Vermont EPSCoR

Track-1 Research Infrastructure Award for

Research on Adaptation to Climate Change in the Lake Champlain Basin: New Understanding through Complex Systems Modeling

NSF EPS# 1101317

NARRATIVE FOR Strategic Plan
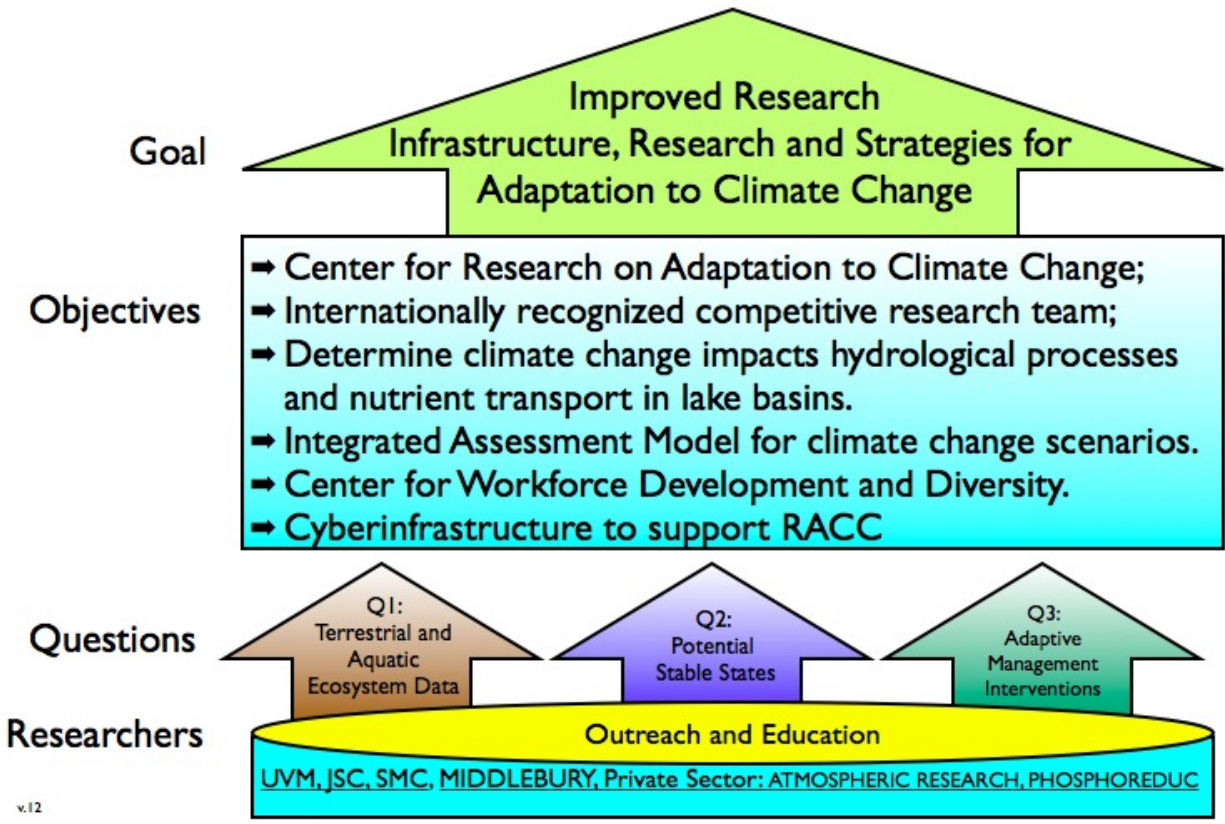
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EXECUTIVE SUMMARY

This document describes the strategic plan for Vermont NSF EPSCoR Track 1 award # EPS-1101317 "Research on Adaptation to Climate Change: New Insights through Complex Systems Modeling" that began September 1, 2011 and continues through August 31, 2016. It summarizes foundational areas of the project as described in the project proposal, and develops linkages and additional detail in the project plan based on discussions during the strategic planning meeting held November 1 and 2, 2011.

Vermont EPSCoR's goals are to improve the human, physical and cyber infrastructure that supports research and education and make Vermont investigators competitive for large research awards; increase the number of institutions and individuals involved in research, expand the diversity of the STEM workforce, and in other ways impact the state's economy; and foster innovation.

Our primary strategy to accomplish this in the next five years is to create a center for Research on Adaptation to Climate Change (RACC) and a Center for Workforce Development and Diversity (CWDD) that will be aligned with the state's priorities and engage a broad range of institutions, students and teachers in RACC research. From these two centers, external engagement efforts including broader outreach to the community through several mediums including broadcast media, mobile applications, and Public Information Officers (PIOs) will follow. A more detailed description can be found the milestones section of this report.

Through RACC we will build transdisciplinary teams of social and natural scientists who will coalesce around the study of fundamental, hypothesis driven research questions about the Lake Champlain Basin as a coupled human and natural system affected by climate change. We will emphasize complex systems modeling among our approaches. The State EPSCoR Committee endorses this overarching theme and approach as one that will significantly improve Vermont's future R&D competitiveness for several reasons; it builds upon core strengths, including Vermont EPSCoR's current research in complex systems modeling of the many extant data sets of the Lake Champlain watershed, and because the theme is aligned with national and state priorities. These priorities include using complex systems methods to extend research on the Lake and working landscape of the watershed, to land use management and other policies in the Basin; and generalizing this research to regional and national contexts through work with collaborators in Idaho and New Hampshire.

The RII Track-1 project on Adaptation to Climate Change is a multi-institutional, multi-sector partnership consisting of four universities and colleges, state agencies and entities, a federal agency, private sector companies, and non-governmental organizations (NGOs). The primary higher education institutions participating in RACC are the University of Vermont (UVM), Johnson State College (JSC), St. Michael's College (SMC), and Middlebury College. However, faculty from all Vermont institutions of higher education will have opportunities to participate. Public sector and other partners include the Lake Champlain Basin Program (LCBP), the VT Agency of Natural Resources (ANR), the USDA National Sediment Laboratory, the Nature Conservancy, Vermont Natural Resources Council, Governor's Commission on Climate Change, and Vermont Climate Collaborative. Private sector partners include businesses working with technologies and systems addressing climate change, aquatic and terrestrial processes. Companies include Atmospheric Research, Tetra Tech ARD, and PhosphoReduc; business groups such as the Vermont Software Developers Alliance will also be involved.

Goal
Improved Research Infrastructure, Research and Strategies for Adaptation to Climate Change

Objectives
- Center for Research on Adaptation to Climate Change;
- Internationally recognized competitive research team;
- Determine climate change impacts hydrological processes and nutrient transport in lake basins.
- Integrated Assessment Model for climate change scenarios.
- Center for Workforce Development and Diversity.
- Cyberinfrastructure to support RACC

Questions
Q1: Terrestrial and Aquatic Ecosystem Data
Q2: Potential Stable States
Q3: Adaptive Management Interventions

Researchers
Outreach and Education
UVM, JSC, SMC, MIDDLEBURY, Private Sector: ATMOSPHERIC RESEARCH, PHOSPHOREDUC

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The RACC center is organized around an Over-arching theme with three research hypothesis driven Questions, involving a diversity of scientists and engineers from academia and the private sector who are integrated with public and private stakeholders, undergraduates, middle school teachers, high school students and teachers. They will study climate change-driven impacts on hydrological processes and nutrient transport in the lake basin (Questions 1 and 2), and develop ecosystem assessment scenarios and models to inform the work of policymakers (Question 3 and Integrated Assessment Model (IAModel)). Each of the three Questions examine a critical area of inquiry in relation to the Over-arching Question, and the research of each Question will dynamically inform the other Questions and their integration in addressing the Over-arching Question. One of our most important success measures will be efficiency in coordinating and sharing data between highly overlapping research teams working on the three questions and across the entire project. A strong theme of the strategic planning meeting on November 1 and 2, 2011, was the importance and value of supporting interdisciplinary conversations and connections among researchers and teams early and throughout the project. This translated into immediate plan developments in how specific research activities will be timed and linked, and these have been incorporated in tables of project outcomes and activities (Tables of Milestones embedded below and Broad Goals Table in the Appendix).

RACC will enable the increase of STEM workforce and its diversity in the state through recruitment of researchers and involvement of students with focused support for girls and underrepresented minorities, including Abenaki Native American students, veterans, rural poor high school students, and students with disabilities through the CWDD.

Planning Process:
Vermont EPSCoR hosted a strategic planning meeting on November 1-2, 2011 on the campus of the University of Vermont (UVM) based upon the Programmatic Terms and Conditions (PTCs) and the Post-Award Strategic Plan Guidance documents. Prior to this meeting, on-going large RACC group and individual Question group meetings were held beginning in September 2011. In attendance at the November meeting were 17 faculty researchers from UVM, Saint Michael's College, Johnson State College and Middlebury College; Dr. Denise Barnes and Dr. Sian Mooney of the NSF EPSCoR Office; Meeting Facilitator Stephanie Lahar; State Governing Committee President, John Evans; UVM Chief Information Officer, David Todd; Internal Advisory Committee Members Linda Gabrielson, Academic Dean of Community College of Vermont and Curt Stager, Paul Smith College; External Advisory Committee Member, Anna Michalak; External Evaluator and Assessment Consultant, Joy Livingston; and Vermont EPSCoR Leadership and Administrative Core Members Drs. Judith Van Houten, Kelvin Chu; Ms. Lillian Gamache, Project Coordinator; Dawn Shackleton, Operations Manager; Mr. Steven Exler, Information Technologist; Nora Joyal, Administrative Assistant; CWDD Director, Miranda Lescaze. A complete participant list and agenda are attached as appendices.

Following the meeting, the science leaders continued to work on the Milestones document and Matrix of goals and metrics.

