Southern California Stormwater Monitoring Coalition 2014 Research Agenda

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Southern California Coastal Water Research Project
Technical Report 828

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This research agenda was compiled by an Expert Panel, comprised of 11 disciplines, over a period of three days October 1–3, 2013. The Southern California Stormwater Monitoring Coalition is extremely grateful for their knowledge and commitment. Panel members included (from left to right, starting on top row) Scott Taylor, Eric Strecker, Gary Hildebrand, Ken Schiff, David Senn, Peter Ode, Larry Honeybourne, Ali Boehm, Iraj Nasseri, James Smith, Chris Sommers, Sara Aminzadeh, and Eric Stein.

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1.0 INTRODUCTION

Collaboration is a powerful vehicle towards common understanding. The Southern California Stormwater Monitoring Coalition (SMC) exemplifies this collaborative synergy, having spent the last 10 years filling foundational gaps in knowledge about how to improve stormwater management. Creating monitoring infrastructure, deciphering stormwater mechanisms and processes, and assessing receiving water impacts have brought tremendous leaps in how dischargers and regulators address the challenging issues of urban runoff. Cumulatively, the SMC and its project partners has expended over $6M to fill these data gaps.

The SMC has improved stormwater management as they have learned by implementing applied research projects (Table 1). The SMC addressed peak flow hydromodification, and the result was interim peak flow criteria and the development of monitoring and management tools for identifying and minimizing hydromodification impacts in at-risk stream segments. The SMC addressed stream biological assessments, and the result was an integrated, coordinated regionalized monitoring program that provides holistic views of ecosystem health and has become the foundation of California's upcoming biological integrity program. The SMC addressed low impact development (LID), and the result was a practitioners' manual on the most efficient designs for LID management practices. These are just a few examples of the meaningful impact from collaborative SMC projects. Virtually every project the SMC has undertaken has led to some change in stormwater management and/or policy.

Despite the success of the SMC, numerous stormwater issues persist and unresolved problems stymie regulatory and regulated agencies. After a decade of steadily improving progress, the remaining challenges are much more difficult to resolve. For example, the SMC can now identify where stream biological communities are impacted, but deciphering the cause(s) of the impact remain elusive. The SMC installs numerous structural control measures such as on-site retention basins, but optimal sizing, location, and flow controls have yet to be defined for the various precipitation and geologic conditions found throughout Southern California. The SMC now has quantifiable accuracy and precision limits for measuring routine, traditional pollutants identified in regulatory permits, but have little idea about the occurrence or toxicity for thousands of non-traditional chemicals of emerging concern that may be impacting their stream.

The SMC is about to recommit to their interagency collaboration. A master agreement, the document that binds them together as an entity, will be signed before fiscal year-end. The master agreement calls for a Five-Year Research Agenda, a forward-looking list of issues to address as implementable projects. This document is that Research Agenda and it will serve as the road map for the SMC.

2.0 METHODS AND APPROACH

The approach used for developing this agenda follows the SMC's previous Research Agenda (SMC 2001), utilizing an Expert Panel, selected by discipline. This Panel consisted of experts in hydrology, BMP engineering, Total Maximum Daily Loads (TMDLs), biology, chemistry, microbiology, public health, and hydromodification. Three additional members were selected to represent regulated, regulatory, and non-governmental representatives. The Panel was given the charge to:

- Develop a cohesive list of project concepts that will support stormwater management needs and address issues of concern
- Create a written summary of these project concepts for future use by the SMC

Table 1. List of SMC research projects and their management outcomes.

Collaborative Project	Product	Outcome
Stormwater Data Compilation Study	Assessment of stormwater pollutant loads	Developed framework for stormwater data in the California Environmental Data Exchange Network (CEDEN)
Implementing A Regional Monitoring Program	SMC Regional Bioassessment Monitoring Program	Southern California specific data to support California's Biological Objectives Policy
Peak Flow Impacts	Monitoring and assessment of hydromodification effects	First hydromodification requirements in Southern California stormwater permits
Hydromodification Study	Tools for evaluating hydromodification effects and prioritizing management actions, model monitoring program for hydromodification	Development of HMPs in response to permit requirements in all S. CA counties ,
Effects of Wildfires on Contaminant Runoff and Emissions	Documentation of pollutant loading associated with post-fire runoff, Post-fire monitoring plan	SMC member agency post-fire monitoring plans
Low Impact Development Study	LID Construction Manual on the California Stormwater Quality Task Force web site	Primary reference for LID implementation of NPDES permit requirements
Regional Protocols for Trash Monitoring and Management	Trash monitoring Standard Operating Procedure	Data used as primary evidence for several plastic bag bans
Laboratory Intercalibration Studies	Performance based Laboratory Quality Assurance Manual	Participants are pre-qualified vendors for SMC member agency NPDES monitoring
Bacterial Reference Watershed Study	Background concentrations and loads of bacteria	Data supports several bacterial TMDL numeric targets
Develop Standardized Sampling and Analysis Protocols	Model Monitoring Program Guidance Document	Question-based approach is the underpinnings for nearly every stormwater NPDES permit
Microbial Source Tracking Method Comparison	Test and ranked multiple MST research methods	Best performing method is now encapsulated in the State's MST method manual

The Expert Panel was told that these needs should be regional in scale and not focused on individual or site-specific concerns. In addition, the Expert Panel was told that these needs should include medium- and long-term issues and not just short-term requirements.

After listening to testimony from SMC member agencies, the Expert Panel identified 63 discrete project concepts in less than four hours. Over the next 24 hours, the Expert Panel refined and prioritized these research concepts into 36 project ideas. Ultimately, 21 of these research concepts were cultivated into project descriptions found in this document.

The 21 research projects are consolidated into four groups of studies:

- Ecosystem Characterization and Assessment
- Method Development and Tool Evaluation
- Optimizing Management Effectiveness
- Foundational Scientific Understanding

This document is organized into these four groupings. Each project description is comprised of a problem statement, desired outcome (products), tasks, schedule, and necessary resources (expertise, costs, and potential collaborators). The sequence in which the projects are presented does not constitute any sort of prioritization. The SMC will prioritize implementation of these projects based on collective needs and available funding.

3.0 ECOSYSTEM CHARACTERIZATION AND ASSESSMENT

Effective use of limited resources requires understanding which issues have the greatest effect on beneficial uses of our watersheds. As such, monitoring and assessment provides the foundation for making informed management decisions. The SMC structure provides a mechanism for coordinating assessment efforts, leveraging resources, and making results of monitoring and assessment programs broadly available to managers. This research theme includes projects that investigate new and emerging water quality issues, such as contaminants of emerging concern, evaluates effects of stormwater on biological endpoints in order to help prioritize management efforts, and improves the consistency of our monitoring and data management efforts in order to facilitate information sharing.

3.1 Standardizing Monitoring Approaches for Wet and Dry Weather Monitoring

Problem Statement

In May, 2012, the SMC held a workshop to identify the similarities and differences in stormwater monitoring among member agencies. The ultimate outcome was that existing monitoring and reporting requirements were inconsistent, leading to incompatible sampling designs and incomparable data and information across programs. The result is a large potential for redundancy, inefficiency, and ineffective outcomes. This is exacerbated by our already limited resources for assessing receiving water environmental health and end-of-pipe compliance.

Desired Outcome

The goal of this project is to develop a uniform approach to monitoring that will effectively demonstrate trends, identify stressors, identify sources and evaluate effectiveness of Management Measures in addressing the stressors. This approach should be adopted by stormwater NPDES Permit Monitoring and Reporting Programs, either in text or by reference. The model program should also address: a) monitoring questions; b) design criteria; c) sampling and analysis protocols and methods; d) database and QA/QC rules, and; e) reporting formats. The sampling approach should contain a three-part framework including core monitoring, regional monitoring, and special studies. After the first iteration of the model program, SMC member agencies should evaluate the efficacy of the monitoring recommendations, and update model program requirements, as needed.

