceptance.)

The project provided a total of 4,003 devices to 62 municipalities, including 42 high-flow capacity devices.

Figure 2: High-flow capacity device types

Left, a gross solids removal device; below large trash nets collecting trash and vegetation after a storm
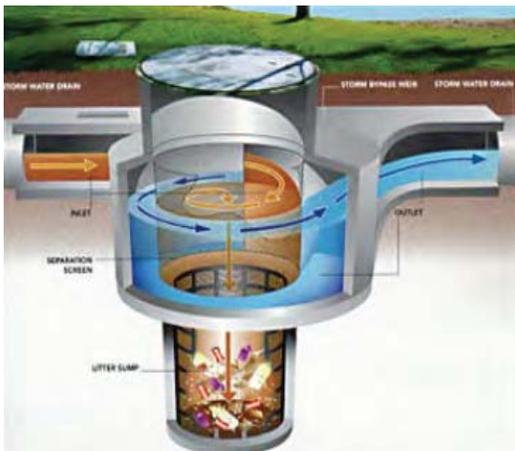
Above left, a diagram of a hydrodynamic separator. Right, installation of a unit in San José

Figures 3 and 4 illustrate the relatively long period of time required to order and complete construction of large capacity, high-flow devices such as hydrodynamic separators, as compared with catch basin retrofits. In most cases project funding covered only provision of these large devices, which meant that municipalities needed to bid out, contract, and pay for construction/installation on their own. In one case where the municipality could not undertake the bid process and still be sure of meeting the construction deadline, the city opted to spend its allocation on catch basin inserts instead of a large device. (See Lessons Learned, below.)

On these charts, ticks on the blue lines indicate purchase order submittal dates; the signature dates for associated Notices of Acceptance are in red on the vertical axis. The original construction deadline (for signed NOAs) was on November 1, 2012; this was extended to March 1, 2013. In both cases SFEP accepted NOAs after the deadline, as long as they were signed and dated by the deadline.

Figure 3: Order and installation completion dates for small devices
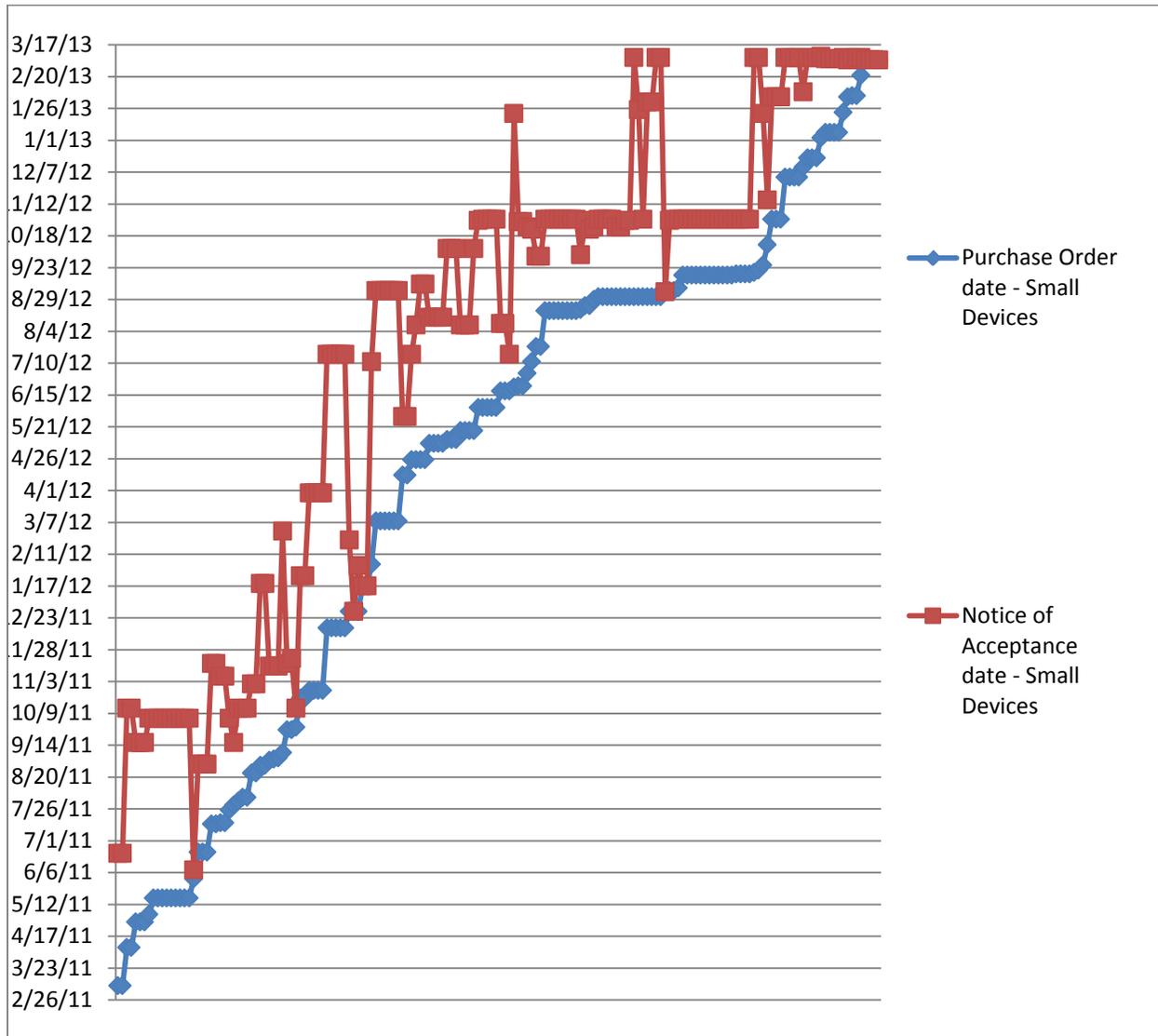
Figure 4: Order and installation completion dates for high flow capacity devices

Chart legend:
- Purchase Order date - Large Devices
- Notice of Acceptance date - Large Devices
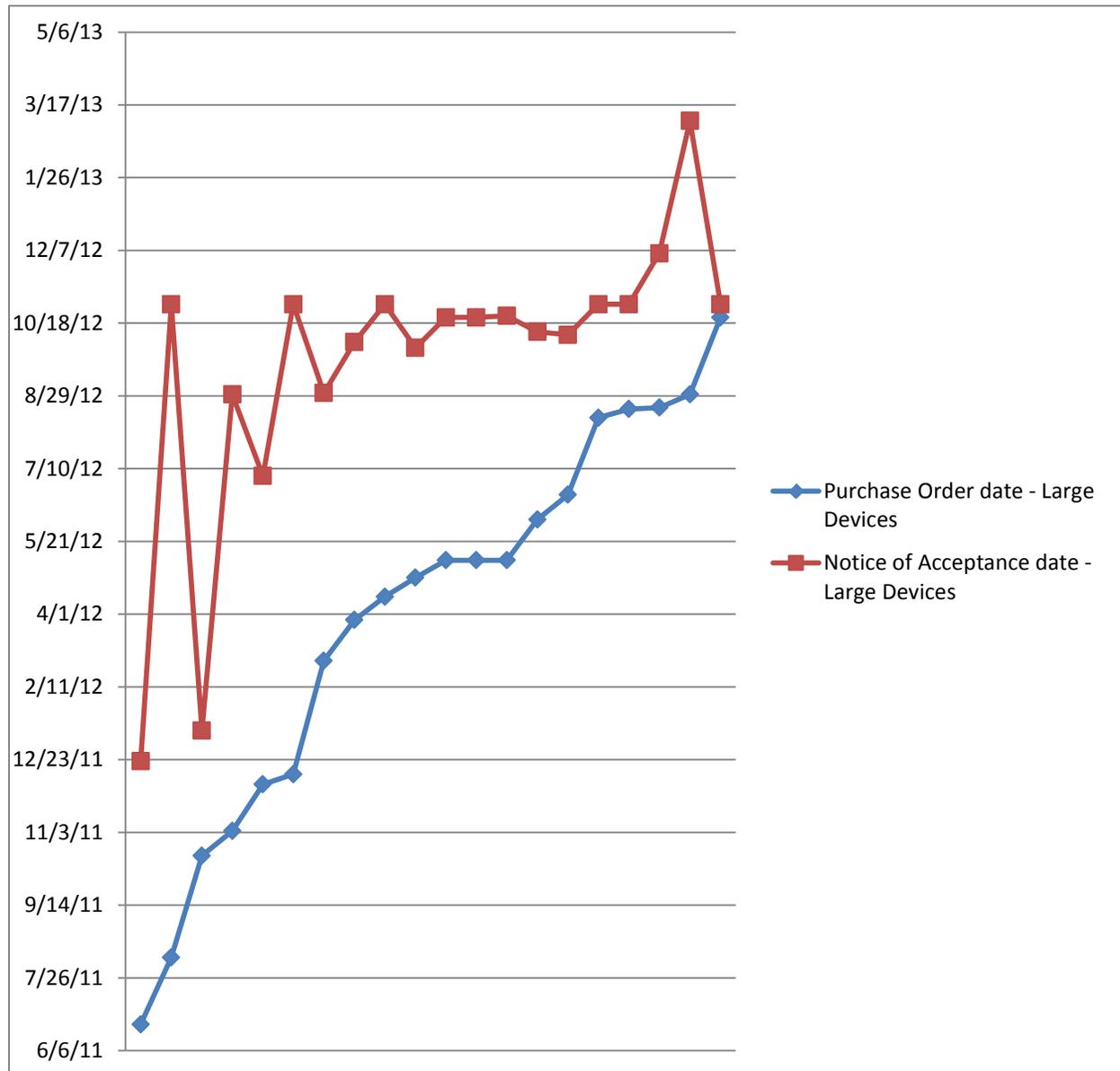
Evaluation and lessons learned during the construction process

This project has had a lot of moving parts. To keep it moving smoothly and meet all deadlines, everything had to work in sync. SFEP staff's problem-solving abilities were honed in a number of situations:

- *According to our agreement with the Division of Financial Assistance, the State would only pay "after construction is complete." In May 2011 we met with vendors of high-flow capacity devices, and representatives of municipalities intending to install large devices, to resolve payment timing issues in cases where final completion of site construction could likely extend considerably past delivery and installation of a costly device. We worked out a compromise, where the municipality could test the device and issue a Notice of Acceptance before final paving/striping was finished. In some cases this resulted in a municipality issuing multiple*

Notices of Acceptance for a single installation site, or paying installation contractors in installments.

