ND EPSCoR
Established Program to Stimulate Competitive Research

ND EPSCoR White Paper:

A Partnership to Build STEM Research and Education Capacity

Prepared by the members of the

EMPOWERED-ND Corps Committee

October, 2018

In cooperation with

Cankdeska Cikana Community College

Dickinson State University

Mayville State University

Minot State University

North Dakota State University

Nueta Hidatsa Sahnish College

Sitting Bull College

Turtle Mountain Community College

United Tribes Technical College

University of North Dakota

Valley City State University

(Original document December 2016, updated April and December 2017)

Background

North Dakota Established Program to Stimulate Competitive Research (ND EPSCoR) is currently in year five 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*):

- Intellectual Merit / Research:
    - 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
    - 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 that affect the STEM research and education ecosystem within the state:
    - Diversity
    - Education and Workforce Development
    - Partnerships, Collaborations and Communication

ND EPSCoR is scheduled to complete its current NSF EPSCoR award on July 31, 2019. The ND EPSCoR State Office submitted a new NSF EPSCoR RII proposal in July 2018 to further enhance research capacity and competitiveness throughout the state, which, if accepted will provide a new $20 million award.

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 what NSF describes as the "Broader Impacts" portion. NSF includes efforts to expand diversity, enhance educational and workforce development outreach, and increase partnerships, collaborations and communication within these impacts.

Thus, a concerted effort was undertaken by the ND EPSCoR **EM**erging **P**r**O**grams for **W**orkforc**E** Development, Out**R**each, **E**ducation and **D**iversity-North Dakota (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) with each of the state's three primarily undergraduate institutions [(PUIs): Dickinson State University, Mayville State University and Valley City State University]; a master's college/university (MCU): Minot 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 white paper.

Thank you to the members of the ND EPSCoR EMPOWERED-ND Corps and representatives from each of the institutions they each represent who assisted with this paper:

- Voting members:
  - Scott Hanson, **Chair**, ND EPSCoR Tribal Colleges Liaison Manager and NATURE Program Coordinator
  - Eric Brevik, Professor of Geology and Soils and Chair, Department of Natural Sciences, Dickinson State University. ND EPSCoR roles: campus PI / RII CRCS researcher
  - Mikhail Bobylev, Professor, Science – Chemistry, Minot State University. ND EPSCoR roles: campus PI / RII CSMS researcher
  - Andre DeLorme, Professor and Chair, Department of Science, Valley City State University. ND EPSCoR roles: State Steering Committee member / campus PI / RII CRCS researcher / RII emerging areas recipient
  - Jeremy Guinn, *Tribal* Environmental Science Chair / Instructor, United Tribes Technical College. ND EPSCoR role: campus PI
  - Brent Voels, science faculty, Cankdeska Cikana Community College. ND EPSCoR role: campus PI
  - Kerry Hartman, Academic Dean and Chair, Sciences, Nueta Hidatsa Sahnish College. ND EPSCoR roles: campus PI / RII CRCS researcher / RII emerging areas recipient / Nurturing American Tribal Undergraduate Research and Education (NATURE) Coordinator
  - Khwaja Hossain, Professor, Science and Mathematics, Mayville State University. ND EPSCoR roles: campus PI / RII CSMS researcher
  - Mafany Mongoh, Agriculture/Science Instructor, Sitting Bull College. ND EPSCoR roles: campus PI / RII CSMS researcher / RII emerging areas recipient / NATURE Coordinator
  - Austin Allard, Turtle Mountain Community College. ND EPSCoR roles: campus PI / NATURE Coordinator / American Indian STEM Mentor
- Ex-officio members:
  - Aaron Kennedy, Co-Lead, ND EPSCoR's NSF RII CRCS and Partnerships, Collaboration and Communication Project Element (also: Associate Professor, Chemical Engineering, UND)
  - John Mihelich, Associate Project Director, ND EPSCoR - UND office (also: Associate VP for Research & Economic Development & Compliance)
  - TBD, Co-Lead, ND EPSCoR's NSF RII Education and Workforce Development Project Element
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  - Jean Ostrom-Blonigen, Project Administrator, ND EPSCoR - NDSU office
  - Joyce Eisenbraun, ND EPSCoR Communication Manager
  - Tyson Jeannotte, ND EPSCoR American Indian Student Mentor for UND
  - Lisa Johnson, Interim Vice Chancellor for Academic and Student Affairs, ND University System
  - Mukund Sibi, Co-Lead, ND EPSCoR's NSF RII CSMS and Partnerships, Collaboration and Communication Project Element (also: Distinguished Professor, Chemistry and Biochemistry, NDSU)
  - Chad Ulven, Co-Lead, ND EPSCoR's NSF RII Diversity Development Project Element (also: Associate Professor, Mechanical Engineering, NDSU)