Tasks

1) Identify Stakeholders and develop a monitoring Committee
   a) Mandatory participation would include Regulators and SMC member agencies
   b) Additional monitoring organizations may include NGO, POTWs, Public Health Agencies, Industrial Storm Water Monitoring, Ag Waiver, Construction SW, 401 certifications
2) Develop agreed upon list of questions/goals
3) Update the inventory of existing monitoring effort
4) Identify deficits/needs of the existing program relative to the monitoring questions
5) Refine or redesign existing monitoring programs based on monitoring questions
   a) Calculate necessary spatial and temporal frequencies and constituents to be measured.
   b) Develop standard monitoring protocols and QA measures
   c) Assign agencies to monitoring locations and constituencies.
   d) Develop standard information management activities for submitting and sharing data
6) Present monitoring design to SMC Executive Committee and seek acceptance from all member agencies.
7) Advocate for inclusion in all permits that require monitoring.
   a) Development of exact permit language is preferred.

Schedule
This project could start immediately and would require 18 to 36 months to complete, depending on the level of detail and number of participants.

Necessary Resources
The cost of this project would range from $150,000 to 450,000, depending upon the number of monitoring questions and the complexity of their monitoring design. The project team will require an expert in monitoring design to ensure statistical robustness. This project should incorporate SWRCB Surface Water Monitoring Program (SWAMP) to ensure that there is no duplication of effort.

3.2 Improving Storm Water Agency Reporting and Communication

Problem Statement
Regulated entities and regulatory agencies alike need to communicate the benefits associated with stormwater management to the public and to governance bodies. A proliferation of data portals, tools and report cards have been generated by non-governmental organizations and the California Water Quality Monitoring Council to collect and relay up-to-date information about water quality (For example, www.healthebay.org or www.cawaterquality.net). Additionally, the state is increasingly collecting monitoring data in electronic databases such as the California Environmental Data Exchange Network (www.CEDEN.org) and SMARTs (https://smarts.waterboards.ca.gov). Yet, agencies do not currently have an all-encompassing water quality index to quantify water quality improvements or identify and report areas of needed improvement. This information-based, rather than data-based, communication is crucial for agencies to communicate to managers and the public the value of their programs, advertising successes, and obtaining resources needed for further work.

Desired Outcome
The goal of this project is to create new analytical tools and report card formats for transmitting information to non-scientists and upper level managers for easily interpreting, and acting upon, information collected by SMC member agencies. SMC member agencies should be able to upload their monitoring information to web accessible data portals, and then report this data in dashboards or other primary reporting approaches. SMC Member Agencies can then broadcast these links via their own media and use regional portals as a clearinghouse to communicate water quality information to their target audiences. Ultimately, the SMC should use these tools to publish a “State-of-the-Watershed Report.

Tasks
This project will consist of two phases:

Phase 1:
1. Survey Stormwater Monitoring Committee members to identify communication needs and target audiences for potential tool development.
2. Identify existing databases, indexes, report cards and portals that provide information about the relative health of Southern California waterbodies, and identify the most effective techniques.
3. Synthesize and determine whether
    a. existing tools and systems are sufficient to meet needs, but can be used more effectively,
    b. additional data or utilities must be added to make existing tools useful; or
    c. development of an additional framework, website, report card, or tool is necessary.

Phase 2:
1. Based on the findings of Phase 1, refine or develop reporting tools

    a. Additional data collection
    b. Software programming
2. Apply the tool in a test watershed or county
    a. Evaluate the application and make modifications as necessary
3. Repeat for the entire region based on regional monitoring data, compiled permit-specific monitoring, or both.
4. Capture the information in a State-of-the-Watershed report

Schedule

This project could begin immediately and be completed within 12 to 36 months, depending on the complexity of the report card, volumes of data to be submitted to CEDEN, and the extent and speed of review process.

Necessary Resources

This project should cost between $150,000 and $400,000. The project team will require a skilled data analyst in quantitative messaging and index development. The project will also require a skilled facilitator to ensure the index meets the needs of multiple agencies.

3.3 Characterization of Stormwater Effects

Problem Statement

Significant amounts of monitoring and reporting occur about the presence and extent of pollutants in stormwater. However, there is relatively little known about the effect of these pollutants on beneficial uses. Significant resources are expended to characterize stormwater pollutants while scant effort is expended in understanding how those pollutants do or do not affect environmental outcomes. Understanding which pollutants result in the greatest effects can be used to help prioritize management actions.

Desired Outcome

The goal of this project is to improve regional understanding of the relationship between changes in flow, sediment, or pollutant levels and indicators of designated beneficial uses. This understanding can be used by SMC member agencies to refine assessment endpoints for monitoring programs and to set priorities for future management actions (based on areas of highest likelihood of effects).

Tasks

Given the complexity of this analysis, initial efforts should occur in a pilot watershed(s). Once the approach is perfected in the pilot watershed, it can be scaled to other areas or the SMC region as a whole.

1. Collect stormwater characterization data and summarize Southern California stormwater characterization studies to date.
2. Select pilot watershed(s) where stormwater runoff has been well characterized in terms of flow and multiple constituents of concern.
3. Identify beneficial uses associated with different portions of the watershed. New beneficial use mapping being conducted by the State Water Board can support this effort.
4. Determine appropriate tools and endpoints to measure beneficial use attainment, e.g. toxicity, bioassessment, CRAM, habitat or species occurrence
5. Compile data sets for beneficial use assessment at key locations of interest within the watershed
6. Analyze linkages between stormwater runoff constituents and measures of beneficial uses or effects measures

7. Produce report on linkage analysis, lessons learned, and approach for scaling up process to the SMC region
8. Propose measures to more appropriately manage stormwater discharge impacts to beneficial uses, as needed.

Schedule
This project should take advantage of the beneficial use mapping that is currently occurring by the State Water Board. Consequently, initiation of this project should wait until the products from that effort are available. Once initiated, the project should take approximately 24 months to complete.

Necessary Resources
The project should cost $150,000–200,000 assuming no additional data collection is required. It will require participation of an individual with knowledge of bioassessment, toxicity, and water quality, and a skilled data analyst.

3.4 Contaminants of Emerging Concern
Problem Statement
Historically, monitoring programs have focused on the priority pollutants, a list of 126 specific chemical constituents that has changed little since the 1970s. Contaminants of emerging concern (CECs) represent a relatively modern and uncharacterized class of stormwater pollutants, but with high potential for negative impacts on beneficial uses. CECs may include endocrine disrupting compounds, current use pesticides, industrial chemicals, and pharmaceuticals and personal care products. Assessment of CECs, however, will require an innovative approach because there are thousands of potential CECs, there is wide variety of CECs, laboratory analytical protocols are lacking for most CECs, and new CECs are continually being developed and released to the environment each year.

Desired Outcome
The goal of this project is to build off the State's Surface Water Ambient Monitoring Program (SWAMP) by adding new monitoring design to measure CECs. This new design will include the use of bioanalytical screening tools to limit and prioritize the number of chemical analyses necessary to characterize risk to receiving waters. These bioanalytical screening tools can identify biologically active compound classes including metabolic inhibitors, reproductive hormone mimicry, tumor promoters, amongst others. Then, subsequent analysis for a limited set of CECs within a single compound class can be undertaken, focusing resources on assessing the extent and magnitude of the riskiest few of the potentially hundreds of CECs found in the environment.