- *In September 2011, a Davis Bacon prevailing wage submittal from one of our small-device suppliers indicated that the company may not have been paying its employees appropriately. Subsequent investigation revealed that the entity with which ABAG had contracted was in fact a middle-man operation, where the sole proprietor worked alongside subcontractors who fabricated and installed devices. Our contractor paid his subcontractor based on a very simple invoice, and prepared Davis Bacon paperwork after the fact.*

  The Davis Bacon unit at the Division of Financial Assistance investigated, and called in the U.S. Environmental Protection Agency's Inspector General, who ultimately resolved the objection after the supplier corrected his paperwork and provided proof of appropriate payment.

- *In August 2012, just two and a half months before the November 1, 2012 construction deadline in our original ARRA contract, the small-devices vendor that had a majority of orders (due to providing high quality products at relatively low prices, and representation by a very personable project manager), surprised us all when the company withdrew from the project mid-construction. What we did not know when we originally contracted with this supplier was that they were in arrears to the Franchise Tax Board due to non-payment of sales tax. A notice of garnishment sent by the state Board of Equalization to ABAG, and our required response, led to West Coast Storm, Inc., eventually closing its doors, at least temporarily, in California.*

  Project staff, ABAG legal staff, and partner cities relying on West Coast Storm to install ordered devices before the construction deadline, entered a period of intense scrambling to 1) negotiate a State Board-ABAG contract amendment extending the construction deadline, 2) amend contracts with other suppliers who could provide more than 1,500 devices on a new deadline, and 3) arrange for the cities to withdraw from their contracts (executed purchase orders totaling $730,850) with West Coast Storm.

  We are grateful to the Division for extending the construction deadline to March 2013. All of this additional time was necessary to get substitute devices ordered, installed, and accepted.

- *Throughout the project, the small businesses we contracted with to provide devices were consistently challenged by the delay in payment: from installing the device(s), to executing and countersigning the Notices of Acceptance, to submittal to SFEP and ABAG, to inclusion in ABAG's monthly financial reports, and finally to invoicing the Division – after which the State could take up to a month or more to pay ABAG. While we explained this sequence to our suppliers and correctly estimated the time from billing to payment, none of the small device vendors seemed to have the cash reserves to be comfortable with the inevitable payment delay.*

Lessons learned

- *While we did check references on all of the suppliers in the program, generally good relations with past customers and a quality product line may not be not sufficient criteria for inclusion of a small business in a project that will extend over three or more years. In future I would ask to see evidence of good business practices, and perhaps cash reserves.*
- *In future we would also insist that each supplier attend Davis Bacon training as a contract requirement.*
- *And, we would build more project administration time, for unforeseen contingencies, into the project budget.*

- *Siting, ordering, and construction of large, high-flow capacity devices is extremely labor-intensive and time consuming for municipalities, especially in the context of the Demonstration Project, which provided devices, but did not directly fund installation in most cases. This meant that most municipalities that used their project allocation for large devices had to 1) contract with ABAG, 2) choose a device vendor, 3) solicit bids for device installation, 4) select and contract with an installer firm, and 5) schedule device delivery to coincide with construction, 6) complete construction, and 7) submit the Notice of Acceptance to SFEP – all before the project construction deadline. For many municipalities, especially those where attorneys wanted to negotiate over required (and non-negotiable) ARRA contract certifications, this was extremely challenging. We note, however, that our partners felt it was worth the trouble. Two entities that would have preferred to install a single large device ended up using their allocations for small devices; only one municipality pulled out because they could not get it done before the deadline.*
- *Our Notice of Acceptance process worked as it needed to. The requirement for wet signatures on device documentation ensured communication and cooperation between vendors and municipalities, and bound the vendors to their warranty agreements.*
- *As project expenditures and the construction deadline converged, we were able to allocate a few thousand "leftover" dollars among municipalities, in some cases supporting, or partially supporting, construction of large devices.*

C. Bay Area Trash Tracker website

Since the key objective of the Demonstration Project was to enable municipal staff to evaluate and compare the performance of different types of full trash capture devices in different land use locations, SFEP intended from the beginning to develop a map-based website that would, at a minimum

- Make information about the Demonstration Project and trash capture in general available to Bay Area municipalities
- Show locations of installed devices on a map
- Record land use and device installation site characteristics
- Allow municipal users to upload and download maintenance records and other information related to device functionality, for future planning purposes
- Be password-protected (essential for the cooperation of partner municipalities)

In addition, we needed the site to be integrated with ABAG's device ordering and payment records; and for project staff to be able to upload and update device installation information fed into the website.

During the grant application process, SFEP staff discussed the project with the IT lead at the San Francisco Estuary Institute, which has worked with the California Monitoring Council on My Water Quality Portals and developed a variety of map-based planning tools such as Wetland Tracker and EcoAtlas. SFEI agreed to join the Demonstration Project as the web architect, and to provide a budget for the grant proposal and contract.

We released a Request for Proposals to graphic designers to develop the site design. Lauren Wohl Design was the successful proposer.

Development of the Bay Area Trash Tracker website started as soon as work on the overall project began. We realized from the beginning that we were inventing something new; and that the website would need to "talk" to both the device location information (database) on SFEI's web server and to ABAG's financial management project database.

We sought guidance and agreement from stakeholders to determine specific types of information the website would record. The Technical Advisory Group and the Bay Area Stormwater Management Agencies Association (BASMAA) Trash Committee (which includes San Francisco Bay Water Board staff) helped to develop, and signed off on the fields and forms associated with the website.

Key questions in the site development process included:

1. Would the project ask municipalities to record amounts of trash recovered from devices?
2. Would the project ask municipalities to characterize trash recovered from devices?

From the beginning, SFEP's aim was to make participation in the program and use of the Trash Tracker net helpful to the Bay Area's stormwater programs – which meant that, aside from complying with project requirements related to taking legal responsibility for devices, the project would not add to municipalities' permit compliance reporting workload. In fact, it was our hope that use of the Trash Tracker would make MRP compliance reporting easier. For these reasons we determined to follow the regulators' lead in requiring trash capture data.

For a number of reasons, we decided to make the site password-protected, and to grant access to all Bay Area municipalities (participating in the project or not), BASMAA, SFEP, and the Division of Financial Assistance. One reason was that the site included design specifications and proprietary information about trash capture devices that vendors did not wish to share with competitors. Another was that in early days of the stormwater permit and concerted local efforts to reduce trash, while compliance requirements were still being negotiated with the regulators, permitted entities requested that the site not be public.

Unfortunately for our project, negotiations between BASMAA and the municipalities did not resolve the question of acceptable reporting parameters until May 2013, two months after device construction was complete and several months into the driest year in California since the Gold Rush. The agreement that was reached was that MRP permittees would report on device maintenance frequency and not volume, weight, or characterization of trash. The Trash Tracker reflects this, as these parameters are in the "optional" section of the maintenance reporting form.

For most of the duration of the Demonstration Project, the Trash Tracker did not work smoothly for participating municipalities, and SFEP staff refrained from urging our partners to use it. As we learned, the need to include device-location-specific payment status information from an ABAG database, while also incorporating device-location-specific land use and maintenance information uploaded from municipal data by SFEP staff, added a challenging level of back-end complexity to the site. With the end of the construction period and the completion of vendor invoicing in spring 2013, the ABAG database was disconnected and the Tracker is at this writing wholly on the SFEI server. The site is now functional, and includes the following tools and resources:

- The map shows locations of installed devices, including – if added by municipal staff – devices not purchased through the Demonstration Project, and devices installed by municipalities that did not participate in the project
    o Icons on the map link to key information about that installation
    o Users can opt to see all devices of the same type on the map
- Each entity's "My Municipality" page lists all of the municipality's devices
- Municipal staff can upload location-specific information
- Municipal staff can upload maintenance data
- All uploaded data can be downloaded by municipal staff

- The site posts fact sheets about key device types and specifications of all devices included in the project
- The resources page posts information about trash capture from many sources
- The site includes a link to a discussion board for municipal information exchange

See Figures 5 and 6, screen shots of the Trash Tracker. Appendix II includes forms municipalities can use to record data for later uploading to the site.

