SSWR Project Charter
Watershed Sustainability – Project 1 (3.01)

Project Title: SSWR Project 3.01: Assess, map, and predict the integrity, resilience, and recovery potential of the Nation's water resources
Project Subtitle: Watershed and Waterbody Integrity and Sustainability

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Project Start Date: FY16

Project End Date: FY19

Executive Summary

The U.S. EPA, in partnership with the States and Tribes, is required under the Clean Water Act to assess and report on the integrity of the Nation's water resources. For inland water resources the integrity of the system is reliant on the integrity of their surrounding and supporting watersheds. For coastal systems (e.g., Great Lakes, estuaries and near-shore marine coasts), the contributions (chemical, physical and biological) of the coastal watershed and the offshore inputs to their integrity must be considered. Thus, for inland waters, EPA needs the capability to determine the integrity of the watersheds and aquatic systems therein and their sustainability, i.e. the sustained provision of ecosystem services and beneficial uses upon which we rely. For coastal waters, it is important to understand how the linked watershed-waterbody-coastal system functions and the contribution of each portion of the system. Predicting and retroactively assessing the impacts of policy and management decisions affecting our water resources is needed to enhance the EPA's ability to set sound water policy applicable to the Nation's flowing waters, lakes and reservoirs, wetlands, estuaries and coastal waters, for the protection of aquatic life and human health. Project 3.01 will strengthen EPA's

ability to estimate and map the integrity of our Nation's water resources, and develop the capability to determine the integrity of any watershed in the Nation. Additionally, ORD research will apply and quantify the concept of aquatic system and watershed integrity and connectivity at multiple spatial and temporal scales. System vulnerability, restoration potential, and effect on waterbody and watershed resilience will be assessed to facilitate policy and management decisions by stakeholders at national, regional, state and local scales. Lastly, modeling tools that will allow the Office of Water and EPA Regions to estimate the expected improvement in aquatic condition, integrity and resiliency resulting from any proposed policy and or management shifts.

Research Project Description

The ambitious vision for Project 3.01 is to provide the scientific basis and tools for integrated assessment of watersheds and waterbodies, from headwaters to coastal systems at local, regional, and national scales. At a broad scale, the science focuses on using the Office of Waters National Aquatic Resource Surveys (NARS) and large-scale data sets to monitor and assess the condition and integrity of the Nation's waters. The tools will focus on endpoints of aquatic life, human health, and final ecosystem goods and services to quantify the complex nature of watershed integrity and sustainability. In addition, Project 3.01 research will consider the impacts of human activities that result in the most significant changes to integrity, as well as the ability of natural systems to maintain integrity when exposed to stressors. A brief list of potential stressors include climate change, invasive species, land use change, physical habitat changes, hydrologic changes, nutrient additions and toxicant loading.

EPA, under the Office of Water's NARS is currently implementing tools developed by ORD to monitor and assess the condition of the Nation's water resources. OW and the Regions require ORD's continued technical support for these programs which will include the development of additional tools, technologies and indicators, as well as capability to address additional waterbody types and components and to bring to bear advanced geospatial and analytical tools. For instance, ORD is currently developing the capability to predict the probability of system integrity at unmonitored locations. This research on spatially predicting condition will continue under the proposed SSWR project until a stable set of tools can be demonstrated nationally and delivered to OW for long-term implementation. Also, under current SSWR efforts, ORD has proposed an operational definition for Watershed Integrity and proposed an approach to quantify this watershed characteristic. Operationalizing the components of watershed integrity and developing the tools to produce a reliable map of watershed integrity will be a key research activity within Project 3.01. Research to quantify connectivity will also be conducted, including research to examine the connectivity of freshwater streams, wetlands, and other aquatic features and the connections between coastal waters and both their immediate watersheds and the broader offshore inputs. Another key research area under Project 3.01 will be to quantify waterbody and watershed resilience at multiple spatial and temporal scales. As part of this research, the variables important to resilience and vulnerability (components of ecosystem and watershed integrity) will be defined and quantified, and used to help to define restoration potential. This information will help managers to make decisions and

communicate those decisions to the public. The scientific basis and the tools quantifying waterbody and watershed integrity and elements of resilience and recovery potential will provide for national, regional and local assessments that are interpretable and translatable at different scales and allow end-users the ability to set and evaluate policy and management options at the appropriate management scale.

Project Impact

The easiest way to envision the end results of SSWR 3.01 are as color-coded maps of watershed integrity and sustainability underlain by maps of resilience and recovery potential. These multiple layers are important in facilitating policy and management decision-making. The models and other tools underpinning these maps are the research elements of SSWR Project 3.01: the development of assessment tools and characterizing the complex functional and supportive relationships within, among, and between systems.

By the end of FY19, SSWR Project 3.01 will: (1) Support and further the broad-scale monitoring and assessments that are currently produced under NARS and other programs; (2) Expand NARS interpretation to the integrity of watersheds and watershed components; (3) Define and demonstrate operational applications of the concepts of resilience and restoration potential at multiple spatial and temporal scales; (4) Working across SSWR Topic 1, develop models and scenarios supporting policy and management alternatives to improve the integrity of the Nation's watersheds and aquatic components; and (5) In concert with SSWR projects and our collaborators in SHC (and other ORD national research programs), integrate environmental, social and economic science in a common model of watershed integrity and sustainability.

Project Scope

SSWR Project 3.01 will provide the scientific basis for informed decision-making and tools applicable to EPA Office of Water and Regions' needs at the national and regional scales. This intended scope recognizes the need to support local- and regional-scale research insofar as the lessons learned and research products are transferable to national and large-scale assessments and the outcome will further refine, complement and/or supplement the national assessments. Technological transferability of these tools to states and tribal nations will also be an important component of research in Project 3.01, as well as throughout Topic 3. Application of Project 3.01 tools, models and maps at different spatial scales will allow more appropriate matching of management action at the scale at which the threat or cause of degradation can be most effectively addressed. The term multi-scale assessment recognizes that our water resources range from small headwater streams to large coastal estuaries, and that these resources can be examined at regional as well as national scales. Within each water resource type (e.g., flowing waters, lakes and reservoirs, wetlands, estuaries and near shore waters) and watershed elements, a wide range of types and sizes of aquatic systems occur, as well as stressors and effects (i.e., perturbations affecting functional, community, and ecosystem processes within aquatic systems). The condition assessment, watershed integrity, resilience, and restoration potential tools must be developed such that they are applicable across large regions of the country, indeed, to all of our Nation's water resources.

Project Structure and Rationale

There are multiple components to this project charter which are organized below into four focal task areas, with multiple sub-tasks. The four major task areas include:

1) Technical Support and Research on Enhancement of OW National Aquatic Resource Surveys (~15 FTE),
2) Estimating and Predicting Water Resource Condition and Watershed Integrity (~10 FTE),
3) Watershed resilience, recovery potential and sustainability (~15 FTE), and
4) Modeling to predict watershed sustainability and predict improvements resulting from any proposed policy and or management shifts (~15 FTE).

These focal task areas, the task leads and research projects (i.e., subtasks) therein will interact provide tools for the integrated assessment of watersheds and component waterbodies, including estuarine systems, at national, regional, and local scales.

Proposed Task Focal Areas

Task A: Technical support and research on enhancement of Office of Waters National Aquatic Resource Surveys (NARS) – The primary focus of this task is to provide the technical support and research needed to maintain and enhance the national and regional assessment needs of the Office of Water. Subtasks envisioned under this Task Area include the following:

Subtask A.1: Scientific Development and Support of Broad-scale Surveys. Approaches and indicators for some broad-scale surveys are well developed yet require updating as additional tools and technologies become available and additional endpoints rise to attention. For example, multiple NARS status and trends survey cycles have been completed for inland lakes and streams, but there is potential for incorporating new endpoints (e.g., ecosystem goods and services metrics, contaminants of emerging concern) and new assessment methods (e.g., new sensor types, DNA-based identification of organisms, stable isotopes). Other waterbody types and other survey goals still require approaches to be developed and tested. For example, outcomes of the first national-scale wetland condition assessment are still being analyzed, piloting of designs for Great Lakes connecting channels is actively underway, and research to develop strategies for invasive species early detection monitoring is ongoing. This subtask focuses on providing technical support for survey design, indicators, and assessment in the NARS program. It further brings together a combination of survey-specific research (e.g., designs and indicators for specific water body types) and research developing capacities applicable to multiple survey efforts (e.g., tools and technologies) as well as general support to program offices and regions in collecting and analyzing survey data.

Subtask 3.01A.2: Research that Underpins the Foundations of Integrity. This research subtask focuses on enhancing the critical vulnerabilities for NARS which are primarily related to setting thresholds for interpreting indicator results. For instance, defining reference conditions for

aquatic systems, including the functional, biological, physical, and energy transfer components of aquatic systems, is important to understanding system processes and integrity. Reference conditions will vary among water body types, and perhaps among ecoregions. Research to characterize and define unimpacted and minimally impacted areas and quantify system component functioning therein will be explored. Furthermore, research quantifying appropriate thresholds to define system condition (e.g., excellent, good, fair, poor and severely altered) as indicated by incremental changes in response are needed to help decision-makers prioritize management actions. The relationships between ecological endpoints (e.g., biotic resources in a waterbody) and the multiple stressors present in the waterbody and watershed will be examined. This subtask within Project 3.01 will also analyze the connectivity of aquatic elements, including wetlands (e.g., geographically isolated wetlands, coastal marshes, submerged aquatic vegetation, etc.), lakes, streams, rivers, estuaries, and near-coastal areas and how the transfer and transformation of materials and energy between and among system components characterizes and supports system integrity.