Tasks
1. Collate a list of currently available bioanalytical screening tools
2. Conduct range-finding tests to narrow the list of viable bioanalytical screening tests
3. Calibrate and validate the most sensitive, accurate, and precise bioanalytical screening tools
4. Refine bioanalytical screening tools, as necessary, to improve performance
5. Apply the bioanalytical screening tools in a pilot watershed to ensure its validity in a field study
6. Utilize the bioanalytical screening tool in the SMC's Regional Watershed Monitoring Program to identify the CECs generating the greatest risk

Schedule
This project should be initiated not long after the state releases its SWAMP monitoring recommendations

and could be completed in less than three years. These recommendations can be implemented through the SMC Regional Watershed Monitoring Program.

Necessary Resources

This project will cost between $100,000 and 200,000, depending upon the number of sites and parameters, and frequency of sampling. However, implementing through the Regional Watershed Monitoring program will save considerable resources in sampling costs. Project collaborators should include wastewater treatment agencies, CDPH, Recycled water agencies, and selected universities since extensive research and evaluation of CECs has been conducted by all in conjunction with potable recycled water use. This has also included extensive laboratory method development and an evaluation of surrogate functional chemical groups of concern. These project partners may bring additional resources to the project.

3.5 Characterization of Stormwater Impacts on Marine Protected Areas

Problem Statement

The state invested a tremendous amount of resources into the Marine Life Protection Act (MLPA) Initiative to develop and adopt a statewide network of marine protected areas (MPAs), where fishing and take is limited. The MLPA Science Advisory Team recommended that MPAs be sited to avoid areas of poor or threatened water quality, such as areas near power plant intakes, areas receiving storm runoff from developed watersheds and areas near municipal sewage or industrial wastewater outfalls.

Although water quality may impact fishery recovery and overall MPA performance, the regulatory jurisdiction of the Fish and Game Commission has led to a focus on fish and marine life. Similarly, existing state funding for MPA monitoring has had a defined scope of ecological and socioeconomic data collection, as directed by the MLPA.

The MPA monitoring framework recognizes the need for partnerships and collaborations so that water quality information is available to correctly interpret and use MPA monitoring results. Indeed, without information about the role of water quality on MPA performance, lack of performance or lack of success may be erroneously attributed to water quality impacts.

Desired Outcome

The goal of this study is to analyze whether proximity to stormwater outfall, and volume or quality of outfall discharges, impacts MPA performance in Southern California. The study aims to characterize the types of discharges, if any, and combine this information with monitoring by the MPA Monitoring Enterprise, Ocean Science Trust, Department of Fish and Wildlife to inform the 5 year review of the South Coast MPAs and the State Water Resources Control Board ASBS Ocean Plan requirements.

Tasks

1. Collect existing studies about stormwater outfall impacts to coastal water quality and marine health in California (e.g. Irvine Company study about impacts to Crystal Cove) to inform study methodology and approach.
2. Collate baseline data and information about Southern California MPA performance (currently underway).
3. Identify stormwater outfalls that potentially impact Southern California MPAs and select a subset of representative outfalls and MPAs for in-depth study.
4. Quantify proximity, volume, and quality from selected outfalls.
5. Compare rates of change in community structure, rates of infection, and/or numbers of lesions on

marine organisms in MPAs proximate to stormwater outfalls and those not proximate to stormwater outfalls.

6. Analyze correlation between stormwater discharges and MPA performance (e.g. community structure and function).
7. Use study results to develop recommendations to inform coastal water quality and marine protection policies and monitoring programs (Ocean Plan, ASBS, SWQPAs, MPA Monitoring Enterprise).

Schedule

This project should require between 15 and 24 months. Longer timeframes may be necessary if additional data collection is necessary.

Necessary Resources

The project cost will vary between $175,000 and $700,000, depending largely on amount of data necessary. Project collaborators should include ASBS dischargers that are not SMC member agencies including individual cities (i.e., Malibu or Laguna Beach), marine aquaria (i.e., Scripps Institution of Oceanography, USC), and federal agencies (i.e., US Navy). The project must include interaction with the agencies responsible for MPA performance including the CA Dept. of Fish and Wildlife and the MPA Monitoring Enterprise.

4.0 METHOD DEVELOPMENT AND TOOL EVALUATION

Stormwater programs must continue to evolve to address changing assessment or management needs. In particular, advances in assessment tools and technology can help improve program efficiency and refine programs to address new questions or regulatory requirements. This research theme includes projects that improve and standardize existing tools, adapt existing tools for new environments, and explore application of new technologies.

4.1 Adapt Biological Assessment Tools for Non-Perennial Streams

Problem Statement

The State has developed a standardized approach for scoring stream health in perennial streams (streams with year-round flow) based on biological condition. However, more than half the stream miles in the SMC region are non-perennial in most years. It is unknown how applicable the scoring tool developed for perennial streams will perform in non-perennial systems. Therefore, managers are left without an assessment tool in this prevalent stream type. Moreover, non-perennial streams are most at risk as urban development continues to extend towards areas where non-perennial stream predominate.

Desired Outcome

The goal of this study is to refine and/or adapt the suite of biological assessment tools developed in perennial streams for use in non-perennial streams. After assessing accuracy, precision, and sensitivity, there will be a need to develop standardized guidance for their application in a consistent and systematic manner. Once developed, these tools will allow for a more complete evaluation of stream resources in the SMC region.

Tasks

This project consists of six basic tasks:

1. Evaluate new USGS flow permanence models to validate their accuracy for Southern California, and translate to a GIS layer. Compare the modeled data to local gage data. Use the results of this analysis to update stream maps based on their flow regime.
2. Update the sample frame for Southern California stream monitoring using the new stream maps.
3. Enhance the existing network of reference sites in non-perennial streams by identifying and evaluating candidate reference sites.
4. Evaluate the new California Stream Condition Index (CSCI) to assess its applicability to streams with declining discharge due to climate, urbanization and groundwater use.
5. Refine the CSCI for improved accuracy, precision, and sensitivity in non-perennial streams.
6. Explore the applicability of multiple biological indicators to develop an optimum package for assessment of a range of non-perennial streams (e.g. short term vs. long-term non-perennial).

Schedule

This project could begin right away and may take up to three years to complete. This length of time is necessary because data collection can only occur once per year. Actual tool development and testing can occur in one year or less.

Necessary Resources

The approximate costs will range from $350,000 to $750,000 based on quantity of new data collection. The project will require hydrology and ecology skills. The SMC should look to collaborate with the USGS who are the current leaders in developing the flow permanence models.

4.2 Develop New Tools for Causal Assessment

Problem Statement

The State Water Resources Control Board is preparing a statewide Plan for setting Biological Integrity (www.waterboards.ca.gov/plans_policies/biological_objective.shtml). This Plan will establish biological assemblage expectations for benthic macroinvertebrates in perennial wadeable streams. Not surprisingly, early evaluations indicate that many of the sites that do not meet expectations occur in urban stream reaches such as those under the jurisdiction of SMC member agencies. Given this, the next challenge is to identify the stressors that are leading to the decreased biological integrity as a first step in the path towards remediation.

As part of the biological integrity development process, the State evaluated the US Environmental Protection Agency's Causal Assessment Data and Diagnostic Information System or CADDIS (http://www.epa.gov/caddis/). CADDIS is designed as a causal assessment framework specifically to identify the stressor(s) responsible for biological impacts, but had not been used in California. The State's evaluation determined that the framework will work in California, but that several new data analysis tools would be required to optimize the framework for biological objective purposes.