Figure 5: Bay Area Trash Tracker map
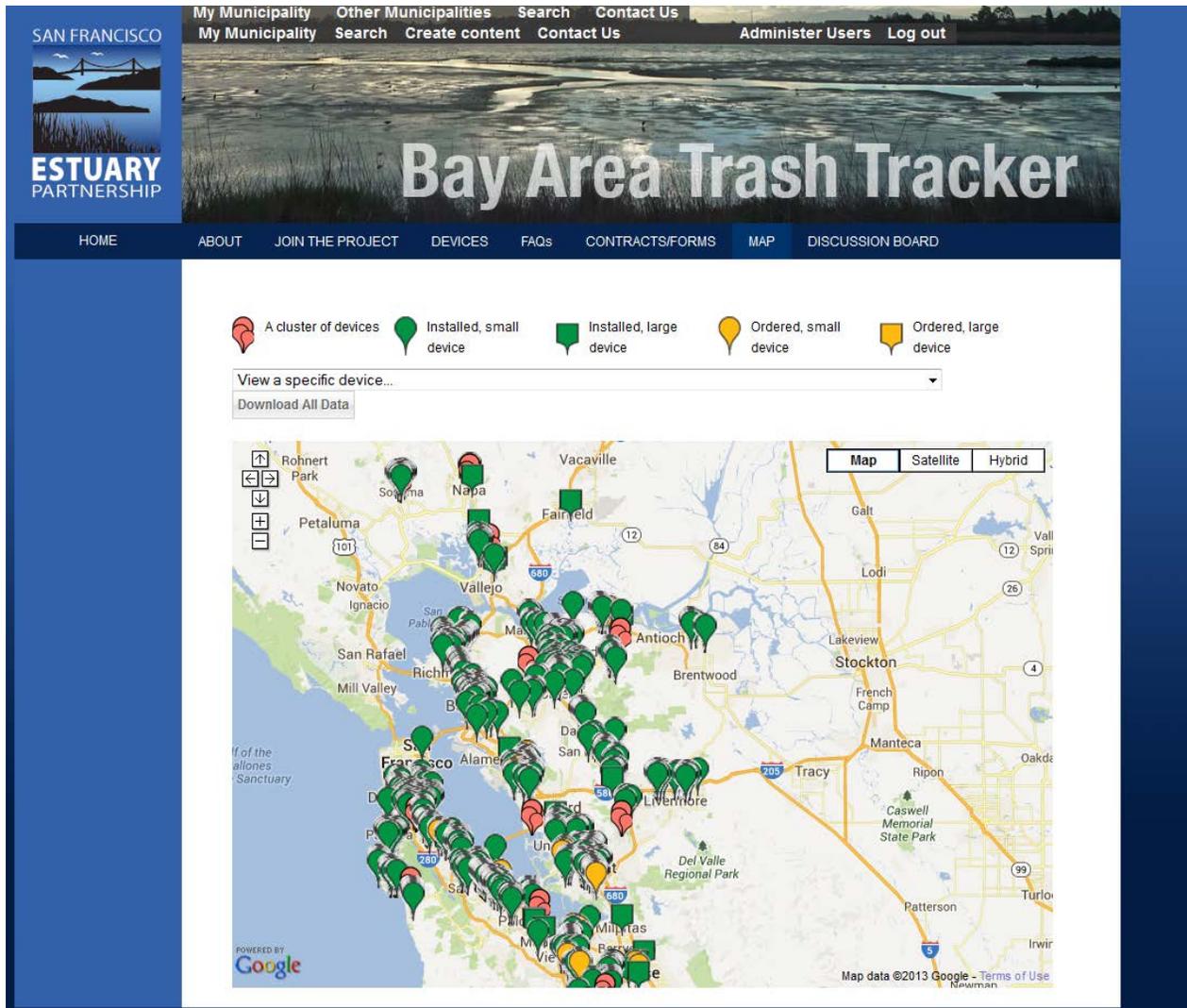
Evaluation, lessons learned, and next steps for the Bay Area Trash Tracker

It has been a long road getting the Trash Tracker up and running, but Demonstration Project staff are convinced that the Tracker will be the most important and lasting legacy of our ARRA-funded project.

Initial funding for the Tracker was based on a professionally prepared budget that underestimated both the time required and the technical complexity of the site we intended to develop. As available funds for

the tracker remained extremely tight over the course of the project, and since the site maintenance budget was exhausted early in the development of basic site functionality, the site was buggy for much of the project term. Hence SFEP staff were reluctant to urge our municipal partners to use the site.

By the end of the project the Tracker was brought to a stage where the basic functionality described above is operational. We are gratified that nearly half of the municipalities in the project are using the site to track the performance of their devices.

Figure 6: Trash Tracker: device installation locations in downtown Walnut Creek
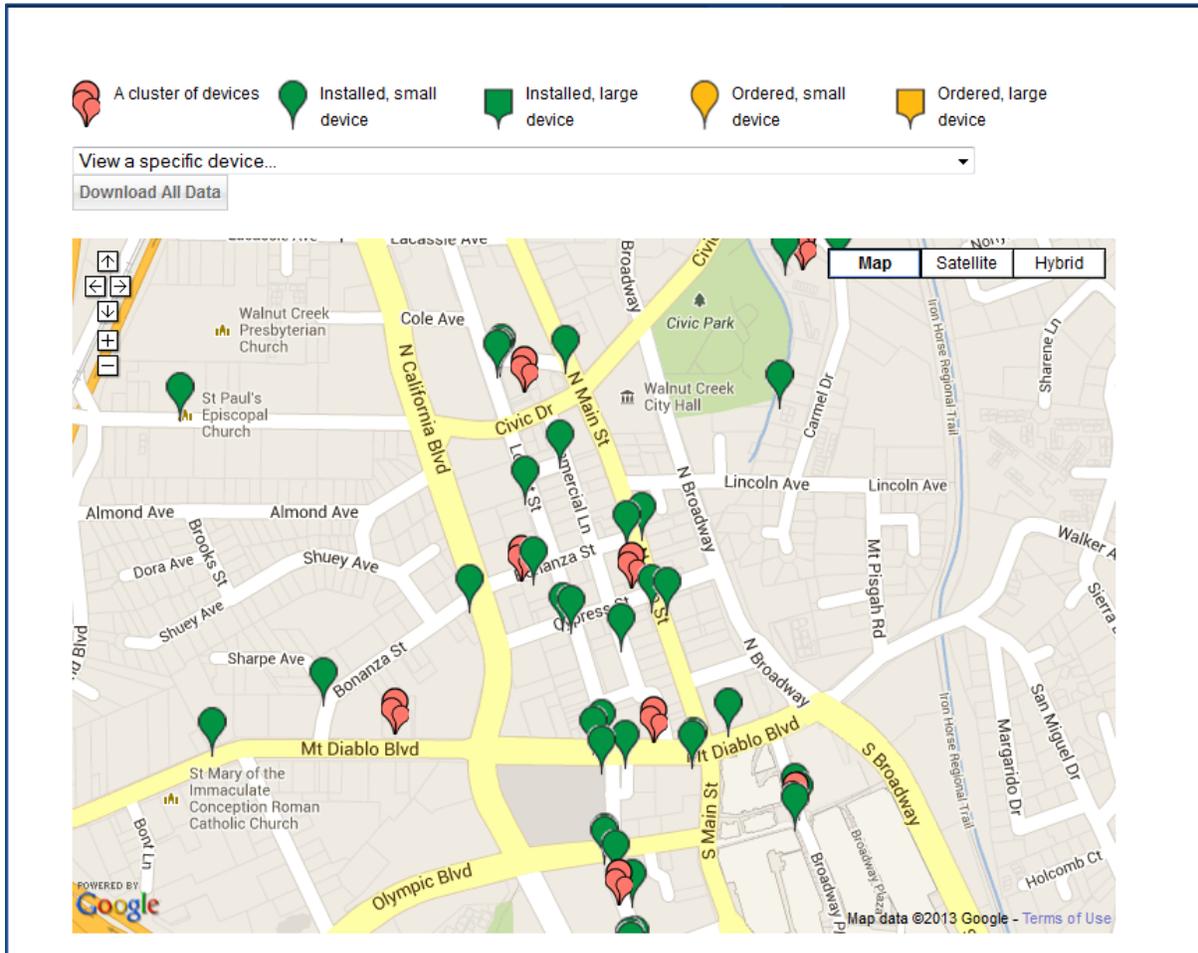
Lessons learned

SFEP probably erred in writing our frequent partner agency, SFEI, into the contract. If we had released a Request for Proposals for development of the site, SFEI could have applied -- and likely won the contract due to their experience with My Water Quality portals and Wetland Tracker -- but we would have been better able to evaluate their cost estimate.

We now understand that designing a website to coordinate data in two separate databases (ABAG's and SFEI's) led to many problems.

Exhausting the maintenance budget early caused problems throughout the project term. This meant that when the site "broke," as it frequently did due to its complexity and the way it was designed, SFEI needed to find the least-cost workaround to "fix" it – and the least-cost solution was not always robust. Further, we needed ongoing maintenance funds to keep the site up to date with current versions of Drupal (the open-source content management system the Tracker is based on) and Google Maps. Since we were unable to perform such essential software upgrades, the stability of the site was precarious during much of the project term.

In future similar projects we would add some contingency funding to subcontracts for projects that are as inherently creative as development of the Bay Area Trash Tracker.

Next steps for the Trash Tracker

SFEP has, from the beginning, intended to turn the Tracker over to BASMAA at the end of the Demonstration Project. It is our hope that the BASMAA co-permittees and the Phase II municipalities (which must soon comply with trash reduction requirements in the statewide NPDES permit for small municipal separate storm sewer systems) will continue to use the Tracker to record and evaluate their trash reduction efforts.

BASMAA, in partnership with SFEP/ABAG, has been awarded funding under the Proposition 84 Stormwater Grant Program for a suite of projects, "Tracking California's Trash." Work on this project is expected to be completed by fall 2016. Key elements of the Trash Tracker portion of the project include:

- *Working with a technical advisory workgroup to prioritize improvements and ensure the utility of the Tracker to municipalities*
- *Expanding the Tracker to include Los Angeles' trash capture efforts (since Los Angeles has a Trash Total Maximum Daily Load)*
- *Adding a trash hotspots layer to the Tracker, which will record dates, times, and results of municipal and volunteer trash cleanup events*
- *Developing a My Water Quality portal according to the guidelines of the California Water Quality Monitoring Council, which will provide a public interface to the Tracker for the first time*

In the course of the Prop 84 project, the Trash Tracker will be stabilized and the back-end software will be updated.