Task B: Estimating and Predicting Water Resource Condition and Watershed Integrity – The objective of this effort is to develop a regional or national scale modeling and diagnostic system that provides spatially explicit modeled outputs of waterbody and watershed integrity for both current conditions and future scenarios in inland and coastal watersheds. Subtasks include the following:

Subtask B.1: Characterization of Aquatic System Condition at Multiple Scales and Supporting Cross-scale Research. The focus of this area is continuation of efforts to develop models that predict ecological condition in aquatic resources that were not specifically monitored but whose resource class was included in broad-scale surveys (e.g., NARS). The modeling within subtask B.1 will be spatial in nature so that maps of condition can be developed.

Subtask B.2. Application of System Models to Assess and Predict Watershed Integrity. Though modeling and diagnostic processes are available to assess and predict how watershed alterations impact human health and ecosystem integrity, no dedicated system exists to place these processes into a systems construct (incorporating waterbodies and component structures and targeting waterbody and watershed integrity). ORD has proposed a definition of watershed integrity and a conceptual model of how it might be modeled and spatially predicted. This research will apply these concepts, evaluate their applicability, and map the outcome nationally and regionally.

Task C: Watershed resilience, recovery potential and sustainability – The objective of Task C is to focus on identifying resilient watersheds and aquatic systems to characterize the components of resiliency. Furthermore, Task C will focus on identifying potential system and system components with high recovery potential, and work to quantify the potential effects of recovery on sustainability. Subtasks include the following:

Subtask C.1 Characterization of Resilience and Recovery/Restoration Potential for Waterbodies and Watersheds. Watershed resilience and recovery potential are important concepts for the

management of aquatic systems. They address how well aquatic systems rebound when stressors are removed and when management actions are taken. Structural, physical, chemical, hydrological, and biological factors contribute at both proximal and distal scales to affect the resiliency of aquatic systems. System component interchange, such as between surface and ground waters, can also affect resiliency. Through modeling and data exploration, subtask C.1 will identify resilient systems and provide decision-makers tools and information to implement adaptive management for sustainable outcomes. Adaptive management scenarios within C.1 will also consider impacts from climate change, which may include sea level rise and associated loss of habitat (for coastal areas), climatological changes in precipitation and temperature patterns and intensity (etc.), acidification and other physical and chemical changes, along with associated species distribution shifts and changes in system functioning. The development of indicators of resiliency within C.1 will provide the potential to map resilient systems at state, regional, and national scales and to understand the elements that improve system resiliency.

Subtask C.2 Application of System Models to Assess Watershed Sustainability. Sustainability relies on the concepts of water resource integrity, resilience and recovery potential and applies them in concert with final ecosystem goods and services and economic analyses. The main objective of subtask C.2 is to develop a regional or national-scale modeling and diagnostic system that provides spatially explicit modeled outputs of waterbody and watershed sustainability for both current conditions and future scenarios in inland and coastal watersheds. This research works with ORD's Safe and Healthy Communities to apply definitions of Sustainability as they apply to watersheds and evaluates how they might be implemented by Office of Water in its strategic planning.

Task D: Modeling to Predict Watershed Sustainability and Predict Improvements Resulting from any Proposed Policy and/or Management Shifts – The objective of Task D is to provide guidance on the use or modification of existing models and tools for integrated watershed management at multiple scales for multiple water body types. Subtasks include the following:

Subtask D.1: Watershed Modeling and Its link to Watershed Sustainability and Connections between National, Regional and Local Models. Watershed sustainability is a goal of EPA Regions and Offices but our state, tribal, and community partners are challenged by a lack of efficient tools, incomplete management approaches, and data gaps in order to maintain their water resources. Issues of how to monitor improvement (or impairment), how to reconcile model based assessment with real-world conditions, and how to apply and interpret complex water quality standards make sustainable watershed management exceedingly complex. There is a need to evaluate existing watershed models, examine their commonalities and linkage across national, regional and local applications and their potential linkages to sustainability. Evaluation of watershed modeling tools, especially for extreme high- and low-flow events and an understanding of the watershed components and processes that are not well represented in these models (i.e., green infrastructure, riparian systems, wetlands, ground water/surface water interactions, etc.) will be necessary to improve the models. New methods of economic valuation of water quality and availability on a watershed scale can be integrated with decision

support tools that also include state-of-the-science modeling and assessment to create dynamic and robust systems-based approaches to water management.

Subtask D.2: Estimate Final Ecosystem Services (FEGS) and their Values (Monetary and Non-Monetary). In concert with research in the Safe and Healthy Communities Research Program, estimates of FEGS will be defined as functions of watershed integrity and quantified over a range of scales. It will also be important to understand how benefits and values cascade downstream from headwaters to estuaries and coastal waters. Inclusion of FEGS as potential NARS endpoints will be explored in collaboration with OW, Regions, and states.

Subtask D.3: Develop and Apply Techniques for Estimating and Communicating the Human Health Benefits of Watershed Integrity. Urban and agricultural watersheds that have impaired water quality, aquatic habitats and biotic communities may also be areas associated with higher incidence of human illnesses. In partnership with the Safe and Healthy Communities Research Program within ORD, application of outputs from model organism exposures as well as epidemiological studies can be applied, and perhaps spatially described, at a watershed or subwatershed scale so that the benefits of watershed integrity are more easily communicated.

Subtask D.4 Modeling tools that will allow the Office of Water and EPA Regions to estimate the expected improvement in aquatic condition, integrity and resiliency resulting from any proposed policy and or management shifts. This area of research requires modelers from across disciplines to work together in producing a suite of models that allow Office of Water and Regions to have this important capability. OMB and others expect EPA to be able to inform them on the expected ecological and human health benefits of any proposed action at National and Regional scales. With predictions of expected improvements, future monitoring will the allow us to evaluate the effectiveness of the policy and management shifts. This cross discipline modeling is an important link with the economic cost and benefit analyses desired within the Agency and Congress. This area of research will have to link with modeling efforts throughout SSWR, SHC, and ACE.

Measures of Success

Measures of success for Project 3.01 are separated into expectations and endeavors. In summation, we expect to provide tools for the integrated assessment of watersheds and component waterbodies (including estuarine) at national, regional, and local scales through:

- National Aquatic Resource Surveys (NARS) support, including development and application of new tools and technologies
- Use of systems models to assess and predict watershed (and/or associated off-shore system) integrity and sustainability at multiple scales (including a national map)
- Characterization and prediction of watershed and/or waterbody resiliency and recovery potential at multiple spatial and/or temporal scales through advanced modeling (e.g., numeric, process-based, etc.)
- Quantification of watershed connectivity and effects, including connections between freshwater landscape elements (e.g., non-adjacent wetlands, streams lakes) as well as connections in coastal and near-shore systems

- Working across StRAPs to develop modeling scenarios addressing climate change impacts on watershed integrity (ACE), valuing and communicating ecosystem integrity (SHC), and linking human health and drinking/recreational water to watershed integrity

Under Project 3.01, we will further endeavor to achieve the:

- Development of models to hindcast and predict watershed integrity, resilience, and sustainability based on national-scale data (e.g. NARS)
- Application, quantification, and mapping of system resilience and recovery potential and potential impact on ecosystem function
- Operational definition of sustainability linking environmental, social and economic science in a common model of watershed integrity and sustainability

Stakeholders (outside ORD):

EPA Office of Water
Great Lakes National Program Office
EPA Regions
States
Tribes

Output(s)

There will be two major outputs from this task. The first is guidance to characterize and predict the condition and integrity of aquatic systems and their watersheds at multiple scales. The second is development and delivery of scientific tools for multi-scale assessments of multi-media effects on the condition, integrity and sustainability of the Nation's waters.

Key Products Identified

The major outputs of Project 3.01 will be comprised of multiple products. We anticipate the following key products will be delivered under Project 3.01:

- National Map of Watershed Integrity (and accompanying report)
- Report Predicting Coastal Water Integrity Based on Watershed and Off-shore Influences
- Report on Connectivity of Aquatic System Components (e.g., geographically isolated wetlands)
- Report Predicting Resilience and Recovery Potential for Multiple Waterbody Types

In addition, we anticipate that ORD scientists working within Project 3.01 will develop and deliver multiple additional tools and technologies in support of broad-scale monitoring and function assessment.

Assumptions and Constraints

Dependent upon development of the Enviro-Atlas (SHC) to overlay FEGS onto watershed and water body integrity maps and models.

Dependent upon collaboration with on Final Ecosystem Goods and Services. SHC to lead research on FEGS metrics; SSWR 3.01 research focused on incorporating those metrics into surveys and mapping efforts.

Sufficient FTE and extramural support available to support program objectives

Linkage with ACE for Climate Change predictions

Linkage with nutrient research under SSWR as one of the primary drivers of watershed and waterbody condition

Continued OW funding for annual sampling and data management for NARS

Availability and participation from human health scientists to work on applying human health models at the watershed or subwatershed scale

SSWR Project Charter
Watershed Sustainability – Project 2 (3.02)

Project Title: SSWR 3.02 Science to support new or revised water quality criteria to protect human health and aquatic life

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Project Start Date: October 1, 2015

Project End Date: September 30, 2019

Executive Summary

The objective of this project is to provide OW with the scientific basis to strengthen existing or advance new methods for prioritizing, deriving, and implementing water quality criteria that address the challenges presented by the expanding numbers, combinations, and novel features of contaminants and stressors to be addressed under OW's Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) responsibilities. This project will also provide Regions, States, Tribes and other stakeholders with the science and tools to support the implementation of criteria. The research contained in this Charter supports human health and aquatic life applications of the CWA. Research to support nutrients related criteria will be included in SSWR Topic 4.