Desired Outcome

The goal of this project is to create the additional tools necessary to optimize CADDIS for cost effectively finding streamlined ways to identify causes of biological community impacts in Southern California. The tools should be focused on three particular areas recommended in the CADDIS evaluation; comparator site selection, chemical stressor diagnosis, and physical habitat stressor diagnosis. The ultimate product will be a revised CADDIS Guidance document documenting and describing the tools and their use. Online, automated tools are also a likely outcome to increase speed and simplicity, reduce ongoing costs, and remove potential bias.

Tasks

New/refined tools should be developed through application to a pilot watershed with sufficient data to allow testing and evaluation.

1. Identify pilot watershed(s) for development and evaluation of new tools
2. Compile all existing, relevant data from the watershed. Include regional data that could be relevant for comparator analysis.
3. Develop an improved and automated process for identifying appropriate comparator sites.
4. Develop new tools for linking biological characteristics to specific stressors (i.e., species sensitivity curves, molecular methods).
5. Identify a suite of indicators of physical habitat impairment.
6. Evaluate the effectiveness of the tools in demonstration watersheds or pilot projects.
7. Refine the tools based on the results of Task 6.
8. Update CADDIS guidance document using the results of this study

Schedule

This project will require up to 36 months to complete tools in all three areas. Individual tools could be developed and released early, if the need arises.

Necessary Resources

This project will cost between $250,000 and $500,000, depending on the number of individual chemical and physical habitat metrics evaluated, and the number of demonstration watersheds utilized. This project will require expertize in ecology and toxicology.

4.3 Standardize Hydrologic Methods

Problem Statement

Most SMC member agencies are utilizing hydrologic models for designing structural BMPs to improve stormwater quality and mitigate the impact of hydromodification on natural drainage systems as required in their respective NPDES permits. However, there is no standardized hydrologic procedure for designing these BMPs. The current hydrologic practices vary among SMC member agencies. As a result, methods for hydrologic computations for stormwater quality fate and transport or flow-based impacts from hydromodification assessment also differ among SMC member agencies. Engineers working on local projects are left to specify model parameters and, without a standardized procedure, resulting BMP performance and mitigation will vary. This is especially important since several regulatory applications for both TMDL and NPDES permits are now being based on modeled BMP performance. This inconsistency is also a barrier to sharing information on BMP design and performance among SMC partners.

Desired Outcome

The goal of this project is to develop a consistent hydrologic method for modeling stormwater quality, implementing LID strategies, and assessing hydromodification impacts. Ultimately, the SMC will want to agree on acceptable computer model(s), design storm definitions, the allowable range for model parameters specific to the Southern California region (or subregions), and produce an associated guidance document for implementing the standardization. These products will improve consistency and enable enhanced sharing of information on BMP performance (and the factors that affect performance).

Tasks

1. Convene a workshop of practicing modelers and SMC member agencies to:
    a. Evaluate available models and criteria for application throughout Southern California;
    b. Specify key model parameters for standardization; and
    c. Specify data needed for calibration, verification, and estimation of model's parameters.
2. Evaluate hydrologic modeling software in terms of documentation, technical support, and training program.
3. Develop frequency-based design storms to comply with the NPDES' requirements.
4. Develop guidelines for estimating models' parameters.
5. Select a few gaged watersheds representing the range of Southern California's hydrologic characteristics and test the application of hydrologic models including: calibration, validation, and verification. Two (or more) hydrologic models may be needed for different model applications.
6. Develop a user's manual and post on the SMC website

Schedule

This project will take between two and four years. An intermediate step that could be completed within one year (and at a lower cost) is the modeling workshop and selected model(s) outlined in Tasks 1 and 2.

Necessary Resources

This project will cost between $500,000 and $1,000,000 depending number of models selected, number of model parameters to be standardized, and magnitude of effort in the test application.

4.4 Hydromodification Guidance for Urban Streams

Problem Statement

Hydromodification program mitigation requirements often involve controlling runoff from new development or redevelopment on a project specific basis without regard to the current geomorphic condition of the receiving stream. Many urban streams have been channelized and stabilized. Others are in a highly degraded condition due to existing development impacts, limiting the ability of project-by-project controls to improve conditions. Managing urban streams is subject to many constraints such as right of way limitations, changes in channel alignment, changes in longitudinal grade, and floodplain encroachment, all of which limit opportunities to restore individual channel segments to conditions that approximate a natural state. Research is needed to develop options for in-channel restoration projects and/or regional controls in lieu of (or in addition to) site-specific flow and sediment mitigation.

Expected Outcome

The goal of this project is to develop criteria for in-channel mitigation projects and/or regional controls for urban stream corridors that can serve as an alternative to project specific flow and bed sediment mitigation. Criteria will inform both the identification of locations suitable for alternative approaches and the selection of the specific strategy. The criteria will be flexible enough to apply to a stream segment or river system. This will help determine if in-stream and/or regional mitigation is environmentally preferred over project specific flow and sediment control. It will also have the added benefit of standardizing guidance across the region.

Tasks

1. Perform a literature review and consolidate case studies, including work by SMC Member Agencies, of existing urban creek restoration and management projects designed to address hydromodification effects to define the current state of practice.
2. Develop a classification system for stream systems. For each stream class:
    a. Determine if targets or thresholds for desired stream functions and values are feasible.
    b. Develop recommended physical stream properties and desired biological measures that will define a successful modification project.
3. Develop criteria to apply to the stream classification system to separate streams, or stream segments into: i) those that should be preserved as is and protected with implementation of project-by-project controls, and; ii) those that would better benefit from in-channel improvement and/or regional projects. Work on this task will require the development of a model for an urban stream in southern California for a menu of constraints and opportunities typically encountered.
4. Provide a description of stream restoration and regional control projects that may be suitable for various classifications of urban streams to restore desired functions and values.
5. As a case study, apply the criteria to a highly degraded urban stream and develop a preliminary restoration design. Include recommended performance measures as part of the model output.

Schedule

This project can be completed in 18 to 24 months.

Necessary Resources

This project will cost between $350,000 and $700,000 depending upon the number of stream classes, variety of stream restoration and regional control options, and magnitude of validation desired in the case study. This project will require expertise in geomorphology, modeling, and stream/floodplain restoration. This project should be coordinated with other work targeting in lieu, credits, banking or offsets (See project *Nutrient banking*).

4.5 Evaluating Potential of Remote Sensing Technology

Problem Statement

The SMC member agencies spend tremendous amounts of time and money collecting physical and chemical monitoring data to support management decision making. Unfortunately, much of this data is collected using decades-old technology that involves sampling at discrete points in time and space providing a disjointed “snapshot” of conditions. As a result, the applicability or relevance of this monitoring data to discharges and receiving water conditions at other times and locations are uncertain. New technology holds great promise. For example, satellite imaging, genetic laboratory methods, and *in situ* chemical probes are currently being used for stormwater assessments. All of these new technologies are capable of collecting large quantities of data at highly refined temporal and/or spatial scales. Examples of remote sensing methods have also illustrated that this increase in temporal and spatial resolution may be cheaper and faster to obtain than the traditional approaches.

Expected Outcome

The goal of this project is to evaluate and recommend new technological methods for accessing, quantifying, and interpreting selected parameters to assess receiving water health. Ultimately, these tools can be incorporated into specific compliance monitoring programs and to support the SMC’s regional watershed monitoring program.