D. Outreach and Education

As the Demonstration Project was designed to inform and assist municipal staff in meeting permit requirements for trash capture, the audience for our outreach efforts has been our partner cities, towns, and counties.

As noted above, the Bay Area Trash Tracker, the password-protected website for use by Bay Area municipalities both in and out of the project, went live in April 2010 for the purpose of posting trash-related

Project Kickoff meeting, May 10, 2010

resources, fact sheets and specifications of approved trash capture devices, and (later) executed vendor contracts. Within a few months of its launch, the Tracker site included a map of ordered and installed devices, and location and maintenance information uploaded by municipal staff. (See figs. 5 and 6.)

Throughout the project SFEP has worked to keep municipalities informed about trash capture in general as well as about the details of the Demonstration Project, including use of our forms and website, and key deadlines. Much of our communication with municipalities has been by email, but we have also hosted a number of trainings and webinars for staff, including:

- Project kickoff meeting and vendor fair, May 2010
- WebEx training on use of purchase order forms, March 2011
- WebEx Trash Tracker demonstration, June 2011
- Training/Q+A on large device siting and installation, September 2011
- Presentation on the use of the website to record device location information, and generation of compliance reports, to stormwater municipal staff from Alameda County cities. Event included a vendor fair, September 2011
- WebEx training on use of maintenance tables, July 2013

Other presentations

- Presentation on the Demonstration Project to U.S. EPA Region 9 watersheds and TMDL staff, May 2010
- Project update in the Executive Officer's report to the SF Bay Water Board, June 2010
- Project updates in the Director's report to the SFEP Implementation Committee, May 2011 and March 2013
- Participation in a seminar on large device construction and maintenance in San Ramon, July 2011

Vendor fair at kickoff, May 2010

- Presentation on device tracking to San Francisco Bay Water Board Watershed Division, July 2011
- Presentations at the SFEP Implementation Committee, May 2009 (while planning application) and August 2011
- Presentation at the State of the Estuary conference trash session, September 2011
- Conference call discussion of municipal options after West Coast Storm, Inc. left the project, September 2012.
- Presentation to the Friends of Five Creeks, October 2012
- Presentation and moderation of concurrent session on trash reduction, State of the Estuary conference, October 2013
- Presentation at San Francisco Bay Water Board trash workshop, November 2013

Additional outreach and materials

- Discussion Board (linked from the Trash Tracker site), intended to facilitate communication among municipal staff

- Fact sheets for all offered devices, posted on Trash Tracker website and included in Appendix I
- Sample press releases about the program, provided to all partner municipalities for distribution to local news outlets
- Project signage provided to and posted by all participating jurisdictions (contract requirement)
- Project page on SFEP website (http://www.sfestuary.org/our-projects/water-quality-improvement/trashcapture/), posted in December 2009 and regularly updated

Evaluation and Lessons Learned

Feedback we have received from our municipal partners, related to our efforts to keep them informed, updated, and trained in the use of the purchasing process and website, has been uniformly positive. SFEP/ABAG staff's commitment to providing excellent "customer service" to our partners has served the Demonstration Project well. Throughout the project we have worked extensively with individual municipalities and their staff to explain the program and help them fill out forms, access the website, etc. etc. In a sense, the more organized, mass trainings and WebEx presentations have been secondary in importance to one-on-one work with municipal staff.

Some external stakeholders have asked that the Trash Tracker, and the data uploaded by municipalities, be made public. Our response has been that 1) at the request of partner agencies, we have committed to keeping their information confidential, and 2) in the absence of complete information related to a city or county's devices and trash capture activities, partial information is bound to give an outside viewer an inaccurate view of what government is accomplishing. Similarly, because all municipalities are not using the Trash Tracker uniformly, it is not possible to generalize or extrapolate from data on the site to valid conclusions about trash reduction area-wide.

Results of the Demonstration Project

As noted above, the purpose of the Demonstration Project was to provide Bay Area cities, towns, and counties with useful information about the functionality of types of trash capture devices, and device models, in specific land use situations. While we intended to use the Trash Tracker to collect this data, the Tracker was only fully functional in the final months of the project. Consequently we developed and sent to our partners two Excel spreadsheets ("reporting tables") for data specific to 1) device locations and 2) device models, and asked municipalities to use them in lieu of or in conjunction with entering location and maintenance data into the Tracker.

In this section we summarize results of the Demonstration Project in four categories:

A. Device type performance by land use
B. Functionality of specific device models
C. Amounts of trash recovered from certain high-flow capacity devices
D. General comments about the Demonstration Project

A. Device type performance by land use

25 municipalities used the reporting tables to tell us:
1. Which device types were installed in high-trash generating areas
2. Land use type in the surrounding area
3. If the device type was appropriate for the land use
4. Maintenance burden associated with types of devices

This information is summarized in Tables 1 and 2.

In general, research has shown that commercial/industrial/ areas generate the most trash.[8] The municipal regional stormwater permit encourages municipalities to install full trash capture devices in high-trash generation areas, and over the course of the project term permittees have delineated those areas.

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[8] City of Los Angeles Department of Public Works, "High Trash-Generation Areas and Control Measures," January 2002.

Table 1: Device type performance by land use (From Trash Tracker. NR = not recorded)

Device type	Land use	Condition at maintenance	Maintenance time (range)	Equipment used for maintenance	Staff to maintain (range)	Comments
Small Devices						
Connector pipe screens	Commercial/271 devices	Intact – 269 devices Damaged - 2 (removable screen was bent)	15 min-1 hour	Vactor truck, manual tools, utility truck, "Green Machine", Vac-Con	1-3 persons	
	Residential/155 devices	Intact – 155 devices	15- 20 min	Vactor truck, manual tools, utility truck, "Green Machine"	1-3	
	Industrial/29 devices	Intact – 29 devices	NR	NR	1	
	School/15 devices	Intact – 14 Damaged - 1 (removable screen was bent)	15- 20 min	Vactor truck	1-3	
	Park/14 devices	Intact - 14	15 min	Vactor truck	1-3	
	Surrounding land use not indicated for 395 devices where other info was recorded	Intact– 392 devices Missing bolt -1 device Front grill support damaged – 1 device Grate malfunction -1 device	15 min	Vactor truck, manual tools	1-5	City is looking at other options that are easier and quicker to remove for cleaning, when necessary.
Drop inlet filter inserts	Commercial – 10 devices	Intact – 10 devices	6 min	Vactor truck, manual tools	2	
	School - 8	Intact - 8	6 min	Vactor truck, manual tools	2	
Curb inlet screens – manual retractable	Commercial – 17 devices	Intact - 17 devices	NR	manual tools	2	
Curb inlet screens –	Commercial - 14 devices	Intact - 14 devices	15 min	manual tools, utility truck	2-3	

Device type	Land use	Condition at maintenance	Maintenance time (range)	Equipment used for maintenance	Staff to maintain (range)	Comments
automatic retractable	Park - 7 devices	Intact - 7 devices	NR	manual tools, utility truck	2	
	Land use NR – 68 devices	Intact – 68 devices	15 min	Vactor truck, manual tools	1-4	
Large Devices						
Hydrodynamic separators	Commercial - 9 devices	Intact – 7 devices NR -2 devices	45min-4 hours	Vactor truck	2-5	
	Residential – 3 devices	Intact – 3 devices	1 hour	Vactor truck	2-3	
	Industrial - 4	Intact – 4 devices	NR	Vactor truck	2	
	School – 1 device	Intact – 1 device	6 min	Vactor truck	2	
	Park – 1 device	Intact – 1 device	5 hours	Vactor truck	6	
Gross solids retention devices	Commercial – 1 device	Intact – 1 device	30 min	Vactor truck, manual tools	2	
	Residential – 1 device	Intact – 1 device	30 min	Vactor truck, manual tools	2	
	School – 1 device	Intact – 1 device	30 min	Vactor truck, manual tools	2	
End-of-pipe netting	Not indicated - 16 devices	Intact – 9 devices "Two of the four nets were torn" – 4 devices, "Nets are ripping" – 1 device Fixed hole – 1 device 2" hole repaired – 1 device Nets ripped – 1 device	30 min- 1 hour	NR	3-5	

It is important to note, however, that studies completed for the Bay Area Stormwater Management Agencies Association (BASMAA) show that while land use is important to predicting trash generation rates, not all similarly categorized land uses are created equal. Figure 7, a map of NPDES Phase I entities regulated under the Municipal Regional Stormwater Permit, shows trash generation rates in the Bay Area. Table 2 shows the very wide range of trash generation rates in both residential and retail areas. The conclusion drawn by BASMAA is that trash generation is influenced more by household income than by zoning type.9

Figure 7: Trash generation rates in municipal regional stormwater permitted jurisdictions (NPDES Phase I)

Source: Presentation at the 2013 State of the Estuary Conference by Chris Sommers, EOA Inc.

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9 C. Sommers, presentation at the 2013 State of the Estuary Conference

Table 2: Trash generation rates, by land use, in selected San Francisco Bay Area locations

SF Bay Area Trash Generation Rates (gallons/acre/yr)			
Land Use	Low	Best	High
Commercial & Services	0.7	**6.2**	17.3
Industrial	2.8	**8.4**	17.8
Residential	0.3 - 30.2	**0.5 - 87.1**	1.0 - 257.0
Retail	0.7 - 109.7	**1.8 – 150.0**	4.6 - 389.1
K-12 Schools	3.0	**6.2**	11.5
Urban Parks	0.5	**5.0**	11.4

Source: Presentation at the 2013 State of the Estuary Conference by Chris Sommers, EOA Inc.
The center "best" column compensates for outliers and provides the best estimate.