Research Project Description

The CWA and SDWA give EPA the policy and regulatory responsibility to develop guidance to protect aquatic life in the Nation's waterways and reduce human exposures to poor water

quality from microbial and chemical contaminants. SDWA protects public health by regulating the nation's public drinking water supply including the nation's source waters (rivers, lakes, reservoirs, springs and ground water) that are used for drinking water. EPA is responsible for conducting research to inform decisions to ensure that the nation's watersheds are safe and sustainable for future generations. Research under Project 3.02 will focus on chemical and biological contaminants that can affect ecological and human health in freshwater and marine environments, or waters that serve as supplies for drinking water or both. In particular this research will focus on the prioritization, development, and implementation of ambient water quality criteria as important tools in meeting OW's responsibilities under the CWA and SDWA. Research will also assess impacts of climate change on criteria considerations.

The bulk of the current guidance for deriving ambient water quality criteria for aquatic life and human health was developed in the 1970's and 1980's. This guidance was deliberately designed to be fairly prescriptive, with the goal of maximizing the consistency and transparency of the criteria development process, and thereby avoid the ad hoc processes that were typical of prior criteria. Consistency and transparency remain important characteristics for criteria development; however our advancing understanding of the diversity and complexity of chemicals and other stressors and how they affect both human and ecological health make clear the need and opportunity to refine, enhance, or in some cases even replace those original methods and to address new challenges.

One such challenge is presented by the rapidly expanding range and characteristics of contaminants for which regulatory guidance is required, often loosely categorized as "Chemicals of Emerging Concern (CECs)" – these include chemicals that were not previously thought of as environmental pollutants (e.g., pharmaceuticals), chemicals whose presence in the environment was largely unnoticed but has been "discovered" more recently (e.g., through advancing analytical capabilities), and chemicals that may not necessarily be new, but whose potential for risk to human health or the environment was not widely recognized. Research to better understand the distribution, fate, and effects of these chemicals in aquatic environments is needed to identify those chemicals and exposures that pose significant risk, and to prioritize chemicals as candidates for the development of water quality criteria. Research on screening and prioritization techniques being conducted under the Safe Pesticides/Safe Products (SP2) is likely to have application to these issues.

Because of the large numbers of CECs of potential concern, development of means to efficiently monitor for exposure is critical. Several new technologies may help meet this need by monitoring chemicals via the biological responses they elicit, rather than just their chemical presence. For example, gene expression assays can be applied as indicators of exposure (and perhaps inferred effect) for groups of compounds that act through a common mechanism; such measures have the potential to inform development of ambient water quality criteria for chemical mixtures. Because many CECs act through mechanisms that are conserved across both ecological and human receptors, these studies also provide opportunities to simultaneously inform development of criteria for protection of both aquatic life and human

health. Tools developed under SP2, such as the SeqAPASS approach for predicting sensitivity via conserved toxicant targets, may be useful in establishing such connections.

Research to develop and improve human health Ambient Water Quality Criteria (AWQC) for pathogens and contaminants.

An important goal of the CWA is to protect and restore waters for swimming. Section 304(a) of the CWA directs EPA to publish and revise the AWQC to accurately reflect the latest scientific knowledge on the identifiable effects on health and welfare that might be expected from the presence of pollutants in any body of water. The CWA also provides regulatory tools to protect microbial water quality through microbial TMDLs and NPDES permits. Human health risks have been linked with recreational activities such as swimming related exposure due to the presence of pathogens in ambient water associated with fecal contamination. Fecal contamination can occur from not only human sources but also from animal (agriculture and wildlife) sources. The presence of pathogens in ambient water can affect human health through a) recreational exposures, b) chemical contaminants through consumption of fish or ingestion of water and c) chemicals and pathogens from anthropogenic activities in source water that have the potential to affect some of the Nation's drinking water even after treatment for naturally occurring pollutant concentrations.

There are a number of challenges associated with the development of microbial AWQC. One major challenge is the low densities of human pathogens in ambient waters which are often difficult to detect and yet can cause significant exposure risks. The Agency has used fecal indicator bacteria as surrogates to the presence human pathogens most of which originate from fecal sources. Understanding fecal sources in ambient waters becomes important to understand the potential health risks because pathogens associated with fecal contamination vary in part depending on the source of fecal contamination. Therefore the development of fecal indicators that closely mimic the persistence of pathogens and efficient (rapid, cost effective and sensitive) monitoring of the indicators, predictive modeling of fecal contamination and in the longer term the development of methods that are based on direct detection of pathogens are critical elements to identifying and controlling risks associated with recreational and potential drinking water exposures.

Rapid real-time determination of microbial water quality is an important element both for reducing health risks from swimming in recreational waters and to identify challenges in source water used for drinking water. Current methods typically take 24 or more hours for culture methods to be completed. This means that bathers are potentially exposed to poor water quality before the microbial water concentrations can be determined. Technological advances in molecular and other detection methods make it more feasible obtain water quality information in a timelier manner. However such methods need to be cost effective and perform well under widely varying water qualities.

Another important element to criteria development is understanding which pathogens are responsible for causing health effects and developing relationships between illness and

indicator densities. The development of biomarkers of exposure and infection to specific pathogens is an important element to the identification of pathogens which are the most responsible for increases in illness from swimming.

The development of new or revised human health criteria for chemicals are being considered for 118 chemicals taking into consideration new toxicological data, exposure data, detection methods, models and approaches for assessing risk including the use of bioactivity-based criteria and finally consideration of the toxicity resulting from co-occurrence/co-exposure to groups of chemicals Processes will be developed for prioritizing the research needs for revising the criteria for these chemicals.

Over the past decade, the ability to not only detect the presence of, but to quantitatively measure the concentrations of chemicals in water has advanced markedly even at low-levels of multiple chemical contaminants. Understanding the relevance of the potential human exposure pathways, including oral, dermal and inhalation exposure, as well as consumption of contaminated aquatic organisms is important to improving our understanding of total internal dose. Development of multi-route exposure physiologically-based pharmacokinetic models for key contaminants and for groups/families of contaminants will allow not only estimation of the internal dose resulting from the presence of contaminants in water but also in the determination of the portion of the total internal dose of a particular chemical or group of chemicals derived from their presence of the contaminant in water. Predictive modeling methods to estimate the effects of groups of chemicals will allow determination of when contaminants are more effectively considered as groups than as individual chemicals. Rapid screening methods that account for the bioactivity of all chemical contaminants in water, quantified and unknown, are critical to understanding the potential human health risks associated with water-borne chemical contaminants.

Research to advance the derivation of AWQC for the protection of aquatic life

Derivation of ambient water quality criteria for the protection of aquatic life continues to follow the guidelines developed in 1985, but challenges facing this program make clear the need for this guidance to evolve further. For example, the original procedure for developing aquatic life criteria explicitly required that laboratory toxicity data of specific types be available for at least 8 taxonomic groups. In cases where the toxic mechanism for a chemical was not necessarily known, this taxonomic diversity helped assure that potentially sensitive taxa to the chemical would be identified. However, OW has encountered cases where more is known about the toxicological behavior of a chemical, and this provides insight into which taxa are more likely to be sensitive. To avoid unnecessarily delay in the development of criteria and/or expenditure of resources and test organisms to generate data that does not meaningfully inform the final criterion, supplementary guidance is needed to articulate how and when mechanistic information (such as quantitative structure-activity relationships [QSARs] or genomic information as discussed above) can be incorporated into criteria development and establish regulatory guidance faster and more efficiently. A related need is how to appropriately modify aquatic life criteria development for chemicals whose risks are expressed in ways not

necessarily contemplated in the original criteria derivation guidelines; examples include tributyl tin (acting through imposex on gastropods) and selenium (causing effects on embryo development via maternal transfer).

Experiences with copper and many other contaminants have demonstrated how the risks of aquatic life exposure can be highly dependent on the chemical speciation of the contaminant, as well as characteristics of the water in which exposure occurs. This emphasizes the importance of considering bioavailability in the derivation of effective aquatic life criteria. A related issue is that while aquatic life criteria are generally expressed on the basis of water column concentration alone, exposures of aquatic organisms can also come from contaminated sediments underlying the water column, and/or via dietary exposure from accumulation by prey organisms exposed to water or sediment.

An area of considerable concern in applying toxicological data is the reproducibility and accuracy in characterizing the relationships between effects and exposure, and its implications to the uncertainty of criteria and risk assessment benchmarks. At present, criteria development include only limited consideration of data uncertainty. Improvements are needed in methods for analyzing toxicity test data and test design, especially related to various sources of errors for effect concentrations.

Another aspect of aquatic life criteria for which improvements are needed is the quantification and interpretation of exceedances of criteria. At present, aquatic life criteria are single numbers interpreted in binary fashion (simply above or below); the magnitude of exceedance is not considered, and duration and frequency are only loosely considered through averaging periods and a generic recurrence interval of once in three years. Further, temporal (or spatial) patterns of exposure are not addressed by current procedures, nor are the types or severity of ecological effects that might be expected from different levels of criterion exceedance. This more nuanced understanding of projected risks are particularly important to marrying aquatic life criteria to the development of tiered aquatic life uses, an important related effort by OW. Another element of this is the connection between compliance/non-compliance with criteria and the population/community effects or characteristics that have the greatest societal importance and that better support aquatic life use classifications.

Development of innovative advanced tools and technologies to identify and quantify exposure to and/or effects of CECs for future human health and aquatic life criteria

Research that incorporates endpoints that span human health and ecological endpoints will allow managers and researchers to identify important initiating events in both human health (HH) and aquatic life Adverse Outcome Pathways (AOPs). Further, incorporation of new techniques including DNA sequencing, gene expression, field deployable advanced sensor technologies, enzymatic endpoints and specific functional assays in both HH and aquatic life (AL) endpoints will allow managers to identify AOPs that have broad significance across phyla and species. This ultimately will promote the harmonization of aquatic life and human health

criteria to be updated in a manner that incorporates important genomic and CEC screening tools with exposure and bioaccumulation assessments in an efficient and economical manner.