Tasks

1. Hold a workshop of new technology innovators to assess the state of the art, availability of technology, and applicability to stormwater management needs. This workshop could be held as part of a CASQA Annual Meeting.
2. Identify and select parameters that lend themselves to remote sensing applications based on the workshop.
    a. Identify potential surrogates and translators for parameters that do not lend themselves to remote sensing techniques or that are not directly measured by remote sensing.
3. Prioritize applications based on need and maturity of the technology. Select priority applications for further testing and evaluation
4. Develop a data verification process and apply to confirm validity of the approach. Potential approaches have been used previously:
    a. Intercalibration exercises
    b. Demonstration projects
    c. Verification by comparison to existing methods
5. Develop a model plan to:
    a. Interpret data algorithms to take advantage of the remote sensing data.
    b. optimize the technology for broad use by the SMC member agencies
    c. adopt the technology into current monitoring and characterization programs

Schedule

This project may take up to five years, depending on the technology selected and its proximity to commercialization for stormwater applications. An intermediate milestone of the technology evaluation workshop could be accomplished in less than one year (at a much-reduced cost).

Necessary Resources

This project will cost at least $200,000. The maximum amount is a function of ultimate technology selected and proximity to stormwater application

5.0 OPTIMIZING MANAGEMENT EFFECTIVENESS

Stormwater management programs continue to grow in complexity and scope. In order to make optimal use of limited resources, managers must explore ways to adapt existing facilities and programs to better address multiple needs or priorities. This can include improved strategies to better tailor effort based on specific site constraints or receiving water conditions. This research theme includes projects aimed at optimizing management effectiveness by exploring retrofit of existing facilities, customizing on-site and off-site management approaches, and developing alternative endpoints for specific stream types (e.g. highly modified streams).

5.1 Optimizing Best Management Practices for Southern California

Problem Statement

Best Management Practices (BMP's) are commonly used as a means to comply with water quality requirements. Understanding BMP performance under a variety of circumstances provides valuable information regarding selection, design, and maintenance. A comprehensive assessment of the performance of BMPs for reducing pollutants and addressing hydromodification effects is not currently available for the large variety of environmental settings found in Southern California systems. One opportunity is to analyze data from the International Stormwater BMP Database, which contains monitoring and reporting information for BMPs throughout the United States (and some international sites) including 43 studies in Southern California. National assessments on the performance of BMPs, as well as BMP assessments specific for the Chesapeake Bay area, have been completed by the Database Team, but no BMP database assessment has been conducted specific to Southern California or other arid climates.

Expected Outcome

The goal of this study is to assess the performance of BMPs in Southern California and identify BMP types that appear to be more effective for addressing the pollutants and parameters of concern in this region. The results of this study can be used to develop improved bioretention/filtration media specifications and designs, and to produce recommendations for BMP implementation based on the stream type and constituent(s) of concern.

Tasks

1. Conduct an assessment of BMP performance for Southern California BMPs using available data (International BMP Database and other available studies) and compare to National BMP Assessment. Provide a summary report of results.
2. Based upon the assessment, identify BMP performance data gaps and potential BMP design improvements to study.
3. Develop study Plans for BMP monitoring and special studies for improving BMP Design. Consider potential evaluations for a range of operation and maintenance practices that may affect BMP performance.
4. Conduct a study of media components, mixtures, and sources to determine recommended media for improving performance of bioretention/filtration media. Include both hydraulic properties as well as pollutant removals. Develop set of recommended media configurations and associated BMP configurations (for applicable situations)
5. Compile BMP monitoring data from SMC member agencies and load monitoring results, and reporting information into the BMP Database or other regional database/portal.
6. Develop/update a report on BMP performance in a variety of circumstances/situations for Southern California to provide guidance to decision makers and practitioners on BMP selection and design.

Schedule
This project could begin immediately and would take a minimum of three years to complete. Task 5 (compiling monitoring data) may take longer depending the availability and accessibility of existing BMP modeling and/or the need to compile new data.

Necessary Resources
This project would cost between $100,000 and $350,000 depending upon the number of design experiments outlined in Task 3. Additional cost considerations are dependent upon quantity and quality of BMP performance data from existing monitoring in Task 5. Additional monitoring for pollutants of concern would increase costs. The price estimate assumes that existing databases/portals could be used or modified to house BMP performance data compiled during the project.

5.2 Flood Control Detention Retrofit to Improve Water Quality Performance

Problem Statement
Water quality or hydromodification management often involves use of detention, retention, or flow duration control. In urban watersheds, there is often little space to construct such facilities on a regional or subwatershed scale. However, detention and retention basins are commonly used flood control facilities and most urbanized watersheds contain one or more such basins. These facilities have storage capacity that is utilized very infrequently (i.e. peak shaving for the 50-year storm event). In the last few years, there have been significant advancements in the use of real-time control (RTC) to adaptively manage how water is discharged from detention basins in order to provide increased water quality function from existing flood control facilities. However, little to no RTC adaptive management has been implemented in Southern California or other climates with flashy rainfall-runoff patterns.

Expected Outcome
The goal of this project is to evaluate the potential for retrofitting detention systems in Southern California with RTC to improve water quality. Ultimately, RTC could maintain the primary mission of flood control via operation of the outlet to ensure that flood control capacity is available when needed, but water quality functions are available at other times. If successful, this would provide a new BMP opportunity in highly urbanized settings for minimal costs. Results would be demonstrated through a retrofit case study in Southern California.

Tasks
1. Work with the SMC member agencies to select a potential test site based upon agreed upon selection criteria. Criteria could include: potential water quality (and hydromodification) benefits; ease of outlet modifications, and; ability to gain flood control agency approvals and any permitting required.
2. Develop conceptual and final designs for outlet retrofit. Develop operating rules for outlet structure that maintain flood control functions while achieving water quality benefits.
3. Implement retrofit and develop algorithms for controlling the outlet discharge, as well as monitoring performance. Develop monitoring plan based upon design.
4. Monitor performance of the retrofit facility in terms of both hydrologic/hydraulic and water quality functions.
5. Using the information above, develop a Southern California Guidance Document on retrofitting of flood detention facilities with RTCs to improve water quality and hydromodification performance.

Schedule
The entire project would take 2 to 4 years. Site selection, design, and construction could be completed within two years. Once constructed, the facility should be monitored for a minimum of two years.

Necessary Resources
This project will cost at least $200,000. Initial design work would cost approximately $100,000 and would require contracting with an engineering firm with experience in both flood control and water quality design. Construction costs could vary greatly depending on the facility. Monitoring and reporting may cost an additional $100,000, depending upon number of site events and constituents analyzed.

5.3 Evaluating the Potential Benefits and Negative Impacts of On-site Stormwater Retention

Problem Statement
On-site retention of stormwater runoff is an increasingly common BMP being required and implemented through stormwater permits. Retention can be accomplished via infiltration, harvest and use, and/or evapotranspiration. The primary mechanism for retaining on site is infiltration. Infiltration of stormwater can be highly beneficial for augmenting water supplies, restoring natural infiltration levels, and providing base flows to streams when done carefully. Studies have shown that, if soil conditions are suitable for infiltration at a given site, the post project infiltration at that site can be up to several times higher than natural conditions. However, stormwater infiltration has the potential to result in un-intended impacts to groundwater systems that subsequently can impact infrastructure, mobilize and move existing contaminated soils and groundwater, introduce stormwater pollutants to groundwater, and alter natural stream flow regimes. Harvest and use of runoff has its limitations for being effective as well, as the key to success is having a relatively rapid demand for the harvested water to recover storage. If demand is inadequate, harvest and use systems will be marginally effective.

Desired Outcomes
The goal of this project is to develop a Southern California specific guidance document on how to determine the appropriate situations for on-site stormwater retention. The document would include criteria aimed at maximizing effectiveness of this BMP, while minimizing potential negative effects or unintended consequences.