B. Functionality of specific device models

Each participating municipality selected device types, and devices, based on local conditions including available budget resources. In some locations existing infrastructure precludes installation of large devices. In other cases, a city or county's project allocation was not enough to support engineering and installation of a large device.

We asked municipalities to use the maintenance tables to report on the functionality and maintenance burden associated with specific device models, correlated with the trash generation characteristics of nearby land uses. Table 3 summarizes submitted information; Table 4 includes specific responses.

Table 3 indicates that most municipalities selected devices, and sited device installation locations, appropriately. For more information about cities' and counties' experience with these devices, see Table 5.

Table 3: Device model appropriateness by land use (From device performance tables, NR=no response)

Device Type	Device Model Name	Land Use Type (for each unique land use indicated)	Number of times "Device Appropriate for Land Use" responses/total responses	Number of "High Trash Generation Area" responses/total responses
Filter Inserts	REM Triton Bioflex drop inlet trash guard	Commercial	391/391	369/391
		Industrial	18/18	18/18
		Residential	352/352	351/352
		Retail	390/390	389/390
		K-12 School	20/20	20/20
		Urban Park	6/6	4/6
		Urban Open Space	31/31	31/31
Connector Pipe Screens	Advanced Solutions – Stormtek Connector Pipe Screen	Commercial	24/24	24/24
		Retail	24/24	24/24
	United Stormwater- Connector Pipe Screen	Commercial	195/198	134/198
		Industrial	17/17	16/17
		Residential	208/227	69/227
		Retail	135/135	131/135
		K-12 School	77/77	9/77
		Urban Park	11/11	7/11
		Urban Open Space	25/26	21/26
	West Coast Storm – Connector Pipe Screen	Commercial	104/104	101/104
		Industrial	13/21	13/21
		Residential	65/65	39/65
		Retail	19/19	19/19
Automatic Retractable Screens	G2 Construction - CamLock Debris Gate	Commercial	28/28	28/28
		Industrial	22/22	22/22
		Residential	72/72	72/72
		Retail	51/51	51/51
		K-12 School	5/5	5/5
		Urban Park	3/3	3/3
		Urban Open Space	42/42	42/42
	West Coast Storm – Auto Retractable Screen	Commercial	36/36	34/36
		Industrial	No answer/8	0/8
		Residential	32/32	19/32
		Retail	15/15	15/15

Device Type	Device Model Name	Land Use Type (for each unique land use indicated)	Number of times "Device Appropriate for Land Use" responses/total responses	Number of "High Trash Generation Area" responses/total responses
Manual Retractable Curb Inlet Screens	United Stormwater- Manual Retractable Screen	Commercial	105/105	105/105
		Industrial	1/1	1/1
		Residential	60/60	20/60
		Retail	126/126	126/126
		K-12 School	40/40	1/40
		Urban Open Space	3/3	3/3
Large Trash Nets	Kristar – Nettech Gross Pollutant Trap	Commercial	7/7	4/7
		Residential	10/10	4/10
		Retail	8/8	4/8
		K-12 School	1/1	0/1
		Urban Park	4/4	0/4
		Urban Open Space	6/6	0/6
Hydrodynamic Separators	Contech Continuous Deflective Separator	Commercial	3/3	3/3
		Residential	2/2	2/2
	Kristar FloGard Dual Vortex HDS	Commercial	2/2	0/2
		Industrial	2/2	2/2
		K-12 School	1/1	0/1
Gross solids retention devices	Roscoe Moss- Stormflo Screen	Commercial	3/3	2/3
		Industrial	1/1	0/1
		Residential	3/3	2/3
		Retail	1/1	0/1
		K-12 School	1/1	1/1
		Expressway	1/1	0/1

Note that most high-flow devices (trash nets, hydrodynamic separators, and gross solids retention devices) drain very large areas. Large device catchments frequently encompass several land use types.

Table 4: Device model functionality and maintenance burden – individual responses (From device performance tables)

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Small devices								
Connector pipe screen	Advanced Solutions AS-2	Because these devices were only installed in March, maintenance will be done as part of annual Department drainage inlet maintenance conducted Sept-Oct before the rainy season.	3-4 people are anticipated.	TBD	Use of a Vac Truck, shovels is anticipated.	No. Unfunded cost for equipment and maintenance in the future is a real concern for the County.	Good	Yes
Connector pipe screen	United Stormwater - connector pipe screen	1/4 to ½ full	2	20 minutes	Vac truck	Yes, for the current number of devices	Good	yes
Connector pipe screen	United Stormwater - connector pipe screen	5%	3	15-30 minutes	Shovels & Buckets	Yes	Good	Yes
Connector pipe screen	United Stormwater - connector pipe screen	County has not yet maintained its connector pipe screens, which will commence in Sept. 2013.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Connector pipe screen	United Stormwater - Connector Pipe Screen	All devices were new in Oct. 2012. Checked during 1st rainstorm; not full, but were cleaned as needed to ensure effective operation	2	30-45 minutes each depending on amount of debris	Cleaned with manual equipment	No, it's difficult to remove devices for cleaning. Less maint. Required for the inlets w/curb screens (49 out of 52). City will start cleaning w/ vacuum truck in FY 13-14.	Good; no vandalism and no damage, but devices are relatively new.	Not exactly - City is looking at other options that are easier and quicker to remove for cleaning, when necessary.
Connector pipe screen	United Stormwater - connector pipe screen	75%	2	15-25 minutes	shovel, rake, trowel	Maintenance is under staffed and underfunded; maintaining the trash capture units stretches an already over committed staff even further	Good	Yes
Connector pipe screen	United Stormwater - connector pipe screen	half full	2	20 minutes	vactor jetter truck	yes	good	yes

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Connector pipe screen	United Stormwater - connector pipe screen	20%	2	10-15 minutes	Shovel, Rake, &/or Vac truck	Yes, but only because we have only a small number. If we had a larger number of devices, the maintenance and time required would become a problem.	GOOD	YES
Connector pipe screen	United Stormwater - connector pipe screen	Varies with location. For MidCoast, units were generally 1/3 full, mostly leaf litter and debris.	4	15 minutes	Vac-Con	Yes	Good	Yes
Connector pipe screen	United Stormwater - connector pipe screen	1/4	2	35 minutes	Vactron, 2 pickups, and an arrow board	No but we will make it work.	Good	Yes
Connector pipe screen	West Coast Storm - connector pipe screen	half full	2	20 minutes	vactor jetter truck	yes	good	yes

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Connector pipe screen	West Coast Storm - connector pipe screen	Varies with location. For Broadmoor & Daly City, units were general 1/4 full. For North Fair Oaks, units were generally less than 1/4 full.	2 to 3 staff	15 minutes	Vac-Con	Yes	Good	Yes
Connector pipe screen	West Coast Storm - connector pipe screen	1/4 to 1/2	2	20 minutes	Vac truck	Yes, for the current number of devices	Good	yes
Curb inlet screen -- auto retractable	G2 Construction - CamLock Debris Gate	County has not yet maintained its automatic retractable screens, which will commence in Sept., 2013.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.
Curb inlet screen -- auto retractable	West Coast Storm - auto retractable screen	N/A	Sweeper truck (1 staff person); Hand sweeping as needed during rainy season in Broadmoor - 2 staff	10 minutes for hand sweeping	Sweeper truck and broom	Yes	Good. Curb inlet screens were effective in reducing maintenance of CPS units.	Yes

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Curb inlet screen -- auto retractable	West Coast Storm - auto retractable screen	N/A, inlet screen	N/A	N/A	N/A	Yes	good	yes
Curb inlet screen -- manual retractable	United Stormwater - manual retractable curb inlet screen	Screens keep trash in street for the sweeper. Not full or clogged at first cleaning	In general 1 street sweeper driver	less than 3 minutes	high efficiency PM10 vacuum sweeper (picks up particles of 10 micrometer or less)	Yes	Good: all devices installed in Oct. 2012; 1st maintained in Nov-Dec	Yes, but as products improve, will use newer improved models
Curb inlet screen -- manual retractable	United Stormwater - manual retractable curb inlet screen	N/A (device deflects trash, does not house it)	2	5-10 minutes	Rake & Shovel	Yes, but only because we have only a small number. If we had a larger number of devices, the maintenance and time required would become a problem.	GOOD	YES
Curb inlet screen -- manual retractable	United Stormwater - manual retractable curb inlet screen	N/A, inlet screen	N/A	N/A	N/A	Yes	Good	yes

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Curb inlet screen -- manual retractable	United Stormwater - manual retractable curb inlet screen	In conjunction with device installation, the County began a bi-monthly sweeping program for this area. During initial run of sweepers, curb screens were semi-full of leaves and garbage. In follow up sweepings, curb screens were much cleaner.	None. Street sweeping done by contract.		Street sweepers	No.	Good	Yes
Filter insert	Kristar - FloGard Plus Catch Basin Insert	5%	2	6 minutes	Vector Truck	Yes	Good	Yes
Filter insert	Kristar - FloGard Frame Mount Perimeter Insert	5%	2	6 minutes	Vector Truck	Yes	Good	Yes
Filter insert	Kristar - FloGard T-Series Catch Basin Insert	5%	2	6 minutes	Vector Truck	Yes	Good	Yes
Filter insert	REM - Triton Bioflex Drop Inlet Trash Guard	moderately	2	10 minutes	hydro	Yes	Good	yes