Alignment with the State Priorities and S&T Plan:
The RACC center and CWDD very directly align with the S&T Plan of Vermont.
- *1.1 Firmly establish a culture of research and development in Vermont's universities and colleges…;*
- *1.2 Focus our R&D on several key science and technology areas: environmental science and sustainable technologies; biological science and technology, and computational science…;*
- *1.3 Under the direction of VT EPSCoR, establish state-wide high-end computing capabilities and complex systems modeling programs…."*
- *2.1 Increase technology transfer activity at UVM and expand university-wide collaborations.*
- *2.3 .. provide research and development vouchers to help Vermont's small technology based businesses take advantage of the resources found in academic research facilities;*
- *3.3 Build strategic alliances between the Vermont Center for Emerging Technologies…*
- *3.6 Expand and promote Vermont EPSCoR's highly successful SBIR "Phase 0" program....*
- *4.2 … expand science and engineering graduate programs and promote hands-on research opportunities through programs such as VT EPSCoR's summer internship initiative.*
- *4.3 Create a clearing house for internship opportunities with Vermont companies.*
- *4.4 Maintain strongly performing K-12 science and mathematics education system by providing increased professional development opportunities for science and math teachers.*

Expected Benefits of the Project
Benefits will be realized at the broad jurisdictional level and within the academic research and education infrastructure of Vermont and are all intrinsically linked. Jurisdictionally, outcomes will include new, transdisciplinary research teams that draw from across Vermont as a new state resource. We will develop new understanding of the policies that guard the health of Lake Champlain, which is an economic driver for the region. Academically, UVM has identified areas of excellence that have potential for technology transfer and development of our technology sector. The RACC research will directly augment UVM's new spire of excellence in complex systems modeling. Education Infrastructure improvements from our CWDD will promote a

diverse STEM workforce, which is a high priority of the current Governor of Vermont, Peter Shumlin. We will be inclusive of veterans, Abenaki students, disabled, and the rural poor, and thereby bring the best potential to the research and future STEM careers. The work that we carry out will result in a protocol and set of models and modeling platform that will be extensible to other basins and therefore of significance nationally. Lastly, the data that we collect and scenario testing are of great interest to the State of Vermont and our partners such as the multi-jurisdictional Lake Champlain Basin Program.

VISION

Our vision is (1) to improve the human, physical and cyber infrastructure that supports research and education and make Vermont investigators competitive for large research awards; (2) increase the number of institutions and individuals involved in research, (3) expand the diversity of the STEM workforce, and (4) in other ways impact the state's economy; (5) foster innovation (6) enable broader impacts through external engagement efforts.

MISSION

Our fundamental purpose is to implement the vision above by creating a center for Research on Adaptation to Climate change (RACC) and a Center for Workforce Development and Diversity (CWDD) that will engage a broad and diverse range of institutions, policy makers, students, teachers and the general public into RACC research. Through RACC we will build transdisciplinary teams of social and natural scientists who will coalesce around the study of fundamental and hypothesis driven research questions about Lake Champlain Basin as a coupled human and natural system that is being affected by climate change and emphasize complex systems modeling among our approaches. Part of our mission is to provide scenarios and policies for adaptation (distinct from mitigation) and management of the Basin including an Integrated Assessment Model (IAModel) that can be extended to other basin systems. Equally integrated parts of our mission are to enhance STEM education, workforce size and diversity, and innovation in the private sector R&D through broad participation in RACC research.

PROJECT AREAS

The overarching question that links and focuses our project is:
How will the interaction of climate change and land use alter hydrological processes and nutrient transport from the landscape, internal processing and eutrophic state within the Lake and what are the implications for adaptive management strategies?

Researchers are organized around three questions and the Integrative Assessment Model (IAModel). The following milestones are action items and objectives that are measurable. These milestones reflect the resources and planning and may be slightly different from those in the proposal.

MILESTONES					
Overarching Question: How will the interaction of climate change and land use alter hydrological processes and nutrient transport from the landscape, internal processing and eutrophic state within the Lake and what are the implications for adaptive management strategies?					
Draw from data collected and models developed in Questions 1-3 a description of the processes that affect the states and health of the Lake.					
Put into action the IAmodel for policy makers and managers to address potential responses to climate change.					
Lake process model development (Question 1)	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Install instrumented stations and long term under ice sensor array water column sampling	X	X	X		
Establish work flow with Labs in UVM, SMC, JSC	X	X			
Determine nutrient transport parameters for and integrate with IAModel (ARIES platform)	X	X	X	X	X
Organize and carry out biological & nutrient sampling	X	X	X	X	
Data collection and hydrology model development (Question 2)					
Install and use automated water samplers at gauging stations and well networks	X	X	X	X	X
CWDD teams collect/analyze samples during high precip events	X	X	X	X	X
Parameterize and validate coupled watershed/vegetation model	X	X	X		
Integrate lake and watershed and ABM into ARIES platform			X		
Scenarios & Theoretical studies (stable states)			X	X	X
Select and downscale Climate Scenarios	X	X			
Recruit additional sociologist		X			
Governance and ABM model development (Question 3)					
Convene mediated modeling sessions regarding climate change, land use storylines, coupled human system drivers, policy and governance drivers	X	X	X		
Engage stakeholders in adaptive mgmt. intervention scenarios				X	X
Develop conceptual models of watershed governance, parameterize watershed governance ABM, calibrate and validate governance ABMs	X	X	X	X	X
Integrate governance and ABM to ARIES platform			X		
Develop adaptive management framework to select proactive policy interventions			X	X	X
Collaborate with ID, NH scientists; Hold joint meetings (VT 2012, ID 2014)	X	X	X	X	X
Integration: IAModel Spatial Database Management Development					
Adapt the ARIES platform for RACC research through scoping models	X	X	X	X	X
Integrate multiple models	X	X	X	X	X
Run the model applications for scenario testing				X	X
Integration of Participants and STEM Workforce Development					
Use cyber-enabled communication for training and education outreach	X	X	X	X	X
Provide water analysis to support RACC research	X	X	X	X	X
Integrate high school students and teachers into research (16-25 teams per year)	X	X	X	X	X
Integrate undergraduates into research (30-37 students per year)	X	X	X	X	X
Integrate middle school teachers into research (4 by year 2)	X	X	X	X	X
Increase diversity of participants at all levels, including disabled and veteran students	X	X	X	X	X
Partner with GIV to increase participation of girls and economically-disadvantaged students	X	X	X	X	X
Establish a scholarship program to support first generation and Abenaki students enrolled in STEM majors	X	X	X	X	X

Partner with VT Technology Council to coordinate private sector technology internship program	X	X	X	X	X
Partner with INBRE to coordinate mentoring program for graduate students, postdocs and faculty	X	X	X		
Sustaining RACC Research and Innovation through Seed Funding					
Review proposals and make up to 8-10 SBIR Phase (0) awards annually	X	X	X	X	X
Review proposals and make up to 4 IF awards annually	X	X	X	X	X
Review proposals and make 4-6 Pilot awards for complementary research annually	X	X	X	X	X
Review proposals and make up to 2 Use of Facility Awards	X	X	X	X	X
External Engagement					
Utilize Web based communication (RACC Website, Social Media Sites, YouTube) supplemented with print materials	X	X	X	X	X
Use cyber resources for video conferencing with Partners & Stakeholders and meetings hosted by VT EPSCoR	X	X	X	X	X
Produce Emerging Science Television Series, Webcasts, Outreach Visits and Curriculum Guides with VPT	X	X	X	X	X
Develop cyber technology (Mobile-Device Applications); use in face to face engagement		X	X	X	X
Develop Two-Minute Videos of scientific papers, authors, awards		X	X	X	X
Increase face to face interactions of RACC group; Café Scientifque, Emerging Science HS, VT State House	X	X	X	X	X
Host NSF OLPA Communicating Science Workshop	X				
Host annual State meeting, Research Symposium, Grant Writing Workshop, Tech Transfer	X	X	X	X	X
Cyberinfrastructure					
Deploy cyberinfrastructure for sensors in lake and under ice	X	X			
Connect data flows from models		X	X	X	X
Curate data in appropriate CUAHSI and ICPSR sites	X	X	X	X	X
Drupal-drive web site established for RACC participants to upload data and communicate	X	X	X	X	X
Support videoconferencing	X	X	X	X	X
Assessment and Evaluation					
Gather data and submit Annual Reports to NSF; share all data and committee reports with NSF, External Advisory Committee, Internal Steering Committee, and AAAS	X	X	X	X	X
Survey all participants through external evaluator who provides analysis and reports	X	X	X	X	X
Hold annual meetings of Internal Steering Committee, External Advisory Committee, AAAS	X	X	X	X	X
Present progress at Reverse Site Visit		X		X	

Question 1:

What is the relative importance of endogenous in-lake processes (e.g. internal loading, ice cover, hydrodynamics) versus exogenous to-lake processes (e.g. land use change, snow/rain timing, storm frequency and intensity, land management) to lake eutrophication and algal blooms?

Participants and Stakeholders:

Leader: Gregory Druschel (UVM Geology), who is leaving UVM but will continue with this research as an adjunct and a consultant. We are in the final stages of recruiting an assistant professor, who will be full time, research track, and very knowledgeable about the research in

Question 1. We feel that a full time research faculty member will bring even more effort to this aspect of RACC research than we had originally organized in the proposal. Other senior leadership for Question 1 comes from Jason Stockwell, Rubenstein Lab Director UVM. Dr. Stockwell's salary and set up are supported by VT EPSCoR as part of the RACC research. Dr. Stockwell is the "to be recruited" new aquatic ecology faculty mentioned in the proposal to join Question 1. Although Dr. Stockwell is relatively new to UVM, he has already immersed himself into the RACC research and directs the UVM lab that will be carrying out water analysis. Dr. Stockwell will work with Dr. Druschel to support the leadership of the new research faculty member.