Tasks
1. Conduct review of existing on-site retention guidance. Identify potential data sources, including relevant GIS layers, available data for on-site retention BMPs, and other relevant data. Review and describe potential water rights issues associated with infiltration and harvest/re-use.
2. Review other studies that have linked surface water to groundwater pollutant transfer.
3. Build a GIS data set of relevant layers of information that should be considered when siting retention facilities. Some examples include soil types, depth to groundwater, slopes, natural and man-caused soils and groundwater contamination or elevated concentrations (i.e. nutrients), areas with sanitary inflow and infiltration problems, drainages to ephemeral streams with critical species. Also, obtain GIS layers for areas with reclaimed water use for irrigation to help inform harvest and use evaluation.
4. Use GIS layers to identify potential areas for infiltration opportunities, as well as harvest and use areas. Also, delineate areas where these BMPs are potentially not feasible or desirable.
5. Conduct evaluations of potential harvest and use scenarios that consider long-term continuous precipitation records vs. demand levels for irrigation and toilet flushing. Develop parameters for when harvest and use is a viable option.

6. Critically review and evaluate potential evapotranspiration options for Southern California, considering plant pallets for landscaped areas, potential for routing runoff into landscaped areas, green and brown roofs (considering the irrigation and maintenance demands), etc. Prepare guidance on ET options.
7. Conduct modeling evaluations to assess potential benefits for water supply or restoration of natural groundwater recharge levels, as well as potential impacts from infiltration and harvest and use of urban runoff. A variety of scenarios should be evaluated to provide demonstrations of potential benefits and impacts.
8. Develop a Southern California Guidance Document on siting of on-site Stormwater Retention, including recommendations for future monitoring and research needs.

Schedule

This project could begin immediately and would take 18–24 months to complete.

Necessary Resources

This project would cost approximately $300,000. The project should leverage work already initiated by the Counties of Orange and Ventura.

5.4 Improving Trash Controls and Tools to Assess Progress

Problem Statement

Trash is one of the most publically visible water quality concerns. In response, recent permits require municipalities to achieve significant trash load reductions from their stormwater conveyance systems. There are currently two main options for compliance; a) install full capture devices in all areas identified in the plan; or b) implement actions in all areas identified in the plan that achieve an equivalent level of trash reduction as full capture. The latter option typically takes the form of true source control (e.g., product bans), pollution prevention (e.g., public education and outreach), and/or institutional control BMPs (e.g., street sweeping and storm drain cleaning). However, critical information gaps on the performance of these strategies exist. Additionally, standardized assessment methods that may be used to demonstrate progress towards trash reduction goals are currently unavailable.

Desired Outcome

The goal of this project is to develop tools to assist SMC member agencies in evaluating the efficacy of their trash control programs. Ultimately, two main products will be produced; a) a performance evaluation of alternatives to full capture devices and revising performance standards for these actions. The second is an assessment tool that may be used by SMC members to demonstrate progress towards trash implementation requirements in general.

Tasks

This project would occur in two phases based on the two primary goals of the project. The two phases could occur simultaneously.

Phase 1 – Assessing performance of alternative trash control methods

1. Survey SMC members to determine the trash control strategies currently used. Supplement this information with a literature review on trash assessment methods used by other programs or states
2. Select a set of trash control measures to be tested and the locales in which initial testing will occur. This will be based on the commonality of the methods and the willingness of project partners.

3. Develop a sampling and analysis plan
4. Conduct performance assessments of alternative methods based on the sampling and analysis plan
5. Analyze performance relative to pre-established criteria and/or regulatory targets.
6. Develop technically defensible performance standard for one or more trash control measures that demonstrate equivalency to full capture devices

Phase 2 – Developing a trash reduction assessment procedure (TRAP)

1. Survey SMC members on the strengths and weaknesses of currently used trash assessment methods, including methods used in past SMC monitoring. Supplement this information with a review of trash assessment procedures used in other areas.
2. Convene a workgroup of regulators, regulated entities and NGO to provide input on appropriate endpoints for trash assessment.
3. Develop draft assessment procedure based on assessment of existing approaches. Include metrics for assessing how well the tool performs
4. Pilot test the assessment tool in selected areas based on willing project partners
5. Refine assessment tools based on pilot application. Include development of quality control measures and data quality objectives
6. Produce assessment tool document that SMC participants can use to demonstrate progress towards achieving trash reduction goals associated with MS4 discharges.

Schedule

Phase 1 of this project can be completed in 2 years and will require active participation from one or more municipalities to identify and evaluate alternative measures. Phase 2 will take an additional 2 years that will include at least one full sampling season.

Necessary Resources

The project will cost between $200,000 and $400,000 with approximately half of this cost associated with each task. The range of costs is based on the number of devices selected for testing. The project will also require in-kind contributions from project partners in terms of information compilation and testing of assessment tools.

5.5 Development of a Model Framework for a Stormwater Control Offset/Trading Program

Problem Statement

Stormwater permit requirements encourage strategies such as on-site retention to reduce water quality and hydromodification effects to streams. However, many parcels are located in areas where on site infiltration is not feasible or desirable due to factors such as geologic and groundwater issues, space limitations due to development density, or economic feasibility of BMP construction and operation and maintenance costs. Under such circumstances, the ability to provide for an equivalent offsite opportunity to satisfy compliance with stormwater quality requirements is needed. This could be accomplished through construction of an equivalent sized BMP at another location or a monetary contribution to a regional BMP project. Many of the current MS4 permits allow for this approach, however, the means and methods to implement such an approach have not been developed or evaluated.

Desired Outcome

The goal of this project is to develop a model framework for implementing a stormwater control offset/trading program that will assist SMC participants in meeting water quality and hydromodification management requirements through off-site or alternative control measures. This framework could be used as a component of alternative compliance strategies allowed by some stormwater permits.

Tasks

1. Form working group of representative stakeholders including regulatory agencies, municipalities, and NGOs
2. Conduct a needs assessment that documents the benefits and constraints associated with developing an offset/trading program
3. Survey existing offset programs that have been developed in the U.S., EU, and Australia. Develop a synthesis of potential strategies that could be adapted for use in Southern California.
4. Develop model framework for offsets that includes an appropriate crediting mechanism and institutional, policy and technical guidance and recommendations.
5. Test the offset framework through a model application in a test subwatershed of interest.
6. Amend framework document to include recommendations and lessons from the model application.

Schedule

Development of the framework would take approximately 24 months. Pilot application would be contingent on having an appropriate watershed and willing local stakeholders, but could be accomplished in approximately 12 months.

Necessary Resources

This project would cost between $150,000 and $250,000. The project should be coordinated with other research plan projects with similar elements or objectives:

- *Hydromodification Guidance for Urban Streams*
- *"Retention" of Stormwater Onsite – Benefits and Potential Negative Impacts*

5.6 Use Attainability Analysis Case Study for an Engineered Channel

Problem Statement

A Use Attainability Analysis (UAA) is a tool recommended by EPA to revise and change use designations where needed. The use of UAA is nowhere as important as in in the highly engineered channels of urbanized Southern California due to conflicts in use designations, beneficial use applicability, and water quality objectives/TMDL targets for these uses. However, there is no well-defined framework describing the technical criteria for conducting UAAs in this region, which has been a challenge to revising existing designated uses. Such a framework needs to be developed in collaboration with all appropriate stakeholders, including facility owners, dischargers, regulators, and public interest groups. In addition, there may be other approaches that could be identified that could modify how compliance with a beneficial use is required by a discharger. Such an approach could provide the same benefit without the need to change the actual beneficial use designation.

Desired Outcome

The goal of this project is to develop a model approach that defines the technical criteria to perform a UAA for engineered channels in Southern California. The approach(s) should provide a consistent and credible evaluation process for designated beneficial uses.