Project Impact

The impact of the research outlined in this charter will enable the Office of Water to develop new or revised AWQC for human health, microbes and aquatic life (TMDLs, NPDES permits and beach monitoring). Research on the occurrence, exposure and health effects of waterborne pathogens and relationships to microbial indicators will serve to inform regulatory and policy decisions that will improve microbial water quality in watersheds and reduce health impacts. Research contained within Topic 6 that improves wastewater treatment and develops new indicators of treatment effectiveness will complement the research in 3.02. Topic 4 research on tools to improve predictive models for HABs and the understanding of the health effects in recreational exposures complement methods for toxin detection in this Charter.

The results of this research will also lead to new or revised human health and aquatic life criteria for chemicals. Multi-route exposure model assessments will enable our partners to more accurately assess the potential for human health and aquatic life risk and multi-chemical assessments will allow for improved estimates of the total risk associated with exposure to numerous chemicals, at low levels, in water. Family physiologically-based pharmacokinetic (PBPK) models that take advantage of and make new advances in high throughput approaches will allow health assessments to consider the risk of groups of chemicals and factors known to affect susceptibility, such as age, genetic polymorphism and disease status.

The research will also assist OW's efforts to identify and quantify precursors for drinking water contaminants along with other monitoring requirements under the SDWA for the protection of source water. Some methods/monitoring may be useful for both source AND finished drinking water.

Project Scope

Research conducted under Project 3.02 will fall into three general focus areas:

1. **Research to develop and improve human health AWQC for pathogens and contaminants**.

The scope of human health related research contained in Topic 3.02 includes chemical and microbial contaminants that are of concern for ambient water under the CWA and SDWA. Research will also include effects of climate change on extreme weather events, temperature, drought etc. Research will provide science to support new or revised AWQC as well as impacts of source water protection that impact the SDWA. Research also includes studying the fate and transport of pathogens and chemicals in watersheds to both bathing beaches and to intakes or wells of drinking water systems. Research efforts for microbial components of this project

include: a) development of human and other fecal source specific markers and the science to support the implementation of their use; b) development of rapid methods for the detection and quantification of fecal indicators including real-time methods, ambient water quality criteria based on these new methods and the science to support their implementation; c) improved modeling capabilities and their implementation for predicting microbial water quality at beaches; d) the development of microbial and chemical fate and transport models; e) development of methods and tools to more effectively detect and quantify waterborne pathogens that constitute a public health risk in natural systems or through drinking water intakes or wells; and f) development of epidemiological or QMRA-based health relationships between microbial indicators and pathogens and human health effects (including development and utilization of exposure/infectivity measurements). Research efforts in the chemical component of this project include: a) developing or revising toxicity assessments for fish consumption or water ingestion; b) developing or revising chemical analytical methods or bioactivity methods suitable for ambient water; c) bioactivity-based criteria that utilizes biological activity as an alternative to chemical detection; d) screening tools to determine when multi-route exposures should be considered for chemical contaminants in water; e) methods to more rapidly screen large numbers of chemical contaminants and as groups; and f) effective grouping tools for chemical contaminants including family PBPK and AOP models for groups of chemical contaminants. Targeted chemical contaminants include those that have the potential to be modified during drinking water treatment processes and therefor have application to the SDWA. Collectively these research efforts will enable improved tools to reduce potential adverse human health effects from microbial and chemical contaminants that are addressed in the AWQC and are of concern for source waters for drinking water. Bioassay-directed fractionation in which chemical analysis is coupled to bioassays should be improved and used for evaluation of waters of various sorts, including recreational, source, marine, fresh water, engineered, and waste water. Incorporation of molecular methods, including epigenetic changes, mutational analysis by next-generation DNA sequencing, global gene expression, and related endpoints should be used to evaluate the biological effects of various waters and, coupled with chemical analyses, determine the effects of groups of chemicals on these important biological processes.

2. **Research to advance the derivation of AWQC for the protection of aquatic life**

OW/HECD is planning a workshop in April 2015 to help target and prioritize refinements in aquatic life criteria derivation methods; ORD will participate in the workshop and follow-on consultation and collaboration. Anticipated areas of ORD research to support improvements of aquatic life criteria include a) improved exposure-effect characterization methods; b) extrapolation methods for chemicals (or chemical groups) with limited data; c) improved quantitative expressions for criteria; d) uncertainty assessment; e) criteria development for mixtures of major geochemical ions; and f) criteria development approaches for chemicals where multiple routes of exposure are important.

3. **Development of innovative advanced tools and technologies to identify and quantify exposure to and/or effects of CECs for future human health and aquatic life criteria**

Field-based application of advanced tools and endpoints will be used to better identify the exposures and effects of CECs in the environment. Areas of emphasis include application of genomic measures and other endpoints that are interpretable in the context of adverse outcome pathways (AOPs), including those with applications across human health and aquatic life effects. In addition, bioassay-directed fractionation in which chemical analysis is coupled to bioassays will be used in developing assessment approaches that consider groups of chemicals (including CECs) acting through a common AOP and that can aid in identifying potentially sensitive taxa or subpopulations and increase the efficiency and representativeness of criteria development and derivation. New tools such as field-deployable sensors and other technologies that provide real-time exposure estimates will also be considered. Research will support the regulatory requirements of both CWA and SDWA.

Project Structure and Rationale

The project structure is organized by the three general focus areas listed in the Project Scope:

1. **Research to develop and improve human health AWQC and SDWA standards for pathogens and contaminants**

Human health focus area addresses risks associated with chemical and microbial AWQC under the CWA and SDWA. Microbial risk research will cover: a) new pathogen and indicator methods including rapid real-time methods and forecasting models and the implementation of the tools; b) fecal source identification tools for ambient waters (recreational waters, TMDLs and for identifying sources and levels of fecal contamination); and c) health impacts of microbial pathogens (viral, protozoa and bacterial) in ambient water. Chemical contaminant research for AWQC and source water for SDWA will be organized by: a) methods, models tools and approaches for groups of chemicals, b) multi-exposure route and chemical family models; c) revised or new human health criteria for chemicals; d) bioactivity-based criteria using as an alternative to chemical detection. It is important that linkages are identified and established to other areas of SSWR and to the other programs where appropriate. Within SSWR, Topic 3.01 contains research that has the potential to identify new markers associated with microbial contaminants through large watershed assessments using large-scale genomic sequencing methods. Research on new microbial indicators (e.g. bacteriophage) for wastewater treatment (Topic 4) will need to be coordinated with methods being developed and tested under this Charter including fate and transport assessments. Methods to measure microbial water quality in wastewater and drinking water treatment processes will likely be linked to methods used to assess ambient water quality. It is therefore important that common technologies, data, tools and models be develop in concert between Topic 6 (6.01 and 6.02) and Topic 3.02 and results communicated between the two areas. Detection methods for HABs developed in 3.02 to identify and quantify HABs in ambient water will be coupled with studies in Topic 4.01 that identifies conditions in the environment that favor HABs and assessing the toxicity of HABs. Rapid screening of chemical contaminants or groups of contaminants may also be linked to CSS RAP projects designed to discover and quantify AOPs (Project 12.01). The performance, cost, and market-readiness of new and emerging technologies will also be considered as appropriate

to support the development and application of indicators and methods for their detection and quantification.

2. **Research to advance the derivation of AWQC for the protection of aquatic life**

This project component will include several areas of work. As further defined by the April 2015 workshop and associated consultations with OW, the necessary toxicity testing, data analysis, and method development will be conducted to support improvements in AWQC derivation procedures, with likely issues including chemical group-based extrapolations to address limited data, changes in data requirements appropriate to chemicals of emerging concern, improved descriptors of effects on assemblages of species, consideration of multiple routes of exposures, and uncertainty characterization. Some aspects of this work will draw on efforts in CSS regarding chemical screening methods, AOP identification, and population modeling (Projects 12.01-AOP and 11.02-EcoModeling). Particular attention will be given to data reproducibility issues, especially regarding the estimation of the relationship of effects to exposure in aquatic toxicity tests; which will be conducted in coordination with and help address model parameterization of CSS Project 11.02-Toxicity translators. Chemical mixture issues will be addressed in a testing program regarding major geochemical ion toxicity across a range of exposure conditions and test species sufficient to support developing AWQC for mixtures of these ions. This ion mixture work will also support and be informed by efforts in SSWR Project 3.03.

3. **Development of innovative advanced tools and technologies identify and quantify exposure to and/or effects of CECs for future human health and aquatic life criteria**

This research effort will be focus on: a) developing methods and techniques for measuring the concentrations and distributions of select, high priority CECs in fresh and marine ecosystems; b) understanding the ecotoxicity of selected CECs to marine organisms; c) linking aquatic life and human health AOPs sensitive to CECs (microbial and chemical) via targeted selective functional, genomic and molecular endpoints; and d) identifying a list of candidate CECs for future human health and aquatic life criteria development and derivation. Relative to linkages to other research programs, methods used for measuring the concentrations and distributions of CECs in fresh and marine environments may include similar approaches as used in SSWR topic 5.02 and 6.02, Sustainable and Healthy Communities (SHC) 3.61 (passive sampling procedures). Further, this research will be linked to the current task in CSS 2.6.2 as functional, genomic and molecular endpoints are similar in both research programs. The objective is to demonstrate that these endpoints can be used across a range of contaminant classes (including CECs) for read across and grouping based on similar AOPs.

