

## ND EPSCoR BROADER IMPACTS WHITE PAPER

*April 2017*

### Background

North Dakota Experimental Program to Stimulate Competitive Research (ND EPSCoR) is currently in year three of its five-year \$20 million National Science Foundation (NSF) Research Infrastructure Improvement (RII) award, titled Innovative and Strategic Program Initiative for Research and Education – North Dakota (INSPIRE-ND).

NSF EPSCoR RII awards require components of intellectual merit and broader impacts. ND EPSCoR's INSPIRE-ND RII project addresses two major research topics relevant in ND and contains three identified areas of broader impact focus (*for more information on ND EPSCoR's current award see: [www.ndepscor.ndus.edu](http://www.ndepscor.ndus.edu)*):

- Intellectual Merit / Research:
  - o ND EPSCoR's Center for Regional Climate Studies (CRCS) – researchers examine the effects of climate change on the food and bio feedstock supplied to the nation and the world by the Northern Great Plains
  - o ND EPSCoR's Center for Sustainable Materials Science (CSMS) – researchers examine new sustainable materials that can contribute to ND's economy, their sources (low cost, renewable), lifetimes (long, high durability) and recyclability (efficient, high value)
- Broader Impacts / Project Elements:
  - o Diversity
  - o Education and Workforce Development
  - o Partnerships, Collaborations and Communication

ND EPSCoR is scheduled to finalize its current NSF EPSCoR award on July 31, 2019 and will be eligible to submit its next NSF EPSCoR RII proposal in August 2018\*.

### Purpose of this White Paper

NSF EPSCoR RII awards have become increasingly competitive:

- In 2016, nine eligible jurisdictions submitted RII proposals; only three were successful.
- In 2017, the remaining six jurisdictions that did not receive a NSF EPSCoR RII award in 2016 will be joined by five more jurisdictions (with awards ending in 2018) for a total of 11 competing jurisdictions\*.
- The 2018 NSF EPSCoR RII eligible cohort (which includes ND) has six additional jurisdictions\*; thus it is anticipated that competition will be especially fierce.

On NSF Day at North Dakota State University (NDSU) on May 18, 2016, ND EPSCoR learned that, for the most part, jurisdictions have been successful in competing on the Intellectual Merit portion of the RII award proposal. However, jurisdictions are not doing justice to the Broader Impacts portion.

Thus, a concerted effort was undertaken by the ND EPSCoR EMPOWERED-ND Corps to determine which research university (RU) efforts by NDSU and the University of North Dakota (UND) would result in significant and individualized broader impact(s) for each of the state's four primarily undergraduate institutions [(PIUs): Dickinson State University, Mayville State University, Minot State University and Valley City State University] and each of the five tribal colleges [(TCs): Cankdeska Cikana Community College, Nueta Hidatsa Sahnish College, Sitting Bull College, Turtle Mountain Community College and United Tribes Technical College] located in ND.

The results of those efforts are outlined in this paper.







**Table 2. Demographics of the four PUIs in North Dakota**

*(As information is updated, revised versions of this table will be posted at*

<https://www.ndepscor.ndus.edu/committee-members/>)