Tasks

1. Form a working group of representative stakeholders to participate in development process
2. Evaluate previous UAAs for lessons learned
3. Determine if there are other approaches that could modify how compliance with a beneficial use is required by a discharger without the need to change the actual beneficial use designation.
4. Develop proposed model technical approach for a UAA which includes an assessment of the cost to comply with the present designations.
5. Identify an engineered channel to perform a pilot study of the model approach
6. Complete and assess pilot study results
7. Prepare Model guidance document

Schedule

Given past complications associated with development of UAA's it is difficult to precisely estimate how much time this project would take. A minimum of 24 months should be allotted; however, it could take substantially more time if the process proves to be controversial. A time-saving option, albeit less realistic, is to conduct the pilot study virtually.

Necessary Resources

The project could cost between $50,000 and $150,000 depending on how many meetings might be necessary to complete the process. This would not include the cost of additional data collection for the pilot study.

5.7 Optimizing Retrofit of Existing Urban Areas with Green Infrastructure

Problem Statement

LID features (green infrastructure) such as infiltration and biofiltration are a common strategy required by most stormwater permits. LID is often implemented through incorporation into new development, through stand-alone retrofit projects (by municipalities), or by integration into redevelopment. Little study has been dedicated to retrofit planning to determine the costs and benefits of various retrofit strategies, and where resources for retrofit should be prioritized. The lack of information demonstrating the return on investment of public funds may be a barrier to LID implementation. Understanding the extent of retrofit required to meet water quality goals, as well as the extent to which it is practical to retrofit in the built environment, would help planners determine the most effective combination of green and grey infrastructure (traditional end of pipe solutions).

Desired Outcome

The goal of this project is to demonstrate an approach for assessing the optimum level of green vs. grey infrastructure retrofit in an urban watershed. Using a case study in a specific watershed, the project will determine the most effective combination (optimized for cost and benefit) of green and grey infrastructure retrofit, when fully implemented along with non-structural measures. Results will be available for use as a model for other watersheds interested in conducting similar analysis.

Tasks

1. Select a watershed to conduct the optimization case study. The selected watershed (or sub-watershed) ideally will have mixed land uses, drain to a single concentration point, be gauged and have water quality sampling data.
2. Develop a GIS database for the selected watershed including topographic information, rainfall data, existing water quality data, land use, storm drain infrastructure, soils, and locations and

types of existing BMPs

3. Develop a model to simulate the hydrologic and pollutant transport in the selected watershed/subwatershed. Existing structural and non-structural BMPs should be included in the model.
4. Identify potential locations for implementation of green and grey infrastructure retrofit. The candidate retrofit sites will be refined based on field review as necessary.
5. Identify management targets and assessment endpoints based on water quality issues of the selected watershed.
6. Incorporate BMP layers into the watershed model. Performance measures for BMPs will be based on information from local studies, supplemented by information from the International BMP database.
7. Model various BMP retrofit scenarios. A mix of grey and green infrastructure retrofits in various proportions can be evaluated, e.g. 50% LID/50% Grey, 60% LID/40% Grey, 70% LID/30% Grey.
8. Produce a guidance document based on the watershed study that illustrates how to conduct the optimization analysis and present the results of the watershed case study

Schedule

The project will take approximately 24 months to complete assuming little or no new field data needs to be collected. An additional 12-24 months should be added to the schedule if additional field data is necessary.

Necessary Resources

This project will cost between $300,000 and $500,000. This cost assumes minimal data collection of BMP performance. The study will require having access to both GIS data layers and field monitoring data. The more field data that needs to be collected empirically, the higher the cost.

6.0 FOUNDATIONAL SCIENTIFIC UNDERSTANDING

Environmental management is confounded by limitations in our basic understanding of mechanisms and processes that control stormwater discharge and its effects on receiving waters. The complexities increase dramatically when large-scale processes impose baseline shifts in the local environment. The theme of this research area is to elucidate these challenges by taking first steps towards expanding foundational scientific understanding of key processes and mechanisms. This understanding will provide the necessary context for managers to select future management actions.

6.1 Improved Quantification of Links Between Nutrient Concentrations and Indicators of Beneficial Uses

Problem Statement

The State is moving towards Nutrient Numeric Endpoints (NNE), a water quality objective framework based on the ecological response of a waterbody to nutrient over-enrichment. The NNE framework attempts to link nutrient concentrations and loads to proximal receiving water effects (e.g. excessive algal growth, decreased dissolved oxygen) that impact beneficial uses. However, causal relationships between nutrient inputs and the proximal effects/regulatory endpoints are uncertain, which precludes managers from setting defensible targets and minimizing impacts. The linkages between nutrients and endpoints must be better understood in order to take advantage of the NNE framework in setting water quality objectives in streams, lakes, and estuaries.

Expected Outcomes

The goal of this project is to improve our understanding of the relationship between nutrient inputs and both proximate effects and more integrative endpoints such as aquatic life. This understanding should culminate in a predictive model that can accurately predict response under a range of ecosystem characteristics (light, residence time, temperature, substrate type).

Tasks

1. Review status of the science on nutrient numeric endpoints
2. Compile available data on inputs and response indicators
3. Identify data gaps and use those data gaps to prioritize data needs
4. Identify priority habitats for investigation
5. Collect supplemental data in target habitats
    a. Nutrient sources and biological endpoints
    b. Basic characterization of sources including seasonal variability
6. Develop predictive models that relate nutrient sources to biological effects
    a. Investigate utility of different modeling approaches, both statistical and mechanistic
7. Conduct mechanistic or process studies that can be used to validate models
    a. Relationship between algal biomass and benthic indicators
    b. Mitigating effects of flow
8. Provide a user interface for SMC member agencies to use
    a. Guidance manual
    b. Web calculator (optional)

Schedule

This project could begin right away and would take between two and four years, depending on habitat selected. More than one habitat could be worked on at one time.

Necessary Resources

This project will take between $250,000 and $1,000,000 depending upon which habitat is selected and the availability of existing data for calibrating and validating the model. Intermediate steps could be undertaken (i.e., data gap identification, data collection) to investigate the scope of future work at a reduced cost and schedule. Expertize in biogeochemistry and stress-response modeling will be required for this project. Additional resources from the State may be available for cost leveraging if the project is implemented soon. This project has the potential to link with *Improve Quantification Linkages between Nutrient Concentrations and Indicators of Beneficial Uses* if cyanobacteria are used as a management endpoint.

6.2 Stormwater Effects on Ocean Acidification and Hypoxia

Problem Statement

As carbon dioxide in the global atmosphere increases, it results in two global threats to oceans. The first is a decrease in the pH, known as ocean acidification, which results directly from carbon dioxide reactions with seawater. The second is low dissolved oxygen (hypoxia) resulting from, among other things, increasing global temperatures that enhances the shoaling of deep, hypoxic ocean waters. Both pose a global threat to marine life, particularly here in Southern California. Local nutrient contributions can exacerbate the effects of ocean acidification and hypoxia. As excess nutrients enter the coastal ocean, they fuel algal blooms that eventually senesce, consuming oxygen and decreasing the pH. The extent that local nutrient inputs can accelerate the rate of ocean acidification and hypoxia impacts is uncertain. Nevertheless, regulatory and management agencies are considering placing limitations on future nutrient discharges as a strategy to mitigate the localized effects of acidification and hypoxia in near-shore coastal waters. Nutrients in stormwater are one source that managers are considering for increased controls. Understanding the relationship between stormwater associated nutrients and effects in the coastal ocean are critical to making informed management decisions regarding acidification and hypoxia.

Expected Outcomes

The goal of this project is to determine linkages between stormwater nutrient inputs and local patterns of hypoxia and ocean acidification. This will require a linked physical oceanographic and biogeochemical model that can incorporate other sources of nutrients including treated wastewater, atmospheric deposition and upwelling. Ultimately, the project should create a map outlining zones of potential concern for stormwater effects on ocean acidification and hypoxia along the Southern California coast relative to major stormwater inputs (e.g. river mouths and storm drains).