Measure of Success

A major measure of success for this project will be the adoption and use of the science developed under this Charter to support OW CWA and SDWA,, State and Tribal policy and regulatory decisions that are protective of human health and aquatic life. Water quality criteria are the tools risk managers use to eliminate, decrease or otherwise mitigate threats from chemical and pathogenic contaminants. Risk management of chemical and pathogenic

contaminants is dependent on the appropriate risk characterization of these xenobiotics. Ultimately, the science developed in this project is expected to assist in the risk management of chemical and pathogenic contaminants in ambient water. Where feasible, multi-sector collaborations will be established to foster and help track the development, transfer and adoption of information and tools, including new and emerging technologies used detect and quantify AWQC indicators.

Stakeholders (outside ORD): OW, States and Tribes

a) OW (OST, OWM, OWOW, OGWDW) Regions
b) Federal Agencies, (USGS, CDC)
c) State, local and tribal governments
d) Academic community
e) Technology developers and business and economic development community

Output(s)

Title: Scientific basis and tools for expanded water quality criteria capability to protect human health and aquatic life
Brief Description: Report providing science to support AWQC for chemical and biological contaminants for human health and aquatic life for fresh and marine waters that OW can use to make regulatory and policy decisions in support of the CWA. Other stakeholders such as states, tribes, local governments can use the science to inform decisions on whether to adopt the guidelines. The findings will provide information on contaminant detection methods, health and aquatic life impacts, predictive modeling, contaminate source identification and other tools that will be important in developing criteria. Science and tools to support the implementation of the criteria will also be a critical element of what is produced.
Delivery Date: 2019
Intended user and audience: OW, Regions, States, Tribes, Local governments

Potential Key Products Identified

1. **Research to develop and improve human health AWQC for pathogens and contaminants**

Title: Research to establish new microbial indicators, or pathogen detection method suitable for monitoring microbial water quality including forecast models to support ambient water quality criteria and their implementation.
Brief Description: Refinement of culture methods and the development of more rapid detection methods including real-time methods as well as forecast models.
Delivery Date: 2019
Intended user and audience: OW, regions, states

Title: Develop human and other fecal source identification tools for ambient water

Brief Description: Development of methods and science to support the use of these tools for recreational waters, public and private water supplies and TMDLs.
Delivery Date: 2019
Intended user and audience: OW, regions, states

Title: Health impacts of microbial pathogens in ambient water.
Brief Description: Assess health impacts of exposure to waterborne pathogens (including immunological response) and develop health relationships (GI etc) between pathogens and/or their indicators including epidemiological and QMRA approaches.
Delivery Date: 2019
Intended user and audience: OW regions states

Title: Methods for improved processes for developing human health ambient water quality criteria
Brief Description: Methods, tools and supporting data to improve development of human health ambient water quality, along with results of toxicology screening assays on individual and groups of CEC, including Hazard Index and Margin of Exposure estimates of risk
Intended User and audience: OW/OWOW/OGWDW, regions, states
Delivery Date: 2019

Title: Contaminant grouping and multi-route exposures
Brief Description: Methods, Models, and approaches including: screening approaches to determine the need to group contaminants; screening approaches to determine the need to consider multi-route exposures; tools to apportion mixture toxicity to contaminants contained in in the mixture; and tools to determine the relative contribution of routes of exposure total internal dose and toxicity
Delivery Date: 2019
Intended user and audience: OW, regions, states

2. Research to advance the derivation of AWQC for the protection of aquatic life

Title: Methods for improved derivation of AWQC for the protection of aquatic life
Brief Description: This will product will consist of a set of methodologies and supporting data to improve AWQC derivation with regard to identifying/selecting needed data, estimating selected data when not available, addressing various exposure issues, and more completely quantifying risks and their uncertainties.
Delivery Date: 2019
Intended user and audience: OW/HECD, regions, states

Title: The toxicity of mixtures of major geochemical ions to aquatic life
Brief Description: This product will address the toxicity of mixtures of major geochemical ions (Ca, Mg, Na, Cl, SO4, HCO3/CO3) to a variety of aquatic organisms as a function of the mixture

composition, sufficient for deriving AWQC for the protection of aquatic life from these mixtures.
Delivery Data: 2019
Intended user and audience: OW/HECD, regions, states

3. **Development of innovative advanced tools and technologies identify and quantify exposure to and/or effects of CECs for future human health and aquatic life criteria**

Title: Development of innovative tools and technologies to determine bioassay/bioactivity for aquatic life effects of selected contaminants of emerging concern (CECs) in fresh and marine ecosystems of the United States
Brief Description: This product contains research in the development and application of in vitro and in vivo bioassay/bioactivity measures for chemicals acting along similar AOPs in aquatic systems. The research will critically evaluate the status of these approaches and identify additional applications and delineate a path forward for their eventual use in a regulatory framework. . The research will determine the toxicological effects of selected CECs to sensitive aquatic life with an emphasis on identifying candidate CECs for Aquatic Life Criteria development and derivation.
Delivery Date: 2019
Intended user and audience: OW/OWOW, OWM

Title: Development of innovative tools and technologies to identify exposure and effects from CECs.
Brief Description: This research will identify and assess the effects of CECs through the use of bioassay/activity measures for groups of contaminants acting along similar AOPs. Areas of emphasis include application of genomic measures and other endpoints that are interpretable in the context of adverse outcome pathways (AOPs), including those with applications across human health and aquatic life effects. New technologies that such as field deployable sensors will also be described. Innovative approaches for field-based application of advanced tools and endpoints will be used to better identify the exposures and effects of CECs in the environment Research will support the regulatory requirements of both CWA and SDWA.
Delivery Date: 2019
Intended user and audience: OW/OWOW, OWM

Intended user and audience: OW/OST, OWOW, OWM

Assumptions and Constraints

- Products require the necessary FTEs, extramural support, and technical support. (contractor support) for laboratory methods development, field monitoring, and process work, which are required to validate the modeling paradigm.

- Successful completion of products will require close collaboration with the Program Office
- Integration and coordination of research with other areas of SSWR and programs where appropriate.
- Projects with technology transfer, adoption and deployment components will require collaboration with technology developers, water technology clusters, economic development organizations, communities, and/or other stakeholders as appropriate.

SSWR Project Charter
Watershed Sustainability – Project 3 (3.03)

Project Title: Protecting water while developing energy and mineral resources

Project Lead (PL): Susan Mravik (PL), Brent Johnson (Deputy PL)

PL's L/C: NRMRL, NERL

Project Development Team Members: NRMRL: Barbara Butler, Susan Mravik; NERL: Kate Sullivan, Stephen Kraemer, Brent Johnson; NCEA: Sue Norton; NCER: Ben Packard; OW: OST: OGWDW: Mary Reiley;

Project Start Date: October 1, 2015

Project End Date: September 30, 2019

Executive Summary

Increasing demands for energy and mineral resources, the desire to supply a greater fraction of energy and mineral needs from domestic sources, the increasing need for clean freshwater, and the need to mitigate the production and release of greenhouse gases all argue for greater diversification of both energy and mineral production. The nation's energy portfolio may span such diverse activities as enhanced recovery of conventional and unconventional fossil fuel sources, geothermal, wind and wave, solar, biofuels, and possibly nuclear energy, all of which exert differing pressures on water resources. Mineral mining in the U.S. could increase as increased use of green energy technologies results in increased demand for a variety of metals, including rare earth elements that are used in wind turbines, solar panels, and batteries, among other products.

Energy and mineral production already have impacted surface and subsurface water resources and impacts in the future potentially could be greater and more diverse. Scientifically rigorous information and assessment techniques are needed to support program efforts to protect water resources and provide healthy watersheds and safe drinking water. Research to understand impacts over the entire life cycle (e.g., from extraction, production, transportation, use, storage, disposal and residuals) of conventional and unconventional energy sources and metals and minerals is necessary to provide a proactive approach to assessing potential risks to

watersheds and aquifer integrity and sustainability and to ensure effective mitigation technologies. The assessment and mitigation tools of the future must be able not only to accommodate diverse impacts independently, but also must be able to account for cumulative impacts of mixtures of such activities in different proportions in differing geographic and climatic regions.

- This project will provide tools to
    - Inform strategies for responsible water management, including optimizing water usage, minimizing changes to water quality, and protecting source waters related to impacts of energy exploration, production and remediation/restoration (decommissioning);
    - Inform strategies for responsible water management, including optimizing water usage, minimizing changes to water quality, and protecting source waters related to impacts of minerals exploration, production and site restoration;
    - Lead to more informed decisions regarding ability and use of aquifers for source water and pollution sequestration.
- The main products will be reports and tools useful for technical and policy staff and decision makers charged with protecting water quality and quantity while providing for the safe development of energy and mineral resources.

Research Project Description

The activities conducted as part of this project will:

- Synthesize and integrate what we already know, identify research gaps and fill them.
- Provide information and decision support tools to clients in OW, EPA Regions, states, Tribes and communities.
- Support EPA's goal to safeguard and sustain the nation's surface waters and groundwaters.
- Leverage opportunities to inform water use associated with evolving energy and mineral extraction portfolios to make a visible difference in communities.
- Develop new approaches/processes for evaluating future energy impacts on water.
- Create increasing awareness with local, state and federal partners regarding impacts to groundwater and surface water from evolving energy portfolios.
- Leverage EPA resources through collaborative opportunities with industry, NGOs, and other public sector partners (e.g., Federal, State, Tribal, etc.).

Project Impact

- Better enable protection of the nation's groundwater and surface water resources in areas of energy and mineral resource development.
- Empower communities to protect environmental and economic health.
- Support EPA Program and Regional Offices to carry out their immediate, intermediate and longer-term needs with respect to water and resource extraction.