Dickinson State University	Mayville State University	Minot State University	Valley City State University
Location: Dickinson, ND	Location: Mayville, ND	Location: Minot, ND	Location: Valley City, ND
President: Dr. Thomas Mitzel	President: Dr. Gary Hagen	President: Dr. Steven Shirley	President: Dr. Tisa Mason
Total Enrollment: 1317	Total Enrollment: 1110	Total Enrollment: 3354	Total Enrollment: 1422
Student/faculty ratio: 10 to 1	Student/faculty ratio: 15 to 1	Student/faculty ratio: 12 to 1	Student/faculty ratio: 11 to 1
<u>by state of residency:</u> in-state: 60% out-of-state: 40%	<u>by state of residency:</u> in-state: 51% out-of-state: 49%	<u>by state of residency:</u> in-state: 65% out-of-state: 35%	<u>by state of residency:</u> in-state: 69% out-of-state: 31%
<u>by ethnicity:</u> American Indian: 1% Asian: 1% Black or African American: 4% Hispanic/Latino: 5% White: 78% Two or more races: 3% Nonresident Alien: 6%	<u>by ethnicity:</u> American Indian: 1% Asian: 0% Black or African American: 8% Hispanic/Latino: 5% White: 79% Two or more races: 3% Nonresident Alien: 3%	<u>by ethnicity:</u> American Indian: 1% Asian: 2% Black or African American: 5% Hispanic/Latino: 6% White: 68% Two or more races: 4% Nonresident Alien: 11%	<u>by ethnicity:</u> American Indian: 1% Asian: 0% Black or African American: 4% Hispanic/Latino: 5% White: 84% Two or more races: 3% Nonresident Alien: 3%
<u>by gender:</u> female: 60% male: 40%	<u>by gender:</u> female: 57% male: 43%	<u>by gender:</u> female: 61% male: 39%	<u>by gender:</u> female: 60% male: 40%
<u>by age:</u> 24 or under: 77% 25 and over: 23%	<u>by age:</u> 24 or under: 76% 25 and over: 24%	<u>by age:</u> 24 or under: 74% 25 and over: 26%	<u>by age:</u> 24 or under: 77% 25 and over: 23%
<b>NUMBER OF DEGREE PROGRAMS:</b>			
Certificate level 1	Certificate level 0	Certificate level 4	Certificate level 0
Associate level 4	Associate level 2	Associate level 1	Associate level 0
Bachelor's level 45	Bachelor's level 29	Bachelor's level 65	Bachelor's level 37
Graduate level 1	Graduate level 1	Graduate level 11	Graduate level 1

**Table 2. Demographics of the four PUIs in North Dakota (continued)**

Dickinson State University	Mayville State University	Minot State University	Valley City State University
FIVE LARGEST STEM PROGRAMS AND NUMBER OF STUDENTS/PROGRAM			
Biology BS 36	Biology BS 6	Mathematics BS 580	Fish & Wildlife Man. BS 70
Computer Science BS 3	Mathematics BS 4	Biology BS 523	Health Science BS 40
Chemistry BS 6	Computer Science BS 2	Chemistry BS 236	Computer Science BS 3
Mathematics BS 2	Chemistry BS 1	Geology BS 180	Chemistry BS 2
Environmental Sci. BS 10	none NA	Computer Science BS 169	Mathematics BS 2

**Table 3. STEM faculty research interests at the TCs in North Dakota**

*(As information is updated, revised versions of this table will be posted at*

<https://www.ndepscor.ndus.edu/committee-members/>)

Cankdeska Cikana Community College	Carrie Duafala	Wolf ecology
	Michael Parker	Mushroom biology
	Brent Voels	Molecular genetics; mushroom physiology
Nueta Hidatsa Sahnish College	Kerry Hartman	Juneberry ecology, air quality, water quality
Sitting Bull College	Dan Buresh	General ecology, wetland ecology, aquatic ecosystems, environmental health
	Gary Halvorson	Soil chemistry, water quality, soil fertility, land reclamation
	Joshua Mattes	Robotics, physics, and engineering
	Mafany Mongoh	Animal health/epidemiology, microbial ecology, and climate change
	Francis Onduso	Forest ecology, range ecology, riparian ecology, fire ecology, mycology, genomics
	Rena Schmitt	General ecology, grassland ecology, avian ecology, invasive species ecology
Turtle Mountain Community College	Lyle Best	Human genetics
	Stacie Blue	Plant phenology, water quality
	Deborah Hunter	Molecular genetics, water quality
United Tribes Technical College	Alexa Azure	Water quality, clean energy and sustainability
	Levi Binstock	Rangeland systems ecology
	Jeremy Guinn	Wildlife biology
	Mandy Guinn	Bat ecology
	Julie Stock-Porter	Human cell physiology and disease effects

**Table 4. STEM faculty research interests at the PUIs in North Dakota***(As information is updated, revised versions of this table will be posted at**<https://www.ndepscor.ndus.edu/committee-members/>)*