Tasks

1. Develop a conceptual model of the role of stormwater inputs relative to other sources of nutrients and the subsequent effects on pH and dissolved oxygen in coastal waters.
2. Compile data on relative stormwater derived inputs of nutrient and freshwater along the Southern California coast relative to known locations of hypoxia or low pH.
3. Select endmember sites that bound assumed high vs. low contributions of stormwater inputs.
4. Develop preliminary budget of relative source contributions in end member locations.

The results of this project can be made available to existing and proposed efforts focused on investigating ways to mitigate localized acidification and hypoxia. Specifically, the preliminary budgets developed under this project could serve as input to regional models (being developed by the Ocean Protection Council and others) evaluating the effects of water and wastewater inputs. However, development of such models is beyond the scope of this project.

Schedule

This project should begin soon, since the linked physical oceanographic and biogeochemical modeling is kicking off with an Ocean Protection Council modeling workshop in December 2013. This workshop will identify the best model(s) for this project. Timing is also important since the State is about to initiate an Ocean Acidification and Hypoxia Expert Panel that will determine if stormwater nutrients are a potential source of concern.

Necessary Resources

This project will cost approximately $100,000–150,000 assuming no new data collection is required.

6.3 Effect of Climate Change on Stormwater Quality

Problem Statement

Recent downscaling studies of global climate change predict increases in annual average temperature of more than 5°F, with a commensurate loss in annual precipitation in southern California by the year 2050. These region-wide changes will overlay each SMC member agency's stormwater program with fewer, but perhaps more intense, local storm events. As Southern California plans for the effects of climate change, most modeling efforts have focused on hydrologic (i.e., flooding, sea level rise) effects. However, changes in the frequency, magnitude and duration of runoff have the potential to also affect water quality and resident biological communities, which are the current focus of regulatory and management programs. Yet, virtually no research into climate change effects on water quality and resident biota has occurred.

Expected Outcomes

The goal of this project is to identify potential water quality effects associated with anticipated changes in temperature and runoff. In addition, the project should identify how climate induced changes in biological communities may affect performance/interpretation of existing condition assessment tools. Ultimately, this project should culminate in a white paper listing the potential areas of concern, and a list of recommended future studies or actions.

Tasks

1. Summarize existing status of science and modeling for climate change effects on rainfall runoff patterns, including build-up/wash-off scenarios
2. Convene a task force of scientists and managers to identify potential hydrologic and water quality effects
3. Create a flow chart of potential mechanisms that could affect stormwater quality under future runoff scenarios
4. Identify potential management actions that might be influenced by potential changes in stormwater quality/loading
5. Identify potential changes that could affect the performance or scaling of current biological assessment tools (e.g. California Stream Condition Index)
6. Produce task force recommendations for future studies and monitoring efforts that can be used to assess trends over time relative to climate change effects

Schedule

This project could begin immediately and should take less than one year to complete. The task force should include both scientists and managers, which will likely include both SMC member and non-member agencies.

Necessary Resources

This project should cost less than $75,000 depending upon number of task force members and meetings they attend. Although little research into the effect of climate change on water quality and biological communities has occurred, some universities are very active in modeling the climate conditions including UCLA, USC, UCSB, and UCSD.

6.4 Interaction Between Stormwater Runoff and Cyanotoxins

Problem Statement

Cyanotoxins are released by *Cyanobacteria*, a genus of blue-green algae. Exposure to cyanotoxins can range from skin rashes to death, particularly when dense *Cyanobacteria* blooms form as a result of eutrophication. Recent monitoring of streams and lakes around California has observed *Cyanobacteria* in virtually every location sampled, indicating the potential for a bloom in almost any waterbody. However, the causal pathways that link excess nutrients to blooms is unclear; high nutrient concentrations do not necessarily result in *Cyanobacteria* blooms and *Cyanobacteria* blooms do not always produce cyanotoxins. Therefore, it is unclear if there is the need for new or different management actions to control for this harmful toxin.

Expected Outcomes

The goal of this project is to investigate the relationship between dry and wet weather runoff on freshwater cyanotoxins. Ultimately, this project will provide preliminary information on potential mechanistic relationships and make recommendations for future monitoring and assessment programs

Tasks

1. Develop conceptual model of relationship between runoff and blooms, including potential mitigating or exacerbating factors of chemical or physical properties (e.g. conductivity, turbidity, pH, temperature, flow).
2. Analyze relationships between stressors (flow, nutrients, etc.) and blooms using existing environmental data – include exploration of differences based on season, year, and habitats/subhabitats (e.g. pools vs. riffles).
3. Identify priority habitats for investigations.
4. Conduct studies to test hypotheses based on conceptual model using either field or laboratory methods.
5. Investigate relationship between cyanotoxins and biological communities (e.g. BMI, fish).
6. Develop monitoring recommendations to improve future predictive efforts and validate conceptual model.

Schedule

This project should take between 24 and 36 months to complete, depending on the number of environmental variables selected.

Necessary Resources

This project will cost between $100,000 and $300,000 depending on the level and intensity of testing. A factorial design will be used for lab/field testing, so each factor added doubles the cost of the study. Fortunately, the statewide survey can be combined with the SMC regional survey to produce a reasonably large data set for evaluation in Task 2. The State Water Resources Control Board has convened a Cyanobacteria Working Group that should be contacted for collaboration opportunities.

7.0 IMPORTANT PROJECTS NOT IN THE AGENDA

While the Expert Panel selected 21 high priority projects, there were at least three projects the Expert Panel thought were important, but were not selected for various reasons. These three projects included: 1) Quantitative Microbial Risk Assessment for swimming related illnesses; 2) deriving numeric effluent limits for urban stormwater runoff, and; 3) stormwater pollutant fate and transport. The Quantitative Microbial Risk Assessment (QMRA) was not selected because there is currently an effort underway to evaluate QMRA funded by the State. The Expert Panel felt it would be wiser to wait and see what the efforts of this demonstration study were before planning an SMC study. In this way, the SMC can learn from the State's challenges and successes, and conduct the additional work identified in the State's demonstration project. Deriving numeric limits for stormwater discharges was not selected because the concept of numeric limits was incorporated into several projects already including *Hydromodification Guidance for Urban Streams or Improving Trash Controls and Tools to Assess Progress.* Stormwater pollutant fate and transport was not selected because of the overlap with projects like *Characterization of Stormwater Effects*. However, the panel was particularly interested in the linkage of stormwater particle-associated pollutants and its ultimate fate in sediments at the bottom of the watershed. The Panel would like the SMC to steer towards these projects, even though they are not immediately implementable on their future agenda.

8.0 LINKAGES AMONG PROJECTS

While the 21 projects selected by the expert panel are presented independently, there are a number of important linkages. These linkages fall into one of three categories: 1) sharing of tasks among projects; 2) projects that build off one another, and; 3) projects that will spawn future efforts. A good example of projects that share tasks would be the nutrient related projects, which both focus on inventorying mass contributions relative to effects. A second example are the projects that require a test watershed such as *Standardize Hydrologic Methods, Hydromodification Guidance for Urban Streams, Flood Control Detention Retrofit to Improve Water Quality Performance*, and *Development of a Model Framework for a Stormwater Control Offset/Trading Program*. All of the projects in this plan could potentially spin off potential future projects. However, the tool development and scientific understanding projects are particularly well suited for this purpose. An example from the assessment tool section would include *Evaluating Potential of Remote Sensing Technology* and *Effect of Climate Change on Stormwater Quality*.