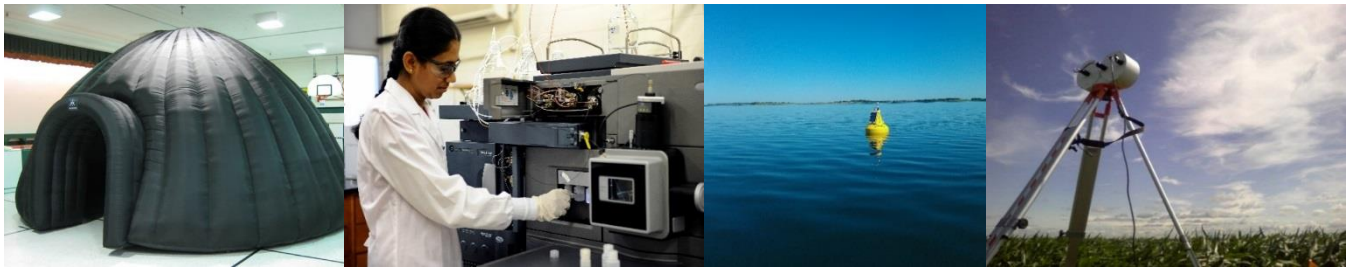

Innovative and **S**trategic **P**rogram **I**nitiatives for **R**esearch and **E**ducation-**N**orth **D**akota
INSPIRE North Dakota

NSF EPSCoR RII Track-1 Strategic Plan 2014-2019

OFFICIAL START DATE: August 1, 2014
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ND EPSCoR
Advancing **S**cience **E**xcellence in **N**orth **D**akota
Experimental Program to Stimulate Competitive Research

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TABLE OF CONTENTS

TABLE OF TABLES

Table 1. Glossary of Acronyms

CCCC	Cankdeska Cikana Community College, Fort Totten, ND
CI	CyberInfrastructure
CRCS	Center for Regional Climate Studies
CSMS	Center for Sustainable Materials Science
DoE	Department of Energy
DSU	Dickinson State University, Dickinson, ND
EMPOWERED-ND	Emerging Programs for Workforce Development, Outreach, Education and Diversity-ND
FBCC	Fort Berthold Community College, New Town, ND
FFA	Future Farmers of America
GCM	Global Climate Model
GLDAS	Global Land Data Assimilation Systems
HPC	High Performance Computing
IHM	Integrated Hydrological Modeling
INSPIRE-ND	Innovative and Strategic Program Initiatives for Research and Education-ND
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
LLISST-VSF	Laser In Situ Scattering and Transmissometry - Volume Scattering Function
MaSU	Mayville State University, Mayville, ND
MiSU	Minot State University, Minot, ND
MODIS	Moderate Resolution Imaging Spectroradiometer
NATURE	Nurturing American Tribal Undergraduate Research and Education
NDSCS	North Dakota State College of Science, Wahpeton, ND
NDSU	North Dakota State University, Fargo, ND
PRISM	Portable Remote Imaging Spectrometer
PUIs	Primary Undergraduate Institutions
REU	Research Experience for Undergraduates
RII	Research Infrastructure Improvement
SA	Sunday Academy
SBC	Sitting Bull College, Fort Yates, ND
SBIR	Small Business Innovation and Research
STTR	Small Business Technology Transfer
SWAT	Soil and Water Assessment Tool
TCs	Tribal Colleges
TMCC	Turtle Mountain Community College, Belcourt, ND
UND	University of North Dakota, Grand Forks, ND
USDA	United States Department of Agriculture
UTTC	United Tribes Technical College, Bismarck, ND
VSCU	Valley City State University, Valley City, ND

1. EXECUTIVE SUMMARY

1.1 Introduction

North Dakota (ND) EPSCoR's Strategic Plan details the conceptual, programmatic and management framework for successfully accomplishing the goals of **In**novative and **S**trategic **P**rogram **I**nitiatives for **R**esearch and **E**ducation-**N**orth **D**akota (**INSPIRE-ND)** set forth in North Dakota's NSF EPSCoR Track I award IIA-1355466 [2014-2019]. Through INSPIRE-ND, the state's two research universities, North Dakota State University (NDSU) and the University of North Dakota (UND), will lead a dually-focused research effort that capitalizes on the growing research capabilities of the state's Tribal Colleges (TCs) and the Primarily Undergraduate Institutions (PUIs).

Regional climate change and sustainable materials directly impact North Dakota's traditionally strongest economic sector, agriculture. With diverse crops, ND is a national leader in the production of all dry edible beans, navy beans, pinto beans, canola, flaxseed, honey, durum wheat, spring wheat, barley, lentils, oats, dry edible peas, sunflowers, and all other wheat production[1]. INSPIRE-ND examines the effects of climate change on the production of food [systems, supply and protein density] and biofeedstock supplied to the nation and the world by the Northern Great Plains. INSPIRE-ND will demonstrate the viability of alternative biofeedstock sources that are low cost and renewable, with long product lifetimes, high durability, offer efficient recyclability and high value to discover new sustainable materials that will influence ND's economy by strengthening its overall competitiveness. INSPIRE-ND is designed to build and sustain a transformative, multifaceted, synergistic academic research and education enterprise, anchored by a more diverse skilled workforce to drive ND's emerging knowledge-driven economy. With these outcomes in mind, the program will : 1) develop two new research themes/platforms in regional climate studies and sustainable material science; 2) build physical and human research infrastructure; and 3) integrate research, education and human resources with statewide workforce development initiatives to increase public scientific literacy through a coordinated initiative titled: **EMPOWERED-ND** (**EM**erging **P**r**O**grams for **W**orkforc**E** Development Out**R**each, **E**ducation and **D**iversity-**N**orth **D**akota). EMPOWERED-ND is a modern STEM workforce program aimed to build human capacity for the future use of renewable resources for chemicals, food and energy. The program will explore innovative research areas focused on bio-based materials (Center for Sustainable Materials Science (CSMS)) and coupled natural human systems driven by a changing climate (Center for Regional Climate Studies (CRCS)) while working to strengthen workforce development; expand and leverage our collaborative cyberinfrastructure environment; provide primary as well as seed funding for emerging high impact and transformative research; further encourage the diversity of our programs; and partner and collaborate with private, state and federal entities in ways that improve the long-term research competitiveness of North Dakota.

1.2 INSPIRE-ND: Vision and Mission

North Dakota is poised to continue its recent research program growth trajectory in addressing important scientific problems of agricultural global relevance through broadening participation of the Tribal Colleges and Primarily Undergraduate Institutions. Through these collaborations, North Dakota envisions building a competitive 21st century workforce equipped with the skills necessary to meet the environmental challenges of the agricultural sector. The INSPIRE-ND Strategic Plan was formulated based on the program's vision and mission articulated in the original proposal submitted to NSF in August 2013.

Vision: INSPIRE-ND will help lead the nation in environmentally sustainable, agriculturally-related food production and biofeedstock development, integrated with an educated workforce necessary to meet the agricultural challenges in the face of a shifting environmental climate.

Mission: INSPIRE North Dakota to address and mitigate the regional environmental threats to the state's agriculture production.

INSPIRE-ND has five strategic foci: 1) CRCS; 2) CSMS; 3) Diversity; 4) Education and Workforce Development; and 5) Partnerships, Collaborations and Communication. Cyberinfrastructure is embedded throughout each of the five strategic foci and is an enabling technology. As such, cyberinfrastructure is not considered a goal. Each focus area is associated with a strategic priority, goal(s), several objectives, numerous activities and benchmarks, key impact, team lead and participants. Team participation is from multiple institutions. The goals, objectives, benchmarks and activities are presented in easy–to-read tables to facilitate tracking and reviewing program progress by the program leads, ND EPSCoR management team, NSF Programs Directors, and external evaluation teams (including the external evaluator, the External Advisory Committee, and Reverse Site Visit panel members).

The INSPIRE-ND program was designed to promote an EMPOWERED-ND by threading activities into each of the research cluster foci in an effort designed to increase the program's long-term sustainability. To further promote diversity, education, workforce development, partnerships, collaborations and communication, interdisciplinary and inter-institutional teams of program members reviewed program plans and identified new ideas and opportunities for synergy among program components during the Strategic Planning Workshop. The five Tribal Colleges in North Dakota (Cankdeska Cikana Community College, Fort Berthold Community College, Sitting Bull College, Turtle Mountain Community College and United Tribes Technical College,) are important partners of INSPIRE-ND, as are the state's four PUIs (Dickinson State University, Mayville State University, Minot State University and Valley City State University).

The INSPIRE-ND Strategic Plan also includes the following programs: 1) synergies for sustainability, 2) risk mitigation, 3) management and succession plan and 4) evaluation and assessment process.

2. INTRODUCTION

2.1 Strategic Planning Process

The strategic planning process involved a logical sequence of productive meetings during August through December 2014 with the program's PI (Rusch), co-PIs (Hoffmann and Ostrom-Blonigen), previous co-PI (Anderson), ND EPSCoR Steering Committee chair (Milavetz), external evaluator (Shaw), external facilitator (CONCUR, Inc.) and program team members.

The management and program teams corresponded regularly and met in Hillsboro, ND on September 23, 2014 to review and update program benchmarks and milestones in preparation for the Strategic Planning Workshop, held on October 20-21, 2014 at NDSU, Fargo, ND. The goal of the workshop was to produce a collaborative plan for managing and measuring ND EPSCoR RII Track-1 project progress. Thirty-three participants engaged in the two-day facilitated discussion, including Dr. Timothy M. VanReken, NSF EPSCoR Program Director for North Dakota, ND EPSCoR leadership, program leads and team members, other representatives from NDSU and UND, the chair of the ND EPSCoR State Steering Committee, two members of the ND EPSCoR State Steering Committee (Dr. Kalpana Katti and Dr. Michael Poellot), one member of the North Dakota University System–representing the PUIs (Dr. Richard Rothaus), the project's external evaluator and the external facilitators. Although invited, the state Tribal College representative to the ND EPSCoR State Advisory Committee was unable to be present for the workshop.

Participants were provided with workshop information in advance that included the agenda, the proposal summary, and a list of participants. During the workshop, the 33 participants reviewed program plans; articulated outcomes and objectives, drafted and refined benchmarks and metrics; refined a program succession plan; outlined plans for program collaboration efforts; and identified program risks and mitigation approaches.

Subsequent to the workshop, group leads took on responsibility to continue to develop their respective tables: CRCS, CSMS, Diversity, Education/Workforce Development and Partnerships/ Collaborations/Communication for feedback from the ND EPSCoR leadership and the external consultant. Additionally, members of the ND EPSCoR Leadership team visited with all of the Tribal College Presidents at the November 18, 2014 ND Tribal Association Meeting to confer with them about the new award and to discuss the vacant Tribal Colleges Liaison position. The TC presidents were asked to review and provide input on the strategic plan on December 1, 2014. Although none of the TC presidents provided feedback on the strategic plan; their campuses are engaged in the Track-1 program. TC involvement as of 1/15/15 includes:

- August 2014 – Research cluster personnel and the ND EPSCoR Office visited Cankdeska Cikana Community College (CCCC). As a result of that visit, Brent Voels, Science Instructor, CCCC, has been confirmed by CCCC's president as a researcher on the Center for Regional Climate Studies (CRCS) team. Voels' research interests are oil spill impacts: soil quality, persistence of heavy metals, and crop yields and he seeks to tie his research to broader impacts on land-use.
- November 2014 - ND EPSCoR's Hoffmann and Ostrom-Blonigen attended the North Dakota Association of Tribal Colleges meeting and discussed the Track-1 initiatives, the upcoming C2 interactive video conference, and additional upcoming TC visits with all five of the TC presidents.
- November 2014 - Research cluster personnel and the ND EPSCoR Office visited Sitting Bull College (SBC). As a result of that visit, SBC faculty have expressed interest in work being done at both the CRCS and the Center for Sustainable Materials Science (CSMS). SBC faculty are planning to meet during spring semester 2015 to determine which project their campus will

bring forward. Additionally outside of immediate goals for research cluster collaboration, SBC expressed interest in working with NDSU and UND to develop partnerships in which graduate students from both campuses would work with their advisors to teach modules outside of the expertise of current faculty.

- December 2014 - Research cluster personnel and the ND EPSCoR Office held a final C2 interactive video conference session, which was attended by four of the five TCs. During that meeting, a faculty members at Fort Berthold Community College (FBCC) and United Tribes Technical College (UTTC) expressed interest in joining research projects. Also present during this videoconference was Dr. Richard Rothaus, representing the PUIs.
    - January 29-30, 2015 - Research cluster personnel and the ND EPSCoR Office will visit FBCC and UTCC to determine which project those campuses wish to bring forward.
- February 2015 - The ND EPSCoR is waiting for Turtle Mountain Community College (TMCC) to respond to a request to visit that campus in February 2015.

The collaborative input derived from the two-day workshop and subsequent meetings yielded the **INSPIRE-ND Strategic Plan**. This Plan outlines how ND EPSCoR will achieve its program vision, mission and goals and will be reviewed and restructured annually.

2.2 Alignment of INSPIRE-ND with the North Dakota Science and Technology Plan

The ideas for INSPIRE-ND emerged from an analysis of the State's economy as it aligns with research strengths of NDSU and UND. Selection of this set of aims was guided by a set of strategic documents including North Dakota's Science and Technology Plan (S&T), which identified five major areas of economic development: 1) advanced manufacturing, 2) energy, 3) value-added agriculture, 4) technology-based business, and 5) tourism. INSPIRE-ND is directly linked to value-added agriculture and will be enhanced by the advanced manufacturing, energy and technology-based business initiatives in the State.

The North Dakota S&T Plan identified seven strategies to help drive economic development across the five areas: 1**)** focus research and development in areas that are already strengths in the state so that ND can continue to increase its competitive advantage; 2) support and expand the infrastructure for research, particularly at the two research universities; 3) support technology transfer and, where appropriate, commercialization of inventions and innovations developed by universities; 4) foster partnerships between the private sector and research universities; 5) find ways to produce, hire, and retain more high school-level STEM teachers (a shortage occupation in the state), especially for small rural schools; 6) increase state investment in research at the institutions in the ND University System; and 7) create ways to increase awareness of the S&T capacity of the state, and to use it to develop regulatory schemes based on sound science. North Dakota's Science and Technology Plan can be found at: http://www.ndsu.edu/epscor/documents/Sci-TechStrategicPlan2-2013.pdf**.**

North Dakota's future prosperity depends on the successful, coordinated and funded implementation of activities within the stated strategies. INSPIRE-ND capitalizes on the agricultural, water (quantity/quality), energy and advanced manufacturing research strengths (4 of the 6 strengths detailed in the S&T Plan) at NDSU and UND, combined with the coordinated ND University System and Tribal College System to position the State as a national leader in environmentally sustainable, agriculturally-related food production and biofeedstock development. The State's goal to remain a top national agricultural producer: serves to foster the development of a diverse and sustainable agriculture platform with a variety of market pathways (i.e., food, renewable feedstocks for materials, energy); strengthens the need for a trained STEM workforce; and underscores the need of educating the public about the benefits of environmentally adaptable and sustainable agriculture for today's economy. This goal aligns precisely with North Dakota's Track-1 program goals for INSPIRE-ND.

2.3 Strategic Impacts

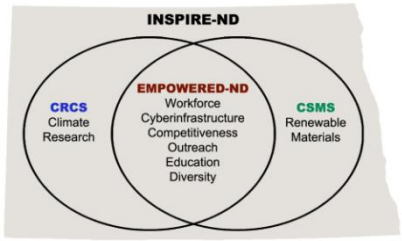
North Dakota's agricultural economy is growing; to sustain that growth, it is important to understand and predict how regional climate changes impact crop production. Additionally, due to the negative environmental impact of non-biodegradable materials on the environment, it is important to discover new ways to maximize the use of sustainable materials. North Dakota's RII Track-1 project supports researchers as they conduct innovative research on regional climate patterns and seek to identify the physical components necessary to transition away from fossil-based petrochemicals and their materials to more sustainable platforms. In conducting this program, North Dakota will demonstrate the essential linkage between research innovation and the social change required to embrace alternative energy sources. Two research centers, **Center for Regional Climate Studies (CRCS)** and **Center for Sustainable Materials Science (CSMS),** have been created to facilitate research, education, workforce development, and outreach on regional climate change effects on coupled natural human systems and the importance of sustainable materials. The project also includes the resources to hire four (4) NDSU faculty who will participate in CSMS research, graduate and undergraduate students to conduct research at both centers, and up to nine other affiliated facilities (5 TCs and 4 PUIs). The consequences associated with climate change and unsustainable materials are not unique to North Dakota. EMPOWERED-ND is aimed at increasing social awareness and future economic growth. The competitiveness of North Dakota researchers in NSF programs will increase as a result of this award.