Dickinson State University	Paul Barnhart	Wildlife biology, specifically bats
	Corinne Brevik	Astrophysics, recently has been working on light pollution due to flaring in western ND
	Eric Brevik	Soil science, specifically soil carbon sequestration, soil health/quality
	Lynn Burgess	Biology, specifically toxicology and cancer
	Ken Pierce	Chemistry, specifically theoretical physical chemistry
	Joshua Steffan	Microbiology, specifically cancer and soil microbiology
	Craig Whippo	Botany
Mayville State University	Thomas Gonnella	Enzyme biochemistry
	Khwaja Hossain	Plant-based biocomposites; plant uptake and translocation of micronutrients and drugs
	Joseph Mehus	Invertebrate ecology and parasitology
Minot State University	Mikhail Bobylev	Design and synthesis of environmentally friendly agrochemicals and safe pharmaceuticals based on natural templates
	Joseph Collette	Arthropod evolution
	Robert Crackel	Absorption spectroscopy, water quality studies, and chemical education
	Alexandra Deufel	The function and evolution of the snake feeding apparatus
	Christopher Keller	Mechanisms of growth and development control in plants
	Paul Lepp	Microbial ecology and evolution
	Bryan Schmidt	Allosteric disulfide bonds in proteins
	Shkelzen Shabani	Motivational circuits that control appetitive behaviors for natural rewards and drugs of abuse
	Alexey Shipunov	Plant phylogeny, systematics and bioinformatics
	Heidi Super	Cancer genetics, in particular chromosome abnormalities associated with leukemias
Valley City State University	Jerzy Bilski	Heavy metal remediation in coal fly ash
	Andre DeLorme	Macroinvertebrate bioassessment, aquatic insect species ranges in response to climate change, toxicity testing
	Samuel Keasler	Modeling of aerosol particles in the atmosphere
	Susan Kilgore	Archeo-geology of villages on the north shore of Lake Superior
	Hilde van Gijssel	Fruit fly genetics
	Casey Williams	Distributions of native fish in North Dakota

### STEM needs at the TCs and PUIs in North Dakota and their priority at each institution

Members of the EMPOWERED-ND Corps asked faculty and administrators at TCs and PUIs to describe the STEM needs on their campuses. The committee then compiled a list of all of the STEM needs that were described by the TCs and another list of needs expressed by the PUIs. The TCs and PUIs then prioritized their STEM needs (Tables 5 and 6). The STEM needs expressed by the TCs and PUIs are described in more detail in the broader impacts narrative below.

**Table 5. STEM needs at the TCs and their priority rankings.**

STEM NEEDS	CCCC	NHSC	SBC	TMCC	UTTC
Scholarships for junior and senior STEM undergrads	7	1	4	5	6
Tutoring	3	6	5	3	5
TC STEM students doing K12 outreach activities	4	2	2	4	3
More research opportunities for TC STEM faculty	6	3	3	1	7
Summer bridge camp for graduating high school seniors	2	5		2	4
Transfer specialist at each TC	1	7	6	7	2
K12 STEM outreach coordinator at each TC	5	4	1	6	1

**Table 6. STEM needs at the PUIs and their priority rankings.**

STEM NEEDS	DSU	MaSU	MiSU	VCSU
K12 outreach activities	4	3	4	2
Renovating labs	2	2	2	4
Graduate student teaching interns	1	1	3	3
A sponsored programs office	3	4	1	1

#### 4.3.1 Workforce Development

*Scholarships for junior and senior STEM undergrads.* While tribal colleges offer a few four-year degrees in STEM, most tribal college students desiring a four-year degree in STEM must attend a university elsewhere to get the specific baccalaureate degree they want. Consequently, after completing their first two years of college at the TC in their local community, they must then transfer to another institution to complete the next two years of the four-year STEM degree. But moving away from their community and social support system to a distant university creates a financial burden that prevents many of them from obtaining the baccalaureate degree. Therefore, it would be good to help STEM students overcome this financial barrier by offering scholarships to juniors and seniors pursuing BA and BS degrees at a TC, PUI or RU.