_____	_____	_____
Kelly Rusch, RII PI *ND EPSCoR Project Director*	*John Mihelich, RII Co-PI* *ND EPSCoR Associate Project Director*	*Jean Ostrom-Blonigen, RII Co-PI* *ND EPSCoR Project Administrator*

The TCs in North Dakota

The five tribal colleges in North Dakota (Table 1) were established between 1969 and 1973. With the exception of UTTC, each of them is located on a reservation. UTTC, located in Bismarck, was chartered by all of the tribes in North Dakota. The tribal colleges were created to provide culturally responsive programs designed to meet the needs of tribal students and to be catalysts of cultural and socioeconomic revitalization for their communities. Research was not part of the original vision of the tribal colleges, but they began to engage in research as opportunities arose. The amount of research activity has risen steadily since the 1990s, when federal agencies and private foundations began funding STEM capacity-building and STEM research at the TCs. The research conducted at TCs has always involved students and has always focused on projects that would be of benefit to the TCs' constituent communities. The current TC research activities are described in table 3.

Table 1. Demographics of the five TCs in North Dakota

(As information is updated, revised versions of this table will be posted at: https://www.ndepscor.ndus.edu/resources/documents/)

Cankdeska Cikana Community College	Nueta Hidatsa Sahnish College	Sitting Bull College	Turtle Mountain Community College	United Tribes Technical College
Location: Ft. Totten, ND	Location: New Town, ND	Location: Ft. Yates, ND McLaughlin, SD Mobridge, SD	Location: Belcourt, ND	Location: Bismarck, ND
President: Dr. Cynthia Lindquist	President: Dr. Twyla Baker-Demaray	President: Dr. Laurel Vermillion	President: Dr. James Davis	President: Dr. Leander McDonald
Total Enrollment: 188	Total Enrollment: 198	Total Enrollment: 317	Total Enrollment: 567	Total Enrollment: 315
Student/faculty ratio: 5 to 1	Student/faculty ratio: 8 to 1	Student/faculty ratio: 8 to 1	Student/faculty ratio: 10 to 1	Student/faculty ratio: 8 to 1
by state of residency: in-state: 100% out-of-state: 0%	by state of residency: in-state: 99.5% out-of-state: 0.05%	by state of residency: in-state: 57% out-of-state: 43%	by state of residency: in-state: 99% out-of-state: 1%	by state of residency: in-state: 60% out-of-state: 40%
by ethnicity: American Indian: 91% Asian: 0% Black or African American: 1% Hispanic/Latino: 1% White: 7% Two or more races: 0%	by ethnicity: American Indian: 84% Asian: 0% Black or African American: 2.5% Hispanic/Latino: 2% White: 9.6% Two or more races: 4%	by ethnicity: American Indian: 93% Asian: 0% Black or African American: 0% Hispanic/Latino: 0% White: 7% Two or more races: 0%	by ethnicity: American Indian: 96% Asian: 0% Black or African American: 1% Hispanic/Latino: 0% White: 3% Two or more races: 0%	by ethnicity: American Indian: 81% Asian: 0% Black or African American: 2% Hispanic/Latino: 3% White: 6% Two or more races: 8%