3. INSPIRE-ND Strategic Plan

3.1 Vision

INSPIRE-ND will help lead the nation in environmentally sustainable, agriculturally-related food production and biofeedstock development, integrated with an educated workforce necessary to meet the challenges in the face of a shifting environmental climate.

3.2 Mission



INSPIRE an **EMPOWERED** North Dakota: Our **In**novative and **S**trategic **P**rogram **I**nitiatives for **R**esearch and **E**ducation are building **EM**erging **P**r**O**grams for **W**orkforc**E** Development Out**R**each, **E**ducation and **D**iversity in **N**orth **D**akota to address and mitigate the regional environmental threats to the state's agriculture production.

EMPOWERED-ND is a tightly integrated workforce development, education and outreach and partnership program designed to ensure a continual pipeline of highly qualified individuals to meet the future needs of the ND economy. To encourage and sustain participation of students from underrepresented groups, EMPOWERED-ND is integrated with statewide diversity efforts.

The ND EPSCoR program will increase public scientific literacy and train a modern STEM workforce to build human capacity for future use of renewable resources for chemicals, food and energy. ND undergraduate and graduate students, as well as postdoctoral researchers, will participate in the research programs and receive mentoring for career development. Discoveries will be translated into marketable, commercial applications using strategic relationships with the private sector. Partnerships with the private sector and non-profit organizations include programs that provide students with opportunities to work with companies on technology development projects and mentoring programs for intellectual property management and technology transfer. RII elements that support underrepresented groups, especially Native Americans, to pursue STEM-based careers are key features of EMPOWERED-ND. These initiatives will be accomplished via collaborations with our TCs and PUIs. EMPOWERED-ND broadens diversity of participation and builds a network of STEM advocates and stakeholders to promote new strategies for communicating the pathways and outcomes of ND EPSCoR activities. Meaningful and two-way partnerships and communication networks established from EMPOWERED-ND, and coupled with INSPIRE-ND, will foster development of the next generation of globally engaged scientists and engineers in renewable resources discovery and utilization.

3.3 Program Goals

The **overall program goals** of INSPIRE-ND are captured in the letters of the word "INSPIRE":

- **IN**novative research focused on bio-based materials and climate change
- **S**trategic integration of research, STEM education and outreach through EMPOWERD-ND to serve the entire State
- Increased workforce diversification through strategic **P**rogrammatic elements
- Increased research and technology capacity through **I**nitiatives aligned with the State's Science and Technology Plan
- Increased participation of underrepresented groups in general and in particular by research opportunities from the TCs and PUIs through engaged **R**esearch experiences
- Broader public **E**ducation on issues of sustainability and environmental stewardship through increased partnerships and communication.

3.4 Strategic Focus Areas, Goals, Objectives, Benchmarks, Metrics, Impacts, Partners, and Participants

Five focus areas of North Dakota's Track-1 project support its mission to INSPIRE an EMPOWERED North Dakota to discover new ways to care for our environment and secure the economic sustainability of our agricultural economy: 1) Center for Regional Climate Studies (CRCS); 2) Center for Sustainable Materials Science (CSMS); 3) Diversity; 4) Education and Workforce Development; and 5) Partnerships, Collaborations and Communications.

The following outline describes the organization for each of the five focus areas in the Strategic Plan:

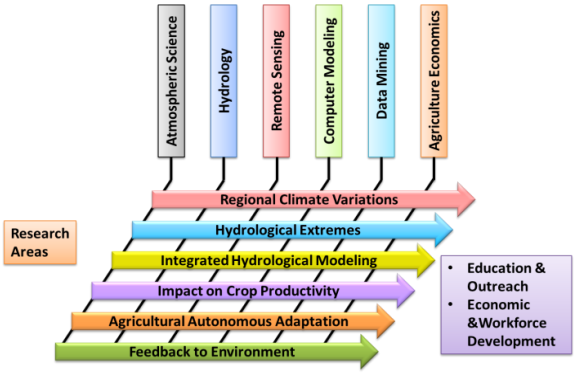
1. The focus areas are first described in a narrative format, which includes:
   - Strategic priority
   - Goals
   - Objectives to achieve goals
   - Team leads
   - Team participants and partners
   - Key outcome(s)

2. A focus area table format follows for each goal (color-coded blue), which contains:
   - Objectives for each goal (green)
   - Benchmarks/activities (gray) for each year.
     - The activity section is also highlighted (gray) in the years in which a benchmark has not started or is complete.
     - The word *"ongoing"* means that the activities of a certain year will exactly mirror the activities of the immediate prior year.

3. A separate table of Output Metrics (beige) with associated baseline and cumulative measurement targets follow each focus area table. The metrics that are highlighted (lighter beige) represent the collaboration synergy metrics (which relate to sustainability components of the program) discussed in section 3.11 of the Strategic Plan. These metrics will be used by the external evaluator to assess project progress.

3.5 Focus Area 1-Center for Regional Climate Studies (CRCS)

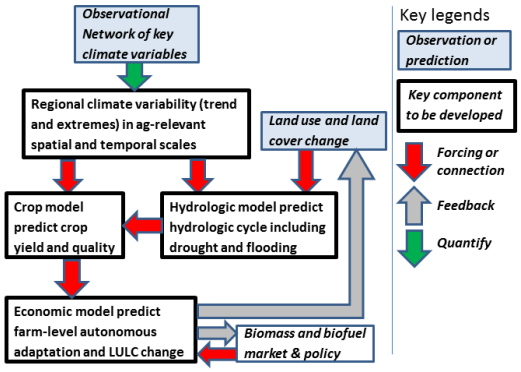
Strategic Priority: North Dakota, recognized as a major sustainable supplier of food crops and biofeedstocks, seeks to continue and advance that ranking through an increased understanding of regional climate patterns.



Goals:

1. Develop and apply an integrated modeling approach to project the impact of climate variations on the agricultural economy of the Northern Great Plains (NGP).

2. Build CRCS into a high functioning, interdisciplinary, sustainable regional climate and education center that includes utilization of cyberinfrastructure (CI).



Objectives to Achieve Goals: To achieve Goal 1, the CRCS team has identified 6 objectives with benchmark activities that are aimed to:

- Develop a comprehensive understanding of regional climate variations over the Northern Great Plains region (*objectives 1.1 and 1.2*). These climate results will provide inputs to the regional hydrological, agricultural, and atmospheric studies as mentioned in *objectives 1.3-1.6.* In addition, the team will analyze linkages between regional climate variations and extreme hydrological conditions to improve predictions of regional flooding and drought.

- Develop an integrated hydrologic modeling (IHM) system based on hydrological and meteorological databases, remote sensing observations across spatial and temporal scales (meters to 25 km, minutes to monthly), and new field data collection (*objective 1.3*). The IHM will provide varying-resolution predictions of precipitation-induced surface runoff, infiltration and ponding, subsurface flow, evapotranspiration, and stream flow. The IHM will be used to compare results for drought and flood predictions from *objectives 1.1 and 1.2* and to evaluate possible feedbacks to the hydrological cycle from climate-driven agricultural land use changes.

- Develop and demonstrate an integrated modeling approach to project the impact of climate variations on the agricultural economy in the Northern Great Plains (*objectives 1.4, 1.5 and 1.6*). This work, which demands truly collaborative efforts from multiple disciplines and has never been attempted over the study region, addresses the NSF grand challenge: "climate change prediction to advise regional adaption strategies". The team will apply both statistical- and dynamic modeling-based techniques to detailed agricultural, climate, and hydrological data to determine crop productivity (*objective 1.4*) and agricultural autonomous adaption in response to recent climate trends (*objectives 1.5*). Together these objectives will link environmental, agricultural, economic, and behavioral models to create an integrated modeling system. Further integration will occur through exploratory modeling efforts to investigate possible feedbacks of land use changes from agricultural adaptation on cloud formation and water resource quality (*objective 1.6*).

Goal 2 will be achieved by completing four objectives with benchmark activities that are aimed to:

- Create a sustainable and collaborative infrastructure (human, computational, and instrumental) for regional climate studies. This project integrates previously isolated research activities in ND and enables us, for the first time, to tackle this interdisciplinary research topic that is significant to regional agricultural-based economy and policy making. *Objective 2.1* aims to facilitate a collaborative and integrated effort among group members from more than 7 different disciplines at UND, NDSU, PUIs and TCs. Researchers from the two research universities, UND and NDSU, provide core expertise in agricultural economics, atmospheric science, computer science, hydrology, and vocational psychology. New team members from the PUIs and TCs will add more diverse geographical and cultural perspectives, while strengthening research efforts at these institutions and collaborations between institutions.

- Develop robust cyberinfrastructure necessary to support information exchange and collaborative research activities within the Center. To assist CRCS team members, located across the state, in growing, curating, processing, and sharing large climate, agriculture, and other datasets the CI team will develop/upgrade associated cyberinfrastructure, including possible enhancement to High Performance Computing (HPC) file systems *(objective 2.4)*, implementation of the Globus Online GridFTP data transfer tool (*objective 2.2*), installation of a Relational Database Management System minicloud (*objective 2.3*), and possible enhancement to the HPC modeling and simulation capabilities (*objective 2.4*).

Team Leads: CRCS Director, **Jianglong Zhang** (Associate Professor, Atmospheric Sciences, UND), is an expert in satellite remote sensing of atmospheric aerosols and data assimilation. The CRCS co-Lead, **Frank Bowman** (Associate Professor, Chemical Engineering, UND), studies atmospheric aerosols and also conducts research on assessment of K-12 STEM outreach.

Team Participants and Partners:

- **Xuefeng Chu** (Associate Professor, Civil and Environmental Engineering, NDSU) carries out research on the measurement and modeling of multi-scale watershed hydrology and topography.
- **Anne Denton** (Associate Professor, Computer Science, NDSU) is an expert in data mining of complex environmental and agricultural data sets.
- **Cindy Juntunen** (Professor, Counseling Psychology, UND) studies vocational psychology of rural and underrepresented groups.
- **Andrei Kirilenko** (Associate Professor, Earth System Science and Policy, UND) is an expert on global and regional impacts of climate change, with a focus on agriculture and land use change.
- **Gretchen Mullendore** (Associate Professor, Atmospheric Sciences, UND) performs numerical modeling of convective cloud dynamics and leads initiatives on climate change.
- **David Roberts** (Assistant Professor, Agribusiness and Applied Economics, NDSU) conducts econometric analysis on the impacts of agricultural production methods on environmental resources.
- **Xiaodong Zhang** (Associate Professor, Earth System Science and Policy, UND) leads research efforts on radiative and water fluxes from surface waters and land.
- **Haochi Zheng** (Assistant Professor, Earth System Science and Policy, UND) studies environmental and natural resource economics.
- Research center members will leverage and interact with all other program components, PUIs, TCs, businesses, local and national media, other potential research partners and governmental agencies.

Key outcome(s): Increased statewide physical, human and research assets to further the understanding of regional climate variations on the agricultural economy of the Northern Great Plains.

Table 2. Focus Area 1 Goals, Objectives, Benchmarks and Activities, Output Metrics and Baseline and 5-year Targets

Goal 1: Develop and apply an integrated modeling approach to project the impact of climate variations on the agricultural economy of the Northern Great Plains (NGP).					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 1.1: Analyze regional climate variations and data uncertainty. **(Chu/Kirilenko/Mullendore/J. Zhang/X. Zhang)**					
Perform statistical and dynamical downscaling of Coupled Model Intercomparison Project Phase 5 (CMIP5) ensemble.	Acquire regional climate data from CMIP5. Test different methods for statistical and dynamic downscaling (case study).	Apply downscaling on a limited set of data: Test multiple down-scaling methods with one CMIP5 GCM. Inter-compare downscaling for one GCM.	Apply down-scaling to the full dataset (~20 GCMs) and intercompare the results. Inter-compare downscaling for the entire dataset.	Use the results to inform sensitivity testing and adaptation studies.	Continue utilizing results for continuing climate studies.
Conduct observational based regional climate studies.	Acquire observational-based climate data - both satellite and regional surface observation.	Conduct the studies for selected parameters, including short- and long-wave radiation, temperature and precipitation.	Conduct observational based regional climate studies to the full dataset. Inter-compare with CMIP5 based studies.	Integrate into the CMIP5 based studies.	Continue integration into the CMIP5 studies.
Make new observations of evapo-transpiration (ET).	Set up instruments (scintillometer).	Collect scintillometer measurements for estimating ET.	Ongoing. Compare data with MODIS-ET estimates.	Collect data. Compare data with the IHM model prediction (1.3).	Evaluate needs for additional data.
Objective 1.2: Predict hydrological changes for extreme conditions. **(Chu, Kirilenko/J. Zhang/X. Zhang)**					
Identify linkages between climate extremes and large-scale dynamics.	Identify historical extreme drought and flood cases over the NGP study region.	Study potential linkages to Atlantic Multidecadal Oscillations and Pacific Decadal Oscillation	Study potential linkages to other larger scale atmospheric oscillations.		
Estimate effects of climate and land use change on flood potential in Devils Lake watershed.	Test model runs for sample scenarios.	Construct CMIP5 statistical ensemble of GCM projections downscaled for the Devils Lake watershed.	Study linkage between regional climate change, land use change and flood potential in Devils Lake watershed.	Investigate linkages in relation to flood mitigation practices.	Explore linkages in relation to mitigation and adaptation practices.
Develop a prognostic model for	Collect data (e.g. soil moisture, precipitation	Collect data from GLDAS, PRISM and MODIS.	Collect data from GLDAS, PRISM and MODIS.	Validate new time series model with	Validate new time series model with

regional drought prediction.	and ET) from GLDAS, PRISM and MODIS.	Develop time series model for surface soil moisture.	Develop time series model for surface soil moisture.	IHM model (1.3).	historical drought events.
Objective 1.3: Analyze regional climate variations and data uncertainty. (**Chu/Denton/X. Zhang**)					
Develop, calibrate and validate an improved integrated hydrologic (IHM) model.	Plan for development, calibration and validation; review local and regional scales.	Develop a new algorithm for topographic delineation and modeling.	Develop improved algorithms for IHM model; calibrate and validate at regional and local scales	Develop a new integrated hydrologic model; calibrate and validate IHM at regional and local scales	Calibrate and validate IHM at regional and local scales.
Collect precipitation and hydrologic data.	Select site and setup equipment (wireless gauges and sensors).	Collect precipitation (rainfall and snow) data.	Collect data (precipitation, stream/lake, and soil moisture data).	Collect, process and analyze precipitation, stream/lake, and soil moisture data	Data processing and analysis.
Study impact of hydrology on agricultural variables.			Demonstrate data mining proof of concept model that uses hydrology output.	Establish relationship between hydrology-explicit models and models that use elevation as proxy.	Complete model based on hydrology output.
Objective 1.4: Determine crop productivity response to climate change. **(Denton/ Kirilenko)**					
Perform dynamic modeling of crop productivity response with DSSAT software	Review updating DSSAT software to latest version	Start the agriculture part when the climate study is at least 60-percent complete	Demonstrate proof of concept of dynamic modeling of crop productivity response.	Integrate multiple GCMs; identify scenarios of crop change.	Perform model simulations; analyze results; formulate adaptation options based on simulation results.
Apply large data statistical methods to identify yield response of major crops in the NGP.	Identify preferable aggregation of precipitation data.	Determine preprocessing of precipitation data.	Use climate modeling output in data mining models to extrapolate yield response to future years.		
Use multiple resolutions to build more specific statistical models using dynamic modeling.	Develop proof of concept for window-based techniques using massively available data, in particular elevation and satellite imagery.	Use model to relate yield to input variables based on length scale. Develop proof of concept of zone-based approach.	Integrate water-related variables. Relate yield to input based on zones.	Test water-related conclusions against other models. Account for salinity and water aggregation. Identify opportunities for comparison.	Complete development of models for window-based analysis. Complete models for zone-based analysis. Compare with dynamic modeling.