Breck Bowden (Rubenstein School UVM) brings expertise in lake and streams in Vermont as well as a connection to the Lake Champlain Basin Program (LCBP). He is the chair of the LCBP technical committee. Mary Watzin, Dean of the Rubenstein School, is also a member of the international governing board for the Lake. Declan McCabe (Saint Michael's College), Pat Manley and Tom Manley (Middlebury College) bring expertise on water chemistry and the Lake. Beverley Wemple (UVM Geography), Arne Bomblies (UVM Civil and Env. Engineering and Leader for Question 2), Sallie Sheldon (Middlebury College), Donna Rizzo (UVM Civil and Env. Engineering), Austin Troy (UVM Gund Institute), Les Kanat (Johnson State College), Robert Genter (Johnson State College), Alexandra Drizo (PhosphoReduc), and Don Ross (UVM Plant and Soil Science) bring expertise on the hydrology, soil chemistry, land use and watershed input into the Lake. Christopher Koliba (Question 3 leader and UVM Community Development and Economics) and Asim Zia (UVM Community Development and Economics) bring a strong connection to the human aspects of the coupled human and natural system of the basin. Alan Betts (Atmospheric Research), Lesley-Ann Dupigny-Giroux (UVM Geography) and Brian Beckage (UVM Plant Biology) bring watershed land use and climate change expertise.

Two graduate students will join this group; one student, Peter Isles, is already participating. The postdoctoral associate is Courtney Giles, who will join in January. Undergraduates and High School students are being recruited through the CWDD.

The stakeholders who meet with the group regularly are: Lake Champlain Basin Program (LCBP) director William Howland; Kari Dolan (Agency of Natural Resources (ANR) and Clean and Clear Program), and Eric Smeltzer (International Mississquoi Bay Board and Vermont ANR); Nature Conservancy from NY Curt Stager and from VT Phil Huffman; Brian Wood, Vermont Climate Collaborative.

Brief description, assumptions: We will collect data relevant to determining the fundamental roles of nutrient speciation, transport to the lake, cycling, ice dynamics and nutrient mobility play in Lake states. This effort relates directly to the overarching question about the processes that affect the state and health of the Lake.

Goals or major tasks or strategies: Our strategies are to deploy sensor instrumentation and cyberinfrastucture for the sensors and analyze the samples and data that result. We will work closely with the investigators for Questions 2 to develop models and with investigators for Question 3 and the IAModel to integrate models and data for scenario testing.

Objectives or action items that are measurable (Milestones), Metrics for measuring success toward milestones, and Baselines are in the Appendix Table.

Anticipated impacts: When the field work is successfully established, data will feed into the models that are used through the IAModel in the ARIES platform for scenario testing. ARIES will become a useful, transferrable modeling platform for Lake Champlain Basin and transferrable to other systems.

Challenges and risks: Risks associated with Question 1 in the short term are recruiting the personnel who will carry out this research, including the Research Assistant Professor who will coordinate with Dr. Druschel in steering the research. We are confident given the interviews of applicants that we will have a talented faculty member on board soon. One graduate student and one postdoc have joined the program, leaving just one more graduate student to recruit.

Other risks come with the instrumentation. We do not anticipate problems in purchasing and deploying sensors in time for the first field season; we do not anticipate problems with maintenance. We have sufficient expertise at UVM and Middlebury College with sensors in the Lake to make us confident that we can handle problems with instruments as they arise.

Question 2:

Which alternative stable states can emerge in the watershed and lake resulting from non-linear dynamics of climate drivers, lake basin processes, social behavior, and policy decisions?

Participants and Stakeholders: Leader: Arne Bomblies (UVM Civil and Environmental Engineering); Beverly Wemple (UVM Geography); Lesley-Ann Dupigly-Giroux (UVM Geography and State Climatologist); Donna Rizzo (UVM Civil and Environmental Engineering); Brian Beckage (UVM Plant Biology); two new graduate students and one new postdoc have been recruited. Stephanie Hurley (a new faculty member of UVM Plant and Soil Science) and Carol Adair (new member of the Rubenstein School) have been recruited to join Question 2 for their land management and climate change expertise. Undergraduates and High School students are being recruited through the CWDD.

Participating from Question 1: new Research Assistant Professor); Gregory Druschel consultant; Mary Watzin is also a member of the international governing board for the Lake. Participating from Question 3 and IAModel: Christopher Koliba (Question 3 leader and Community Development and Economics UVM) and Asim Zia (UVM Community Development and Economics) bring a strong connection to the human aspects of the coupled human and natural system of the basin.

Also participating is Breck Bowden (Rubenstein School UVM) who brings expertise in lake and streams in Vermont as well as a connection to the LCBP as the chair of the LCBP technical committee. Declan McCabe (Saint Michael's College), Sallie Sheldon (Middlebury College), Austin Troy (UVM Gund Institute), Les Kanat (Johnson State College), Robert Genter (Johnson State College), Alexandra Drizo (PhosphoReduc), and Don Ross (UVM Plant and Soil Science) bring expertise on the hydrology, soil chemistry, land use and watershed input into the Lake. Alan Betts (Atmospheric Research brings climate change expertise.

We will collaborate with Dr. Cynthia Rosenzweig, (NASA GISS) to generate downscaled RCMs that can be used as starting points for the efforts in Question 2.

The stakeholders who meet with the group regularly are: LCBP director William Howland; Kari Dolan (Agency of Natural Resources (ANR) and Clean and Clear Program), and Eric Smeltzer (International Mississquoi Bay Board and Vermont ANR); Nature Conservancy from NY Curt Stager and from VT Phil Huffman; Brian Wood, Vermont Climate Collaborative.

Brief description, assumptions: We will develop a model of stable and alternate states for the Lake Champlain Basin that couples forest dynamics, land use patterns, human agency and fluxes (water sediment, nutrients). This effort relates directly to the overarching question about the processes that affect the state and health of the Lake.

Goals or major tasks or strategies: We will carry out field work in two sub-watersheds and develop watershed models that will be integrated into the IAModel for scenario testing.

Our strategies are to deploy samplers in two watersheds and from these and other samples from streams in the watersheds gather data on "to Lake" processes, especially in high flow events. We will work closely with the investigators for Questions 1 as we develop models and with investigators for Question 3 and the IAModel to integrate models and data for scenario testing.

Objectives or action items that are measurable (Milestones), Metrics for measuring success toward milestones, and Baselines are in the Appendix Table.

Anticipated impacts: As the field work is carried out, data will feed into the models that are used through the IAModel in the ARIES platform for scenario testing. ARIES will become a useful, transferrable modeling platform for Lake Champlain Basin and transferrable to other systems.

Challenges and risks: One challenge for Question 2 comes from the very large number of participants who will be collecting from the ISCO samplers in high water events and from other tributaries in the two sub-watersheds year round. The CWDD will organize and train the undergraduates, high school and middle school teachers and high school students. Nonetheless, we anticipate many samples that will be collected, analyzed and surveyed for quality before they can provide useful data to the modelers.

We anticipate having all the personnel recruited very shortly. We already have a graduate student and one postdoc joining Question 2. The technicians who will be key to water analysis at SMC and JSC are in place.

Question 3:

In the face of uncertainties about climate change, land use and lake response scenarios, how can adaptive management interventions (e.g. regulation, incentives, treaties) be designed, valued and implemented in the multi-jurisdictional Lake Champlain basin?

Participants and Stakeholders: Christopher Koliba (Question 3 leader and Community Development and Economics UVM) and Asim Zia (UVM Community Development and Economics) bring a strong connection to the human aspects of the coupled human and natural system of the basin. Alan Betts (Atmospheric Research), Lesley-Ann Dupigny-Giroux (UVM Geography) and Brian Beckage (UVM Plant Biology) bring watershed land use and climate change expertise.

Also participating are: Breck Bowden (Rubenstein School UVM) brings expertise in lake and streams in Vermont as well as a connection to the Lake Champlain Basin Program (LCBP). He is the chair of the LCBP technical committee. Mary Watzin, Dean of the Rubenstein School, is also a member of the international governing board for the Lake. Arne Bomblies UVM (Civil and Env. Engineering and Leader for Question 2), Sallie Sheldon (Middlebury College), Donna Rizzo (UVM Civil and Env. Engineering), Austin Troy (UVM Gund Institute), Les Kanat (geologist, Johnson State College), Tania Bacchus (climatologist, Johnson State College). The stakeholders who meet with the group regularly are: Lake Champlain Basin Program (LCBP) director William Howland; Kari Dolan (Agency of Natural Resources (ANR) and Clean and Clear Program), and Eric Smeltzer (International Mississquoi Bay Board and Vermont ANR); Nature Conservancy from NY Curt Stager and from VT Phil Huffman; Brian Wood, Vermont Climate Collaborative. Invited to our mediated modeling sessions will also be town managers, EPA, USDA, USFWS, USGS representatives in Vermont; State departments of Agriculture, Transportation, Tourism and Marketing; Champlain Valley Heritage Network, Northern Lakes Citizens Advisory Committee, Lake Champlain Bikeways, Lake Champlain Chamber of

Commerce; thirty local planning commissions, farmers, landowners, and citizens.

Two graduate students will join this group; the postdoc recruitment is close to concluding. An additional sociologist will be recruited by the beginning of Year 2, as required in the Programmatic Terms and Conditions. Undergraduates and High School students are being recruited through the CWDD.

Brief description, assumptions: Our broad goal is to develop a new understanding among Lake Basin stakeholders about climate change scenarios and various proactive policy and governance solutions. We will accomplish this through mediated modeling sessions regarding climate change, and the development of agent based models that will help us to create a system-wide map of network actors and their functions.

This effort relates directly to the overarching goal to put into action the IAModel in order to address potential responses to climate change as well as contributing to the overarching question by studying the human contributions to the state and health of the Lake.

Goals or major tasks or strategies: We will engage Lake Champlain Stakeholders in learning what will be needed to implement adaptive management practices through Mediated modeling and scenario development. We will develop, refine, validate and share Agent Based Models for watershed governance networks and policy tools.

We will work closely with the investigators for Questions 1 and 2 to integrate models into the IAModel ARIES platform for scenario testing.

Objectives or action items that are measurable (Milestones), Metrics for measuring success toward milestones, and Baselines are in the Appendix Table.

Anticipated impacts: Data will feed into the models that are used through the IAModel in the ARIES platform for scenario testing and identification of agricultural and residential land use and other best management practices to proactively deal with climate change impacts in the Lake Champlain Basin.