Table 1. Demographics of the five TCs in North Dakota (continued)

by gender: female: 61% male: 39%	by gender: female: 67% male: 33%	by gender: female: 64% male: 36%	by gender: female: 60% male: 40%	by gender: female: 65% male: 35%
by age: 24 or under: 53% 25 and over: 47%	by age: 24 or under: 58% 25 and over: 42%	by age: 24 or under: 42% 25 and over: 57%	by age: 24 or under: 60% 25 and over: 40%	by age: 24 or under: 51% 25 and over: 49%
NUMBER OF DEGREE PROGRAMS:				
Certificate level 3	Certificate level 8	Certificate level 10	Certificate level 13	Certificate level 5
Associate level 17	Associate level 12	Associate level 18	Associate level 11	Associate level 15
Bachelor's level none	Bachelor's level 3	Bachelor's level 7	Bachelor's level 3	Bachelor's level 3
Graduate level none	Graduate level none	Graduate level 2	Graduate level none	Graduate level none
FIVE LARGEST STEM PROGRAMS AND NUMBER OF STUDENTS/PROGRAM				
Nat. Res. Man. AS 2	Pre-Engineer AS 12	Pre-Engineer AS 6	Gen. Science AS 32	Environ. Sci. AS 13
Pre-Engineer AS 5	Environ. Studies AS 7	Environ. Studies AS 3	Pre-Engineer AS 6	Environ.Sci. BS 6
Computer Sci. AS 1	Science AS 5	Environ. Studies MS 2	Pre-Environ. Sci. AS 1	Pre-Engineer AS 9
Environ. Sci. AS program furloughed	Environ. Sci. BS 5	Info. Tech. AS 1	Biology AS 0	none NA
none NA	Mathematics AS 1	Sec. Sci. Ed. BS 0	Chemistry AS 0	none NA
ND EPSCoR Involvement: ND EPSCoR PI: Brent Voels NATURE Coor.: Chris Dahlen CSMS Researchers: Brent Voels Mike Parker	ND EPSCoR Involvement: ND EPSCoR PI: Kerry Hartman NATURE Coor.: Kerry Hartman CRCS Researcher: Kerry Hartman	ND EPSCoR Involvement: ND EPSCoR PI: Mafany Mongoh NATURE Coor.: Mafany Mongoh CSMS Researcher: Mafany Mongoh	ND EPSCoR Involvement: ND EPSCoR PI: Austin Allard NATURE Coor.: Austin Allard CRCS Researcher: Stacie Blue	ND EPSCoR Involvement: ND EPSCoR PI: Jeremy Guinn NATURE Coor.: Mandy Guinn CRCS Researcher: Mandy Guinn

The PUIs and MCU in North Dakota

The state of North Dakota established the three PUIs and one MCU (Table 2) between 1889 and 1918. Originally called "normal schools" they were created to produce K12 teachers for schools in ND. To this day, they still have robust education departments that attract large numbers of students, but they have added departments and degree programs in STEM and many other areas. In addition, they produce education majors in STEM fields, thereby helping fulfill STEM training needs in the local communities. While some STEM faculty at the PUIs and MCU started conducting scientific research in the 1980s, research really increased in the 1990s, when faculty and administrators began to see the value of research to undergraduate education. Currently, although their primary focus is still teaching, the PUIs and MCU now enjoy a significant level of STEM research as well. The current research activities at the PUIs and MCU are described in Table 4.

Table 2. Demographics of the three PUIs and one MCU in North Dakota

(As information is updated, revised versions of this table will be posted at: https://www.ndepscor.ndus.edu/resources/documents/)

Dickinson State University (PUI)	Mayville State University (PUI)	Minot State University (MCU)	Valley City State University (PUI)
Location: Dickinson, ND	Location: Mayville, ND	Location: Minot, ND	Location: Valley City, ND
President: Dr. Thomas Mitzel	President: Dr. Brian Van Horn	President: Dr. Steven Shirley	President: Dr. Alan LaFave
Total Enrollment: 1425	Total Enrollment: 1140	Total Enrollment: 3216	Total Enrollment: 1522
Student/faculty ratio: 10 to 1	Student/faculty ratio: 14 to 1	Student/faculty ratio: 12 to 1	Student/faculty ratio: 13 to 1
by state of residency: in-state: 62% out-of-state: 38%	by state of residency: in-state: 54% out-of-state: 46%	by state of residency: in-state: 67% out-of-state: 33%	by state of residency: in-state: 75% out-of-state: 25%
by ethnicity: American Indian: 1% Asian: 1% Black or African American: 4% Hispanic/Latino: 5% White: 77% Two or more races: 3% Nonresident Alien: 6%	by ethnicity: American Indian: 1% Asian: 1% Black or African American: 5% Hispanic/Latino: 6% White: 79% Two or more races: 3% Nonresident Alien: 3%	by ethnicity: American Indian: 2% Asian: 2% Black or African American: 6% Hispanic/Latino: 7% White: 70% Two or more races: 4% Nonresident Alien: 8%	by ethnicity: American Indian: 1% Asian: 1% Black or African American: 3% Hispanic/Latino: 5% White: 83% Two or more races: 4% Nonresident Alien: 2%
by gender: female: 62% male: 38%	by gender: female: 61% male: 39%	by gender: female: 60% male: 25%	by gender: female: 57% male: 43%
by age: 24 or under: 77% 25 and over: 23%	by age: 24 or under: 72% 25 and over: 28%	by age: 24 or under: 75% 25 and over: 25%	by age: 24 or under: 75% 25 and over: 25%
NUMBER OF DEGREE PROGRAMS:			
Certificate level 2	Certificate level 0	Certificate level 4	Certificate level 1
Associate level 4	Associate level 2	Associate level 1	Associate level 0
Bachelor's level 47	Bachelor's level 31	Bachelor's level 66	Bachelor's level 38
Graduate level	Graduate level	Graduate level	Graduate level