Objective 1.5: Predict agricultural autonomous adaptation in response to changing climate and crop productivity. **(Juntunen/Roberts/Zheng)**					
Perform econometric modeling of crop acreage relation to climate and market variables with data from the USDA (NASS CDL, NASS Quick Stats, Common Land Unit Boundaries parcel data), USGS (geological and soil-type data), and Bloomberg database.	Collect public GIS, climate, economic, USDA, and USGS data. Conduct preliminary analysis of changes in extent of various crops, crop prices, input costs.	Compile GIS data: determine crop planted on each parcel annually, 1997-2013. Identify parcel crop rotation changes. Econometrically model historical crop changes, crop spot prices and major crop acreages at state and county levels, commodity futures prices and input prices	Develop multinomial logit/probit or other discrete outcome model to predict crop (rotation) selection on each parcel given parcel-specific attributes: soil-type, ecoregion, historical climate variables, etc.		
Develop economic land-use model of individual landowner behavior in response to climate and market changes.	Compile spatial data. Begin developing individual land-use framework using crop yields data under various market and policy situations.	Empirically identify the drivers of land-use with various spatial datasets (NLCD, CDL, and CRP). Continue land-use framework development.	Use the individual economic land-use model developed earlier to predict land use change and agricultural profitability. Start integration with IHM, SWAT, and InVEST.	Complete integration with other models.	
Identify the psychological, social, and historical factors that contribute to decision making by ND farmers and ranchers.	Conduct 8-12 focus groups to develop decision-making assessment item pool. Collect and analyze feedback and data gathered from focus groups and interviews.	Validate decision-making assessment instrument. Collect, analyze and synthesize data.	Administer decision-making assessment to ND farmers and ranchers through County Extension, and other farm organizations. Collect and analyze data for integration with other models.	Collect/analyze data for integration with other models.	Continue to collect/ analyze data for integration with models.

Objective 1.6: Explore feedback to environment of land use changes. **(Bowman/Mullendore/J. Zhang/X. Zhang/ Zheng)**					
Measure CCN activation of aerosol sources important to ND.	Perform diesel PM experiments. Update chamber model.	Perform crop secondary PM experiments.	Perform oilfield PM experiments.	Perform PM mixture experiments.	
Identify possible feedback of agricultural land use change on aerosols and cloud formation in the NGP with WRF-Chem.	Identify crop emissions. Define base model configuration and scenarios.	Run base case simulations Develop new CCN parameter-izations.	Run land use change scenarios. Define cloud-aerosol interaction scenarios and numerical approaches.	Test sensitivity of aerosol and cloud predictions in land use change scenarios to CCN parameter-izations.	Test sensitivity of aerosol and cloud predictions in land use change scenarios to cloud schemes.
Quantify impact of land use change on ecosystem services.			Begin scenario development for coupled economic land use – ecological assessment models.	Complete scenario development. Couple model with InVEST.	Couple model with SWAT. Perform coupled model simulations on scenario.
Evaluate impact of land use change on quality of water resources.		Acquire LISST-VSF meter.	Conduct field measurements. Develop method to infer water quality parameters from scattering measurements.	Conduct field measurements. Develop inversion model.	Conduct field measurements. Validate inversion results in terms of water quality parameters.

Goal 2: Build CRCS into a high functioning, interdisciplinary, sustainable regional climate and education center that includes the acquisition of state-of-the-art analytical equipment and utilization of cyberinfrastructure (CI).					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 2.1: Develop and foster interactions between team (UND and NDSU) members including faculty from TCs and PUIs. **(J. Zhang/Bowman)**					
Build the CRCS team by holding meetings that include postdocs and graduate students.	Identify CRCS team members; hold monthly meetings with 90% attendance. Prepare one-page summary of CRCS research and distribute to TCs and PUIs.	Convene monthly meetings of CRCS team with 90% attendance. Convene two CRCS video-conferences.	Convene monthly meetings of CRCS team with 90% attendance. Convene two CRCS video-conferences with all partners to discuss science.	Ongoing.	Ongoing.
Objective 2.2: Develop effective access to file storage through implementation of the Globus Online GridFTP data transfer tool at the NDSU site to transfer files between NDSU and UND. File transfer between the HPC sites at NDSU and UND will also be handled by Secure Copy Protocol (SCP). **(Bergstrom/ Ossowski)**					
Globus online data transfer tool.	Determine data transfer needs	Develop efficient implementation	Ongoing.	Ongoing.	Ongoing.

	of CRCS researchers.	of Globus Online Grid FTP.			
Objective 2.3: Design and build local Relational Database Management System (RDBMS) minicloud at NDSU in support of collaborative activities within the UND CRCS research cluster. **(Denton/Bergstrom/Ossowski)**					
Develop RDBMS.	Determine available funding for the RDBMS minicloud, and the appropriate location for where it will be hosted.	Architect, build, and maintain RDBMS minicloud.	Ongoing.	Ongoing.	Ongoing.
Objective 2.4: Procure a limited amount of HPC equipment needed for modeling and simulation activities. **(Bergstrom/Ossowski)**					
Procure HPC equipment.	Determine need for additional HPC equipment. Determine available funding for HPC equipment. Make purchase decision.	Procure equipment as needed.	Ongoing.	Ongoing.	Take stock of equipment condition and refresh previously purchased equipment if needed and budgets allow.

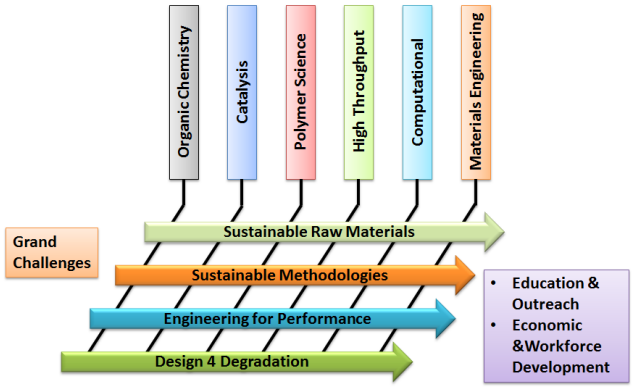
CRCS Output Metrics

Metrics *(Where baseline data is available, it is represented as an initial measure of this metric; where it is not, the Year 1 projection is used and denoted with an *)*	**Baseline or Year 1 projection* Data**	**Five-Year Cumulative Targets**
Number of statistically downscaled Global Climate Models (GCM) for the Northern Great Plains	2*	20
Number of dynamically downscaled Global Climate Models (GCM) for the Northern Great Plains	2*	20
Number of new algorithms or models for understanding parts of regional climate variation	1*	7
Number of integrations of Northern Great Plains data with widely used data sets	*	3
Number of farmer focus groups	10*	10
Number of farmers surveyed	48*	1048
Globus Online Implementation	Determine need*	Integrated
RDBMS minicloud	Match needs to funding*	Developed
HPC Equipment for CRCS activity	Determine need*	Integrated
Total number of peer-review publications	50	93
Number of collaborative peer-review publications (more than one co-author)	21	60
Number of peer-reviewed publications with TC and/or PUI co-authors	*	5
Number of conference presentations	51	90
Total number of submitted research proposals	12	71
Number of submitted collaborative proposals	11	31
Number of submitted research proposals (collaborative research between UND and NDSU)	6	9
Number of collaborative proposals with TC and/or PUI co-investigators	*	6
Total external research funding (million $) – 5-year total is cumulative	$1.0	$4.0**
Number of active grants (collaborative Research between UND and NDSU)	3	9
Number of postdoctoral Students trained	1*	10
Number of graduate students trained	12	70
Number of undergraduate students trained	5	36
Funding for TC faculty to participate in the research centers *(ND has 5 TCs – efforts are currently underway, via campus visits to learn which TC faculty members wish to work with the CRCS or CSMS as cluster members; funds represent total funding to TCs)*	$100,000*	$530,915
Seed grant awards for PUI faculty to participate in the research center *(ND has 4 PUIs– efforts are currently underway with the ND University System to identify PUI faculty members you wish to work with the CRCS or CSMS as cluster members; funds represent total funding to PUIs)*	$0*	$531,000

** CRCS's long-term sustainability target is $1 million per year in new funding

3.6 Focus Area 2-Center for Sustainable Materials Science (CSMS)

Strategic Priority: North Dakota seeks to advance new discoveries of new bio-based, sustainable materials that give more consideration to the environment and contribute to its economy through their sourcing (low cost, renewable), durable lifetimes (long, high durability), and recyclability (efficient, high value).



Goals:

1. Develop and launch a transformative approach to the development of sustainable materials derived from agricultural materials as a means to replace petrochemical polymeric materials in day-to-day use.

2. Build CSMS into a high functioning interdisciplinary, sustainable research team that includes new faculty hires, acquisition of state of the art analytical equipment and utilization of cyberinfrastructure (CI) for the purpose of efficiently processing data, quickly analyzing results, and securely transmitting data between groups.

Objectives to Achieve Goals: To achieve Goal 1, the CSMS team has identified 11 objectives with benchmark activities that are aimed to:

- Engage researchers having complementary areas of expertise via synergistic collaborations in order to fully realize the overall goal of designing new polymers and composites from renewable raw materials that have the required performance properties to replace petrochemical materials and in some cases also be capable of being reverted back to starting materials after their useful lifetime is over. Goal 1 begins with chemicals obtained from biomass such as sugars, cellulose, lignin, or seed oils, these chemicals are then transformed into the building blocks for polymers (monomers, oligomers, etc.) through chemical reactions *(objectives 1.1 and 1.2)*.

- Synthesize polymers - both thermoplastics *(objectives 1.3 and 1.4)* and thermosets *(objective 1.5)* - from these building blocks. The polymers will be thoroughly characterized and benchmarked against petrochemical counterparts. Composites will then be prepared using the bio-based polymers as matrix resins using bio-based fibers and novel bio-based nanofibers as filler materials *(objectives 1.6, 1.7 and 1.8)*. A main component in sustainability is in understanding the fate of the materials at the end of their useful lifetime. Thus, a key aspect of our program is to devise processes that enable materials to be reverted back to starting materials at the end of their useful life using a specific triggering mechanism. Specific triggerable components that can function as monomers will be synthesized *(objective 1.9)* and incorporated into the bio-based polymers *(objective 1.10)*. The impact of these monomers on the overall properties of the polymers will be assessed, as will the mechanism of the degradation of the polymer when excited by the trigger.

- Develop novel triggers derived from biomass, so that a substantial portion of the polymer is derived from bio-based raw materials. The ability to take the degradation products and re-synthesize new polymers will be demonstrated. Finally, bio-based polymers containing the triggerable component will be used in the preparation of composites and the ability to degrade the composite and recover both monomers and fiber fillers will be demonstrated *(objective 1.11)*.

Goal 2 will be achieved by completing five objectives with benchmark activities that are aimed to:

- Create a sustainable and collaborative infrastructure (human, computational, and instrumental) for sustainable materials science. This project integrates previously isolated research activities in ND and enables us, for the first time, to tackle this interdisciplinary research topic that is significant to ND. *Objectives 2.1* and *2.2* aim to facilitate a collaborative and integrated effort among group members from across disciplines at UND, NDSU, PUIs and TCs, which is to be greatly strengthened by the hiring of four additional faculty members (*objective 2.3*). Researchers from the two research universities, UND and NDSU, provide core expertise. Team members from the PUIs and TCs will add more diverse geographical and cultural perspectives, while strengthening research efforts at these institutions and collaborations between institutions using newly acquired analytical equipment (o*bjective 2.4*).

- Develop robust cyberinfrastructure necessary to support information exchange and collaborative research activities within the Center. The CI team will develop/upgrade cyberinfrastructure, including possible enhancement to High Performance Computing (HPC) file systems *(objective 2.6)*, implementation of the Globus Online GridFTP data transfer tool (*objective 2.5*), and possible enhancement to the HPC modeling and simulation capabilities (*objective 2.6*).

Team Leads: CSMS Director, **Dean Webster** (Professor and Chair, Coatings and Polymeric Materials, NDSU) leads research in polymer synthesis, coatings, and polymer structure-property relationships and the use of high throughput methods. The CSMS co-Lead, **Mukund Sibi** (Distinguished Professor, Chemistry and Biochemistry, NDSU), has expertise in catalysis and organic synthesis.

Team Participants and Partners:

- **Bret Chisholm** (Center for Nanoscale Science and Engineering, NDSU) brings polymer synthesis expertise to the team, managing the Combinatorial Materials Research Laboratory.
- **Qianli "Rick" Chu** (Assistant Professor, Chemistry, UND) focuses on the synthesis of nanofibers from bio-based monomers.
- **Guodong Du** (Associate Professor, Chemistry, UND) targets catalytic and stereoselective synthesis of biodegradable polymers that are based on renewable raw materials.
- **Sivaguru Jayaraman** (Professor, Chemistry/Biochemistry, NDSU) studies photochemistry, organo- and supramolecular photocatalysis, molecular recognition and photodegradation.
- **Erika Offerdahl** (Associate Professor, Biological Sciences, NDSU) is a STEM education specialist.
- **Chad Ulven** (Associate Professor, Mechanical Engineering, NDSU) studies the field of composites, with an emphasis on using naturally-occurring fibers as fillers.

The research center members will place an emphasis on leveraging existing North Dakota talent with proven track records of creativity and productivity. In addition, leveraging and interactions will be implemented with all other program components, the primarily undergraduate state universities, tribal colleges, businesses, local and national media, other potential research partners and governmental agencies.

Key Outcome: Increased state-wide physical, human and research assets to progress the development of a sustainable bio-based materials supply chain.

Table 3. Focus Area 2 Goals, Objectives, Benchmarks and Activities, Output Metrics and Baseline and 5-year Targets

Goal 1: Develop and launch a transformative approach to the development of sustainable materials derived from agricultural materials as a means to replace petrochemical polymeric materials in day-to-day use.					
Benchmarks/Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 1.1: Synthesize novel monomers from biomass. **(Sibi/New Hire)**					
Build a library of bio-based monomers for use in a variety of polymer systems.	Continue synthesis of HMF-derived monomers.	Synthesize new diol and diaminemonomers.	Synthesize chain extended analogs of FDCA.	Synthesize new terephthalic acid analogs.	Synthesize HMF-dimer, analog mod./ new monomers.
Objective 1.2: Design new highly functional thermosetting polymers. **(see activity assignments below)**					
Build a library of novel bio-based polymers having different useful functional groups. **(Webster)**	Ongoing activities to synthesize and characterize new methacrylate functionalized sucrose soyate resins.	Synthesize and characterize carbonated sucrose soyate resins.	Identify new core molecules and synthesize vegetable oil ester resins.	Identify new methods of increasing the functionality of bio-based resins.	Continue work with most promising approach for achieving exceptional performance properties.
Synthesize new vinyl ether monomers from biomass derived chemicals. **(Chisholm)**	Use known synthetic procedures to synthesize and characterize novel plant oil-based vinyl ethers.	Evaluate the utility of plant oil-based poly (vinyl ether)s for potential end-use applications.	Synthesize and characterize novel poly (vinyl ether)s based on derivatives of hydroxymethyl-furfural.	Synthesize and characterize polymers derived from acrylate and methacrylate monomers based on hydroxymethyl-furfural and/or its derivatives.	Optimize polymers to obtain best performance properties (stiffness, strength, etc.).
Objective 1.3: Engineer high performance polymers and composites from bio-based raw materials. Benchmark against current appropriate petrochemical counterparts. **(Chisholm)**					
Synthesize new polyamides derived from novel bio-based monomers and synthesize new polyesters made from bio-based monomers.	Use FDCA and other novel bio-based monomers (Sibi) to synthesize polyamides. Characterize physical and mechanical properties.	Continue effort with new monomers as they become available.	Continue effort with new monomers; use FDCA and other novel based monomers to synthesize polyesters.	Characterize physical and mechanical properties of the polymers.	Continue effort with new monomers as they become available out of #1.1.
Objective 1.4: Synthesize bio-based polymers using "green" catalyst systems. **(Du)**					
Synthesize and use novel inorganic catalysts for polymer synthesis.	Synthesize binucleating ligands and catalysts for polycarbonate formation.	Produce polyesters incorporating bio-based epoxides and cyclic anhydrides.	Synthesize block copolymers and evaluate properties.	Develop and synthesize new ligands and catalysts for stereoselective polylactide synthesis.	Synthesize new degradable polymers from bio-based building blocks such as diacids and diols.