Challenges and risks: A challenge for the investigators of Question 3 will be to engage a large number of stakeholders in state agencies, the agricultural and residential communities of the Basin. The LCBP will help to expedite these mediated modeling meetings and surveys. The investigators may encounter resistance to research on climate change or research on adaptation rather than mitigation in the Lake. We have prepared ourselves for these scenarios.

Another challenge will be to integrate the social science data into the IAModel for use in scenario testing.

Integrated Assessment Model:
Members from each of the three question teams will collaborate to create an IAModel for regional management, an instrument demanded by regional and national studies for adaptive capacity.

Participants and Stakeholders: The primary participants are the leaders of Questions 1-3, Donna Rizzo (UVM Civil and Environmental Engineering), Beverley Wemple (UVM Geography), Brian Beckage (UVM Plant Biology), Richard Kujawa (Saint Michael's College), Austin Troy (Gund Institute, Rubenstein School, UVM).

The stakeholders who will be the most directly involved in the IAModel are: LCB; Kari Dolan (Agency of Natural Resources (ANR) and Clean and Clear Program), and Eric Smeltzer (International Mississquoi Bay Board and Vermont ANR); Nature Conservancy from NY Curt

Stager and from VT Phil Huffman; Brian Wood, Vermont Climate Collaborative.

Brief description, assumptions: This effort relates directly to the overarching goal to put into action the IAModel in order to address potential responses to climate change as well as contributing to the overarching question by studying the human contributions to the state and health of the Lake.

Goals or major tasks or strategies: We will incorporate data from all questions into the Question 2 and 3 models and integrate the models into the IAModel in the ARIES platform. An important outcome will be that our models and ARIES become useful and transferrable for climate change analysis in other settings.

Objectives or action items that are measurable (Milestones), Metrics for measuring success toward milestones, and Baselines are in the Appendix Table.

Anticipated impacts: data will feed into the models that are used through the IAModel in the ARIES platform for scenario testing. ARIES will become a useful, transferrable modeling platform for Lake Champlain Basin and transferrable to other systems.

Challenges and risks: The integration of models will be the most challenging aspect of our work. The personnel who will adapt the ARIES platform for use in the integration of the models developed in Questions 2 and 3 for scenario testing are consultants to the Gund Institute at UVM. If the adaptation process is more difficult than we anticipate, the testing of scenarios could be delayed. However, we have been conservative in our estimation of when we will begin that testing.

RACC Seed Funding:

In order to further stimulate competitiveness and to identify emerging research and innovation, we have proposed pilot awards for Vermont faculty, and SBIR Phase (0), Use of Facilities and Innovation Fund (IF) Awards for the private sector.

Participants and Stakeholders: Faculty from across Vermont compete for Pilot Awards. Small businesses compete for the SBIR Phase (0), Use of Facilities and IF Awards. Entrepreneurs and venture capital companies assist us in reviewing. The Vermont Center for Emerging Technologies (VCET) provides review assistance. Small technology businesses across Vermont participate.

Strategy: Our strategy is to continue to make SBIR Phase (0), Use of Facilities, IF and Pilot awards.

Goals or major tasks: Make SBIR Phase (0), Use of Facilitates, IF and Pilot awards annually and follow the PIs for resulting research and funding. See Milestones Table.

Anticipated Impacts: The small business community in Vermont has leveraged SBIR Phase (0) awards to create a large return on investment (ROI) in federal Phase (1) and (2) SBIR Awards. Likewise, IF Awardees are successful in competing for federal funds. We intend to continue this impact on small businesses and the Vermont economy.
Pilot awardees have carried out research that is complementary to our previous RII – Track I funded research on the Lake Champlain watershed. We anticipate that success rates similar to what we have experienced in the past (i.e. private sector awardees are competitive for federal funding opportunities at roughly twice the national average).

Challenges and Risks: The challenges for the private sector awards are in identifying truly innovative, high risk research for IF awards and determining what "success" for these awards looks like. We are working on a longitudinal study of our IF Award program now that it is in its 5th cycle. The risks are in developing review panels of entrepreneurs who can estimate the innovation and risk of proposed research.

Plan for the Center for Workforce Development and Diversity:
The Center for Workforce Development and Diversity (CWDD) will engage a broad range of institutions, students and teachers in RACC research and the Governor's Institutes. Our planned STEM Workforce and Diversity outcome is that CWDD will increase the size of the Vermont STEM workforce and make it more diverse by integrating into research students and teachers who come from diverse backgrounds and a diversity of institutions.

Participants and stakeholders: Key partners including Vermont colleges and universities (18 private and 5 state colleges); Vermont high and middle schools; Puerto Rico university and high school partners; Northern New York State high schools; Bronx high schools; Providence Rhode Island high schools; the Abenaki Nation Tribal Council; Governor's Institutes of Vermont; Eric Smeltzer (International Mississquoi Bay Board and Vermont ANR); SMC, JSC, Community College of Vermont, NASA EPSCoR and Vermont INBRE and others will be working with VT EPSCoR to achieve this outcome through a number of programs and initiatives.

Brief description, assumptions: Our inclusion of a diverse group of students and teachers from a diversity of institutions in RACC research will contribute to the overarching question of the research, which is to create a description of the processes that affect the states and health of the Lake. In addition to this approach to workforce development and increased diversity, we support other programs for the rural poor and the private sector.

Goals or major tasks or strategies: The Center for Workforce Development and Diversity (CWDD) is now hosted at Saint Michael's College (SMC) and includes a water analysis lab for RACC research. There is a second CWDD water analysis lab and a ribotyping lab at Johnson State College (JSC). The Center's Director and Manager recruit undergraduates, high school teams of students and teachers, middle school teachers and Vermont faculty (through pilot awards) to participate in RACC research. With Declan McCabe (SMC), Robert Genter (JSC), and Sallie Sheldon (Middlebury College), the CWDD trains the students and teachers in stream and river sampling, water analysis and modeling that are necessary for Question 2. Participants who prefer to work on Question 1 on the Lake or Question 3 on the mediated modeling and surveying will be trained directly by the RACC researchers. We are developing new networks among colleges in Vermont to include Veterans and students with disabilities in our research.

The CWDD hosts the spring symposium at which the participants present their research. The CWDD also works with the Governor's Institutes to support scholarships so that economically disadvantaged Vermont children and more girls can attend these valuable summer institutes. This effort supports our goal to increase the opportunities for rural poor children and increase the number of girls in historically male dominated STEM disciples (e.g. computer science). CWDD assists the Vermont Technology Council's private sector summer intern program by holding videoconferencing interviews so that students in distant sectors of the state can participate. New to the CWDD are the scholarships that will be provided to first generation Vermont students who attend Vermont institutions of higher education in STEM majors and the Abenaki scholarship that NASA EPSCoR and the Abenaki Nation will help us to administer.

A new program through the CWDD is the training of mentors and the oversight of the

mentoring program for graduate students, postdocs and new faculty. The CWDD Director collaborates with the Vermont INBRE for these programs.

We increasingly depend on videoconferencing for our CWDD activities. It is important for the work of the CWDD staff with JSC and Middlebury faculty and other participants and for communication between the CWDD offices and labs at SMC and JSC. Videoconferencing is also critical to training and to communication with students especially for the high school teams in the Bronx, Puerto Rico, New York State, Vermont partner institutions, and remote parts of Vermont.

Another cyber-enabled approach to engagement of students and the lay public is the development of applications for mobile devices for RACC research. Our first app will be for identification of macroinvertebrates in watershed streams, linking to the web site for macroinvertebrates developed by Declan McCabe. A second app will be developed by Year 3.

Objectives or action items that are measurable (Milestones), Metrics for measuring success toward milestones, and Baselines are in the Appendix Table.

Anticipated impacts: After RACC graduate students, postdocs and faculty work with undergraduate and high school students, high school and middle school teachers, all of these participants will present (students and teachers with their RACC mentors) at the spring symposium in order for everyone to understand the program and their contribution. Another impact is that participants become acquainted, network and collaborate. Another outcome is increased inclusion of students in general and under-represented groups in particular in STEM research and STEM careers.

We anticipate that research opportunities for students and teachers will increase numbers of students in the Vermont STEM majors and work force. Through a combination of research and mentoring, we will retain well trained RACC participants in STEM majors and careers.

Challenges and risks: We have set very high goals for recruitment and involvement of Vermont high schools. It is possible that we will not always meet this bar given the small number of Vermont high schools (87). However, there are many schools in Puerto Rico and elsewhere that have expressed interest where we can recruit. Another challenge is to recruit from Burlington and Winooski high schools where the population of students is the most diverse in Vermont due in part to the refugee settlement programs. We will make more visits to the schools, with the faculty and graduate students to help promote RACC research.

<u>**External Engagement Plan**</u>:
External Engagement efforts include "outreach, communication and dissemination of information for the development of a diverse, well-prepared STEM workforce and a more scientifically literate public." (RFP NSF 10-582). The RACC CWDD specifically expands and addresses the workforce and diversity of STEM initiatives in VT (described above). Our Plan to communicate and disseminate information for a well-prepared STEM workforce and a more literate public is below and in the Milestones and Appendix "C" Tables. We also include our plans for Cyber-enabled education (above in CWDD) and in external engagement as a requirement of our Strategic Planning Process that w
ill be tracked as part of ongoing reporting.

Participants and Stakeholders: Vermont Universities and Colleges; Vermont High Schools; Vermont Public Television; University of Vermont Public Information Officer (PIO); Leahy Center for Lake Champlain ECHO Lake Aquarium and Science Center; Champlain College; RACC investigators, Vermont's two museums, libraries. The Connect Vermont

program (Karen Marshall, Director) is working with us on the broadband connectivity of these last partners who will benefit not only from our face to face visits, but also RACC research via videoconferencing and the Internet.

Brief description, assumptions: The Communications plan that is part of the External Engagement Plan uses cyber, broadcast media, print and public information officers to make information available quickly, accurately and broadly to the broader public, stakeholders and partners in the state and region. Underlying assumptions include the premise that the scientific merit of the award is of great significance to the region and will likely be of interest to many of its constituents.