Project Scope

This project will synthesize and integrate information on the role of water in energy production and mineral extraction to inform planning, evaluation, and decision-making among community, private, and public stakeholders with the following goals:

- Understand and describe the implications of different energy production/mineral extraction technologies relative to the short and long term availability and quality of groundwater and surface water;
- Optimize environmental and public health safeguards to energy and mineral resources development using approaches and technologies that provide long term-protection of groundwater and surface water resources;
- Identify, test and rank technologies that increase water re-use and/or improve the quality of water discharged post-use. (linkage to Topic 4)
- Inform stakeholders of evolving understanding and new technologies that might influence decisions regarding development of energy and mineral resources and their alternatives.
- Link with SHC 3.61 (Contaminated Sites)

Project Structure and Rationale (separate out into immediate, intermediate and longer-term tasks)

Task A: Assessing and predicting the ecological effects of wastewaters associated with energy and mineral extraction activities

Energy and mineral extraction activities can influence surface water quality both by direct discharges of process or waste waters, and through indirect means such as accelerating rates of geochemical weathering as a result of land disturbance. While these discharges may introduce a wide variety of pollutants, increases of major geochemical ions (i.e., sodium, calcium, potassium, magnesium, chloride, sulfate, and carbonate/bicarbonate) are often associated with activities such as mountaintop mining, the construction of valley fills during coal mining, oil and gas resource extraction, and hard rock mining. These increased ion concentrations have in turn been shown to be associated with changes in aquatic communities in receiving waters. At both state and national levels, regulatory authorities are recognizing the need to develop and implement water quality criteria/standards or other tools as a means to manage activities that lead to major ion enrichment in surface waters.

Activities include:

- Laboratory experiments to better understand physiological and toxicological responses of model species from three groups of freshwater organisms: crustaceans, fish, and aquatic insects. Experiments will focus on ion transporters under different environmental conditions and will also make use of genomic tools to identify that identify transporter proteins.
- Development of suitable, regionally-specific toxicity test organisms that enable EPA Regions to detect and assess impacts of wastewater discharges on aquatic life.
- Stream mesocosm studies to evaluate different ion and chemical mixtures on toxicity at single-species and community levels to determine influence of background water and

sediment chemistry on toxicity – [this part of this task is completion of ongoing work from SSWR 2.4.C]

- Development or enhancement of statistical models that can be used to address acute and chronic effects from ion mixtures [this part of this task is completion of ongoing work from SSWR 2.4.C] and in development of conductivity benchmarks across multiple spatial scales.
- An integrated assessment of major ion effects on aquatic organisms that synthesizes existing knowledge, discusses recent advances and uncertainty, and provides recommendations for effective assessment and resource management.

The overall goal of this task is to further understanding of the effects of elevated major ion concentrations on aquatic life, and to translate that understanding into practical approaches that can be used by the Office of Water, EPA Regions, and states to assess and manage sources that increase loading of major ions. As part of achieving this goal, we intend to build understanding across different levels of biological organization, from physiological to community levels, and use that understanding to inform robust assessment/management approaches.

Task B: Assessing challenges to sustainable water resource management from underground injection practices

The Underground Injection Control (UIC) program protects underground sources of drinking water (USDW) from being contaminated by injection of fluids. Under the Safe Drinking Water Act (SDWA), injection into a USDW of fluids that may be harmful to human health or cause violation of a primary drinking water regulation is prohibited. The lack of adequate data relating to biogeochemical and hydrologic processes that could potentially impact existing groundwater quality hampers UIC permitting programs; therefore, this research is intended to fill knowledge gaps and provide stakeholders the tools for evaluation and risk management relating to aquifer exemption status and geologic sequestration of carbon dioxide.

An aquifer exemption waives protection under the SDWA in order to allow injection that otherwise would be prohibited. Decisions about aquifer exemptions are made by EPA, usually following identification of the proposed exempted area(s) by the state UIC program. In order to grant an aquifer exemption, EPA must determine that the proposed exemption area is not a current source of drinking water, and is not reasonably expected to be a source of drinking water in the future. Basic data submitted by the applicant for review includes information on nearby public and private water supplies, remoteness/low population, availability of drinking water sources, cost for obtaining drinking water from deeper aquifers, etc. EPA retains the final approval authority over aquifer exemption decisions regardless of state primacy status. This approach protects underground sources of drinking water while also allowing underground injection associated with industrial activities including the production of minerals, oil, or geothermal energy.

To support aquifer exemption decisions, the Office of Water/Office of Groundwater and Drinking Water (OW/OGWDW) and Regional Offices (in particular, Regions VI and VIII) have requested:

1. Development of enhanced methods to monitor, assess and model groundwater flow and solute fate and transport related to the potential impact of injection in exempted aquifers on drinking water (to understand drinking water contaminants' behaviors)
2. Modeling approaches to assess fate and transport (e.g., time of travel, rate of dilution) of groundwater contaminants in order to assess the impact of contaminants injected into an exempted aquifer on nearby underground sources of drinking water
3. Develop technical protocols to facilitate implementation of the Aquifer Exemption Checklist attached to the OGWDW Director's memo, *Enhancing Coordination and Communications with States on Review and Approval of Aquifer Exemption Requests under SDWA,* July 24, 2014.

Activities include:

- Literature review and synthesis to provide a state-of-the-art analysis of uranium fate and transport in aquifer systems.
- Laboratory based studies will be conducted to examine important controls on the attenuation and mobilization of uranium around roll-front deposits, as well as commonly associated contaminants (selenium, arsenic, and vanadium).
- Computer modeling tool development will be conducted to assist EPA Regions in the evaluation of injections of brines (UIC Class II) and aquifer exemptions.

Because very large-scale GS of CO_2 is a developing technology, there is uncertainty regarding its impacts and the precautions needed to protect current and potential future drinking water sources and public health. Failure to prevent or mitigate CO_2 leakage may cause contamination of current and potential underground sources of drinking water (USDWs). Tasks to accomplish these goals include research on understanding biogeochemical processes that potentially impact groundwater quality, and development of tools for siting, design, and monitoring.

Task C: Evaluate cumulative impacts of energy and mineral extraction activities on aquatic life from changes in land use, water quantity and quality, and habitat availability

Energy and mineral extraction processes and their supporting infrastructure have potential to alter landscapes, fragment and degrade habitat, and impact both water quality and quantity. Water quality and habitat can be impacted by both release of wastewaters and excess sedimentation to streams. Mountaintop removal and valley fill (MTM/VF) coal mining is a widespread practice throughout the central Appalachians. By this method, coal seams are exposed by complete removal of overburden that is disposed of by placing it in adjacent valleys, creating valley fills (VF) that completely bury headwater streams. The cumulative impacts of energy and mineral extraction activities, such as MTM/VF, may lead to ecological disturbance and impair watershed integrity on a regional scale. The Clean Water Act (§404[e][1]) requires consideration of cumulative impacts of permitted activities, yet measurement of cumulative impacts is difficult due to a lack of appropriate assessment methods, difficulties associated with

the large temporal and spatial scales, and potential interactions of multiple stressors. As a result, the cumulative effects of multiple permitted activities (e.g., mines, wells, etc.) within watersheds remain poorly understood despite previous measurement efforts. Novel sampling approaches, experimental designs, and methods of statistical analysis, are therefore needed to better evaluate stressors across multiple spatial scales to ensure protection of downstream water quality and ecosystem integrity. Such knowledge will lead to more informed regulatory practices at both state and federal levels.

Making use of extensive field data collected from a mined watershed in eastern Kentucky (by EPA Region 4), research activities will include:

- Conventional analytic approaches (e.g., correlation, regression, principal components analysis, nonmetric multidimensional scaling) will be used to assess impacts of mining on water quality and stream biota
- Novel geospatial tools will be used to measure extent of downstream impacts from surface mining and models will be developed to assess mining impacts on stream biodiversity across spatial and temporal scales.
- State-of-the-science review of cumulative impacts on aquatic life from changes in land use, water quantity and quality from various energy and mineral extraction processes

The overall goal of this task is to apply novel statistical and modeling approaches to spatially explicit field data to better understand and quantify cumulative effects of coal mining in the Appalachian region. Information gained and summarized from this research can be applied to mine permitting activities and lead to more informed decision-making by regulators in the Office of Water, EPA Regions, and states. Methods used in this task for evaluating cumulative effects of watershed disturbance may also be translated to other disturbance types beyond MTM/VF and in other regions of the United States. Field data collected for this task will also be associated with laboratory and mesocosm toxicological studies included in Task 3.03A, *Assessing and predicting the ecological effects of wastewaters associated with energy and mineral extraction activities*.

Measure of Success

- The products (e.g., reports and tools) are used by EPA Program and Regional Offices and others
- The country takes advantage of energy and mineral resources while minimizing impacts on water resources
- Communities are empowered to protect environmental and economic health
- New tools and technologies are developed, transferred, and deployed to the environmental marketplace where they provide environmental and businesses and economic development benefits

Stakeholders (outside ORD):

- OW, OW-IO, EPA Regions, states, Tribes, communities, private sector, water technology clusters, technology companies, other federal agencies, and academic partners

Output(s):

Title: Proactive approaches to assessing risks to watershed integrity and sustainability associated with current, transitioning, or emerging technologies and practices, including water use, for conventional and unconventional energy, minerals, and other materials.

Brief Description: Synthesis of data, information and tools developed to aid stakeholders and policy makers in making informed decisions regarding watershed management relative to energy and mineral extraction.

Delivery Date: FY19

Title: Synthesis of the science on groundwater quality impacts around uranium in-situ recovery sites.

Brief Description: Synthesis of information on potential aquifer vulnerabilities, data gaps, and monitoring strategies for regions downgradient from uranium in-situ recovery sites.