Objective 1.5: Prepare bio-based thermosets and characterize for physical properties. Benchmark against current appropriate petrochemical counterparts. **(Webster)**					
Synthesize novel high performance thermosets useful for coatings and composites.	Combine available bio-based epoxy resin with bio-based crosslinkers (Sibi) and prepare and characterize thermosets. Benchmark against petro-chemical thermosets.	Crosslink new bio-based resins with bio-based and petrochemical crosslinkers and characterize thermosets for physical and mechanical properties.	Crosslink carbonated sucrose ester resin with novel bio-based diamines and characterize properties.	Use novel HMF based monomers (Sibi) as crosslinkers for bio-based resins. Characterize for physical and mechanical properties.	Characterize corrosion of new thermosets performance in coatings as well as weathering durability using QUV or xenon arc for moisture/heat FTIR, etc. methods for degradation mechanism.
Objective 1.6: Use bio-based polymers in the preparation of composites. Benchmark against current appropriate petrochemical counterparts. **(Webster/Ulven)**					
Study and optimize curing kinetics of newly developed resins prior to composite manufacturing.	Provide bio-based resins from Webster to Ulven group for formulation of resin systems for composites. Prepare initial composites. Determine physical and mechanical properties.	Study and optimize cure kinetics of bio-based resin system for use in composites.	Provide new bio-based polymer systems from Webster to Ulven group for use in preparation of composites. Characterize new composites for physical and mechanical properties.	Continue to refine and optimize resin compositions and cure kinetics for use in composite systems.	Continue to refine and optimize resin compositions and cure kinetics for use in composite systems.
Objective 1.7: Study performance properties of composites made using bio-based fillers and fibers. Benchmark against current appropriate petrochemical counterparts. **(Ulven)**					
Develop new totally bio-based composite systems.	Evaluate both physical and mechanical properties of composites from natural fibers.	Tailor fiber sizing or treatment approaches to improve interfacial load transfer between natural fibers and bio-based polymers.	Evaluate composites through freeze/thaw, UV, and humidity exposure.	Model long term performance of optimized bio-composites using known micro-mechanical models for synthetic composites.	
Objective 1.8: Synthesize novel bio-based nanoreinforcements. **(Chu)**					
Develop new types of bio-based reinforcements for bio-based polymers.	Synthesize and characterize bio-based polymeric ladders.	Synthesize and characterize bio-based 2D polymers.	Evaluate the bio-based ladder and 2D polymers in coatings as crosslinking agents (with Webster group).	Synthesize and characterize bio-based 3D polymers.	Evaluate the 3D polymers in coatings as crosslinking agents (with Webster group).
Objective 1.9: Design materials with programmed degradation capability so that raw materials and fillers can be recycled. **(Sivaguru/Sibi)**					
Develop new biomass derived	Continue efforts in the synthesis	Explore routes to the synthesis	Synthesize and evaluate photo-	Broaden approaches to	Elucidate the mechanism of

phototriggers and photoinitiators that can be incorporated into polymers; synthesize building blocks that can be used to trigger polymer degradation.	of phototriggers; conduct degradation and mechanistic studies of phototriggers.	of novel photo-triggers from biomass and evaluate approaches.	initiators for their ability to photoinitiate radical polymerization derived from biomass.	alternative phototriggers and photoinitiators from biomass and evaluate.	photo-degradation of photo-triggers using photo-physical characterization methods.
Objective 1.10: Incorporate triggerable building blocks into polymers and thermosets in order to yield polymers with programmed degradation capability. **(Webster/Sivaguru/Sibi)**					
Synthesize polymers that can be degraded using light.		Incorporate new phototriggers into additional polymer types. Characterize the photo-degradation of polymers containing the phototriggers.	Incorporate novel bio-mass-derived phototriggers into polymers and study photo-degradation.	Incorporate biomass-derived phototriggers into thermo-setting resin systems and study photo-degradation.	Demonstrate re-use of degradation products in synthesis of new polymers.
Objective 1.11: Incorporate photodegradable polymers into composite systems. **(Ulven/Webster/Sibi/Sivaguru)**					
Develop composites that can be degraded using light in order to recover reinforcing fibers.				Use polymer containing phototriggers in the preparation of composites using natural fibers.	Study the degradation of the composites and demonstrate the recovery of reinforcing natural fibers.

Goal 2: Build CSMS into a high functioning interdisciplinary, sustainable research team that includes new faculty hires, acquisition of state of the art analytical equipment and utilization of cyberinfrastructure (CI) for the purpose of efficiently processing data, quickly analyzing results, and securely transmitting data between groups.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 2.1: Develop and build interactions between team (UND and NDSU) members including faculty from TCs and PUIs. **(Webster/Sibi)**					
Build the CSMS team by holding meetings that include postdocs and graduate students.	Identify CSMS team members; hold monthly meetings with 90% attendance; prepare one-page summary of CSMS research and distribute to TCs and PUIs.	Convene monthly meetings of CSMS team with 90% attendance. Convene two CSMS video-conferences.	Convene monthly meetings of CSMS team with 90% attendance. Convene two CSMS video-conferences with all partners to discuss science.	Ongoing	Ongoing
Objective 2.2: Develop collaborative, interdisciplinary projects among CSMS team members. **(Webster/Sibi)**					
Collaborative projects with interdisciplinary teams lead to	Develop time-based work plans for each	Execute work plan and assess progress during	Continue proposal writing and review; plan	Submit at least one center-type proposal; review	Develop plan for continued collaborative, inter-disciplinary

joint proposal submissions.	collaborative project.	CSMS team meetings.	for center-type proposal.	results, amend plan if needed.	projects and proposal writing.
Objective 2.3: Strengthen CSMS research infrastructure with four new hires (hiring plan is in the appendix section). **(Sibi/Webster)**					
Hire four new faculty members and support their integration into the CSMS team.	Prepare descriptions of positions. Initiate searches, interview, select faculty, and hire two: One synthetic organic chemist and one polymer scientist.	Synthetic organic chemist and polymer scientist start FA15, attend CSMS orientation. Confirm mentors, both establish goals and performance measure. Prepare for hiring computational polymer scientist.	Synthetic organic chemist and polymer scientist submits CAREER proposal. New computational polymer scientist and scientist with expertise in life cycle assessment start in FA16.	Computational polymer scientist and scientist with expertise in life cycle assessment submit CAREER proposals. All new hires attain 90% of their performance measures Plans reviewed and revised if needed.	Resubmission of CAREER proposals that were not awarded. Review of tenure and promotion status. Plan constructed for support through tenure and promotion attainment. Review of performance.
Objective 2.4: Acquire needed analytical equipment. **(Webster/Sibi)**					
Identify and prioritize CSMS team needs for supporting new analytical capabilities; acquire equipment, make operational and utilize.	Determine purchasing budget and meet with CSMS team members to develop time-based plan.	Initiate purchases and complete those that are started. Train users (faculty, students and postdocs).	Develop protocols for sharing analytical equipment.	Document usage, maintain equipment and plan for additional equipment.	Include additional equipment in CSMS research proposals; plan for the future.
Objective 2.5: Develop effective access to file storage through implementation of the Globus Online GridFTP data transfer tool at the NDSU site to transfer files between NDSU and UND. File transfer between the HPC sites at NDSU and UND will also be handled by Secure Copy Protocol (SCP). **(Bergstrom/Ossowski)**					
Globus Online data transfer tool.	Determine data transfer needs of CSMS researchers.	Develop efficient implementation of Globus Online Grid FTP.	Ongoing.	Ongoing.	Ongoing.
Objective 2.6: Procure a limited amount of HPC equipment needed for modeling and simulation activities. **(Bergstrom/Ossowski)**					
Procure HPC equipment.	Determine need for additional HPC equipment. Determine available funding for HPC equipment. Make purchase decision.	Procure as needed.	Ongoing.	Ongoing.	Take stock of equipment condition and refresh previously purchased equipment if needed and budgets allow.

CSMS Output Metrics

Metric *(Where baseline data is available, it is represented as an initial measure of this metric; where it is not, the Year 1 projection is used and denoted with an *)*	**Baseline or Year 1 projection* Data**	**Five-Year Cumulative Targets**
Number of new synthesized new monomers	10*	40
Number of new thermoset polymers	5*	20
Number of new synthesized vinyl ether monomers	5*	18
Number of synthesized new polyamides	5*	12
Number of synthesize new polyesters	*	12
Number of synthesize inorganic catalysts	5*	18
Number of high performance thermosets evaluated	3*	12
Number of resin formulations developed	3*	12
Number of bio-based composites	3*	10
Number of synthesized reinforcement polymers	5*	15
Number of synthesized phototriggers-photo initiators	5*	15
Number of new polymers for photodegradation studies	*	12
Number of composites for photodegradation studies	*	6
Globus Online Implementation	Determine need*	Integrated
HPC Equipment for CSMS activity	Determine need*	Integrated
Number of submitted collaborative proposals	3	15
Number of new hires	2*	4
Number of CAREER proposals submitted	*	2-4
Number of new analytical instruments acquired	*	2
Number of postdoctoral associates trained	2	7
Number of graduate students trained (some may be counted in multiple years)	11	25
Number of undergraduate students trained	8	40
Number of individual peer-reviewed publications	14	48
Number of collaborative peer-reviewed publications with TC and/or PUI faculty	5	15
Number of conference presentations by faculty (oral and poster)	5	40
Number of conference presentations by graduate students and postdocs (oral and poster)	13	63
Number of conference presentations by undergraduate students (oral and poster)	5	40
Percentage of all publications in high-impact journals	10%*	25%
Number of cumulative citations	5*	275
Number of invention disclosures submitted	3	10
Number of projects funded with private sector partners (includes SBIR/STTR)	*	12
Funding for TC faculty to participate in the research centers *(ND has 5 TCs – efforts are currently underway, via campus visits to learn which TC faculty members wish to work with the CRCS or CSMS as cluster members; funds represent total funding to TCs)*	$100,000*	$530,915
Seed grant awards for PUI faculty to participate in the research center *(ND has 4 PUIs– efforts are currently underway with the ND University System to identify PUI faculty members you wish to work with the CRCS or CSMS as cluster members; funds represent total funding to PUIs)*	$0*	$531,000

3.7 Focus Area 3-Diversity

Strategic Priority: Build on the success of our Nurturing American Tribal Undergraduate Research and Education (NATURE) programs by continuing to nurture American Indian students throughout their undergraduate and graduate work; particularly in STEM areas. Continue and expand supportive connections between research themes and underrepresented communities, including female participation in STEM.

Goals:

1. Build on the success of our K-12 NATURE programs by continuing to nurture Native American students throughout their undergraduate and graduate work by advancing the collaborative relationship with the 5 North Dakota Tribal Colleges (TCs) and by building on our collaboration with PUIs to strengthen the partnership, thereby resulting in increased research participation from both of those groups.

2. Develop new initiatives that result in Native student retention and completion in STEM areas.

3. Partner with existing campus groups to expand efforts to increase participation of women in STEM; with specific focus on women in science and engineering (ND-WISE) initiatives.

Objectives to Achieve Goals: Advancing the collaborative relationship between research universities and the North Dakota Tribal Colleges requires a tribal college liaison focused on improving interactions between the two (*objective 1.1*). Additionally, for the clusters to achieve increased research participation from TCs and PUIs, information gathering and dissemination are critical (*objective 1.2*) and should be facilitated by the tribal college liaison (for TCs) and project co-directors (for PUIs). The interactions and integrations between research clusters and NATURE Sunday Camp and Summer Camp serve to stimulate interests in the themes of the clusters leading to increased research participation from American Indian students. Due to limited resources (*objective 1.3, 1.4*), American Indian students need help to be academically successful, particularly at the doctoral level. Support systems such as Native American advisers, tutoring programs, and fellowships/assistantships are crucial for enhancing Native American student retention and completion in STEM areas from undergraduate to Ph.D. levels (*objectives 2.1, 2.2*).

Similar to American Indian students, support systems including seed/position funding and mentoring programs increase the number of women faculty in STEM areas and women faculty role models through NATURE Sunday Academy and Summer Camp (*objective 3.2*). As a result, this is expected to lead to higher retention of women faculty and students in STEM areas, and more successful promotion and tenure cases for women faculty (*objective 3.1*).

Team Leads: Diversity team lead, **Eakalak Khan** (Professor Civil Engineering, NDSU) serves as the ND EPSCoR NATURE Coordinator and is the Director of the NDSU Environmental & Conservation Science Program with research interests in water and wastewater. The Diversity co-Lead, **Chad Ulven** (Associate Professor, Mechanical Engineering, NDSU) serves as the NATURE Sunday Academy Coordinator and is a member of the CSMS group.

Team Participants:

- **Mark Hoffmann** (ND EPSCoR Associate Project Director) serves as a team/EPSCoR leadership facilitator for the team, specifically its UND members.
- **Jean Ostrom-Blonigen** (ND EPSCoR Project Administrator) serves as a team/EPSCoR leadership facilitator for the team, specifically its NDSU members and will fill the role of the Tribal Colleges Liaison Manager until someone is hired.

- **Robert Pieri** (Professor, ME, NDSU) coordinates NATURE University and Tribal College Summer Camps
- **TBD (**ND EPSCoR Tribal Colleges Liaison) provides liaison expertise between NDSU, UND and the TCs for all facets of the program.
- **TBD** (ND EPSCoR Project Assistant, NDSU) provides administrative supports including but not limited to hiring/terminating employees, payrolls, travel vouchers, purchasing and reimbursements, billeting, catering requests, and motor pool reservations.
- **All members** of both research clusters will be expected to engage in the activities outlined in the table below. The specific activity will determine the linked faculty member.
- **Cankdeska Cikana Community College** – administrators, faculty and students.
- **Fort Berthold Community College**– administrators, faculty and students.
- **Sitting Bull College** – administrators, faculty and students.
- **Turtle Mountain Community College** – administrators, faculty and students.
- **United Tribes Technical College** – administrators, faculty and students.

Key outcomes: 1) Increased climate and agro-economy scientific capacity within the tribal communities; 2) Increased number of American Indians completing STEM degrees; and 3) Increased number of women STEM faculty at NDSU and UND.

Status of Tribal Colleges Liaison Manager position: As of 1/15/15, the Tribal Colleges Liaison Manager position description, developed in conjunction with the TC presidents, was under review by NDSU's Recruiting Office. Once approved, the position opening will be advertised for 10 days and the screening process will begin. Search committee members include:

- Chair: Jean Ostrom-Blonigen, ND EPSCoR Program Administrator, NDSU
- Mark Hoffmann, ND EPSCoR Associate Program Director, UND
- Jaclynn Wallette, Assistant VP for Equity, Diversity, and Global Outreach, NDSU
- Leigh Jeanotte, Director, American Indian Student Services, UND
- Jean Janecek-Hartman, Director, ND Association of Tribal Colleges

Table 4. Focus Area 3 Goals, Objectives, Benchmarks and Activities, Output Metrics and Baseline and 5-Year Targets

Goal 1: Build on the success of our K-12 NATURE programs by continuing to nurture American Indian students throughout their undergraduate and graduate work by advancing the collaborative relationship with the 5 North Dakota Tribal Colleges (TCs) and by building on our collaboration with PUIs to strengthen the partnership, thereby resulting in increased research participation from both of those groups of students.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 1.1: Hire a tribal college liaison to facilitate interactions between the research universities (NDSU and UND) and the TCs. **(Tribal College Liaison/Ostrom-Blonigen)**					
Tribal College Liaison Position is filled.	Develop plan by engaging stakeholders and hire liaison.	Retain liaison with satisfactory reviews of performed duties.	Ongoing.	Ongoing.	Retain liaison with satisfactory reviews and institutionalize position.
Tribal College Liaison: Growing the research.	Meet with research center leads and/or liaisons.	Identify 5 TC faculty interested in engaging in CRCS or CSMS complementary research	Add Cohort 1 undergraduate researchers.	Add Cohort 2 UG researchers.	Add Cohort 3 UG researchers.
Tribal College Liaison: Communication.	Develop a TC EMPOWERED-ND communication.	Communicate on state stage.	Communicate on state and national stages.	Write policy paper describing communication efforts of EMPOWERED-ND.	Champion broader EPSCoR and TC interaction.
Objective 1.2: Gather and disseminate information the clusters need to integrate TC and PUI participants into their projects. **(Tribal College Liaison/Ostrom-Blonigen/Hoffmann)**					
EMPOWERED-ND Corps (in-person or online IVN meetings) to assess progress and review/revise implementation plans.	Appoint cluster personnel. Hold initial meeting.	Host semiannual face-to-face meetings at central ND college location (an IVN option will be available for each of these meetings).	Ongoing.	Ongoing.	Ongoing.
Continuously gather program and funding information to aid in ongoing decision-making.	Inventory current program pitfalls; target and eliminate overlap. Identify and leverage existing funding. Recommend new programs to further engage and broaden participation.	Provide feedback to researchers to ensure continued participation. Update baseline inventories. Identify and leverage existing funding. Recommend new programs.	Ongoing.	Ongoing.	Ongoing.

Disseminate information.	Host semiannual meetings with ND EPSCoR Steering Committee.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Objective 1.3: Include more cluster research themes into university summer camps in order to enhance student participation in STEM. **(Khan/Pieri/J. Zhang/Webster/Tribal College Liaison)**					
Perform student tracking.	Develop measurement tool for longitudinal study.	Implement by cohort and assess effectiveness.	Ongoing, with tool modifications as necessary.	Ongoing.	Ongoing.
Track research cluster involvement and demographics	Track faculty, postdocs and graduate students	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Collaborate with cluster research liaisons at summer camp planning development lessons	Collect tracking data of cluster research related lessons developed, and faculty involved.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Objective 1.4: Increase the integration of the Sunday Academy programming with the research clusters. **(Khan/Pieri/ J. Zhang/Webster/Tribal College Liaison)**					
Perform student tracking.	Develop measurement tool for longitudinal study.	Implement tracking by cohort and assess effectiveness.	Ongoing.	Ongoing.	Ongoing.
Increase the number of cluster faculty, post-docs, and graduate students involved.	Collect tracking data by cohort.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Increase the number of cluster research related lessons.	Collaborate at summer camp and during other opportunities that arise.	Ongoing.	Ongoing.	Ongoing.	Ongoing.