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Filter insert	REM - Triton Bioflex Drop Inlet Trash Guard	Contra Costa County has not yet maintained its REM filter inserts, which will commence in Sept., 2013.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.	Not yet determined.
Filter insert	REM - Triton Bioflex Drop Inlet Trash Guard	Majority of the items collected were organic materials	City contracts with outside vendor for maintenance	N/A	N/A	YES	Good	Yes
Filter insert	REM - Triton Bioflex Drop Inlet Trash Guard	75%	2	15-25 minutes	shovel, rake, trowel	El Cerrito Public Works Maintenance is under staffed and under-funded; maintaining the trash capture units stretches an already over committed staff even further	Good	Yes
Filter insert	REM Triton Bioflex Drop Inlet Trash Guard	Assumed half full	Assuming 2 (contracted)	Don't know (contracted)	Don't know (contracted)	No	Good	Maybe

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Filter insert	REM Triton Bioflex Drop Inlet Trash Guard	On average it appears they were all approximately 50%	2	20 - 25 minutes per unit	800 gallons industrial vacuum, broom & shovel	Yes	Good	Yes
Filter insert	REM Triton Bioflex Drop Inlet Trash Guard	The amount of trash removed ranges from 2 gallons during dry summer months, to 5 gallons during the rainy season.	1 to 2	15 minutes	Shovel and hand-pick	Yes	The condition of the devices have been very good at maintenance.	Yes
Large high-flow capacity devices								
End of pipe netting	Fresh Creek Technologies End of Pipe Netting Trash Trap[10]	Nets that were full needed to be replaced at maintenance. Recommend emptying them before they are full	3-5	1.5 hours	Crane truck		Many or most were torn, needed repair or replacement. Replacement delivery took over one month. Nets were replaced with heavier gauge material.	

[10] From Trash Tracker

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
End of pipe netting	Kristar - Nettech Gross Pollutant Trap	1/4 to 1/2	Hired an outside contractor. I think they had 3 guys on the job.	60 minutes	Backhoe to remove net.	Yes	We have had a couple cases of minor vandalism. Overall they have held up well.	Yes, and are planning on purchasing another one this year.
End of pipe netting	Kristar - Nettech Gross Pollutant Trap	One of the seven devices was completely full, two others were half full, during the first rain event after installation. After this the nets were less than a quarter full after each rain events.	3	45 to 60 minutes	Service truck, backhoe and a vacuum truck.	Yes	The materials are still in good condition after one season.	Yes
Gross solids retention device	Roscoe Moss Company - Storm Flo Screen	Maintenance not yet conducted as of 8/08/13. Trace material in screens.	estimated 3	unknown at this time	Vactor truck will be used.	no	excellent condition to date	unknown
Gross solids retention device	Roscoe Moss Company - Storm Flo Screen	full	2	90 minutes	Shovel and vactor truck	YES	GOOD	YES
Gross solids retention device	Roscoe Moss Company - Storm Flo Screen	full	2	90 minutes	Shovel and vactor truck	YES	GOOD	YES

Device type	Vendor/ Model name	In general, how full were devices of this type at maintenance?	How many staff were needed to perform maintenance?	How long did it take to maintain one device?	What equipment did you use for maintenance?	Are maintenance requirements for this device reasonable, considering your staff and budget?	In general, what was the condition of devices at maintenance?	Would you purchase this device again?
Gross solids retention device	Roscoe Moss Storm Flo Screen SS4	70-80%	4	150 minutes	Vactor truck	no, the cost of maintenance is too high	good	no
Hydrodynamic separator	Contech - Continuous Deflective Separator	Has not been accepted by the City and developer will be required to clean prior to acceptance	City plans to contract with outside vendor for maintenance	N/A	N/A	YES	Good	Yes
Hydrodynamic separator	Contech - Continuous Deflective Separator	4.4 cu. yds.	5	5 hours	Vactor truck	Y	Good	Y
Hydrodynamic separator	Kristar - FloGard Dual-Vortex Hydrodynamic Separator	10.00%	2	45 minutes	Vactor Truck	Y	Good	Yes

In addition to information in Table 4, we have learned the following about specific device models:

- A number of West Coast Storm devices were found to be damaged or defective during maintenance. ABAG was unsuccessful in recovering the cost of removing and replacing these devices from West Coast Storm's insurer, since West Coast Storm closed its doors in August 2013.
- Trash nets have proved challenging in several locations.
  - Kristar nets were found by one city's maintenance crew to twist during significant storm flow events. Kristar suggested removing the 4.76 mm knit nylon mesh" inner net," specified to bring the devices into compliance permit requirements that full trash capture devices capture all trash particles larger than 5mm; however that would put the city's installation out of compliance. At this writing, Kristar is still developing a solution. The nets are under warranty.
  - Several Fresh Creek Technologies netting systems, installed in two locations in a stormwater retention basin and each draining a catchment of 825 acres, were found to be maintenance-intensive during the fall leaf season. A number of the nets were torn or missing at maintenance events after the first significant rain event post-installation; after they were replaced with a stronger gauge net they held up somewhat better. The city intends to install face plate grates over the curb face openings of inlets in the catchment areas, to keep as much debris as possible on the street (where it will be picked up by street sweepers), and to slow the rate at which the nets fill.

C. Amounts of trash recovered from certain high-flow capacity devices

Because the Water Board did not require MRP permittees to measure or characterize trash recovered from full trash capture devices, but only to report on maintenance frequency, Demonstration Project staff chose not to impose an onerous additional reporting burden on project partners.

Several municipalities that obtained large high-flow capacity devices through the Project did, however, measure volume of recovered material. Data in Table 5 was uploaded to the Trash Tracker.

Table 5: Trash recovered from selected high-flow capacity devices

Municipality	Device manufacturer / model	Estimated catchment area	Date installed	Recorded maintenance date	Recovered material	Est. cost of maintenance event
American Canyon	Kristar FloGard Dual-Vortex Hydrodynamic Separator	2 acres	10/18/12	2/19/2013 6/30/2013	2.67 cu.ft. plastic 0.67 cu.ft. plastic 1.34 cu.ft. paper 0.67 cu.ft. sediment	
American Canyon	Kristar FloGard Dual-Vortex Hydrodynamic Separator	2.3 acres	10.18/12	2/19/13 6/30/13	2 cu.ft. plastic 0.67 cu.ft. plastic 1.34 cu. Ft. paper 0.67 cu.ft. sediment	

Municipality	Device manufacturer / model	Estimated catchment area	Date installed	Recorded maintenance date	Recovered material	Est. cost of maintenance event
Fairfield-Suisun	Contech Continuous Deflective Separator with diversion box	270 acres	5/23/12	7/08/13	0.4 cu.ft. plastic 0.1 cu.ft. paper	$500
Los Altos	Contech Continuous Deflective Separator	75 acres	10/12/12	6/18/ 13	3.5 cu.ft. plastic 12 cu.ft. sediment 100 cu.ft. leaves/ vegetation	$3,000
Napa	Kristar FloGard Dual-Vortex Hydrodynamic Separator	2.54 acres		8/22/13	0.006 cu.ft. plastic 0.114 cu.ft. sediment	$200
Napa	Kristar FloGard Dual-Vortex Hydrodynamic Separator	0.61 acres	12/16/11	8/22/13	0.1 cu.ft. plastic 0.9 cu.ft. leaves/ vegetation	$585
Mountain View	Contech Continuous Deflective Separator	125 acres	10/1/12	3/7/13	2.7 cu.ft. plastic 1.6 cu.ft. paper 2.7 cu.ft. sediment 1.1 cu.ft. metal 45.9 cu.ft. leaves/ vegetation	$1,000
Palo Alto	Contech Continuous Deflective Separator with diversion box	127 acres		6/11/13	5% plastic 5% paper 90% leaves/vegetation	
Palo Alto	Contech Continuous Deflective Separator	40.5 acres			5% plastic 5% paper 90% leaves/vegetation	
Pittsburgh	Roscoe Moss Co. Storm Flo Screen	300 acres	10/30/12	12/10/12	14 cu.ft. plastic 8.75 cu.ft. paper 1.75 cu.ft. metal 10.5 cu.ft. sediment 140 cu.ft. leaves/ vegetation	

Municipality	Device manufacturer / model	Estimated catchment area	Date installed	Recorded maintenance date	Recovered material	Est. cost of maintenance event
Santa Clara	Fresh Creek Technologies End-of-Pipe Netting Trash Trap (two installations of four netting systems each)	825 acres per system	9/15/12	12/4/2012	0.5% plastic 0.5% paper 99% vegetation	$2,000

Additional notes:

Los Altos noted that the device was clogged with leaves, and required repair. The City will increase the frequency of inspection.

The City of Santa Clara installed two large trash nets in a stormwater retention basin. They inspected, cleaned, and/or ordered repairs to these nets on December 4 and 11, 2012; December 17, 2012; January 2, 2013; February 5 and 20, 1013, April 1 and 4, 2013, November 21, 2013, and February 6 and 28, 2014. After significant rainfall at the end of November 2012 the nets were "full, missing, or torn" and had to be replaced. Replacement of the nets had been anticipated, but not at the frequency that turned out to be necessary. In January 2013 the nets were replaced with heavier gauge material. Subsequently, holes in the nets were repaired. By February 2014 two of four nets were again torn.

D. General comments about the Demonstration Project

Throughout the project, SFEP/ABAG staff interactions both with device vendors and our municipal partners have been positive, even during challenging exchanges about contracting requirements and the inevitable delays in payments to vendors.