Delivery Date: FY17

Intended user and audience: OW, EPA Regions, states, Tribes, communities, private sector, other federal agencies, and academic partners

Key Products Identified:

***Title*:** Comparison of Field, Mesocosm, and Laboratory Approaches to Assessing Effects of Major Ions on Aquatic Organisms
Brief Description*:* Summary of findings from investigations on impacts from changes of surface water quality from energy and mineral activities on aquatic organisms. Investigations on the physiological basis for major ion effects across species, multi-species response to major ion exposure in stream mesocosms, and advanced techniques for estimating exposure/effect benchmarks from field data will be included.
Delivery Date*:* FY17Q4
Intended user and audience*:* Office of Water, Regions; States; Tribes

Title*:* Potential Aquifer Vulnerability in Regions Downgradient from Uranium In-Situ Recovery Sites

***Brief Description**:* Review paper and/or report to identify potential aquifer vulnerabilities, data gaps, monitoring strategies, and key elements for modeling applications. This review paper will include: i) problem introduction; ii) background on the geology and geochemistry of uranium roll front deposits; iii) review of aquifer mineralogy and role in water-aquifer interactions; iv) review of leach solutions [lixiviants - generally mildly oxidizing solutions (i.e., sulfuric acid, peroxide, bicarbonate, others) that will mobilize and complex with the target element (i.e., uranium)]; v) potential interactions of lixiviant with other contaminants of concern; vi) review of extraction well approaches/configurations and optimal designs; vii) identify potential aquifer vulnerabilities related to in-situ leaching; viii) identify data gaps, appropriate monitoring strategies, and key elements for modeling applications based on results of review. Results will guide further focused laboratory, field, and/or modeling research.
***Delivery Date**:* FY17Q4
***Intended user and audience**:* OW, federal, state, local, and tribal governments; non-governmental organizations; public; academia; etc.

***Title**:* Evaluation of groundwater flow paths and residence times under the influence of injection of brines and pumping of fresh water
***Brief Description**:* Computer modeling tool development and demonstration to assist EPA Regions in the evaluation of injections of brines (UIC Class II) and aquifer exemptions. The research will explore the appropriate level of model complexity and solution type, ranging from semi-analytical to numerical. The conceptual geologic space will include multiple permeable layers separated by leaky layers, injections and pumping wells, presence of permeable fracture/faults and permeable abandoned wells. The transient advective flow field will also include particle tracking to evaluate the potential communication between the injection wells and the pumping wells. A case study with supporting data will be pursued in consultation with EPA Regions and EPA OGWDW. The injection of fresh water to contain coastal salt water intrusion may be a useful analog for model testing. Note that the technology may also be used for area of potential impact assessment for injections of CO_2 (UIC Class VI) and deep carbon geologic sequestration.
Delivery Date: FY19Q4
***Intended user and audience**:* OW, federal, state, local, and tribal governments; non-governmental organizations; public; academia; etc.

Assumptions and Constraints
Identify key assumptions or constraints if any are known in advance, particularly those that are unusual or very specific. Define those things that if not true or able to be overcome could threaten completion of the proposed research. Include: dependencies, regulatory, statutory, judicial, (e.g., consent decree limitations), and others (e.g., political and logistical).

Many of the products within tasks are interrelated, which could lead to logistically-caused delays. For example, determination of the cause of toxicity observed in ambient waters affected by energy and mineral extraction (and injection) activities will rely on laboratory studies, modeling studies, and field studies that are being conducted within this project. A

second example is that demonstration of improved ASR techniques at a field site in the southern U.S. will rely heavily on results from laboratory and modeling studies.

Projects with technology transfer, adoption and deployment components will require collaboration with technology developers, water technology clusters, economic development organizations, communities, and/or other stakeholders as appropriate.

SSWR Project Charter
Watershed Sustainability – Project 4 (3.04)

Project Title: National Water Quality Benefits (ORD, OP, and OW collaborative effort)

Project Lead (PL): Matthew Heberling (NRMRL)

Deputy PL: Michael Papenfus (NHEERL)

Project Development Team Members: Marisa Mazzotta (NHEERL), Brenda Rashleigh (NHEERL), Hale Thurston (NRMRL)

Project Start Date: FY16

Project End Date: FY19

Executive Summary

The Office of Research and Development (ORD), Office of Policy (OP), and Office of Water (OW) have formed a collaborative team of economists, ecologists and water quality modelers to develop a national water quality benefits modeling framework (i.e., water quality and economic models) to support greatly improved quantification and monetization of the economic benefits of EPA regulations (e.g., improvements to human health, recreation, or other environmental services). The three offices will collaborate (both staff and resources) intramurally in a broad-based estimation effort to improve assessment of benefits from national regulations. In addition, we hope to inform more broadly the economic dimensions of water quality research and management. The project also includes the recently issued STAR Grant Request for Applications (RFA), "Water Quality Benefits" that was funded through SSWR. The RFA anticipates stated preference (or hypothetical behavior) approaches, as well as revealed preference (or observed behavior) approaches while the intramural effort focuses on revealed preference approaches to value water quality improvements. This project charter briefly describes the overall effort and ORD's intramural contribution of outputs and products for the three office effort.

Research Project Description

The 1972 Clean Water Act (CWA) directs EPA to develop national water quality-based regulations for surface waters of the US and technology-based regulations for categories of industries that discharge pollutants directly to surface waters. Under Executive Orders 12866 and 13563, EPA is required to estimate the potential benefits and costs of these regulations to society. While the Office of Air and Radiation (OAR) has the modeling capability for quantifying air quality benefits to support most Clean Air Act regulatory programs (i.e., BENMAP), OW does not currently have similar off-the-shelf modeling capability and this is reflected in its benefit analyses of CWA regulations to date. This situation arose from a focus on estimating the benefits of individual programs or rules, as opposed to a concerted effort to build and use a benefits model applicable to many water programs. Such an effort may require economic valuation of changes in water quality, quantity, stream condition, and/or related ecosystem services.

ORD, OP, and OW have agreed to a significant effort in which each will contribute substantial financial and in-kind (staff) resources to a broad-based benefit estimation effort. Developing the model framework (i.e., water quality and economic models), which includes a combination of in-house and external work, will take at least 5 years, although it is anticipated that, in the interim, this effort will result in intermediate products that may be useful on a case-by-case basis. The model framework will incorporate modules focusing on five main water body types that may benefit from EPA regulatory actions: (1) the Great Lakes, (2) estuaries, (3) fresh water lakes and rivers, (4) coastal waters, and (5) small streams. ORD's contribution and research activities are described below. We will coordinate our efforts with OP and OW to ensure we do not duplicate efforts on the five main water body types.

Capacity to quantify benefits for each of these water body types will be developed through both revealed preference studies identifying market and non-market values associated with water quality, as well as stated preference studies capable of capturing a broader range of the value of non-market—specifically non-use—benefits. Most of the revealed preference work will be done in-house at EPA, while the stated preference work will primarily be done through ORD STAR grant funding (http://www.epa.gov/ncer/rfa/2015/2015-star-water-quality.html).

While this extramural research is ongoing, the interoffice team will integrate the results of these economic studies with water quality models that simulate how regulatory actions impact water quality in various water body types. To start, we will coordinate with other SSWR Topic 1 projects that propose relevant water quality modeling efforts to determine opportunities for collaboration. It is important that water quality model research and outputs measure outcomes that can be valued using current environmental-economic valuation methods; and the intent of these collaborations will be to ensure that modelers attempt to produce the most relevant model outputs for valuing water quality benefits. For example, current economic approaches allow us to estimate increases in property values due to increases in water clarity, decreases in drinking water treatment costs from decreases in turbidity levels, and changes in recreational demand from changes in recreational resources (e.g., fish populations, water quality for swimming, etc.). The water quality modeling should help to predict changes in water

quality and relevant outcomes for small streams, fresh water lakes and rivers, estuaries, Great Lakes, and coastal waters.

Project 3.04 is intended to benefit from and build upon other SSWR projects, and thus may not be able to address the full scope of work needed to quantify changes in environmental endpoints in response to regulatory actions that affect water quality (e.g., the outputs of water quality models, such as How much did water clarity improve?). In addition to other Topic 3 projects, SSWR Topics 4 and 5 describe work that could improve our ability to quantify incremental improvements in environmental quality and resulting economic benefits due to individual regulatory actions addressing nutrients and green infrastructure, respectively. We also will coordinate with Air, Climate, and Energy (ACE) projects and research efforts outside of ORD (e.g., the Hydrologic and Water Quality System [HAWQS] modeling platform). The intent is for this coordination to result in a compilation of information that addresses water quality modeling and data, to advance the overarching goal of producing tools in support of quantifying and valuing changes in water quality for EPA regulations.

Collectively, these modules will provide EPA with a framework to describe, quantify and where possible, monetize the benefits of national regulatory and non-regulatory actions. This will represent a substantial improvement on the current situation, in which benefit quantification efforts generally must be undertaken on an *ad hoc* basis for each situation and are often limited by timeframe and/or resource constraints. Most importantly, this effort will greatly expand EPA's coverage of quantified benefits for changes in water quality (along with intermediate products on a case-by-case basis).

Project Impact

To improve water quality benefits estimation for more complete benefit-cost analyses, and to better inform senior decision makers and the public about the benefits to society. Given the focus on specific water body types the results will also be available for use to support local decision making where appropriate.

Project Scope

In order to develop a national water quality benefits model, a variety of water body types need to be studied. No single national study will work because of the differences in water body and community attributes across the country (in fact, it is common practice to synthesize numerous estimates because of the difficulty in applying one estimate). In order to build the model, a coordinated set of studies representative of important factors that vary across the Nation is needed. This will require working with OW and OP to identify current gaps within the body of existing studies. Therefore, the tasks under this ORD project will have to focus on targeted studies in conjunction with the work going on in OP and OW. For example, ORD potentially has expertise and good quality data to support analyses for Cape Cod Estuaries, Midwestern stream systems, and Puget Sound. As the tasks are developed, they must consider how the

information can be transferable to similar areas (i.e., benefit transfer approaches). The results must be useable by OW and their Regulatory Impact Analyses and defensible under Office of Management Budget review.