Goals or major tasks or strategies: The goal of the communications plan is to enable efficient sharing of data and information among our project partners, stakeholders and broader public using several strategies listed above. Regular communication with the NSF EPSCoR Office will also be included. Direct interaction of the RACC investigators with the public.

Anticipated impacts:
o Efficient data sharing and information among project partners.
o Researchers better trained to communicate science more broadly.
o A diverse and broad audience better informed about ongoing research efforts and implications of the research to the community and region.
o Increased use of cyber resources for external engagement and education outreach.

Challenges and risks: Challenges include capturing research progress in a timely basis; buy-in from researchers who are already very busy; engaging the broader public in research topics that may not immediately appear relevant due to preconceived notions that science as being out of their domain.

RACC Cyberinfrastructure Plan:
Vermont EPSCoR recognizes that cyberinfrastructure is critical to advances in research and education in science and engineering. In addition, cyberinfrastructure enables broad educational engagement at the frontiers of discovery and innovation in science and engineering. We will develop, improve and deploy cyberinfrastructure to support the goals and activities of both the RII project and the jurisdiction's science and technology plan. Objectives include that we will through Track-1
• Deploy cyberinfrastructure for the Lake sensors
• Support data management for connecting models and curating data

In addition we to support communication we will
• Establish a Drupal-driven RACC website for communication and data sharing
• Support videoconferencing that is used by all segments of VT EPSCoR, including communication for new research with investigators in NH and ID

Also through our Track-2 and C2 that complement the Track-1 research we will
• Solve connectivity bottlenecks for researchers (Track-2 and C2)
• Work with the State middle and last mile programs that will bring broadband to schools, museums and libraries etc. by providing cyber-knowledgeable staff who will introduce the value of Internet 2 to these institutions. (The C2 grant supports this staff member and also the membership to SEGP for Internet2.)

Participants and Stakeholders: Vermont EPSCoR's key partners in cyberinfrastructure for

the state are the University of Vermont, the Vermont State College System and the State. Dr. David Todd is Associate Vice President and Chief Information Officer for UVM and brings experience from the private and public sector as well as high-performance computing. Linda Hilton is the CIO of the Vermont State Colleges (Johnson State College, Lyndon State College, Castleton State College, Vermont Technical College and the Community College of Vermont) and is critical in broadening the impact of CI in the state and workforce development. Karen Marshall is the chief of ConnectVT, the state initiative for connectivity that includes coordinating the middle- and last-mile solutions for Vermonters.

Brief description, assumptions: The assumptions in the Vermont EPSCoR cyberinfrastructure plan are based upon a broad jurisdiction-wide survey of the cyberinfrastructure landscape performed as part of the RII planning process. We have identified CI needs for Track-1: the CI for the sensor network on the lake, and the CI needed for data management between models.

Needs identified for Track-2 and C2 are: connectivity between UVM and the Vermont State College system, connectivity between UVM's campus and the research offices for many of the RACC investigators at 80 Colchester in Burlington.

Goals or major tasks or strategies: The major tasks and strategies for CI are connectivity for RACC researchers. UVM researchers who are outside the UVM firewall (located at 80 Colchester) need access to UVM resources, including datasets, and analysis and visualization tools. Non-federated non-UVM RACC researchers (for example, investigators at the state college system or the baccalaureate partner institutions) need high-bandwidth connections to RACC resources. Finally, lake sensors will need cyberinfrastructure for data telemetry. This consists of instrumented moorings (final instrumentation decisions will be made in January 2012) and under ice moorings (final instrumentation decisions will be made by summer 2012).

Anticipated impacts: As the individual modeling components are developed, the anticipated impacts for the ARIES and Question 2 teams are the data management and workflows for connecting the watershed, lake processes and social system models.

The anticipated impacts for this work will be the ability for researchers at 80 Colchester to access large datasets and analysis and visualization tools on campus, access for non-UVM RACC at the Vermont State College system to access RACC datasets.

Challenges and risks: The largest challenge for the cyberinfrastructure plan is the connectivity to the State College system that will be funded by C2. This is due to the large difference in cyberinfrastructure needs between the flagship research university (UVM) and the VSC, whose mission is primarily focused on teaching. At risk specifically for RACC research and CWDD will be the quality of communication among RACC participants at the state colleges and between the CWDD and the water analysis lab at JSC.

Improving connectivity of 80 Colchester through C2 funds is important to RACC because our graduate students, postdocs and new research assistant professor are there. Connectivity to this building a priority for RACC participants' access to data sets and modeling.

Metrics for measuring success toward milestones: In Years 1-2 we will establish the connectivity for the Lake and under-ice sensors. In years 2-5 we will connect data flows from models and in all years curate data in appropriate CUAHSI and ICPSR sites. Our baseline is that there currently are no sensors or data flows.

RISK MITIGATION PLAN FOR PROJECT AS A WHOLE

General Risks for the Project:
Personnel: We have begun to recruit the personnel for the RACC and CWDD, and our success to date indicates that the project is very attractive nationally and internationally and that many candidates are applying for each position. This leads us to predict that we will have normal attrition of people as expected for any project, and that we will be successful in filling positions. (See below for more on succession plans.)

Data Collection: Our faculty have the experience to deploy and collect data from the many sensors that we will use to instrument the lake and rivers. We have anticipated that some instruments might be vulnerable to vandals, and we have made some designs to minimize that. If we lose some equipment, we will redeploy within our budget limits.

Data collection for Question 3 requires stakeholder meetings, which we anticipate will be well attended. There may be attitudes among the citizenry about climate change and research on the Lake that would make surveying more of a challenge, but we will be working with the Lake Champlain Basin Program in particular to engage groups of people. We anticipate that we will collect the data that we need.

Data Management: The archiving and curation of data, especially from the surveys and stakeholder meetings, will be new to Vermont EPSCoR. However, we anticipate few problems because we have experts among our faculty for use and storage of these kinds of data.

Downscaling of Regional Climate Models: Critical to our work are downscaled IPCC story lines and scenarios on a <1 km scale for use in our Basin modeling. We are beginning this work and will have the help of the National Environmental Survey institute at Columbia University to ensure that our methods and validations are sound.

Data Analysis and Modeling: Perhaps the most challenging aspect of our work is the integration of many kinds of models so that the maximum data can be used for scenario testing in the IAModel. We anticipate that we will find challenges and problems to solve as we go along. However, we our research design will address some of these concerns. First, we will use the ARIES platform for integration of the models. ARIES was developed in the Gund Institute at UVM through NSF funding and we are working with its designers first hand. Second, the modelers for Questions 2 and 3 are very experienced with complex systems models including agent based, genetic (Bayesian), artificial neural network, tRIBS and others and several have worked together in the previous phase of Vermont EPSCoR Track-1. They are well positioned to understand and integrate these different models into the IAModel.

A mid-academic year project start may make it difficult to achieve all Year 1 deliverables: As the strategic plan is developed and milestones articulated, we will factor academic schedules into our timeline.

There may be some challenges in securing data from other entities we need to make our complex models as robust as possible: Our very close ties with stakeholders like the Lake Champlain Basin Program, Agency of Natural Resources, Nature Conservancy and the Missisquoi River Project will allow us to work through a network in Vermont, New York and Quebec to acquire the data that we need if not directly then through our partners' connections.

Succession Plans:

To address succession, there is built-in overlap of personnel in the teams for the three questions and the IAModel that should be sufficient for short term absence or loss of personnel. We also have already shown that we can move quickly to recruit a new member of the RACC research. One of our science leaders, Dr. Gregory Druschel, is moving to University of Indiana and, while he will remain as a consultant, we felt that we needed more faculty level involvement in Question 1. We are close to the successful recruitment of a Research Assistant Professor in Geology, Dr. Druschel's department at UVM, to ensure that progress on Question1 is seamless.

The Vermont EPSCoR leadership also has a succession plan. The Associate Project Director will become the next Vermont EPSCoR PD, pending approval of the Vermont Technology Council that functions as the Vermont EPSCoR State Committee.

EVALUATION AND ASSESSMENT PROCESS

The components of the evaluation and assessment process are the Strategic Plan which has milestones by year, metrics and definitions of success; annual surveys of all participants; annual progress report for NSF EPSCoR; annual visit by the External Advisory Committee (EAC); annual visit by a team from the AAAS Research Competitiveness Program; annual Internal Steering Committee (ISC) meetings; Reverse Sites visits in Years 2 and 4. The resulting reports are shared as they are approved. The annual assessments that we carry out are used for formative evaluations by the ISC, EAC and AAAS. These evaluations occur at different times of year, which gives us a more than annual opportunity for mid-course corrections. We will refer to the Strategic plan, the Reverse Site visit reports, and the Programmatic Terms and Conditions in each stage of our iterative evaluation process. See also Table of Milestones (above) and Table of Goals, Strategies, Activities, Metrics and Impacts (Appendix).