The reporting tables asked municipal staff for general comments about the project. Following are submitted comments and suggestions, omitting several that expressed general approval and gratitude to SFEP for implementing the project:

Comments:

"While the Program provided a good resource as to what type of devices were available, unfunded cost for equipment and maintenance in the future is a real concern for the County."

"Would like another demonstration project to help cities buy additional devices after two years of evaluating maintenance, and time allowed for product improvement based on maintenance feedback."

"This project is very helpful toward removing trash litter from the municipal separate storm sewer systems (MS4s). The City appreciates the funding boost. "

"Trash Tracker is cumbersome and needs improvement."

"[Retractable curb] inlet screens are effective in reducing maintenance for CPS units."

"Appreciate the funds to purchase devices and test them how they hold up over time."

"While the Program provided a good resource as to what type of devices were available, unfunded cost for equipment and maintenance in the future is a real concern for the County."

"[End-of-pipe] nets did capture trash; however there was a problem with the inner nets tearing during maintenance. Also, there was the problem with the nets not releasing when they were at capacity and a high flow situation existed in the storm system. "

"The cost of concrete vault for the device installation is too high. Also, it traps leaves which is not trash"

Suggestions:

"Have each device pros and cons available before purchase, and hold a workshop where devices are displayed for viewing." (Note: The Vendor Fair at the kickoff meeting did provide such an opportunity.)

"Do not capture trash at catch basins, capture at outflows."

"If more grant monies could be available we would install another device in the City."

Lessons learned re: data collection

Our data is less than perfectly robust for the following reasons:

- *Bay Area weather was extremely dry between heavy rains in November-December 2012 and our project reporting deadline, September 1, 2013. Consequently many municipalities deferred maintenance of devices or maintained them less frequently than they would have in a "normal" year. By September 1, some jurisdictions had never maintained devices provided by the program.*
- *Due to the time municipalities required for contracting with ABAG, and delays in construction due to the loss of a key supplier, a significant portion of devices were installed in early 2013. This further limited the number of maintenance events that municipalities could have reported on.*
- *Although the Scope of Work in our municipal contracts states that "Municipal staff will use the online reporting website operated by SFEP/ABAG to record" installation and maintenance data, we were unable to enforce, or even promote, this provision due to the non-functionality of the Tracker during much of the project term.*

Next steps for data collection in the Trash Tracker

We understand that the future fate of the Trash Tracker rests on its permit-related utility and intuitive ease of use. It is our intention that over the course of improvements to the Tracker included in the scope of the Bay Area Stormwater Management Agencies Association's (BASMAA's) Proposition 84 project, "Tracking California's Trash"; and as municipalities better understand reporting requirements in the MRP, that more cities and counties will use the Tracker to maintain and share information about trash reduction efforts.

Conclusions; Trash Capture Cost Studies

SFEP owes a debt of gratitude to our funders, our partner agencies, and BASMAA for their faithful work supporting this project for the past four years. Because we were developing a new model for interagency cooperation while we implemented the project, it has been an occasionally bumpy, but always interesting road.

Bay Area communities are under a significant amount of pressure from the regulators to reduce trash impacts to local creeks and the Bay; and they are under no less pressure from ratepayers and elected city councils and county supervisors to provide more services with fewer resources. The Municipal

Regional Stormwater Permit (MRP) landed at a time when budgets were at a low ebb and public works departments were cutting staff wherever possible.

Hence the purpose of our project: to help prepare municipalities to make the best and most cost-effective decisions as they developed MRP compliance strategies.

Based on municipalities' data reported above and four years of communication between SFEP and town, city, and county staff, we believe the project has facilitated MRP compliance and permittees' concerted trash reduction efforts in response to the permit. It is our hope that this report will be of additional help to our project partners and other entities in California that will be required to comply with the forthcoming Trash Amendments to the State Water Resources Control Board's Water Quality Control Plan for Enclosed Bays and Estuaries.[11]

We understand that while $4 million-plus in funding for full capture devices has assisted many municipalities in reaching their first-phase goals of MRP compliance (reduction of trash by 40 percent in 2014, and trash capture in 30 percent of commercial/wholesale areas), this project was never big enough to solve the Bay Area's overall trash problems. The Trash Tracker, however – when augmented through BASMAA's Proposition 84 Stormwater Grant project, "Tracking California's Trash," should have long-term potential for engaging residents in local trash reduction efforts and encouraging municipalities to do more.

Over the course of the project, SFEP and our partner agencies learned some important lessons:

Addressing contracting challenges

A key lesson learned by everyone associated with the Demonstration Project was that municipal bureaucratic machinery, designed to protect cash-strapped governments from both lawsuits and intemperate staff decision-making, moves at a very slow pace and can't be speeded up – no matter the benefit to the community. Consequently this "shovel-ready" project, which finally encompassed upwards of 80 separate contracts and contract amendments, took far longer to get shovels in the ground than anticipated – by either the project staff or the Division of Financial Assistance.

SFEP believes, however, that our problem-solving efforts, which were largely successful, were well worth it. This project raises an issue, however, for future projects that need to distribute benefit among a large number of entities: Contracting requires a great deal of staff time from all participating parties.

Selecting and siting trash capture devices for local conditions

There is no one-size-fits-all solution when it comes to trash capture device selection. Bay Area infrastructure and land uses have developed incrementally, neighborhood-by-neighborhood, over more than a century. Storm drainage infrastructure, like municipal streetscapes, varies widely from community to community and even within a single municipal jurisdiction. In some places it is practical and cost-effective to install large devices that capture trash from a very large catchment area. In other locations retrofitting catchbasins with connector pipe screens is the only practical solution. In still other places, where street sweeping is frequent, retrofitting catchbasins with both CPS units and curb inlet screens minimizes catch basin maintenance costs while providing "full trash capture." Often in multiple areas of a city or county, staff must select a suite of trash reduction strategies based on a confluence of factors, including 1) trash/litter/deciduous vegetation generation rates in the area, 2) the nature of the specific local storm drainage infrastructure, 3) available resources including staff, equipment, and budget.

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[11] http://www.waterboards.ca.gov/water_issues/programs/trash_control/index.shtml

Municipal staff know their local conditions, and are generally able to site trash capture devices in high-trash generation areas. In many cases, however, a large percentage of material recovered at maintenance is leaves from street trees. Cities may wish to adjust their street sweeping schedules during the fall to accommodate leaf litter and reduce the necessary frequency of storm drainage maintenance.

Although most devices have been installed for less than two years, and 2013 was exceptionally storm-free, most devices are holding up well. The Notice of Acceptance strategy that SFEP/ABAG developed, requiring both municipal staff and a vendor's representative to effectively certify that devices were installed and working properly, avoided many problems. In cases where devices failed or were damaged after acceptance, the vendors' warranties led to replacement or repairs at no cost to the municipality. Unfortunately, in the one case where the device supplier closed its doors mid-project, we have not been successful in recovering damages from the insurer.

That said, the full trash capture standard adopted by the San Francisco Bay Water Boards appears to have caused problems for end-of-pipe trash nets, which were modified by the vendors to comply with the 5mm particle capture requirement.be in compliance. Large nets are used in many locations in Los Angeles. More investigation may be warranted to determine what it takes to make nets both functional and cost-effective.

All of the vendors in the program came to the Bay Area with experience capturing trash in Los Angeles, where Trash TMDLs ("total maximum daily loads," action plans for clean water incorporated into the Water Quality Control Plan for the Los Angeles Basin) have been in effect since 2002. Los Angeles' storm drainage/flood conditions, however, are vastly different – more extreme – than typical Bay Area stormwater scenarios. Consequently most trash capture device suppliers have had to modify their products for maximum effectiveness here. We trust that the Demonstration Project has educated vendors, as well as municipalities, about what is needed for northern California conditions.

Continuing funding challenges for municipalities; cost studies

For many reasons, municipal funding for "invisible" storm drainage capital projects has always been a budget challenge for public works departments. For the majority of Bay Area municipalities, full compliance with the NPDES Phase I and Phase II permits requires significant new investment.

Trash capture devices of all types come with significant maintenance requirements: more frequent and labor-intensive for small devices; less frequent but requiring use of expensive equipment for large devices. Several municipalities expressed disappointment that the Demonstration Project would not provide maintenance along with trash capture products.