*Graduate student teaching interns at PUIs and TCs.* Graduate students from UND and NDSU could teach for a semester at a PUI or TC, thus giving release time to the Track-1 researcher at the PUI or TC. The release time would enable the PUI researcher to do more research and/or write grant proposals. The graduate student would benefit from the teaching experience and the mentoring from the researcher. The graduate teaching intern would gain valuable experience in course design, grading, laboratory exercise design, and assessment of student learning and thus be able to have an impressive teaching experience to strengthen their vita. The graduate student would be able to experience what it is like to be faculty at a PUI.

#### 4.3.2 Seed Funding and Emerging Areas

The program will offer more seed grants that require collaboration in order to stimulate more collaboration. Seed grants requiring collaboration between CSMS and CRCS and seed grants requiring collaboration between a RU and either PUI or TC have been offered and funded. Perhaps the next step is to offer a seed grant requiring collaboration between a PUI and a TC.



#### 4.4 Diversity Plan

*Current Diversity Efforts: Native American Tribal Undergraduate Research and Education (NATURE).* While the purpose of this white paper is to explore future directions, it is necessary to describe the current NATURE program. The NATURE program offers three different types of STEM camps:

- A two-week university summer camp at UND and NDSU for high school and college students – this year the camp was held from June 6<sup>th</sup> through June 17<sup>th</sup>
- A two-week summer camp for junior high and high school students at each of the five tribal colleges in North Dakota
- A “Sunday Academy” for high school students one Sunday each month at each of the five tribal colleges in North Dakota during the academic year

*Current Diversity Efforts: NATURE+.* Faculty from TCs are working with faculty and administrators at NDSU and UND to create opportunities for TC graduates to get STEM bachelor’s degrees and advanced STEM degrees at a PUI or RU. The students will receive research assistantships while pursuing their BS, MS, or Ph. D. degrees. As graduate students, they will teach courses for TCs, and after obtaining an MS or Ph. D., they will be employable at TCs. Additionally NDSU/UND, ND PUI and TC faculty are working to develop a bridge program that will expand the NATURE programming to provide advanced summer research opportunities for older students.

*Current Diversity Efforts: Native American Success in Science and Engineering (NASSE).* This initiative gives academic and cultural support to American Indian students attending UND/NDSU in the NATURE+ program. This helps them adjust to, and thrive in, the university culture. An American Indian advisor at UND and a NDSU mentor coordinate cohort activities for American Indian students (e.g. social outings, cultural celebrations, study groups) to increase their sense of belonging and camaraderie.

*Current Diversity Efforts: Women in Science and Education (WISE).* This program is designed to increase the participation and success of female STEM faculty by providing (1) research challenge grants to female faculty post third year review to bolster research productivity, (2) supplemental funding awarded competitively for upgraded labs and equipment, (3) GRA and post-doctoral researchers, and (4) a cohort mentoring program. Faculty and administrators at NDSU and UND combined their efforts to design, launch and administer the different aspects of WISE.

*Summer “bridge” camps at TCs.* Many high school students who plan to attend a TC and major in STEM could benefit from a “bridge” camp experience during the summer between high school and college. The bridge camp would be a good opportunity for the students to brush up on STEM skills. In the process of working on STEM skills, the students could be assessed to see whether they are at college level in all of the STEM areas. If they have the opportunity to do a STEM bridge camp during the summer, they may be more likely to attend college in the fall.

*Outreach coordinator at each TC.* Students in K12 grades are more likely to have positive attitudes about STEM and are more likely to choose STEM majors in college if they have been engaged in STEM activities. The STEM activities can increase the K12 students’ success in STEM classes. Moreover, role models and mentors can increase the proportion of K12 students choosing STEM careers. The K12 teachers often don’t have either the training, time or supplies to create good STEM learning activities, so it is likely that they would welcome the help. To enhance outreach activities with American Indian K12 students, it may be best to have a full-time outreach coordinator at each TC to conduct outreach activities at K12 schools. The outreach coordinator would do STEM activities with the K12 students, recruit students for the NATURE program and even take part in the Sunday Academy and NATURE summer camp activities. The outreach coordinator can get TC STEM students involved in the K12 STEM activities so the TC students can serve as role models or mentors and learn leadership skills.