APPENDICES

- A. *Attendee list for Nov 1-2*
- B. *Agenda for Nov 1-2*
- C. *Table of Goals, Strategies, Activities, Metrics and Impacts*
- D. *RACC participant list*

Last Name	First Name	VT EPSCoR Role	Professional Title
Barnes	Denise	NSF EPSCoR	Senior Staff Associate
Beckage	Brian	Regional Climate Data	Assoicate Professot, Plant Biology
Bomblies	Arne	Project Research Theme Leader Q2	Assistant Professor, School of Engineering
Chu	Kelvin	VT EPSCoR and Cyberinfrastructure	Associate Project Director, Associate Professor Physics
Druschel	Greg	Project Research Theme Leader Q1	Associate Professor, Geology
Dupigny-Giroux	Lesley-Ann	Regional Climate Data	Associate Professor, Geography
Erickson	Jon	Integrated Assessment Model Leader	Professor, Gund Institute
Evans	John	State Committee Representative	President, Vermont Technology Council & Senior Advisor to the President, UVM
Exler	Steve	VT EPSCoR	Information Technologist
Gabrielson	Linda	Internal Advisory Committee	Academic Dean, CCV
Gamache	Lillian	VT EPSCoR and External Engagement	Project Administrator
Genter	Bob	Diversity & Workforce Development, Johnson State College	Professor, Environmental & Health Sciences
Joyal	Nora	VT EPSCoR	Office Administrator
Kanat	Les	Partner Institution Faculty Researcher, Johnson State College	Professor, Environmental & Health Sciences
Koliba	Chris	Project Research Theme Leader Q3	Associate Professor, Com. Dev. & Applied Economics
Lahar	Steffi	External Facilitator	Stephanie Lahar and Associates, LLC
Lescaze	Miranda	VT EPSCoR Center for Diversity & Workforce Development (CWDD)	Center for Workforce Development & Diversity (CWDD) Director at St. Michael's College
Livingston	Joy	External Evaluator and Assessment	Sr. Partner, Flint Springs Associates
Manley	Tom	Partner Institution Faculty Researcher, Middlebury College	Assistant Professor, Geology
McCabe	Declan	Diversity & Workforce Development, St. Michael's College	Associate Professor, Biology
Michalak	Anna	External Advisory Committee	Associate Professor, Stanford University
Mooney	Sian	NSF EPSCoR	NSF EPSCoR Program Director
Rizzo	Donna	Project Research Theme Co-Leader Q2	Associate Professor, School of Engineering

Strategic Planning Participants RACC Research
November 1 and 2, 2011 Burlington, VT

Last Name	First Name	VT EPSCoR Role	Professional Title
Shackleton	Dawn	VT EPSCoR	Operations Manager
Stager	Curt	Internal Advisory Committee	The Nature Conservancy
Stockwell	Jason	Project Research Theme Co-Leader Q1	Associate Professor, RSENR
Todd	David	Cyberinfrastructure	Chief Information Officer, Enterprise Technology Services, UVM
Troy	Austin	Integrated Assessment Model	Associate Professor, Computer Science
Van Houten	Judith	VT EPSCoR	State Director, VT EPSCoR, Professor of Biology
Wemple	Beverley	Project Research Theme Co-Leader Q1	Associate Professor, Geography
Zia	Asim	Project Research Theme Co-Leader Q3	Assistant Professor, Com Dev & Applied Economics

Strategic Planning Meeting Agenda for
Research on Adaptation to Climate Change in the Lake Champlain Basin: New
Understanding through Complex Systems Modeling. NSF EPS#1101317

Dates: November 1 & 2, 2011

Location:
Davis Center, UVM Campus, Silver Maple Ballroom from 9a.m.-4p.m. on November 1
Davis Center, UVM Campus, Livak Ballroom from 9a.m.-12:30p.m.on November 2

Documents Provided for the Meeting Attendees in Advance:
Original Proposal
Review Panel Summary
Reviewer Comments
Programmatic Terms and Conditions
"Planning Excel Sheet "

Facilitator
Steffi Lahar, Stephanie Lahar and Associates, LLC

Participants:
NSF EPSCoR
Denise Barnes, Senior Staff Associate
Sian Mooney, NSF EPSCoR Program Director

Vermont EPSCoR
State Director, VT EPSCoR
Judith Van Houten

Associate Project Director
Kelvin Chu

Project Administrator
Lillian Gamache

Operations Manager
Dawn Shackleton

Center for Workforce Development & Diversity (CWDD) Director
Miranda Lescaze

Office Administrator
Nora Joyal

Information Technologist
Steve Exler

Project Research Theme Leaders:
Question 1
Greg Druschel – Team Leader
Beverley Wemple
Jason Stockwell

Question 2
Arne Bomblies – Team Leader
Donna Rizzo

Question 3
Chris Koliba – Team Leader
Asim Zia

Integrated Assessment Model
Jon Erickson – Team Leader
Austin Troy

Regional Climate Data
Brian Beckage
Lesley-Ann Dupigny-Giroux

Partner Institution Faculty Researchers
Les Kanat, JSC
Tom Manley, Middlebury

Diversity & Workforce Development
Miranda Lescaze, SMC
Declan McCabe, SMC
Robert Genter, JSC

External Engagement
Lillian Gamache

Cyberinfrastructure
Kelvin Chu
David Todd, Chief Information Officer, Enterprise Technology Services, UVM

Evaluation
Joy Livingston, Sr. Partner, Flint Springs Associates

State Committee Representative
John N. Evans, President, Vermont Technology Council & Senior Advisor to the President, UVM

<u>External Advisory Committee</u>
Dr. Anna Michalak, Associate Professor, Stanford University (will participate by phone)

<u>Internal Advisory Committee</u>
Linda Gabrielson, Academic Dean, CCV
Curt Stager, The Nature Conservancy (will participate by phone)

<u>Agenda</u>
Day 1
Tuesday, November 1

8:00 – 8:45 a.m.
Registration and Continental Breakfast

8:45 a.m.
Welcome and Introductions
    Judith Van Houten

9:00- 9:30 a.m. (30 min)
Context for the Meeting
    Denise Barnes, NSF EPSCoR, Senior Staff Associate

9:30 – 9:45 (15 min)
Judith Van Houten
Vision and mission of the project
- Long-term view of the project.
- Fundamental purpose of the project and what will be done to achieve the vision.

9:45 – 10:00 a.m. (15 min)
Steffi Lahar remarks

10:00 a.m. Group presentations
- For each project area the team leaders will provide:
  - brief description, assumptions, and key partners
  - Goals (or Major Tasks or Strategies)
  - Objectives (or Technical Targets or Action Items) that are Specific, Measurable, Actionable, Realistic, and Time-bound (SMART) targets, with a defined timeline and assigned responsibility
- Steffi Lahar will lead discussion for each project area of
  - Metrics for measuring progress toward milestones
  - Baseline measures (values of metrics at project start)
  - Anticipated impacts
  - Challenges and risks involved in meeting the project area milestones and alternative plans for the area's goals, as needed

Q1 (10:00 – 11:00 a.m. 60 min)
    Greg Druschel – Team Leader
    Beverley Wemple
    Jason Stockwell

Q2 (11:00 a.m. – Noon 60 min)
      Arne Bomblies – Team Leader
      Donna Rizzo

Break (12:00 – 12:15 p.m.15 min)

Q3 (12:15 – 1:15 p.m. 60 min)
      Chris Koliba – Team Leader
      Asim Zia

Working Lunch 1:15 – 2:00 p.m. (45 min)

Integration on Multiple Levels
Integrated Assessment Model (45 min)
      Jon Erickson - Team Leader
      Austin Troy

Integration Continued
CWDD – (2:00 – 2:45 p.m. 45 min)
Including postdoctoral and other mentoring plans
      Miranda Lescaze
      Declan McCabe
      Robert Genter

Break (15 min)
2:45 p.m. – 3:00 p.m.

Cyberinfrastructure (3:00 – 3:30 p.m. 30 min)
      Kelvin Chu
      David Todd
            - Telemetry; instruments to ECHO
            - Data Management Plan
            - ARIES/how do models flow into each other?

External Engagement (3:30 – 4:00 p.m. 30 min)
      Lillian Gamache – communications plan
      Kelvin Chu – private sector engagement; SBIR Phase (0), IF

4:00 p.m.
Closing Remarks, Day 2 expectations
      Judith Van Houten
      Steffi Lahar

Day 2
Wednesday, November 2

8:00 – 9:00 a.m.
Breakfast and Registration

9:00 a.m. (10 minutes)
Opening remarks
Steffi Lahar

9:10 – 10:40 a.m. (90 min)
Group Work on Science Milestones led by Steffi Lahar
Q1, Q2, Q3, Integration
- Milestones at different time points for the project as a whole. These milestones serve as check points and may cross project areas, or show integration. Accomplishing all stated milestones should achieve the vision and mission of the project.

10:40– 11:25 a.m. (45 min)
Risk Mitigation Plan
- A risk mitigation plan for the overall project that details the impact to the project if things do not go as planned, including alternatives that could be pursued if necessary. This should include a succession plan.

11:25 – 11:40 a.m. (15 min)
Break

11:40 – 12:25 p.m. (45 min)
Evaluation and Assessment/Reporting Requirements
Joy Livingston
Lillian Gamache
Kelvin Chu
  o Discussion of the evaluation and assessment process, and how the evaluation feedback and recommendations will inform changes to the project and strategic plan.

12:25 p.m.
Summary of Meeting and Next Steps
Steffi Lahar
Judith Van Houten

12:30 p.m.
Lunch
Meeting Adjourned

Overarching Research Question				
Broad Goals	**Strategies to Achieve Goals**	**Activities to Implement Strategies**		**Metrics and Baselines**
A description of the processes that affect the states and health of the Lake	Implement Research on Questions 1-3	Details of activities and metrics below		New data, models and integrated approaches to adaptation to climate change that had not previously existed;
Put into action the IAModel to address potential responses to climate change	Integrate data and modeling through the Integrated Assessment Model (IAModel) using the ARIES platform			New research interactions across jurisdictions and an IAModel that will be transferrable to other basins
				Useful management scenario testing for Basin managers, policy makers and Basin governance that will have an economic impact on the region

Appendix "C"
Goals, Strategies, Activities, Metrics and Impacts Table
Vermont EPSCoR; Adaptation to Climate Change in the Lake Champlain Basin: New Understanding through Complex Systems Modeling
NSF EPS# 1101317