1	1	12	1
FIVE LARGEST STEM PROGRAMS AND NUMBER OF STUDENTS/PROGRAM			
Biology BS 45	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/resources/documents/)

Cankdeska Cikana Community College	Douglas Cudworth	NA
	Chris Dahlen	NA
	Lori Gourneau	NA
	Karl Haefner	NA
	Michael Parker*	Mushroom biology
	Brent Voels*	Molecular genetics; mushroom physiology
Nueta Hidatsa Sahnish College	Tom Abe	NA
	Lori Alfson	NA
	Tanya Driver	Environmental science
	Amber Finley	Environmental science
	Kerry Hartman*	Juneberry ecology, air quality, water quality
	Israt Jahan	NA
Sitting Bull College	Dan Buresh	General ecology, wetland ecology, aquatic ecosystems, environmental health
	Gary Halvorson	Soil chemistry, water quality, soil fertility, land reclamation
	Gina Holman	NA
	Timothy Krahler	NA
	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
	Renae Schmitt	General ecology, grassland ecology, avian ecology, invasive species ecology
Turtle Mountain Community College	Renee Aalund	NA
	Austin Allard	Nondestructive testing and smart structures
	Lyle Best	Human genetics
	Stacie Blue*	Plant phenology, water quality
	Jody Delong	NA
	Deborah Hunter	Molecular genetics, water quality

	Crystal Star	NA
United Tribes Technical College	Alexa Azure	Water quality, clean energy and sustainability
	Levi Binstock	Rangeland systems ecology
	William Fleck	NA
	Jeremy Guinn	Wildlife biology
	Mandy Guinn*	Bat ecology
	Dennis Lowman	NA
	Paul Pansegrau	NA
	Derek Schulte	NA
	Julie Stock-Porter	Human cell physiology and disease effects

*ND EPSCoR track-1 researcher

Table 4. STEM faculty research interests at the PUIs and MCU in North Dakota

(As information is updated, revised versions of this table will be posted at: https://www.ndepscor.ndus.edu/resources/documents/)

Dickinson State University	Paul Barnhart*	Wildlife biology, specifically bats
	Myron Berg	NA
	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
	Cynthia Burgess	NA
	Jundong Chen	NA
	Shawna Egli	NA
	Hilde Fike	NA
	William Harris	NA
	Paul Johanson	NA
	Naomi Johnson	NA
	Katsu Ogawa	1) phosphole/Pt-acetylide based 2-dimensional conjugated polymers and 2) fluorometric chemosensor for biologically active small molecules and ions.
	Reba Olsen	NA
	Ken Pierce	Chemistry, specifically theoretical physical chemistry
	Joshua Steffan*	Microbiology, specifically cancer & soil microbiology
	Monica Watson	NA
	Craig Whippo	Botany
Mayville State University	Thomas Gonnella	Enzyme biochemistry
	Khwaja Hossain*	Plant-based biocomposites; plant uptake and translocation of micronutrients and drugs
	Jeff Hovde	NA
	Dean Johnson	NA
	Joseph Mehus	Invertebrate ecology and parasitology
	Robert Miess	NA
	Patrick Steele	NA
	Fred Strand	NA
	Mary Townsend	NA