NRDC cost report

A 2013 report prepared for the Natural Resources Defense Council12 compiled trash reduction program costs for 221 randomly selected communities of various sizes throughout California. The investigators found that on average, municipalities spent $219,528 per year on trash capture devices, and $251,528

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[12] Natural Resources Defense Council, "Waste in Our Water: The annual cost to California communities of reducing litter that pollutes our waterways," prepared by Kier Associates, August 2013. Available at http://docs.nrdc.org/oceans/files/oce_13082701a.pdf. Retrieved November 6, 2013.

on storm drain cleaning and maintenance.13 The report breaks down these costs by community size and provides expenditure ranges shown in Tables 6 and 7:

Table 6: Annual cost of stormwater capture devices[14]

Community Size	Population Range	Range of Reported Annual Costs	Average Reported Annual Cost	Average Reported Per Capita Cost
Largest	250,000 or more	$0-$7,887,125	$2,093,667	$1.689
Large	75,000-249,999	$0-$760,433	$153,135	$1.210
Midsize	15,000-74,999	$0-$1,100,000	$86,741	$1.654
Small	Under 15,000	$0-$560,000	$15,803	$6.082

Source: NRDC report

Table 7: Annual cost of storm drain cleaning and maintenance[15]

Community Size	Population Range	Range of Reported Annual Costs	Average Reported Annual Cost	Average Reported Per Capita Cost
Largest	250,000 or more	$700,000-$6,400,000	$2,439,232	$1.968
Large	75,000-249,999	$0-$1,098,000	$217,268	$1.717
Midsize	15,000-74,999	$0-$553,053	$86,741	$1.990
Small	Under 15,000	$0-$85,000	$15,803	$2.005

Source: NRDC report.
Null values in these data are explained in notes to the tables in Appendix B to the report. In most cases the municipality does not record, or did not provide, the information requested. Of particular interest is endnote 72: "Santa Barbara received a grant for $2 million to install storm drain grates throughout the city. Stormwater capture devices were discontinued due to unfavorable cost/benefit analysis. Storm drain cleaning cost in FY2012, (12: rainfall that year) = 1,041 hours labor for street crews' time and equipment cost for storm drain cleaning during rainy season."[16]

It is no surprise that the highest expenditures noted in the report are from coastal communities, which often end up taking responsibility for trash generated up-watershed; and from the Los Angeles area

[13] Monroe, Leila, "Waste in Our Waterways: Unveiling the hidden costs to Californians of litter clean-up," NRDC Issue Brief, August 2013. Available at http://www.nrdc.org/oceans/files/ca-pollution-in-waterways-IB.pdf. Retrieved November 6, 2013
[14] Ibid., p. 13
[15] Ibid., p. 14
[16] Ibid, Appendix B, p.x.

where a trash TMDL ("total maximum daily load") is in effect, and the Bay Area where Phase I communities must comply with the Municipal Regional Stormwater Permit's trash provisions.

San José comparative cost study

More specifically and closer to home, In a preliminary cost study, the City of San José analyzed the relative capital and operation/maintenance cost of small devices and large devices (hydrodynamic separators) capturing trash from study areas of 1000 acres, over 10- and 20-year time frames, accounting for repair and replacement of small units and predictable cost-of-living increases for labor. Small devices (connector pipe screens retrofitted into catch basins) were paired with automatic retractable screens (ARS) at the curb. While a connector pipe screen is the "full trash capture device" required in the Municipal Regional Stormwater Permit, addition of an ARS minimizes labor-intensive catchbasin cleaning by keeping some trash on the surface street where it will be picked up by regular street sweeping.

Figures 8 and 9 summarize San José's findings. The City found that while small devices are more economical in the first decade (Figure 8), the cost advantage disappears in the second decade (Figure 9).

Figure 8: Years 1-10 capital and O&M costs: HDS v. small inlet screen/ARS combinations ("Small Full Trash Capture Devices"). Charts courtesy of the City of San José
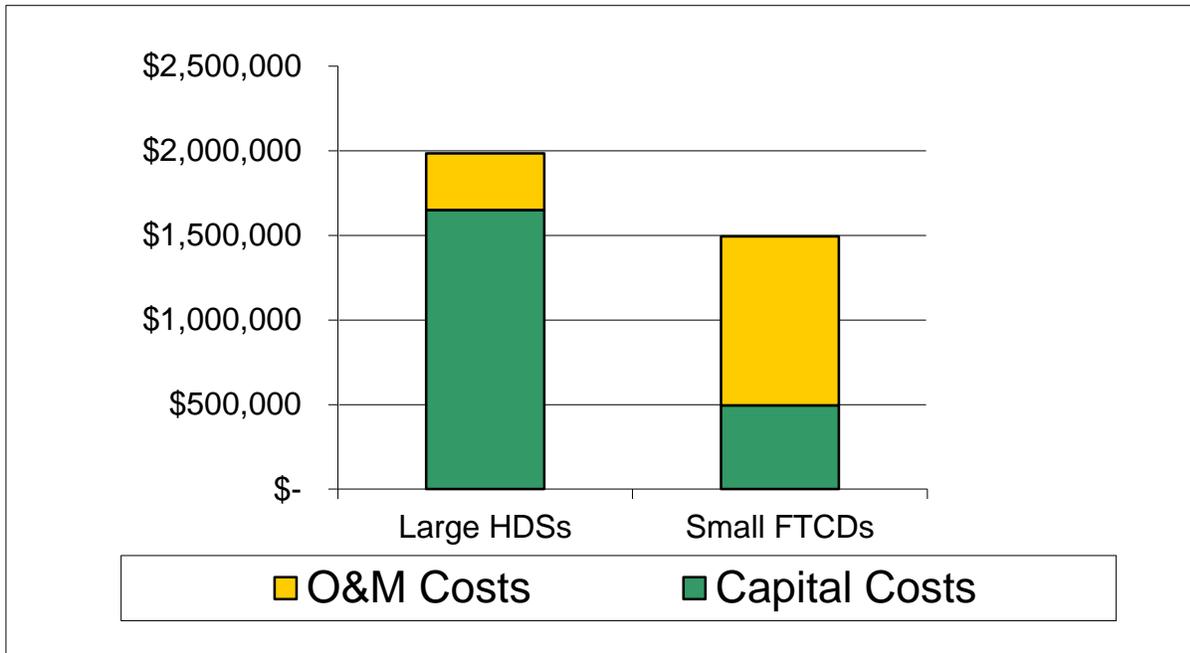
Figure 9: 20 years of capital and O&M costs of HDS and small inlet screen/ARS combinations
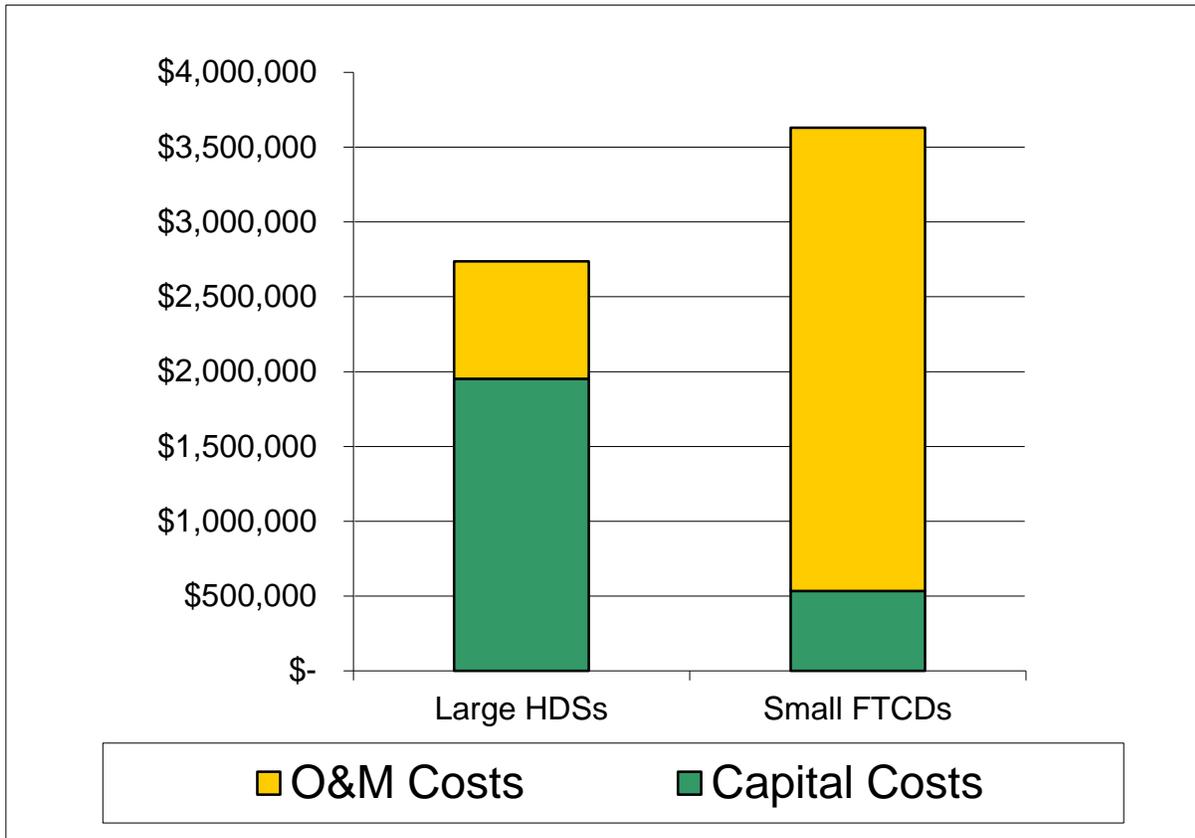
Resolving the Bay Area's trash challenge requires significant local commitment

The questions persist: How can municipal water pollution prevention agencies be effective in keeping trash out of our local creeks, our coastlines, the Bay, and the Pacific Ocean? What are the relative roles of full trash capture, on-land cleanups, ordinances such as plastic bag and Styrofoam bans, extended producer responsibility for packaging, volunteer litter pickup, and public awareness campaigns?

Answers to these questions will come, inevitably, in the form of cost-benefit analyses being developed, implicitly or explicitly, by each permitted municipality for local decision makers. While true source control solutions are always the most effective over the long term, the associated regulatory processes and effective, ongoing public education campaigns that source control requires may be more costly over time than the capital investment and labor costs of full trash capture, street sweeping, and on-land disposal. This is the conclusion reached in Los Angeles, where implementation of trash TMDLs ('total maximum daily loads" for trash in receiving waters) relies wholly on full trash capture.

The Bay Area-wide Trash Capture Demonstration Project has been a team effort, where SFEP's project implementers, staff of participating municipalities, ABAG and municipal legal teams, device vendors, and our funders all worked together to find new solutions to a web of interconnected stormwater quality problems. While this project is ended, we hope that our efforts have contributed to the spirit of cooperation and information sharing that will be required into the future as we all confront the Bay Area's water quality problems.