Goal 2: Develop new initiatives that result in Native American student retention and completion in STEM areas.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 2.1: Support Native American STEM students so that they are successful. **(Tribal College Liaison/ Hoffmann/Ostrom-Blonigen/Webster/Sibi/Zhang/Bowman)**					
Develop and embed the support system at NDSU and UND.	Hire Native American advisors.	Initiate a support plan for students, which includes math readiness.	Evaluate and modify plan as necessary.	Ongoing. Explore institutional-ization of positions.	Ongoing. Institutionalize support system.

Integrate Native American students into STEM research.	Review existing models of retention practices in other successful programs. Meet with researchers to discuss.	Meet TC presidents each year (or two) to review role of STEM advisors on each of their campuses.	Place Cohort #1 Native American students in research groups.	Assess the success rates of students in research groups. Initiate Cohort #2.	Assess the success rates of students in research groups. Initiate Cohort #3.
Objective 2.2: Assist Native American students to pursue and eventually obtain PhDs in STEM programs while maintaining contact with TCs. **(Tribal College Liaison/Hoffmann/Ostrom-Blonigen)**					
Support 5 students as they progress toward a STEM Ph.D. (select individual faculty once students are identified with an academic department).	Open application and identification of one student from each site by Research Cluster, EPSCoR admin, and each TC president.	Enroll 5 students.	Gather feedback from students. Retain students.	Ongoing.	Ongoing.

Goal 3: Increase the participation levels of women faculty.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 3.1: Partner with existing campus groups to expand efforts to increase participation of women in STEM; with specific focus on women in science and engineering (ND-WISE) initiatives. **(Hoffmann/Ostrom-Blonigen/ Webster/Sibi/ Zhang/Bowman)**					
Identify tenure-track women faculty in STEM fields at NDSU and UND	Work with existing campus mentoring programs for women faculty to communicate the availability of EPSCoR funds (state) to women faculty in tenure-track STEM programs. Award EPSCoR seed grants.	Augment existing campus mentoring programs focused on partnering experienced STEM research role models in the research clusters with non-tenured women faculty who are tenure-track. Award EPSCoR seed grants.	Augment existing, mentoring programs for tenure-track women faculty in STEM disciplines. Award EPSCoR seed grants.	Ongoing.	Ongoing. Evaluate efforts.
Objective 3.2: Increase the number of American Indian and women role models participating in NATURE programming. **(Khan/Tribal College Liaison/Ostrom-Blonigen)**					
Track the number of women faculty, post-docs, and graduate students.	Gather baseline participation metrics.	Increase participation.	Ongoing.	Ongoing.	Ongoing.

Diversity Output Metrics

Metrics *(Where baseline data is available, it is represented as an initial measure of this metric; where it is not, the Year 1 projection is used and denoted with an *)*	**Baseline or Year 1 projection* Data**	**Five-Year Cumulative Targets**
Hire Tribal College Liaison	Hired*	Retained
Funding for TC faculty to participate in the research centers *(ND has 5 TCs – efforts are currently underway, via campus visits to learn which TC faculty members wish to work with the CRCS or CSMS as cluster members; funds represent total funding to TCs)*	$100,000*	$530,915
Seed grant awards for PUI faculty to participate in the research center *(ND has 4 PUIs– efforts are currently underway with the ND University System to identify PUI faculty members you wish to work with the CRCS or CSMS as cluster members; funds represent total funding to PUIs)*	$0*	$531,000
Number of meetings of the EMPOWERED-ND Corps	1*	At least every other month
Add UG researchers each year to the clusters identified through NATURE	1-3*	5-15
Hire Native American advisors with STEM backgrounds to advise Native American students at NDSU and UND: NASSE	*	2 – ½ time
Meet annually with TC presidents to report on the impacts of the collaboration efforts between the research centers and the TCs. Report also on the numbers of Native American students who are taking advantage of the programming	Once Annually*	Once Annually
Place Native American students in research group: NATURE+	1-3*	5-15
Identify Native American students interested in obtaining a STEM Ph.D. and are willing to maintain contact with a TC faculty member or administrator: NASSE	1*	5
Assist Native American students in obtaining their doctorate degree: NATURE+	1*	5
Identify Native American students interested in obtaining a STEM M.S. degree and are willing to maintain contact with a TC faculty member or administrator: NASSE	1*	5
Assist Native American students in obtaining their M.S. degree: NATURE+	1*	5
Identify Native American students with a STEM bachelor's degree who are interested in obtaining a M.S. degree in Education and who would be willing to return to a ND tribal community and teach either at the K-12 or TC level: NATURE+	1*	5
Increase the number of newly promoted and/or tenured women faculty in STEM programs at NDSU and UND: WISE-related	*	2
Number of TC cluster faculty	*	2-3 per cluster
Number of cluster themes integrated with university summer camps: NATURE+	*	2-3
Number of cluster faculty/post-docs/GRA	*	2-3
Number of cluster themes integrated with Sunday Academy programs: NATURE+	*	2-3
Number of women involved in NATURE: WISE-related	*	10
Award EPSCoR seed grants to women faculty: WISE-related	1	8+

3.8 Focus Area 4-Education and Workforce Development

Strategic Priority: Capitalize on statewide interest in agriculture at all levels of education, while heeding ND's S&T Plan for the ND University System to build capacity in advanced manufacturing and technology-based businesses to advance the state's economic vitality.

Goals:

1. Build interdisciplinary STEM research capacity state-wide by engaging and equipping students early in their academic careers (K-12) to be successful in the ND workforce through the expansion of existing group relationships (notably 4-H and Future Farmers of America), to leverage the ND EPSCoR investment and reach people from across the state more effectively.

2. Engage graduate students, postdoctoral research associates and faculty associated with the clusters in expanding research and educational opportunities to underrepresented groups and younger learners.

Objectives to Achieve Goals: Increasing statewide interest in preparing a STEM workforce requires a collaborative relationship between research universities, K-12 institutions, groups already engaged with K-12 students (*objectives 1.2, 1.3*), and TC and PUI partners (*objectives 1.4, 1.5, 2.2*) to build on early student interests (*objectives 2.1*) and identify (*objectives 1.1*) and address barriers (*objectives 2.3*) to pursuing STEM disciplines.

Team Leads: Education and Workforce Development co-Lead, **Gretchen Mullendore** (Associate Professor, Atmospheric Sciences, UND) serves as the main research liaison from the CRCS group to the TCs and PUIs for education and workforce development. The other team co-Leads, **Sivaguru Jayaraman** (James A. Meier Jr. Professor, Chemistry and Biochemistry (CBC), NDSU) and **Erika Offerdahl** (Associate Professor, Biological Sciences, NDSU) serves as the main research liaison from the CSMS group to the TCs and PUIs for education and workforce development.

Team Participants:

- **Aaron Bergstrom** (High Performance Computing Specialist, Center for Computational Research, UND) serves as one the teams' two cyberinfrastructure experts.
- **Frank Bowman** (CRCS co-Lead and Associate Professor, Chemical Engineering, UND) serves as an education and workforce development research liaison from the CRCS group.
- **Mark Guy** (Professor, Teaching & Learning, UND) serves as an outreach liaison for K-12 and the general public.
- **Mark Hoffmann** (ND EPSCoR Associate Project Director and Associate Vice President for Research and Economic Development, UND) serves as a team/EPSCoR leadership facilitator/liaison for the team, specifically its UND members.
- **Cindy Juntunen** (Professor, Counseling Psychology, UND) serves as an education and workforce development research liaison from the CRCS group.
- **Martin Ossowski** (Director, Center for Computational Assisted Science & Technology, NDSU) serves as one of the teams' two cyberinfrastructure experts.
- **Jean Ostrom-Blonigen** (ND EPSCoR Project Administrator, NDSU) serves as a team/EPSCoR leadership facilitator/liaison for the team, specifically its NDSU members.
- **Mukund Sibi** (CSMS co-Lead and Distinguished Professor, CBC, NDSU) serves as an education and workforce development research liaison from the CSMS group.
- **Timothy Young** (Professor, Physics and Astrophysics, UND) serves as an outreach liaison for K-12 and the general public.
- The Education and Workforce Development team will work collaboratively with all other project components.

Key outcomes: 1) Increased number of diverse students are equipped with the skills to address problems relevant to North Dakota; 2) Increased number of students early in their education interested in STEM; and 3) Increased state-wide research capacity.

Table 5. Focus Area 4 Goals, Objectives, Benchmarks and Activities, Output Metrics and Baseline and 5-Year Targets

Goal 1: Build interdisciplinary STEM research capacity state-wide by engaging and equipping students early in their academic careers (K-12) to be successful in the ND workforce and through the expansion of existing group relationships (notably 4-H and Future Farmers of America), to leverage the ND EPSCoR investment to reach people from across the state more effectively.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 1.1: Increase student self-efficacy in STEM. **(Juntunen)**					
Assess pre-intervention levels of self-efficacy.	Collect and analyze pre-test data for K-12 students in all experiential learning programs. Identity all activities with significant hands-on activities.	Collect and analyze pre-test data for K-12 students in all experiential learning programs.	Ongoing.	Ongoing.	Ongoing.
Implement and assess impact of experiential learning activities.	Identity all activities with significant hands-on activities.	Collect and analyze post-test data for all students in all experiential learning programs.	Ongoing.	Ongoing.	Ongoing.
Assess impact of mentoring on self-efficacy in K-12 students.		Establish mentoring matches with NATURE TAs and graduate students.	Collect and analyze post-test data from mentor pairs.	Ongoing.	Ongoing.
Objective 1.2: Increase student interest in STEM. **(See activity assignments below)**					
Assess pre-intervention levels of interest. **(Juntunen/ Young/Guy)**	Collect and analyze pretest data for K-12 students in all STEM enrichment curriculum/ activity.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Develop a train the trainers/ educators workshop. **(Juntunen/ Guy)**	Establish partnership with 4-H and FFA; implement workshop with Teacher Ed faculty or graduate students.	Complete "training the trainers" activity.			
Deliver STEM enrichment and		Implement modules in	Ongoing.	Ongoing.	Ongoing.

analyze effect on students in STEM enrichment/ curriculum activity **(Juntunen)**		classrooms, 4-H and FFA chapters and collect and analyze student interest post-test data			
Objective 1.3: Increase student intentions to pursue STEM career or major. **(Juntunen)**					
Assess pre-intervention levels of intention.	Collect and analyze pre-test data for all students in all STEM enrichment programs.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Implement and assess impact of all STEM enrichment learning activities.	Identity all activities with significant hands-on activities.	Collect and analyze post-test data for all students in all experiential learning programs.	Ongoing.	Ongoing.	Ongoing.
Determine the impact of STEM modeling by advanced students.		Develop CRCS and CSMS science content podcasts by graduate and undergraduate students.	Collect and analyze post-test data after viewing podcasts.	Ongoing.	Ongoing.
Objective 1.4: Build capacity for interdisciplinary research state-wide and initiate collaboration with partner institutions (TCs and PUIs) and sustain research collaborations with TC/PUIs. **(See activity assignments below)**					
Initiate collaboration grants at TCs. **(Mullendore/ Jayaraman)**	Ideas for collaboration grant use submitted by UND/NDSU researchers. Host collaboration grant information meetings. Identify researchers.				
Collaboration grants initiated at PUIs. **(Mullendore/ Jayaraman)**	Ideas for collaboration grant use submitted by UND/NDSU researchers and collaboration grant information meetings.	Competitive seed grants for collaborative research grants awarded to PUIs.			

Foster collaboration via regular meetings. **(Mullendore/ Jayaraman)**	Welcome meeting to introduce new collaborators. Convene regular IVN meetings. Promote attendance at state conference.	Convene regular IVN meetings and attendance at state conference.	Ongoing.	Ongoing.	Ongoing.
Collaborative fits identified between UND/NDSU and TC/PUI cluster researchers. **(Mullendore/ Jayaraman)**	Initial research integrations identified.	Collaborative links, such as projects as part of CRCS/CSMS team efforts, enhanced/ adjusted as research matures.	Ongoing.	Ongoing.	Ongoing.
Host HPC Bootcamp for researchers at UND and NDSU. **(Bergstrom/ Ossowski)**	Host HPC Bootcamp each semester for UND and NDSU.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Objective 1.5: Build capacity for interdisciplinary research state-wide, initiate collaboration with partner institutions (TCs and PUIs) and sustain research collaborations with TC/PUIs. **(See activity assignments below)**					
Outreach Portfolio created and maintained. **(J. Zhang/ Webster/ Ostrom-Blonigen)**	Collect project ideas from outreach coordinators, including (but not limited to) NATURE, Presentations or lesson plan development, 4-H, FFA, community	Update portfolio.	Ongoing.	Ongoing.	Ongoing.
Citizen Science Grid (CSG) and outreach to K-12 through STEM organizations. **(Bergstrom)**	Develop CRCS applications and content for CSG.	Develop CSMS applications and content for CSG and market CSG app/content to K-12 classrooms through Dakota STEM Initiative and programs such as NDSCS 'You're Hired!	Market CSG app/content to K-12 classrooms through Dakota STEM Initiative and programs such as NDSCS 'You're Hired!	Ongoing.	Ongoing.
Sharing of cyber-infrastructure expertise. **(Bergstrom/ Ossowski)**	Hold CI sessions at state-wide EPSCoR events.	Ongoing.	Ongoing.	Ongoing.	Ongoing.

General HPC information session for NATURE program. **(Bergstrom/ Ossowski)**	Hold HPC information session for Nature program.	Ongoing.	Ongoing.	Ongoing.	Ongoing.

Goal 2: Engage undergraduate and graduate students, postdoctoral research associates and faculty associated with the clusters in expanding research and provide educational and research opportunities to underrepresented groups and younger learners from other ND institutions.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 2.1: Increase student intentions to pursue STEM career or major. (**Offerdahl/Hoffmann/Ostrom-Blonigen)**					
Engage students in research related to cluster foci by establishing and maintaining a summer REU program that includes PUI and TC faculty and students.	Establish recruitment plan, selection processes. Identify administrative personnel to coordinate recruitment, selection, and logistics.	Administer REU programs based on feedback and increase participation of PUI and TC faculty and students.	Ongoing.	Ongoing.	Ongoing.
Objective 2.2: Engage students from PUIs/TCs in graduate degree programs. **(See activity assignments below)**					
Recruit PUI and TC students into Master's and Doctoral programs at UND/NDSU. (**Jayaraman/ Mullendore**)	Establish and implement recruitment plan. Visit PUIs and TCs. Invite PUI/TC faculty to clusters.	Continued recruitment efforts to achieve desired metrics.	Ongoing.	Ongoing.	Ongoing.
Provide financial support for graduate research. (**Jayaraman**/ **Offerdahl**/ **Bowman)**	Establish criteria for awarding fellowships and identify metrics for adequate yearly progress.	Annual review of fellows' progress.	Ongoing.	Ongoing.	Ongoing.
Objective 2.3: Provide diverse professional development (PD) opportunities for undergraduate and graduate student trainees. **(See activity assignments below)**					
Create a directed mentorship program for graduate student trainees. Create the RPPAC: Research, Policy & Planning Advisory	Articulate criteria for and recruit initial RPPAC. Identify list of PD seminars, semester projects for trainees and establish	Provide two seminars per semester. Communicate standards of mastery. Evaluate trainee writing/work.	Ongoing.	Ongoing.	Ongoing.

Committee (**Jayaraman/ Sibi/ Bowman**)	standards for performance.	Provide feedback to trainees.			
Develop and integrate Science Communication Projects into REU program. **(Offerdahl/ Bowman/ Ostrom-Blonigen)**	Identify and recruit faculty to facilitate projects. Create science communication guidelines. Identify/create assessment rubrics.	Communicate about Summer Science seminar series. Evaluate REU students' communication products. Disseminate products via Web	Ongoing.	Ongoing.	Ongoing.
Graduate students and postdoctoral researchers will participate in at least one outreach activity per funded semester. **(Mullendore/ Offerdahl)**	Outreach choices okayed and facilitated by outreach coordinator. Students collect and summarize assessment (when applicable).	Ongoing.	Ongoing.	Ongoing.	Graduate students and postdoctoral researchers outreach choices okayed and facilitated by outreach coordinator.
Develop graduate students' skills to conduct education and outreach projects. **(Ulven/ Offerdahl/ Bowman/ Ostrom-Blonigen)**	Recruit students for NATURE+. Design outreach portfolio. Articulate expectations for graduate student participation in outreach.	Graduate trainees complete at least one project from the outreach portfolio; also collect and report evaluation data relevant for their outreach activity.	Graduate trainees diversify their own education/ outreach experience by completing new opportunities from outreach portfolio.	Ongoing.	Ongoing.
Use HPC bootcamps to train graduate students on HPC basics. (**Bergstrom/ Ossowski**)	Train graduate students.	Ongoing.	Ongoing.	Ongoing.	Ongoing.