Question 1				
Broad Goals	**Strategies to Achieve Goals**	**Activities to Implement Strategies**	**Metrics and Baselines**	**Anticipated Impacts**
Collect data for the Lake relevant to determining the fundamental roles of nutrient speciation, transport to the lake, cycling, ice dynamics and nutrient mobility play in Lake states	Install instrumentation and cyberinfrastructure for sensors; deploy participants to sample in the Lake and coordinate with those sampling in the watershed	Install instrumented stations and long term under ice sensor array water column sampling	All Lake sensors installed for first field season; cyberinfrastructure plan for collection and archiving of data tested and implemented by first field season	Field work successfully established; data feeding into the models that are used through ARIES for scenario testing
		Implement data management plan (also for Questions 2,3 and IAModel below)	Data stored and accessible	
		Carry out biological and nutrient sampling to be analyzed at UVM, SMC and JSC	Laboratories established and data analyzed beginning with the first field season	
		Make nutrient transport measurements based on analyses of samples	Transport measurements feed into the Question 2 models by end of first field season	
Integrate data into the Question 2 models and into the IAModel (below)	Collaborate with model developers from Question 2 and IAModel	Integrate nutrient transport parameters into the IAModel (ARIES platform)	In all years as new data are collected integration will continue in order to improve the models and IAModel	ARIES becomes a useful, transferrable modeling platform for Lake Champlain Basin
Question 2				
Broad Goals	**Strategies to Achieve Goals**	**Activities to Implement Strategies**	**Metrics and Baselines**	**Anticipated Impacts**
Develop a model of stable and alternate states for the Lake Champlain Basin that couples forest dynamics, land use	Watershed model development	Identify the ecosystem services that act as the primary links to the governance model	Integration with Questions 1 and 3	Preparation for modeling that will integrate Questions 1-3 and models that will be integrated into the IAModel

patterns, human agency and fluxes (water sediment, nutrients)				accomplished New understanding of stable and alternate states of the Lake Basin
		Use story lines from the IPCC in downscaling of regional climate data	Methodology and downscaling established with consultants in Year 1	Downscaled climate data available for RACC and other regional research
	Field research	Experiment with stream bank sediment loads into streams	Data available for use in modeling through all years	Field work successfully established; data feeding into the models that are used through ARIES for scenario testing
		Analyze non-point P and sediment sources: how P and sediment mobilization depends on individuals' choices		
		Deploy ISCO samplers at 10 sites; coordinate with CWDD to ensure the retrieval of the ISCO samples and samples from other sites in the watershed by students and teachers paired with RACC graduate students and postdocs; capture high flow events;		
Feed in and feedback from IAModel	Model application	Accomplish integration of watershed model with IAModel	Models tested and validated with the IAModel by end of Year 2	ARIES becomes a useful, transferrable modeling platform for climate change analysis in the Lake Champlain Basin
		Test various scenarios	Test scenarios beginning in Year 4	
		Test specific hypotheses	Test hypotheses beginning in Year 2	

Appendix "C"
Goals, Strategies, Activities, Metrics and Impacts Table
Vermont EPSCoR; Adaptation to Climate Change in the Lake Champlain Basin: New Understanding through Complex Systems Modeling
NSF EPS# 1101317

Question 3				
Broad Goals	**Strategies to Achieve Goals**	**Activities to Implement Strategies**	**Metrics and Baselines**	**Anticipated Impacts**
Engage Lake Champlain Stakeholders in learning what will be needed to implement adaptive management practices through Mediated Modeling and scenario development	Convene mediated modeling sessions regarding climate change, land use storylines, coupled human system drivers, policy and governance drivers	Clarify timing, sequence and participants for mediated modeling sessions	Accomplish in first 3 years	New understanding among Lake Basin stakeholders about climate change scenarios and various proactive policy and governance solutions
		Implement three mediated modeling sessions		
		Align shared mental models derived through these sessions with IAModel		
Develop, refine, validate and share ABMs for watershed governance networks and policy tools	Watershed governance network model	Generate database of LCWB, Clean and Clear Action Plan, NRCS, and TMDL plans and activities	Databases established in Year 1 and continually updated	A Lake Champlain Basin system-wide map of network actors and their functions
		Generate institutional actor and land use database		
		Conduct stakeholder interviews	Interviews concluded within 3 years	
		Develop conceptual models of VT, NY, and Quebec governance networks	Preliminary models developed and calibrated beginning in Year 1, calibrated beginning in Year 2, and integrated into the IAModel ARIES platform by Year 3; hypothesis testing and scenario testing through Year 5	Integration of policy and governance models into the IAModel ARIES platform
		Develop an agent-based model of the inter-jurisdictional governance network		
		Calibrate model using historical planning and implementation data		Identification of agricultural and residential best management practices to proactively deal with
	Agricultural practices project	Identify all existing datasets available to researchers	Completed by beginning of Year 2	

		Create and implement farmer surveys for selected areas	Completed by end of Year 2	climate change impacts in the Lake Champlain Basin
	Residential practice project	Identify all existing datasets concerning residential practices	Completed by end of Year 2	
		Create and implement resident surveys for selected areas		
	Social/Policy/Governance hypothesis testing	Clarify hypothesis	Hypothesis testing throughout the grant lifetime	
		Test hypothesis using linear regression modeling		
		Test hypothesis using simulation experiments		
		Develop collaborations with other RACC teams and inter-state colleagues to test models and define applications	Throughout grant lifetime	
		Implement data management plan for social science data	Data stored and accessible	
	Develop adaptive management framework to select proactive policy interventions	Engage stakeholders in adaptive mgmt. intervention scenarios	Year 1-2, organize meetings with stakeholders to develop scenario storyline and model parameters. Years 3-5, organize meetings with stakeholders to evaluate scenarios	New level of collaboration with the state managers, policy makers and governance bodies never achieved before.

Broad Goals	Strategies to Achieve Goals	Activities to Implement Strategies	Metrics and Baselines	Anticipated Impacts
				Proactive policy interventions and governance arrangements prioritized and ranked for stakeholder groups
Integration				
Integrate data from all questions into the Question 2 and 3 models and into the IAModel	Collaborate with model developers from Question 2 and 3 and IAModel	Integrate nutrient transport parameters into the IAModel (ARIES platform)	In all years as new data are collected integration will continue in order to improve the models and IAModel	ARIES becomes a useful, transferrable modeling platform for climate change analysis in other settings
	Through the ARIES platform use models developed in Question 2 that are integrated with Questions 1 and 3	Test Scenarios for Adaptive Management and Policy	In Years 4-5 test scenarios requested by the State agencies, town managers, and governance bodies of the Lake	New insights into consequences of future adaptive management policies to respond to climate change
	Make results and modeling accessible for transfer to other basins	Publish data and results of scenario testing	Base: over 3 years 12 collaborative publications; Milestones: 25-30 collaborative publications by Year 5	Research becomes available for application outside the Champlain Basin
		Hold conferences with Idaho and NH investigators	Two conferences (Years 2 and 4)	Expansion of the research through collaboration with other jurisdictions
		Apply for new grant funding based on the research	Baser: 16 disclosures, 3 patents by Year 5; Milestones: 25 disclosures, 10 patents	Sustain the research through other funding sources

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			Base: 13 NSF awards; Milestones: collaborative grant proposal by Year 3; 13-20 NSF awards by Yr 5.	
	Data management	Store and make accessible field and model data, and develop linkages with Questions 1 and 3 in ARIES	Establish curation and storage in Year 1; continuous uploading through all years	Data are accessible
Integration of participants into RACC for increased STEM diversity and workforce development	Orientation of RACC participants into the program to foster integration and collaboration	Organizational and on-going meetings of all RACC research participants	Monthly meetings of all-RACC; monthly meetings of the leaders of Questions 1-3 and IAModel	All researchers understand the program and their research within the program; familiarity with other participants enhances integration and collaboration
Implement other programs of the Center for Workforce Development and Diversity				
	Integrate students, teachers, faculty into RACC research	Recruit diverse group of graduate students, postdocs and new faculty; use videoconferencing for interviews	Recruitment of 6 graduate students, 3 postdocs, 3 tenure track faculty, 1 research faculty member by first field season Year 1; Base: 33% female, 1% disabled. Milestones Yr 1-2 >50% female, 20% under-represented	Increased inclusion of under-represented groups in STEM research and STEM careers;
	Increase diversity of the STEM research community	Recruit from Vermont and high schools outside Vermont; reach out to Burlington and Winooski school districts that have very diverse student populations	Outreach to high schools by December of each year Base: 18 high school teams; Milestones: 16-25 teams in each Year 1-5	

		Recruit middle school teachers	Base: 0 middle school teachers; Milestones: 2-4 by Yr 4;	
		Recruit undergraduates including those from Community College of Vermont that has diverse student populations	Base: 24 undergraduates per yr; Milestones: 30-37 undergraduates in each Year 1-5; Base CCV: 0; Milestones: 4 CCV summer interns per year by Yr 2 and 6 by Yr 4.	
		Provide scholarship funding to rural poor students through the Governor's Institutes	Provide support each year; Base: 28-30% girls; 33 low income students per year; Milestones: 50% girls and 45 low income students by Yr 3 and sustained through Yr 5.	
		Partner with VTC to coordinate private sector technology internship program	Partner each year; Base: 11 interns; Milestones: 20 - 100 interns per year.	
		Provide scholarships for first generation and Abenaki students for STEM major undergraduates	Work through GIV, schools staff and Dr. Jeff Benay of the RACC ISC to identify students yearly; Base: 0 Abenaki students self-identified, 0 first generation scholarships in previous RII; Milestones: 4 Abenaki students in high school teams by Yr 4; 1 scholarship in each of Yrs 1-5; 5 first gen scholarships per year in Yrs 1-5	Increased numbers of students in the Vermont STEM workforce