Minot State University	Lucy Bobylev	Design and synthesis of environmentally friendly agrochemicals and safe pharmaceuticals based on natural templates
	Mikhail Bobylev*	Design and synthesis of environmentally friendly agrochemicals and safe pharmaceuticals based on natural templates
	Larry Chu	NA
	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
	Rahul Gomes	NA
	Christopher Heth	NA
	Nathan Hopkins	physical processes and dynamics of sediment transport systems
	Scott Kast	NA
	Christopher Keller	Mechanisms of growth and development control in plants
	Kathryn Kilroy	NA
	Paul Lepp	Microbial ecology and evolution
	Draza Markovic	evolution of Rossby-Alfven waves in rapidly rotating, magnetized neutron stars
	Timothy Morris	NA
	Luther Olson	NA
	Sayeed Sajal	NA
	Bryan Schmidt	NA
	Bishnu Sedai	NA
	Darren Seifert	NA
	Jennifer Sherman	NA
	John Webster	Igneous petrology and geochemistry
	Naomi Winburn	NA
	Kevin Vang	NA
	Bob Anderson	NA
Valley City State University	Wesley Anderson	NA
	Corey Askin	NA
	Jerzy Bilski	Heavy metal remediation in coal fly ash
	Preston Bush	NA
	Andre DeLorme*	Macroinvertebrate bioassessment, aquatic insect species ranges in response to climate change, toxicity testing
	David DeMuth	NA
	Lauren Dennhardt*	Assessing the effectiveness of assisted migration in prairie restoration projects.
	Nicholas Galt	Stress physiology and regulation of gene expression; educational computer models and simulations
	Jane Hammer	NA
	Curtis Hill	NA
	Carolyn Holen	NA

	Samuel Keasler	Modeling of aerosol particles in the atmosphere
	Gary Ketterling	NA
	Susan Kilgore	Archeo-geology of villages on the north shore of Lake Superior
	Gilbert Kuipers	NA
	Kevin Murphy	NA
	Jamie Paurus	NA
	Susan Pfeifer	Virtual reality
	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
	Teather Sundstrom	NA
	Hilde van Gijssel	Fruit fly genetics
	Louis Matthew Wieland	NA
	Casey Williams	NA
	Jamie Wirth	NA
	Wesley Anderson	NA

*ND EPSCoR track-1 researcher

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, PUIs and MCU 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 and MCU. The TCs, PUIs and MCU then prioritized their STEM needs (Tables 5 and 6). The STEM needs expressed by the TCs, PUIs and MCU are described in more detail in the broader impacts narrative below. They are arranged according to the latest NSF EPSCoR track-1 RFP.

Table 5. STEM needs at the TCs and their priority rankings (1=highest priority).

STEM NEEDS	CCCC	NHSC	SBC	TMCC	UTTC
Scholarships for junior and senior STEM undergrads	7	1	4	5	6
Tutoring	3	6	7	1	5
TC STEM students doing K12 outreach activities	4	2	9	4	3
More research opportunities for TC STEM faculty	6	3	3	3	2
Summer bridge camp for graduating high school seniors	2	5	8	2	4
Transfer specialist at each TC	1	7	11	7	7
K12 STEM outreach coordinator at each TC	5	4	10	6	1
Release time for TC Faculty to conduct research			1		
Scholarships for graduate STEM students			5		
Research facilities and infrastructure development			2		
Grant writing and networking facilitation			6		

Table 6. STEM needs at the PUIs and MCU and their priority rankings (1=highest priority).

STEM NEEDS	DSU	Mayville	Minot	VCSU
K12 outreach activities	3	3	4	2

Renovating labs	2	2	2	4
Graduate student teaching interns	1	1	3	3
A sponsored programs office	4	4	1	1

OUTCOMES OF THIS WHITE PAPER:
Since its inception, this document has:

- **Provided ideas for new grant applications, including the NSF RII Track-1 proposal that was submitted in July 2018.**
- **Enabled ND EPSCoR to:**
  - **Design more individualized subawards to the TCs**
  - **Function as IACUC and IRB for Mayville**
  - **Establish research collaborations between institutions**
- **Inspired ND EPSCoR to:**
  - **Become more involved with STEM, and send out a K12 STEM survey**
  - **Begin writing a Cyberinfrastructure white paper**
  - **Start developing a K12 STEM white paper**