Education and Workforce Development Output Metrics

Metric *(Where baseline data is available, it is represented as an initial measure of this metric; where it is not, the Year 1 projection is used and denoted with an *)*	**Baseline or Year 1 projection* Data**	**Five-Year Cumulative Targets**
Number of K-12 students completing the Lent STEM Self-efficacy Scale baseline	100*	300
Number of FFA and 4-H participants completing the Lent STEM Self-efficacy Scale baseline	*	600-900**
K-12 students will demonstrate an increase in STEM elf-efficacy on the Lent STEM Self-efficacy Scale @ post-test	*	.25 SD increase
FFA and 4-H participants will demonstrate an increase in STEM elf-efficacy on the Lent STEM Self-efficacy Scale @ post-test	*	.25 SD increase
Number of mentor pairs (identified in year 2)	*	24
K-12 students in mentoring pairs will demonstrate an increase in STEM elf-efficacy on the Lent STEM Self-efficacy Scale @ post-test	*	.50 SD increase
Number of K-12 students completing STEM Interest & Values scale, baseline	100*	300
Number of FFA and 4-H participants completing STEM Interest & Values scale, baseline	*	600-900**
Number of 4-H and FFA partnerships established	8-16*	N/A
STEM Enrichment modules: Trainer/Educator training completed	*	8-16
Number of 4-H and FFA participants completing STEM Interest & Values scale, post-test	*	600-900**
Number of K-12 students completing STEM Major/Career Intentions Scale baseline	100*	300
Number of FFA and 4-H participants completing STEM Major/Career Intentions Scale baseline	*	600-900**
Number of K-12 students completing STEM Major/Career Intentions Scale, post-test and repeated measures	*	300
Number of FFA and 4-H participants completing STEM Major/Career Intentions Scale, post-test and repeated measures	*	600-900**
Number of CRCS and CSMS podcasts developed	*	6-10
Number of high school students completing STEM Major/Career Intentions Scale, following podcast viewing	*	600-900**
Number of ND undergraduates recruited as REU participants, 70% from TC/PUIs	*	12-15
Number of PUI/TC students recruited into Master's and Doctoral programs: NASSE	*	6
Number of Graduate Research Assistantships (GRA) and Doctoral Dissertation Assistantships (DDA) awarded to STEM graduate students: NATURE+	*	6
Number of seminars provided both in-person and over the web	9*	81
Number of summer seminar series provided in-person or via web	*	4
Number of REU participant-generated science communication project created and disseminated via WWW	*	4-8
Number of electronic outreach portfolios available on cluster websites	*	6
Number of graduate students participating in HPC Bootcamps	3*	20
Number of informational meetings at TCs	5*	N/A
Number of cluster researchers identified at TCs	>=1/TC*	>=5
Number of cluster researchers identified at PUIs through collaborative seed grants	*	>=4
Number of HPC Bootcamps for UND and NDSU faculty, staff and students	1*	9
Number of TC/PUI participants in cluster group meetings	5*	45
Number of TC/PUI faculty attendees at state conference	5*	45
Number of cluster-related conference presentations including TC/PUI authors	0*	17
Number of cluster-related publications including TC/PUI authors	0*	9
Number of cluster-related proposals submitted including TC/PUI co-investigators	0*	15

Number of CI Sessions at state-wide EPSCoR Events	1*	5
Number of activity ideas included in outreach portfolio	10-30*	50-150
Number of outreach activities completed	10-40*	50-200
Number of Citizen Science Grid CRCS and CSMS apps developed	1*	2
Number of Citizen Science Grid CRCS and CSMS apps in classrooms	0*	21
Number of general HPC information sessions for NATURE program	1-2*	5-10

**These numbers represent 300+ students per year during each of the last three years of the program; individual students may repeatedly participate.

3.9 Focus Area 5-Partnerships, Collaborations and Communication

Strategic Priority: Create a network of well-informed persons and businesses that not only benefit from the research, but who also can advance the overall knowledge base of the public, in general.

Goals:

1. Develop partnerships with regional industries in value-added agriculture and other enterprises that depend on knowledge of climatic variation and weather extremes.

2. Develop collaboration between the research themes and national labs.

3. Engage students and postdoctoral research associates in partnerships and collaborations.

4. Communicate with stakeholders and public in general to ensure and enhance awareness using more contemporary media, such as webinets, blogs and podcasts, to complement traditional means, such as magazines and newsletters.

Objectives to Achieve Goals: Developing partnerships and collaborations to advance the work of the research clusters into a value-added proposition for ND requires a joint communication effort from the research universities to ND K-12, PUIs, TCs; as well as partnership with other state and federal entities and academic research entities (*objectives 1.1, 2.1*) and those across the NGP who have a vested interest in the science (*objectives 1.2*). Just as students will benefit from relationships with ND industry (*objectives 3.1*), ND industry will benefit from the knowledge of students who are engaged in the research clusters. However, the ultimate success of these research efforts lie with stakeholder and the public in general, who are oftentimes unfamiliar with the research efforts with higher education (*objectives 4.1, 4.2, 4.3, 4.4*); thus these groups must also be called upon to collaborate in these efforts (*objectives 4.5*).

Team Leads: The co-Leads on the CRCS project, **Frank Bowman** (CRCS co-Lead and Associate Professor, Chemical Engineering, UND), and the CSMS project, **Mukund Sibi** (CSMS co-Lead and Distinguished Professor, Chemistry and Biochemistry, NDSU), are also the co-Leads for Partnerships, Collaborations and Communication

Team Participants:

- **Bret Chisholm** (Center for Nanoscale Science and Engineering, NDSU) serves as a partnership, collaboration and communication liaison from the CSMS group.
- **Anne Denton** (Associate Professor, Computer Science, NDSU) serves as a partnership, collaboration and communication liaison from the CRCS group.
- **Mark Hoffmann** (ND EPSCoR Associate Project Director and Associate Vice President for Research and Economic Development, UND) serves as a team/EPSCoR leadership facilitator for the team, specifically its UND members.
- **Andrei Kirilenko** (Associate Professor, Earth System Science & Policy, UND) serves as a partnership, collaboration and communication liaison from the CRCS group.
- **Jean Ostrom-Blonigen** (ND EPSCoR Project Administrator, NDSU) serves as a team/EPSCoR leadership liaison for the team, specifically its NDSU members.
- **Kelly Rusch** (ND EPSCoR Project Director and Vice President for Research and Creative Activity, NDSU) serves as a team/EPSCoR leadership facilitator for the team.
- **Chad Ulven** (Associate Professor, Mechanical Engineering, NDSU) serves as a partnership, collaboration and communication liaison from the CSMS group.
- **Dean Webster** (CSMS Director and Professor and Chair, Coatings and Polymeric Materials, NDSU) serves as a partnership, collaboration and communication liaison from the CSMS group.

- **Jianglong Zhang** (CRCS Director and Associate Professor, Atmospheric Sciences, UND serves as a partnership, collaboration and communication liaison from the CRCS group.
- The Partnership, Collaborations and Communications team will work collaboratively with all of the other project components.

Key Outcomes: 1) Increased partnerships with companies and national labs to advance CRCS and CSMS science and engineering infrastructure and translational research opportunities; 2) Increased partnerships with industry to advance STEM workforce development and training; 3) Increased public understanding of the scientific and educational programs and benefits of INSPIRE-ND; and 4) People from across ND will provide feedback to ND EPSCoR and pursue mutually beneficial opportunities.

Table 6. Focus Area 5 Goals, Objectives, Benchmarks and Activities, Output Metrics and Baseline and 5-Year Targets

Goal 1: Develop partnerships with regional industries in value-added agriculture and other enterprises that depend on knowledge of climatic variation and weather extremes.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 1.1: Develop partnerships to advance CRCS and CSMS science and engineering infrastructure and translational research opportunities and specifically Academic/industrial collaborations. **(Ulven/Chisholm)**					
Create partnerships with industry through ND Department of Commerce or other similar programs.		Submit Research-ND proposals.	Ongoing.	Ongoing.	Ongoing.
Develop Translational Research Initiative (TRI) program to provide technology proof-of-concept funding.	Identify private sector industry partners.	Identify collaboration projects.	Select collaboration projects.	Monitor projects.	Review program.
Collaborate with industry on SBIR/STTR opportunities.	CSMS and CRCS faculty initiate collaborations with industry.	CSMS faculty submit one SBIR/STTR proposal.	Ongoing.	Ongoing.	Ongoing.
Objective 1.2: Develop working relationships with agricultural producers and associated organizations in order to strengthen those associations. **(Denton)**					
Strengthen relationship with American Crystal Sugar Company and develop new partner relationship.	Develop data sharing protocols. Identify areas of interest for partners.	Share science outcomes with producers. Recruit new agriculture group partner.	Ongoing.	Ongoing.	Ongoing.

Goal 2: Develop collaboration between the research themes and national labs.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 2.1: Establish collaborations with federal research and other academic research entities. **(Chisholm/ Kirilenko)**					
Participate in observational networks and integrate data into regional climate studies.	CRCS develops climate data partners.	Exchange data with climate partners.	Ongoing.	Ongoing.	Ongoing.
Establish and maintain CSMS-	CSMS initiates and tracks	Exchange ideas with DoE and	Ongoing. Student	Ongoing.	Ongoing.

DoE and USDA lab partnerships.	contacts with DoE labs and USDA labs.	USDA scientists. Track interactions.	internship at DoE and/or USDA labs.		

Goal 3: Engage students and postdoctoral research associates in partnerships and collaborations.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 3.1: Collaborate with ND companies to provide students with STEM-related industry experience. **(Webster/Sibi/Bowman)**					
Identify and support summer internships in ND industry.	Identify ND industry partners for student internships.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Identify and support regional (MN, MT, SD) industry and summer internships.	Develop plan for contacting industries	Identify regional industry partners.	Establish student internships in regional industry.	Review quality and continue.	Ongoing.

Goal 4: Communicate with stakeholders and public in general to ensure and enhance awareness using more contemporary media, such as webinets, blogs and podcasts, to complement traditional means, such as magazines and newsletters.					
Benchmarks/ Activities	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**
Objective 4.1: Improve public awareness of INSPIRE-ND activities. **(All program participants/Rusch/ Hoffmann/Ostrom-Blonigen)**					
Develop INSPIRE-ND Website.	Develop website(s) for CRCS and CSMS with video, webinets, etc. to provide easy access to informative and up to date information.	Maintain and enhance an up-to-date website. Ensure that information is cross-pollinated to reach a larger audience.	Ongoing.	Ongoing.	Ongoing.
Publicize ongoing INSPIRE-ND results and achievements.	Establish website news category. Maintain e-mails to all (NDSU, UND, PUIs TCs). Create blogs by students, faculty on scientific accomplishment and news from EPSCoR.	Publish and distribute a yearly printed and PDF newsletter. Create blogs by students, faculty on scientific accomplishment Include news from EPSCoR personnel on accomplishment	Ongoing.	Ongoing.	Ongoing.
Identify, pursue and develop opportunities for media cross-	Create podcasts using local broadcasting or other media and	Use print and radio/television to disseminate progress and	Ongoing.	Ongoing.	Ongoing.

pollination and coverage.	create webinets on ND-EPSCoR website.	promote story ideas to students			
Define a media/ publication monitoring system to measure coverage by online, newspapers and broadcast media.	Develop web usage statistics. Track articles and reports on CRCS, CSMS, and other EPSCoR accomplish-ments	Continue monitoring web, print, broadcast statistics.	Ongoing.	Ongoing.	Ongoing.
Develop social media toolkit.	Hold workshop (NSF style) on how best to use social media to promote science.	Create web modules on communication skills.	Hold Social Media Workshop.	Ongoing.	Ongoing.
Objective 4.2: Improve awareness of CRCS and CSMS scientific research and integrated education programs to multiple audiences. **(All program participants/ Rusch/Hoffmann/Ostrom-Blonigen)**					
Participate in Science Cafes.	Discuss grand challenges to general public in an open science café format.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Publicize ongoing CRCS and CSMS activities on Center websites.	Develop websites for CRCS and CSMS with more detailed science content than on general INSPIRE-ND website.	Maintain up to date websites for CRCS and CSMS. Organize annual in-house seminar series at NDSU and UND to promote sustainability and showcase the research themes.	Ongoing.	Ongoing.	Ongoing.
Disseminate scientific accomplishment using a variety of media tools.	Disseminate scientific accomplishment using a variety of media tools.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Objective 4.3: Generate public interest in STEM to augment success of EMPOWERED-ND programs. **(All program participants/Rusch/Hoffmann/Ostrom-Blonigen)**					
Promote EMPOWERED-ND activities; develop press releases, engage in media interviews, invited talks and	Use ND-EPSCoR, CRCS and CSMS websites to promote outreach activities. Post videos and	Ongoing. Send mass e-mail mailing of yearly newsletter.	Ongoing.	Ongoing.	Ongoing.

speaking engagements.	webinets on outreach activities.				
Objective 4.4: Inform stakeholders of INSPIRE-ND projects, activities, and achievements (the target stakeholder groups are identified within the activities). **(All program participants/Rusch/Hoffmann/Ostrom-Blonigen)**					
Prepare INSPIRE-ND Annual Report.	Prepare individual progress reports from CRCS, CSMS, outreach and educational activities.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Presentations to stakeholder groups.	Leadership/ faculty visit TC/PUIs; ND-EPSCoR leadership visits with legislators. Hold on-campus open forums about how grand challenges are being addressed.	Continue visits and forums. Visit community and, industry groups with targeted presentations on INSPIRE-ND, highlighting opportunities for participation.	Ongoing.	Ongoing.	Ongoing.
Objective 4.5: Provide opportunities for collaborative discussions and feedback from stakeholders. **(All program participants/Rusch/Hoffmann/Ostrom-Blonigen)**					
Host Annual ND EPSCoR Conference that includes poster and oral presentations by students and faculty, and other sessions e.g., café-like presentations by faculty; break-out session with small working groups	Students and faculty prepare presentations. Review feedback from previous conference; planning committee meets to make arrangements; discuss issues, accomplishment and course of action.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Host External Advisory Board (EAB) Meetings and develop Annual Reports.	Prepare oral and poster sessions by students and faculty; hold Q&A sessions between faculty and EAB.	Ongoing.	Ongoing.	Ongoing.	Ongoing.
Host community, school, and industry group meetings.	Identify groups to visit and topics of interest and develop feedback mechanisms for community meetings.	Include mechanisms to elicit feedback in community meetings.	Ongoing.	Ongoing.	Ongoing.

Partnerships, Collaboration and Communication Output Metrics

Metric *(Where baseline data is available, it is represented as an initial measure of this metric; where it is not, the Year 1 projection is used and denoted with an *)*	**Baseline or Year 1 projection* Data**	**Five-Year Cumulative Targets**
Number of Research ND proposals submitted	1	4
Number of translation research initiatives at $20,000 each	*	6
Number of SBIR/STTR proposals submitted	*	4
Number of climate data partners	1*	5
Number of DoE and USDA Lab partners	1*	10
Number of DoE Lab student internships	*	5
Number of agricultural group partners	1	12
Number of ND industry partners	1*	8
Number of student interns (ND)	1*	13
Number of regional industry partners	*	5
Number of student interns (regional)	*	6
% New content added to website Number of visits to website	100%* 600*	Base +75% 4400
Number of news items posted to the website Number of blog entries	8* 2	47 22
Number of media outlet reports	2	23
Number of in-house seminar series	*	4+
Number of Science Café events	1	8
New content added to CRCS & CSMS websites Number of visits to websites	100* 300*	175 2200
Number of EMPOWERED-ND publicity items (e.g.: video, blogs, print)	3*	36
Annual Report published	1*	5
Number of TC/PUI visits	2*	10
Number of legislator visits	1*	9
Number of campus open forums	1*	9
Number of community/school/industry group visits	*	7
Annual conference held	3	5
Number of external advisory board meetings	1*	5

3.10 Cyberinfrastructure

INSPIRE-ND's Cyberinfrastructure Plan [CI] is embedded across three of the five Focus Areas. Individual benchmarks/activities are incorporated into each of the relevant tables in an effort to ensure integration of CI throughout the project.