		Recruit disabled and Veteran STEM students	Establish pipelines for Veteran and disabled STEM students; Base: 0; Milestones: 1 disabled and 1 veteran in Yr 1, increasing to 2-5 disabled and 2-3 veterans in Yr 5.	
		Base and Milestones for workforce development and diversity	Overall Vermont STEM Student Base: 6949 undergrads in STEM majors, 1257 STEM graduates; Milestones: increase STEM majors and graduates 5% each Yr 1-5. Base for all RACC participants: 33% female; 4% under-represented minority; Milestones: 50% female by Yr 2 and 20% under-represented minority by Yr 5 Base for all of the Track-1 participants: 58% female, 11% under-represented minority of 157 participants; Milestones: 62% female, 20% under-represented by Yr 5.	
	Mentoring for workforce development through successful STEM careers	Partner with INBRE to coordinate mentoring program for RACC grad students, postdocs, and faculty; train mentors to mentor; graduate	Establish mentoring program; work with all graduate students, postdocs and new faculty each year;	Retention of well trained participants in STEM workforce at multiple levels

		students, postdocs and faculty mentor undergraduates and other participating in RACC research	undergraduates, teachers and students mentored each year by RACC participants	
		Annual symposium that brings together all RACC researchers; graduate student and postdoc mentors are co-presenters with the undergraduates, students or teachers they mentored;		
	Increase use of cyberinfrastructure for education outreach, and workforce development	Interactive web site for sharing information among RACC participants; Facebook for student sharing of research experiences; twitter to continue to communicate with RACC researchers and others	Web site established by mid-Year 1	
		Videoconferencing for: intern interviews for the VT Tech Council summer program; communication with JSC and SMC remote lab locations; Middlebury College faculty and students who participate in Question 1; recruitment of graduate students, postdocs and faculty (above)		
		Create Mobile Device Applications for students who are engaged in RACC research	First mobile app by end of first year for identification of macroinvertebrates in streams; additional mobile app by the end of year 3.	
Seed Funding				

Appendix "C"
Goals, Strategies, Activities, Metrics and Impacts Table
Vermont EPSCoR; Adaptation to Climate Change in the Lake Champlain Basin: New Understanding through Complex Systems Modeling
NSF EPS# 1101317

Broad Goals	Strategies to Achieve Goals	Activities to Implement Strategies	Metrics and Baselines	Anticipated Impacts
Sustain RACC Research and Inspire Innovation	Private Sector Awards for SIBR competitiveness and Innovation	Make SBIR Phase (0) Awards Make Innovation Fund Awards Private Sector Use of Facilities awards	Base: up to 10 SBIR Phase (0), up to 6 IF awards per year, up to 10 Pilot awards per year; Milestones: 8-10 per year SBIR Phase (0), 4-6 IF awards per year; up to 2 pilot awards per year.	Vermont businesses increase competitiveness for federal SBIR awards; new ideas tested
	Encourage faculty to do research that builds upon and complements RACC	Make pilot awards	Make 4-5 awards per year	New collaborations among faculty and new research complementary to RACC emerges
External Engagement Plan				
Broad Goals	**Strategies to Achieve Goals**	**Activities to Implement Strategies**	**Metrics and Baselines**	**Anticipated Impacts**
To enable efficient sharing of data and information among our project partners and broader public using several strategies that include cyber-infrastructure, broadcast media, and public information officers (PIOs)	Communication with the Lay Public	Provide guidance to scientists to assist in lay-communication of research	Host NSF OLPA Communicating Science Workshop; work with the UVM Public Relations officer to train RACC participants in communication	Improved understanding of STEM research, STEM workforce, and the impact of research on the state and its economy

Direct interaction of the RACC investigators with the public		Increase face-to-face interactions of scientists and other constituencies	Schedule opportunities for graduate students, undergraduates, postdocs and faculty to meet with the public, especially in school and museum settings and at the state house; all RACC participants will have these opportunities	
		Share broadly scientific paper and grant award news	Create 2 minute videos of interviews with authors of recent papers and grant recipients	
		Host events to enable networking and opportunities for increased successes	Schedule Annual State Meetings, Grant Writing Workshops, Technology Transfer Workshops	
	Partner with Broadcast media and other media through UVM	Circulate success stories to broader audience	Place news on web site, send University PIO success stories, share with NSF EPSCoR	Multiple approaches to inform broadly about the mission and activities of Vermont EPSCoR and its impact on the state
		Distribute funding announcements and events calendar	Use electronic notification	
		Utilize Video Conferencing Capability	Host meetings with video conference option	
		Partner with Broadcast Media	Emerging Science television series with VPT (Base: 4 episodes per yr; Milestone: no change)	
			Webcasts - placement in YouTube; web chats with experts per episode	

			Curriculum guides developed	
		Use Newsletters to share information	Create newsletter each year for web and print	
		Collaboration with SWAC research of Dr. Dupigny-Giroux	Surveys of students who participate in the SWAC grant research	More information on the understanding by children and the public about climate change
	Increased use of cyber technology for external engagement	Mobile Device Applications for students who are engaged in RACC research (CWDD above) will be used during visits of the RACC investigators in schools, museums, etc.	First mobile app by end of first year for identification of macroinvertebrates in streams; additional mobile app by the end of year 3.	Technology encourages exploration & enables workforce development
		Continue our presence on Facebook, Twitter, YouTube and list serve for distribution of news		
		Annual meeting, grant writing and technology transfer workshops, symposium on RACC research hosted by VT EPSCoR will be available through streaming or live video-conferencing		
Assessment				
Broad Goals	**Strategies to Achieve Goals**	**Activities to Implement Strategies**	**Metrics and Baselines**	**Anticipated Impacts**
Use of multiple assessment tools to guide the Vermont EPSCoR program	Collect data annually	Annual progress report captures numbers of publications, grant proposals and funded grants,	We anticipate responses from all RACC participants to these efforts to collect the data for the annual	VT EPSCoR acquires deep data sets upon which evaluation and

through formative and summative evaluations		presentations, awards, book chapters and reviews, students and postdocs trained, promotions etc.	report to NSF EPSCoR; all data are also shared with the ISC, EAC and AAAS consultants.	changes can be based Longitudinal studies provide data on VT EPSCoR programs' impacts on attitudes toward STEM careers
		Each RACC participant has a secure personal page on the web site		
	Surveys and Report on Surveys by External Evaluator	Survey each participant annually through on-line sites on the VT EPSCoR web site; students and teachers participating in RACC research are surveyed before and after their participation; GIV students likewise are surveyed before and after GIV participation	All survey reports from the external evaluator are shared with the IS, EAC and AAAS.	
		Longitudinal study to assess impact of VT EPSCoR on STEM careers and attitudes toward STEM	Year 1 and Year 5 longitudinal surveys will be done with baselines from the current surveys (preceding the RACC research)	
Changes in programs and directions as needed and guided through assessment	Multiple committees review materials, interview participants and provide guidance to VT EPSCoR (formative evaluation in Years 1-4 and summative in Year 5)	Internal Steering Committee (ISC)	Annual meetings to review all the assessment materials collected by VT EPSCoR and the external evaluator	Multiple groups provide guidance and evaluation for optimal outcomes from the VT EPSCoR programs
		AAAS Research Competitiveness Program consultants	Annual AAAS review	
		External Advisory Committee (EAC)	Annual meeting in Vermont to review the research progress and	

			progress toward collaborative, interdisciplinary research	
		NSF Site Reviews	Reverse Site Visit at the Beginning of Years 2, 4	

Appendix D
RACC Participant Table

TABLE 1 Name	Affiliation	Expertise
Adair, C.	RSENR UVM	Climate change, adaptation and complex systems modeling
Bacchus, T.	JSC	Meteorology
Beckage, B.	Plant Bio. UVM	Forests ecosystems, complex systems modeling
Betts, A.	Atmospheric Research	Climate data variability
Bomblies, A.	Env. Engineering UVM	Hydrology; watershed and complex systems modeling
Bowden, W. B.	RSENR UVM	Climate change; lake and watershed processes
Dewoolkar, M.	Env. Engineering UVM	Complex systems modeling; streamback erosion and stability
Drizo, A.	PhosphoReduc LLC	Water pollution
Druschel, G.	Geology UVM, Geology IUPUI	Sediment –water geochemistry; geo-microbiology
Dupigny-Giroux, L-A.	Geography UVM	State Climatologist, climate variability
Erickson, J	RSENR & Gund, UVM	Ecological Economics, integrated modeling
Genter, R.	Biology,. JSC	Ribotyping bacteria from streams
Giles, C.	Env. Engineering UVM	Postdoc, Nutrient biogeochemistry and microbiology
Hill, J.	Env. Engineering UVM	Nutrient speciation; microbiology
Hurley, S	Plant and Soil Sci. UVM	Land use, terrestrial ecology
Isles, P.	RSENR	Grad student, Lake and watershed processes
Kanat, L.	Geology, JSC	Erosion and slope stability, watershed processes
Kline, M.	Agency Natural Resource	River Ecology, Geomorphology
Koliba, C.	Community Dev. UVM	Complex systems; environmental policy and management
Kujawa, R.	Sociology, SMC	Environmental policy
Manley, P.	Geology, Middlebury	Sediment transport; Paleolimnology
Manley, T.	Geology, Middlebury	Limnology; hydrodynamics
McCabe, D.	Biology, SMC	Lake invasive species and stream macroinvertebrates
Mohammed, I.	Env. Engineering UVM	Postdoc, Physical and statistical hydrological modeling
Molina, J.	Env. Engineering UVM	Grad student, Hydrology, watershed and complex systems modeling
Rizzo, D.	Env. Engineering UVM	Complex systems, surface and ground water modeling
Ross, D.	Plant and Soil Sci. UVM	Soil phosphorus and nutrient transport
Sheldon, S.	Biology, Middlebury	Aquatic invasive species
Stockwell, J.	RSENR UVM	Aquatic ecology, lake systems
Stryker, J.	Env. Engineering UVM	Grad student, Hydrology, watershed and complex systems modeling
Troy, A.	RSENR, Gund, UVM	Land use and policy
Watzin, M.	RSENR UVM	Lake and watershed processes
Wemple, B.	Geography UVM	Hydrology and watershed modeling;
Zia, A.	Community Dev UVM	Complex systems modeling; policy analysis; decision analysis
New hire	Geology UVM	Sediment-water geochemistry; geo-microbiology

Table 2	Stakeholders
Howland, W.	Director, LCBP
Moore, J.	Vermont Clean and Clear, ANR
Fidel, J.	Vt. Natural Resources Council
Huffman, P.	Nature Conservancy (VT)
Stager, C.	Nature Conservancy (NY)
Smeltzer,E.	ANR, Intl. Missisquoi Bay Board
Dolan, K.	ANR
Wood, B.	Vermont Climate Collaborative