With a focus on revealed preference approaches, such as hedonic pricing or recreational demand studies, and water quality modeling, ORD will value water quality improvements for key water bodies. Additional areas of research that can support this effort include meta-analyses of benefits or market price methods using commercial markets.

In order to produce benefits estimates, economic valuation models require data on surface water conditions, whether from empirical observation or generated by surface water quality models. An important research need will be an assessment of the availability of the empirical data and surface water models needed to provide information on surface water conditions, particularly in response to regulatory actions, for economic valuation models.

Another important research area is identifying the best water quality metric, index, or indicator (e.g., Dissolved Oxygen [DO], Index of Biotic Integrity [IBI], watershed integrity, water quality index) to use in economic analyses. Determining which indicators provide a linkage between water quality science and economic valuation and at the same time are most relevant for these economic types of studies would be useful. One concern in this regard involves identifying water quality indicators that are as widely available across regions and water bodies as is appropriate. This consistency will greatly improve our ability to integrate and transfer results in a manner that facilitates comparisons across the country and differing water bodies and for transferring benefits from one context to another.

Project Structure and Rationale

EPA wants to add to the body of existing valuation research as well as improve upon methodologies for translating regulatory decisions and the resulting estimates of water quality improvements into environmental services and ultimately monetized benefits. ORD, OP, and OW have agreed to use extramural (STAR grants) and staff resources in parallel to complete necessary models and research to improve our ability to estimate benefits from national regulations. ORD has identified two potential task areas to support the three office effort: 1) economic and water quality studies focused on one of the five water bodies; and 2) optimal choice of water metric, index, or indicator to use in economic analyses.

Specifically, ORD anticipates starting with at most three revealed preference analyses during FY15-FY19 given existing capabilities. There is also the potential for developing meta-analyses of benefits estimates to support this project. During this same time period, the collaborative effort intends to do a comprehensive assessment of existing water quality models with regards to how well they address EPA's current and anticipated water quality modeling needs. Therefore, ORD also can provide water quality modeling support or provide support on assessing availability of water quality data to help improve the economic analyses for

regulatory impact. This will require collaborating with other SSWR projects or other Research Action Plans like ACE (see section on **Collaboration**) that are focused on water quality modeling for particular stressors (e.g., nutrients or stormwater).

Measure of Success

We provide economic analyses and water quality modeling or data that can be used to quantify the benefits of water quality improvements from national regulatory and non-regulatory actions. With OP and OW, this will greatly expand EPA's coverage of quantified benefits for improving water quality.

Stakeholders (outside ORD): Al McGartland (OP-NCEE), Patrick Walsh (OP-NCEE), William Wheeler (OP-NCEE), David Simpson (OP-NCEE), Matt Massey (OP-NCEE), Dennis Guignet (OP-NCEE), Mike Shapiro (OW-IO), Joel Corona (OW-IO), Julie Hewitt (OW-OST), Todd Doley (OW-OST), Ashley Allen (OW-OST), Erik Helm (OW-OGWDW), Randy Waite (OAR-OAQPS), Christine Davis (OAR-OAQPS)

Output(s)

Provide economic analyses, water quality models, and knowledge to program offices, to support the economic valuation of changes in water quality, water availability, and related ecosystem services, at appropriate scales for the Nation's main water body types.

- Brief Description: Additional research is needed on both economic valuation and water quality modeling to support regulatory impact analyses using revealed preference approaches. The primary goal is to develop accurate and valid estimates of the benefits of water quality changes and incremental/step improvements in water quality. The project will be composed of targeted economic studies that address water quality issues in some of the five types of proposed water bodies of interest, using revealed preference approaches, and meta-regression modeling to develop benefit-transfer functions, as appropriate. ORD has proposed three potential regional water bodies to focus on for this initial effort: Midwestern Stream Systems; Cape Cod Estuaries; and Puget Sound. Additional water bodies may be proposed, but they will be coordinated with OW and OP.
- Delivery Date: FY19
- Intended user and audience: Three office effort (ORD, OW, and OP); potential local decision makers where each study is located; and to support programs in similar water bodies where benefits are transferable.

Two Potential Key Products Identified

Economic benefits of improved water quality for national regulatory actions: place-based studies

- Brief Description: Using revealed preference approaches and potentially meta-regression modeling to develop benefit transfer-functions, targeted economic studies that address water quality issues will support the development of a national water quality benefits model. ORD has proposed three potential regional water bodies to focus on for this initial effort: Midwestern Stream Systems; Cape Cod Estuaries; and Puget Sound. The Midwestern Stream System study, applying hedonic property models, proposes to estimate the benefits of reduced nutrient loadings using the East Fork of the Little Miami River Watershed. The Cape Cod Estuaries (and possibly freshwater ponds) study will focus on the changes in recreational demand due changes in nutrients. Data availability may limit Cape Cod study, so a meta-regression model of water-contact recreation, incorporating water quality metrics, may be developed. The Puget Sound study will develop a set of hedonic property models to estimate the benefits of improved water quality. It will use different water quality metrics in both freshwater and estuarine systems.
- Intended user and audience: Three office effort (ORD, OW, and OP) and the East Fork cooperative of federal, state and local stakeholders, Cape Cod Commission, EPA Region 1, State of MA, Region 10

Linking measures of watershed integrity and stream condition to economics

- Brief Description: One of the primary challenges in estimating the benefits of water quality changes on a national basis is the lack of a comprehensive set of water quality conditions that are consistent and uniform within water body types. This project will explore how newly developed measures of watershed integrity and stream condition can be used in lieu of traditional water quality metrics in economic analyses. The immediate goal is expand the analytical toolset available for evaluating policies related to managing water resources both locally and on a national basis. The first step will develop methods for integrating socio-economic data with indicators of watershed integrity and stream condition on a national basis. This initial work aims to develop a quantitative foundation for identifying and evaluating important causal relationships between definitions and metrics of watershed integrity/stream condition and human health, wealth, and well-being.
- Intended user and audience: OW, Regional offices

Collaboration

In addition to the collaboration across ORD, OP, and OW, the results from this effort could be used, if nutrients are part of the water quality modeling, for other projects in SSWR and potentially Safe and Healthy Communities (SHC). For example, SSWR Project 4.03: **Improve**

Nutrient Management Practices, Metrics of Benefits, Accountability and Communication, could benefit from having economic values for changes in water quality due to reductions in nutrients, as anticipated in the Cape Cod Estuaries and Midwestern Stream Systems tasks. Both OW and Office of Air are looking for support to estimate the benefits of water quality changes due to management practices for controlling nutrients. Model evaluation and development effort included in SSWR Project 5.01: **Green Infrastructure Model and Tools** that focuses on mechanistic techniques for simulating green infrastructure scenarios at multiple scales could also be used to support the evaluation of water quality benefits. The existing FY15 SSWR Project 1.1B: **Research to develop methods and indicators for mapping aquatic condition and watershed integrity nationally** is leading an effort to develop metrics that describe watershed integrity and stream condition on a national scale. These metrics may provide an approach to help operationalize a national benefits assessment using watershed integrity. Collaboration across Research Action Plans may lead to efficiencies, but we must keep the goal of this project clear. That is, any collaboration must support quantifying and valuing changes in water quality specifically for EPA regulations. Potential links include ACE 252 and FY15 SSWR 3.1A: **Watershed modeling to assess hydrologic and biogeochemical sensitivity to climate and land use change** and SHC 2.61 **Final Community-Based Ecosystem Goods and Services** where we will examine potential opportunities to collaborate if they satisfy the goal of the project.

Key Resources

- ORD, in particular SSWR, has provided $4 million for the support of the STAR grant research. The STAR funds will be managed by ORD's National Center for Environmental Research.
- Extramurally, ORD views this investment as a unique, one-time collaboration used to fill current gaps in this area best addressed by the academic community.
- ORD, OP, and OW will contribute a minimum of $500,000 each between FY14—FY15 to support the intramural effort, which will be managed cooperatively by the interoffice team. These resources will be used to buy and collect data (water quality, property value, recreational use, fish populations, catch rates, etc.), for contract support, and to fund Special Government Employees and research fellows.
- Part of the intramural funds are being used in a Work Assignment, *Analytical Support for EPA Cross Office Water Benefits Work*, which has been awarded to Abt Associates, Inc. The purpose of this Work Assignment is to support EPA's efforts to improve its ability to monetize the benefits associated with these regulatory actions.
- Each office agreed to contribute at least one FTE to the intramural effort. OP will provide most of the economists' in-house effort; ORD and OW will not only provide economic expertise, but water quality modelers as well. For ORD's research described above, 5-10 FTE/year will be needed.
- Investments in future years for intramural work are expected, but will be based on the progress and evaluation of the team's efforts.

Assumptions and Constraints

- The results must be useable by OW and their Regulatory Impact Analyses and defensible under Office of Management Budget review.
- This project charter covers ORD's contribution to the overall three office effort. OW and OP are providing resources to support a coordinated research area across the five main water body types: (1) the Great Lakes, (2) estuaries, (3) fresh water lakes and rivers, (4) coastal waters, and (5) small streams.
- Economic and water quality data is available and of good quality for the individual studies focused on one of the five water bodies
- Implicit in any projections concerning benefit transfer is that we can find enough information to apply results derived in one area to another.
- Tasks will incorporate climate change as an important driver in the benefits analyses where appropriate (Contacts: Anne Grambsch [NCEA] and Tom Johnson [NCEA)
- Tasks that focus on changes in nutrients will help address important Nitrogen Roadmap Research Recommendations (Contacts: Anne Rea [ORD-IO] and Walt Nelson [NHEERL]).