Goal: The goal of the CI activities under this EPSCoR project is to support activities of the two research clusters as well as to provide opportunities for outreach and sharing of CI expertise in the area of advanced and High Performance Computing (HPC). The Strategic Planning Meeting (SPM) held on October 20-21, 2014 introduced some changes to our CI Plan. In particular, the use of dedicated Cloud Object Storage system, which was a part of our original CI Plan, was meant to provide a data transfer facility that would provide novice and seasoned end-users of our HPC systems with means to easily and efficiently transfer large amounts of data between UND and NDSU. However, in discussions with our EPSCoR research cluster teams and with other North Dakota EPSCoR team members during the SPM it was determined that the emphasis of the CI activities should be shifted toward providing additional training in general HPC and consequently that funds originally allocated for the acquisition of a dedicated Cloud Object Storage system ought to be repurposed toward that training and toward broader HPC outreach. Similarly, it was determined that in order to save additional funds for these activities the research cluster teams should primarily rely on a local storage and a local Relational Database Management system (RDBMS) minicloud at NDSU rather than on extended use of public repositories development of novel data warehousing platforms (which would have necessitated expensive efforts related to development of data integration and cloud interoperability technologies).

The two institutions already have experience with Globus Online implementation of the GridFTP protocol and with the conventional Secure Copy Protocol (SCP) for data movement. As such, we also determined during the SPM meeting that the nature and the amount of data that is planned to be exchanged between NDSU and UND is expected to lend itself well to these technologies. Combined with planned enhancements to our local storage systems, this reduces the need for deployment of the above mentioned dedicated Cloud Object Storage infrastructure. With regard to the proposed RDBMS minicloud infrastructure at NDSU, it was determined during the SPM that such facility will satisfy the needs of the CRCS research cluster. NDSU has the necessary knowledge and experience to architect, build, and maintain the RDBMS minicloud for this EPSCoR project. The changes described above to the CI Plan will therefore not affect our ability to fulfil the original objectives of this EPSCoR project while enhancing our ability to provide additional HPC training, education, and outreach activities.

Team Leads: Martin Ossowski (Director, Center for Computationally Assisted Science and Technology (CCAST)-NDSU)) and Aaron Bergstrom (HPC Specialist, Computational Research Center (CRC), UND).

Team Participants: the point-of-contacts for cyberinfrastructure are the Team Leads for the three focus areas.

Embedded Cyberinfrastructure Activities:

1. Develop an efficient implementation of the Globus Online GridFTP data transfer tool (*Focus Area 1, Goal 2, Objective 2.2 and Focus Area 2, Goal 2, Objective 2.5*).
2. Architect and build local Relational Database Management system (RDBMS) minicloud at NDSU in support of collaborative activities within the UND CRCS research cluster, possibly housed at NDSU CCAST, possibly housed elsewhere (*Focus Area 1, Goal 2, Objective 2.*3).
3. Procure a limited amount of HPC enhancements needed by both research clusters for modeling, simulation, visual analysis and storage (*Focus Area 1, Goal 2, Objective 2.4 and Focus Area 2, Goal 2, Objective 2.6*).

4. Host HPC outreach activities as needed and outlined within the tables above (*Focus Area 4, Goal 1, Objective 1.4*).
5. Sharing of cyberinfrastructure expertise (*Focus Area 4, Goal 1, Objective 1.5*).
6. General HPC information sessions for NATURE program (*Focus Area 4, Goal 1, Objective 1.5*).
7. Train graduate students on HPC basics (*Focus Area 4, Goal 2, Objective 2.3*).

There will be **two general outcomes** of the CI plan. First, through activities within the two research clusters, it will implement strategic enhancements in: (1) Data processing capabilities, (2) Data storage and movement capabilities, and (3) Database technology and its implementation in a cloud/virtual environment. Second, through its Education and Workforce Development activities it will increase awareness of the role of CI among the state's K-12 students and provide opportunities for outreach and sharing of CI expertise in the area of advanced and high performance computing among the state's college students.

3.11 Synergies for Sustainability

Demonstrated throughout this strategic plan are statewide synergistic prospects that will result when the efforts of ND researchers (students (graduate and undergraduate) and faculty) located at institutions of higher education (see map) throughout the state are combined in ways that seek to develop **E**merging **Pr****O**grams for **W**orkforc**E** Development, Out**R**each, **E**ducation and **D**iversity in **ND** (EMPOWERED-ND) and serve to sustain our research efforts.

1. Cankdeska Cikana Community College (CCCC), Fort Totten
2. Dickinson State College (DSC), Dickinson
3. Fort Berthold Community College (FBCC), New Town
4. Mayville State University (MaSU), Mayville
5. Minot State University, (MiSU), Minot
6. North Dakota State University (NDSU), Fargo
7. Sitting Bull College, SBC, Fort Yates
8. Turtle Mountain Community College (TMCC), Belcourt
9. United Tribes Technical College (UTTC), Bismarck
10. University of North Dakota (UND), Grand Forks
11. Valley City State University, (VCSU), Valley City

Throughout the ND Strategic Plan, the highlighted metrics that are contained in each of the individual Focus Areas represent the sustainability components of the INSPIRE-ND program. As depicted in the map above, the distance between the state's public institutions combined with the difficulties associated with winter travel make collaboration challenging. This program seeks to build on collaborative research programs, like CRCS and CSMS, by using infrastructure investments NSF has already made in the state (e.g.: C-2) to provide an EMPOWERED-ND built on diversity, education, outreach, and workforce development that uses all these synergies for the sustainability of ND's research programs.

3.12 Risk Mitigation Plan

During the Strategic Planning Workshop, project members were asked to consider all potential risks to the program and associated consequences: Each of the five group leads worked with their teams to identify risks and consequences, as well as the ideas for mitigation. This process resulted in the Risk Mitigation Matrix (Table 7).

Table 7. Risk Mitigation Matrix

No.	Potential Risks	Consequences	Impact	Likelihood	Mitigations
1.	Too many tasks to complete in the timeframe allocated	May need to redesign/adjust composition of project; delay in meeting ultimate project goals	High	High	Project team to communicate frequently and early-on if there are concerns related to project success
2.	Inability to find TC & PUI faculty who are able to find research time in their schedules	Inability to fully engage the TCs and PUIs at the levels budgeted; thus unable to achieve our workforce development goals	High	Moderate	Continue to communicate with TCs and PUIs; also request Tribal College Liaison to follow-up with faculty on the TCs and work with the NDUS for PUI participation
3.	Insufficient appropriate faculty resources at the TCs and PUIs to engage in the research clusters	No TC or PUI participation	High	Low	Project faculty could engage TCs and PUIs by other means
4.	Decline or discontinuation of state support during the 2015, 2017 or 2019 legislative sessions	Decline in the ND EPSCoR state cash commitment of $4M	High	Low	Continue to communicate ND EPSCoR program outputs and outcomes to ND legislators
5.	Challenges associated with complete degradation of composites	May need to redesign/adjust composition of polymer matrix system; delay in meeting ultimate project goals	High	Low	Seek to anticipate challenges up front. Study degradation of polymer system alone. If needed, redesign polymer system
6.	Inability to recruit and fill Tribal College Liaison position	No Liaison	High	Low	Work more closely with existing TC site coordinators and administration
7.	Inability to find PhD and MS students for NATURE+	No student participation; lessen the potential for workforce development	Moderate	Moderate	None
8.	Too few farmers participate in focus groups	Limited themes emerge; weaker item pool for quantitative survey	Moderate	Moderate	Work with influential colleagues; conduct individual interviews if necessary to replace or augment focus group data

9.	Low response rate to quantitative survey (< 20%)	Limited data; insufficient data to inform models about farmer-level inputs	Moderate	Moderate	Several waves of data collection identified; if sample is not representative, will use statistical weighting models
10.	Insufficient computing resources	Limited modeling capability; modeling efficiency and resolution	Moderate	Moderate	Lower resolution and/or combine separate modeling for different domains
11.	Unavailability of some data for modeling	Limited data; modeling of the related processes	Moderate	Moderate	Estimate or use some reference data
12.	New collaborative proposals not funded	May limit ability to sustain the program	Moderate	Moderate	Engage consultants during proposal writing process for timely feedback to increase chance of program success. Engage program officers ahead of proposal submission to understand program expectations. Submit proposals in a timely fashion to allow for time to resubmit if initial proposals are not funded
13.	A researcher becomes unable to contribute to project due to illness or departs university	Unable to meet metrics	Moderate	Moderate	Shift some work to another peer investigator. Bring on an additional investigator through a seed grant proposal. Initiate a new faculty search for a replacement, if needed
14.	Unable to attract highly qualified and productive postdocs and graduate students	Negative impact on productivity. Hinders ability to meet metrics	Moderate	Low	Actively recruit postdocs from targeted research groups. Actively recruit graduate students with strong backgrounds in undergraduate research
15.	Inability to hire the expertise in a timely manner (e.g., computer programming)	Delay in model development and computer coding	Moderate	Low	Hire postdoc and collaborate with others
16.	Malfunction and possible loss of some field instruments	Limited data for dataset; model calibration and validation	Moderate	Low	Increase field check and maintenance protocols; select secure sites
17.	Some research model developments are delayed	Delayed integration process	Moderate	Low	Study key research subcomponents from both statistical- and modeling-based approaches from different investigators. Synthetic data will be created to facilitate the integration step
18.	Inability to identify Native American	Support for Native American students at	Moderate	Low	University faculty would need to commit more time to better

	advisors in STEM disciplines	the university will be limited			engage TCs students at each university
19.	Monomer targets cannot be synthesized	Monomer not available for polymer synthesis; delay in project progress	Moderate	Low	Work on a number of synthesis targets in parallel. Explore alternate synthesis strategies, use alternate monomers
20.	Spring river flooding shuts down NDSU or UND	Research work delayed	Moderate	Low	Increase effort after normal operations resume
21.	Insufficient physical infrastructure at partner institutions	Barrier to collaborative work	Moderate	Low	ND EPSCoR will continue to work with the TCs and PUIs in this regard
22.	Small amount of yield data from farmers	Small amount of training data for data mining models; limited ability to test algorithms for weather conditions of future years	Moderate	Low	Use existing data and future public data
23.	Dependence of major crop acreages on climate may not be statistically discernible separately from economic and agronomic variables due to statistical confounds, such as multicolinearity	The results would be less interesting, as the effects of climate change on agricultural production is the motivator for this study; publication of results in top tier journal would be more difficult. Forecasting will still be possible even if the effects are not statistically separable	Moderate	Low	Analyze data at a finer scale and draw inferences based on sub-state variation in climate rather than climate change over time
24.	Dependence of field-level crop rotation selection on climate variables may not be statistically separable from the effects of market and agronomic variables	The results would be less interesting, as the effects of climate change on agricultural production is the motivator for this study; Publication of results in top tier journal would be more difficult. Field-level crop selection can still be forecasted even if the effects of climate change are not statistically separable	Moderate	Low	Make statistical inferences based on spatial variation in climate, controlling for site-specific factors like soil type

25.	Inability to recruit Master's and Ph.D. students from in-state	Inability to fully engage the TCs and PUIs at the levels budgeted	Low	Moderate	Continue to communicate with TCs and PUIs; also request Tribal College Liaison to follow-up with students on the TCs and work with Graduate Schools at NDSU and UND
26.	Inability to recruit REU students from in-state	Inability to fully engage the TCs and PUIs at the levels budgeted	Low	Moderate	Continue to communicate with TCs and PUIs; also request Tribal College Liaison to follow-up with students on the TCs
27.	Inability to find undergraduate (UG) researchers from TCs and PUIs to engage in the research clusters	No TC or PUI participation	Low	Low	Continue to communicate with TCs and PUIs; also request Tribal College Liaison to follow-up with students on the TCs
28.	Inability to find Native American students for research clusters	No student participation in research groups; reduction in relationship between research clusters and NATURE	Low	Low	Continue to communicate with TCs and PUIs; also request Tribal College Liaison to follow-up with students on the TCs
29.	American Crystal Sugar Company (ACSC) stops sharing their data	Input data limited to what is available at that time; data can be used for training but not for testing on new years	Low	Low	Most questions can be addressed based on already available ACSC data and new public data

3.13 Management and Succession Plan

Team Leads: Rusch, Hoffmann, Ostrom-Blonigen

ND EPSCoR Office: offices at both North Dakota State University (NDSU) in Fargo, ND and at the University of North Dakota (UND) in Grand Forks, ND. Kelly Rusch, the NDSU vice president for research and creative activity serves as the ND EPSCoR project director. Barry Milavetz, the UND interim vice president for research and economic development chairs the ND EPSCoR Steering Committee. ND EPSCoR leadership staff are also located at both UND (Mark Hoffmann, associate project director) and NDSU (Jean Ostrom-Blonigen, project administrator).

Management Structure: The ND EPSCoR Director (Rusch), Associate Director (Hoffmann), Project Administrator (Ostrom-Blonigen) and the EPSCoR Office team (Jung, Kellner, Lerud, Slicer, TC liaison (currently vacant), project assistant (currently vacant at NDSU)) will oversee the implementation of INSPIRE-ND. They will work with the Team Leads of the five goals to ensure timely execution of project components and delivery of outcomes. The EPSCoR Office Team will coordinate project management, data gathering for reports, global event planning. The Team Leads of the five goals will ensure the strategic priorities of the grant are met.

Succession Plan: The purpose of the Succession Plan is to ensure that the leadership and management of program are in place for the duration of the project. The succession plan for all four leadership and management levels listed in Table 8 will be reviewed and updated annually.

Table 8. Succession Strategies

Position	Strategies
PI / ND EPSCoR Project Director	Following a formal search, the NDSU president will name a replacement. From the time of vacancy until the formal search is completed, the NDSU president will appoint an interim replacement. The selected finalist will be vetted with the ND EPSCoR State Steering Committee and the head of the NSF EPSCoR Office.
Co-PIs / Associate Project Director and Project Administrator	Co-PI will inform PI that he/she will be leaving as soon as possible and replacements will be suggested and discussed with PI and other Co-PI. Vetting for a replacement Co-PI will be among those who are already involved in the program and who have the skills and time to provide program oversight. Once a replacement has been identified and accepts the position, a formal "change of Co-PI" request will be made to NSF. Once the change is approved by NSF, the replacement will shadow the Co-PI who is leaving for as long as possible prior to the Co-PI's departure date.
Research Center Component Leads	Each research center has designated a co-lead who assume the leadership role during any planned or unplanned absences of the component lead. In the event that the absence is greater than one month, a second interim co-lead will also be named.
Benchmark/ Activity Leads	Succession planning is not an issue as most benchmarks / activities have two individuals named for backup and collaboration between the two campuses; however, in the event that the individuals named are from different campuses, the project research cluster members will assist with collaboration efforts. In the instances where just one benchmark / activity lead is named, the component lead for that portion of the project will name an interim benchmark / activity lead.

3.14 Evaluation and Assessment Process

The project's evaluation and assessment process will measure program impacts and achievements as outlined for each focus group in the preceding tables. The project management team will use the evaluation results and evaluators' recommendations to inform changes to North Dakota's Track-1 project. The evaluation process utilizes the services of:

- An *External Advisory Board (EAB)* composed of national experts who will meet twice annually (once in person) to review: (1) the progress of the research focus areas and the research competitiveness of participants, (2) the effectiveness of EMPOWERED-ND activities, and (3) ND EPSCoR's management performance. EAB input will enable mid-course changes and informed response to emerging opportunities. The annual EAB report will be provided to the NSF PD.
- A North Dakota-seasoned *External Evaluator* who will: assist with completion of institutional review board protocols; prepare quarterly reports; and meet with the management team and advisory committee to discuss progress, outcomes, and recommendations for improvement.

The evaluation and assessment process includes:

- **Initial evaluation.** The evaluator has worked with the management team throughout the strategic planning process and provided feedback as metrics were developed.
- **Constructive evaluation**. The evaluator will provide periodic feedback to the management team throughout the duration of the project.
- **Final evaluation.** The evaluator will conduct a final assessment of the project/program to determine whether achievement metrics were attained and render an opinion on those that were not.

For the evaluation and assessment process, ND EPSCoR will utilize six evaluation and assessment mechanisms: (1) a strategic plan and evaluation plan, (2) staff time dedicated to data collection, coordinating and reporting, (3) a tribal college liaison, (4) an annual meeting of the EAB of independent experts to provide guidance and feedback, (5) an external independent evaluator, and (6) a feedback loop to ensure appropriate and timely management responses.

4 APPENDICES

4.1 Programmatic Terms and Condition Resolution: CRCS –Research Plan
4.2 Programmatic Terms and Condition Resolution: CSMS-Hiring Plan

APPENDIX 4.1: PROGRAMMATIC CONDITION RESOLUTION: CRCS – RESEARCH PLAN

NSF's programmatic condition #8 address specific jurisdiction terms and conditions. The CRCS responds to Question #8.1: Develop a detailed research plan for the CRCS research theme that delineates the relationships between the subprojects. The plan must be submitted to NSF EPSCoR along with the required RII Strategic Plan:

a) How will farmers be involved in the research?