#### **4.5 Partnerships and Collaborations**

The program can build on existing collaborations between TC researchers and researchers at either a RU or PUI by providing TC researchers with travel funds to enable them to visit collaborators in order to learn specific research techniques or to use equipment or facilities that they do not have at their own institution. These visits to the collaborating institutions would further foster and strengthen the research collaborations and facilitate the development of meaningful mentoring relationships between the TC, PUI and RU researchers.

#### **4.6 Communication and Dissemination plan**

ND EPSCoR will work to communicate and disseminate this plan by posting it on the ND EPSCoR website and sending it to the research offices at all the institutions participating in ND EPSCoR.

#### **4.7 Sustainability Plan**

Pivot software could provide a way to make our collaboration efforts sustainable. If all of the researchers from every institution could have access to Pivot and enter research interests into Pivot, future collaborations would be easier to initiate.

##### **4.7.1 Education and Human Resources Development**

*Making tutors available at the TCs.* Currently there is a need for more STEM tutors at the TCs, and past tutoring programs show that TC students definitely benefit from tutoring, because tutoring improves course completion, retention and success rates. The instructors work with students on an individual basis between classes, but their time is limited and they are not able to provide all of the tutoring help that is needed. At UND and NDSU, teaching assistants, in many instances, serve as tutors, but the TCs do not have teaching assistants. For tutors, TCs typically hire TC students or members of the community. In the STEM area, TC students typically need tutoring in math, chemistry, physics and engineering courses.

*Sending TC students to K12 schools to do STEM activities.* In an effort to enhance the local K12 students' exposure to STEM, TC STEM students could go to the K12 schools and do STEM activities with them. Ideally an outreach coordinator could coordinate these activities with the TC STEM instructors and students. The STEM and/or education instructors at the TCs and the K12 teachers should review the activities before the TC students do them in the schools. The TC students doing the activities with K12 students could attend Sunday Academies and help with the Sunday Academy activities and then translate them to K12 activities later in the week. It may be possible for education students to partner with STEM students in doing these activities. It may be possible to use past NATURE Sunday Academy and summer camp activities in this program.

*Transfer specialist at each TC.* Most STEM students at the TCs who want a 4-year STEM degree will transfer to one of the universities, and transferring from a TC to a large university is a big transition for a TC student. A transfer specialist can talk with TC students about the challenges they will face and help them design strategies to deal with the challenges. The transfer specialist can take TC students to the university they are considering and introduce them to people who will be part of their academic, financial and social support system. The transfer specialist can help the students find out which courses they should take at the TC that are required for the 4-year degree they want. The transfer specialist can also keep up with changes in requirements at the universities, help resolve course transfer issues and help the student services department keep the articulation agreements current.

*Sending PUI students to K12 schools to do STEM activities.* These activities will enrich the K12 students' STEM education because it has been shown that active learning opportunities help students retain concepts. Another benefit is that the PUI students will provide the K12 students with additional positive STEM role models. The experience will help the PUI students strengthen their mentoring, teaching and science communication skills. When setting up this program in the local K12 schools, the PUI STEM faculty could leverage the already existing partnerships that have been established by that PUI's education department. The STEM activities developed by the current ND EPSCoR outreach activities may be able to be adapted for this program.

*Laboratory Renovation.* Because the main focus of the PUIs is teaching, their facilities were designed and constructed with teaching, not research, in mind. Thus, it may be difficult for PUI researchers to find a space in their STEM building where they are able to do research. Indeed, one PUI researcher has demonstrated that his room, which was originally designed for teaching, will have to undergo major renovation before it can effectively be used for research. For that reason, necessary renovation will significantly increase that PUI's ability to do research.

*Developing a Sponsored Programs Office at a PUI.* Not all PUIs have a sponsored programs office. Sponsored programs office personnel promote and support research on their campus in various ways: They search for funding opportunities and sources, help grant applicants prepare and submit grants, gather institutional data for grant applications, conduct grants-related professional development for those who write or manage grants, and general institutional culture. So a sponsored programs office greatly enhances an institution's ability to conduct research in many ways.