CRCS Response: Year 1 - Farmers will be invited to participate in focus groups designed to assess their essential understanding of and concerns related to regional climate change. They will also be asked open-ended questions about how their farming practices have changed over time, and how they anticipate them changing in the future. These two sets of questions are intentionally broad, so that farmer-generated themes can in turn emerge to support the development of a quantitative survey instrument in Year 2. In addition to broad queries around these two general areas, a final focused set of questions posed to farmers will investigate the ways in which they make connections between climate change and farming decisions. For this phase of this study, the goal is to complete 8 - 12 focus groups, with 4 - 8 members each. These groups will be convened across the state, using the 8 regions of the state as geographies to delineate pools for participants for inclusion in the invitation to each group. Recruitment of participants will continue until themes are saturated, using standard qualitative research methodologies. In the event that we are not able to engage or form enough focus groups, we will conduct qualitative interviews with individual farmers (in person, or via telephone or video conference), again until a sufficiently large representative group is chosen from each region. It is expected that this phase of the study will involve input from at least 36 farmers, representing both farm and ranch operations, small and large operations, and various crop types.

Years 2 - 5 - Farmers will be surveyed, using the quantitative measure developed from Focus Groups in year 1, regarding their attitudes, behaviors, and decision-making strategies related to crop selection and other farming activities. The survey will also measure attitudes, knowledge, and salience of climate information. Associations between these two constructs will be analyzed individually, and will also be fed into the models being developed in RA 4 & RA 5. For these surveys, representative samples of farmers will be sought in each of the following categories:

- Ranchers in oil-bearing country - by North and South
- Ranchers with no oil - by state quadrants (N, S, E, W)
- Grain farmers in oil-bearing country (N & S)
- Grain farmers with no oil (N, S, E, W)
- Root farmers
- Livestock producers other than ranchers

Across each category, farm operation size will be controlled and samples will be weighted consistent with sampling/survey procedures recommended by Mann and Chowhan (2011).

b) What will be the process for installing sensors on farm equipment?

CRCS Response; As a part of a Partnership or Innovation grant we have a collaboration involving NDSU Soil Science and Extension professor David Franzen and a company from which he has long used sensors, Holland Scientific. This collaboration provides us with access to data from Holland Scientific's Crop Circle sensors. The sensor data holds similar information to remote sensing, but its active sensing technology results in somewhat higher quality and higher resolution than the passive sensing from satellites. The collaboration enables us to work with farmers in contexts where the

farmers' payoff comes from Dr. Franzen's research and Extension activities. A positive side-effect of using these existing relationships is that the timescales on which farmers can receive actionable feedback from Extension activities tend to be shorter than those for climate research and more conducive to maintaining such farmer relationships.

c) What role, if any, will farmers play in the research on autonomous adaptation?
CRCS Response: Firstly, data gathered from farmers (as described above) will be entered into the models. In addition, we work together closely with Extension specialists John Nowatzki (Agricultural Engineering) and David Franzen, both of whom lead many workshops for farmers and agronomists as part of their Extension activities. They also interact with farmers as part of their research. David Franzen has offered to facilitate an addition of questions to questionnaires that are annually sent out to farmers through growers associations. These questionnaires reach many farmers and enjoy high response rates. NDSU Extension services have a long history of establishing close relationships and gaining the trust of farmers throughout the state.

d) How will feedbacks between autonomous farmer activities and regional climate be addressed?
CRCS Response: This question will be addressed with respect to land use and land change (LULC). Autonomous farmer activity related land use and land change (LULC) will be studied using an individual based economic land-use model. The identified LULC will be used to further a study on water resources, evaluate possible feedback on the hydrological cycle, as well as conduct an exploratory study to investigate the impacts of LULC on regional cloud climatology.

The impact of the identified LULC on water resources and the regional hydrological cycle will be simulated using the local/regional models to be developed. In particular, we will examine the impact on water quality, such as fertilizer leaking, and water balance, such as evapotranspiration and runoff. The effect of LULC will also be evaluated by examining changes in evapotranspiration, which will be measured using a scintillometry method and modeled.

Feedbacks to regional cloud climatology will be explored through model simulations with the WRF-Chem model to investigate linkages between surface emissions, atmospheric chemistry, and cloud formation. Predicted climate-induced changes in land use and crop selection (from RA-5) will be used to define model input scenarios based on published results. Simulations will examine the impact of land use changes and the sensitivity of model predictions to various CCN parameterizations and cloud modeling approaches. As an exploratory study, by integrating with planned aerosol chemistry research, aerosol modeling research, and an improved hydrological observation network, our goal is to achieve an improved insight into modeling based uncertainties of the effects of LULC on regional cloud climatology.

APPENDIX 4.2: PROGRAMMATIC CONDITION RESOLUTION - CSMS HIRING PLAN

NSF's Jurisdiction Specific Terms and Conditions #8.1: A hiring plan for the CSMS research theme that clearly outlines the plans for hiring four new faculty members in: 1) synthetic organic or inorganic chemistry; 2) computational polymer science; 3) coatings and polymeric science; and 4) polymer and materials LCA, including a detailed timeline. The plan should include risk management in the form of alternatives or mitigation strategies to achieve the research goals in the event that not all of the hires are retained as planned. The hiring plan must be submitted to NSF EPSCoR along with the required RII Strategic Plan:

CSMS Faculty Hiring, Recruiting, and Mentoring Plan

Executive Summary
The Departments of Chemistry and Biochemistry (CHEM) and Coatings and Polymeric Materials (CPM) and the Center for Sustainable Materials Science (CSMS) plan to hire four new faculty members as indicated in the table below.

Department	Rank	Target Start	Research Area
CHEM	Assistant Professor	Fall 2015	Synthetic Materials Chemistry
CPM	Assistant Professor	Fall 2015	Bio-based Polymer Synthesis
CPM	Assistant Professor	Fall 2016	Computational Polymer Science
CPM	Assistant or Associate Professor	Fall 2016	Life Cycle Assessment

For each hire, the search will be initiated in the fall semester prior to the intended start semester. A target list of research groups will be prepared for each search for focused recruiting.

Goals and Metrics
A new faculty member at the assistant professor level will require time and mentoring to reach a level of research productivity required by the CSMS program. Progress toward success will be continually evaluated with the following goals in mind:

- *Anticipated proposal submissions*
  NSF CAREER (SEES Directorate), DoE, USDA, USB
  Joint collaborative proposal with other CSMS participants by year 4
- *Anticipated publications*
  Two publications from NDSU work by year 2
  Collaborative joint publications with other CSMS participants by year 4
- *Presentations*
  Invited presentations at other institutions (seminars, conferences, etc.)
  Contributed presentations at national/international conferences

Salary Requirements
Three positions will be offered at the assistant professor level. One position will be offered at either the assistant or associate professor level. NDSU is committed to providing nationally competitive salaries for these positions.

Startup Requirements
In order to be competitive and recruit the level of talent that the program requires, and to ensure that each new faculty member will be on solid footing for future success, a competitive startup package is required. Undoubtedly, candidates for this position will be highly sought after by top universities across the country. Personnel costs are the majority of startup funds. This includes summer salary for the PI, graduate research assistants and postdoctoral fellows. Travel funds are also needed so the faculty member can attend scientific meetings and visit program officers prior to proposal submission. For the faculty members involved in experimental studies, funds to purchase lab equipment and supplies are also needed. A competitive startup package over three years will be required to successfully recruit and ensure the success of high quality new faculty members in the areas of materials synthesis and bio-based polymer synthesis. The faculty members involved in computational polymer science and life cycle assessment will have similar requirements for personnel and travel funds. In addition, they will need funds to purchase computer equipment and specialized software for their research efforts. Startup funds will come from the departments, the college, and the provost. The EPSCoR program will provide supplemental funds, if available and where appropriate.

Recruiting and Hiring Plan
The Departments and the Center for Sustainable Materials Science (CSMS) will conduct national searches for each new faculty member. The Departments will cover the anticipated costs for conducting the faculty search and hiring. The position will be advertised nationally and internationally in *Chemical and Engineering News*, *Science*, on the NDSU web page, and through targeted emails and letters to chairs and faculty in the targeted research groups and others as well as relevant listservs. The advertising campaigns will commence in the preceding fall semesters and we plan to begin interviewing candidates in the following spring semester. For each position, a search committee will be established consisting of four faculty members and one graduate student. At least one of the search committee members will be female. The committee will initially filter applications, select a top tier list of candidates and the department as a whole will meet to discuss these candidates, or any others that faculty wish to discuss. The committee will continue its efforts until the best candidate is identified. Up to four candidates for initial interviews will be selected.

For on-site interviews, over the course of two days candidates will meet individually with all department faculty members and several outside the department to discuss their science and mutual interests. Candidates will meet with groups of undergraduate and graduate students, the Dean of the College, and any other interested parties. The candidate will present a public seminar on their research accomplishments. And each candidate will meet with the faculty as a whole to discuss the applicant's plans for initiating and sustaining their research program at NDSU. In our experience the critical elements that are important for successful recruiting of new faculty are research facilities, quality of graduate students, balanced teaching loads, supportive and collegial colleagues, salary and competitive startup funding.

The departments of Chemistry-Biochemistry and Coatings and Polymeric Materials have made significant effort to recruit a diverse faculty including females as well members from underrepresented groups. While both departments had been successful in recruiting female faculty in the past, three of these faculty have left. *As both the department and the CSMS core group currently consist of nearly all male faculty, increasing gender diversity will be a high priority in these searches.*

Mentoring Plan
Once hired, the new faculty member will be mentored in the CSMS program and department/college. To integrate them into the program, each new faculty member will receive an orientation to the CSMS research program, its goals, and expected outcomes from the Center Director; be included in the regular team meetings; meet with each of the other team members to identify collaborations; and receive mentoring from senior faculty. In addition, after about six months of residency, each new faculty member will be expected to prepare a plan for their research including goals, milestones, and collaborations with other CSMS team members.

Every new faculty member is a large investment for the university. Therefore it is paramount to support and nurture the new faculty member to be successful. This is accomplished in many ways. Mentoring is critical for any new employee and our new faculty member will be assigned a senior colleague as a mentor. Monthly mentoring sessions throughout the academic year on topics such as grant writing, graduate student and postdoc recruitment, establishing collaborations, etc. are organized and available to new faculty. In addition to formal mentoring, senior faculty colleagues commonly aid each other in reviewing proposals and manuscripts as well as providing advice on issues of science and research. The NDSU-FORWARD program has played a major role in mentoring female faculty on the campus.

The Departments send junior faculty to grant writing workshops, such as "Gear-Up for Grants" and encourage them to take an active part in new faculty training seminars provided by the College. New faculty are not burdened with overly onerous administrative duties and committee involvement is kept minimal as they establish their independent research. All new faculty are provided a semester of release time from teaching in their first year to allow them to get up and running rapidly. Current teaching loads for research active faculty are one lecture course per semester. Senior faculty help make this possible by taking on extra teaching duties. In addition, the Departments provide additional resources for our new faculty to invite outside seminar speakers in their area to aid them in networking within their field. Funds are also provided in the startup package for junior faculty to travel to meet with funding agency officials and collaborators.

Resources Available

Additional resources are available to the new faculty members within the departments and across the NDSU campus. The Department of Chemistry and Biochemistry has outstanding research facilities for materials characterization (NMR, MS, X-ray), computation, Core Synthesis and Core Biology. These facilities are well staffed with Ph.D. level personnel for NMR, X-Ray, Synthesis and Biology. The Department of Coatings and Polymeric Materials has outstanding research facilities for polymer and characterization (GPC, DSC, DMTA, AFM (Atomic Force Microscopy), UV-Vis, FTIR, etc.), and affiliated units such as the CMRL (Combinatorial Materials Research Laboratory) and Electron Microscopy Center have additional equipment useful for polymer materials characterization. The Center for Computationally Assisted Science and Technology (CCAST) has computing infrastructure that can be used by the hires in Computational Polymer Science and Life Cycle Assessment.

Status as of 1/15/15

Department	Rank	Target Start	Research Area
CHEM*	Assistant Professor	Fall 2015	Synthetic Materials Chemistry
CPM**	Assistant Professor	Fall 2015	Bio-based Polymer Synthesis

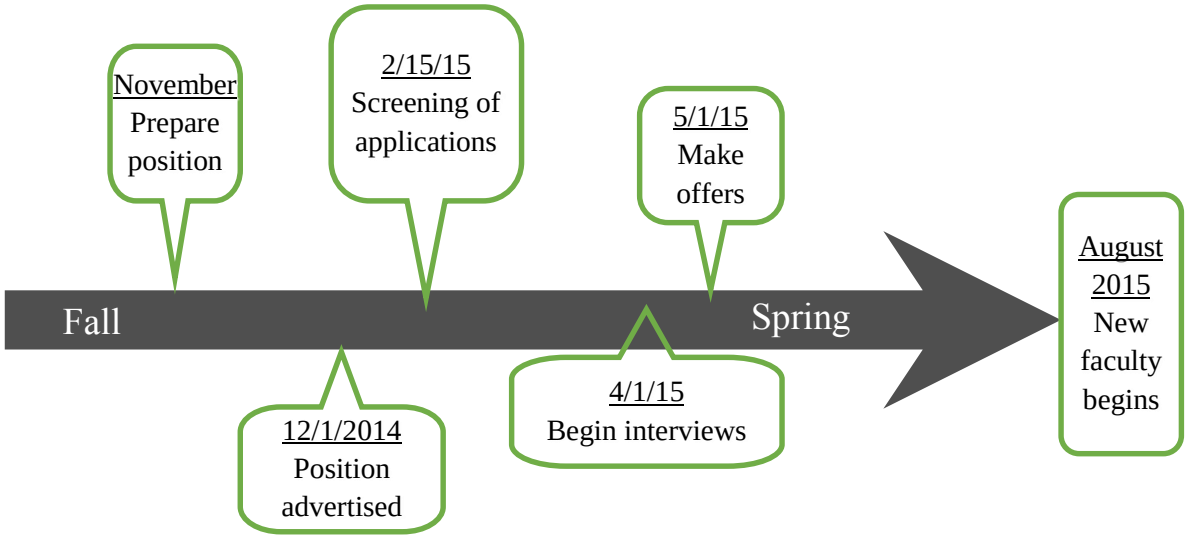
*The organic chemist search is well underway; there are currently 42 applications and we expect to receive another 40+ when with the joint Chemical and Engineering News employment advertisement. The current timeline is that initial screening will start 2/15/15, with interviews in March-April and, hopefully, an offer approximately 5/1/15.

**The search for the CPM assistant professor is also underway and applications are being submitted. We expect to more applications as a result of the joint Chemical and Engineering News employment advertisement. The current timeline is that initial screening will start 2/15/15, with interviews in March-April and, hopefully, an offer approximately 5/1/15.

Risk Management Plan for New Faculty Hires

	Risk	Consequences	Impact	Likelihood	Mitigations
1.	Late start on first two hires.	Best candidates taken by other universities.	High	Moderate	Accelerate the process as much as possible; flip to a mid-year hire if needed.
2.	Inability to hire the right faculty member according to plan	Unable to meet metrics.	Moderate	Low	Identify and address potential weaknesses in recruiting approach. Ensure we have the right targets for recruiting. Redo search the following year.
3.	Inability to hire suitable Synthetic Materials Chemistry faculty member/or faculty leaves prior to end of grant.	Unable to meet metrics	Moderate	Low	Options to ensure metrics are met include: 1. Provide funding for additional graduate students and/or postdocs; 2. Use seed grant mechanism to provide funding for additional faculty to contribute to program.
4.	Inability to hire Bio-based Polymer Synthesis (CPM) faculty member/or faculty leaves before end of grant.	Unable to meet metrics	Moderate	Low	Options to ensure metrics are met include: 1. Provide funding for additional graduate students and/or postdocs; 2. Use seed grant mechanism to provide funding for additional faculty to contribute to program.
5.	Inability to hire Computational Polymer Science faculty member/or faculty leaves before end of grant.	Unable to meet metrics	Moderate	Low	To ensure metrics are met the seed grant funding mechanism could be employed to provide funding for an existing faculty member to contribute to program. In addition, we could seek a suitable collaborator at another university.
6.	Inability to hire Life Cycle Assessment faculty member/or faculty leaves before end of grant.	Unable to meet metrics	Moderate	Moderate	To ensure metrics are met funding can be provided to continue the consulting activities of Professor Amy Landis, Arizona State University.

CSMS New Faculty Hiring Timeline
The timelines below are for the first two hires. Subsequent hires will be offset by one year.



Faculty Development Timeline
The timelines below represent the development protocols for all four hires.