Increasing the Reach of Nanotechnology and Sustainability Content in Multiple Educational Environments

SNO Los Angeles 2017

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Nano-Link: Center for Nanotechnology Education

Sustainability aspects in:

- Courses
- Modules
- Native American outreach
- Undergraduate research

Nano-Link: Center for Nanotechnology Education (formed in 2006)

Funded by:
National Science Foundation
Advanced Technology Education Directorate

Home Institution:
Dakota County Technical College/Inver Hills Community College
Minnesota US

Nano-Link is an Alliance of 18 Educational Institutions
High Schools (3), Colleges (12) and Universities (3) through out the US
Offering Certificates, 2 year degrees and 2+2 programs leading to a BS degree
Multi-disciplinary Nanotechnology (Electronics, Biotech, Materials,)

D. Newberry: Director/PI

Nano-Link is an alliance of educational institutions (high school through graduate school)

That provides nanoscience educational content, guidance and direction to anyone who wants, needs or desires that information

www.nano-link.org

Nano-Link provides nanotechnology content in 3 forms:

- Entire, 16 week courses (25 available)
- College level labs (45+ available)
- Modularized topic specific, 1 hour, activity based content
    - Used by over 850 educators in 6 countries, (48 US states) reaching over 75,000 students
    - Culturally relevant content (Native American outreach, ND, MT, WA)

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Dakota County Technical College
Nanoscience Technology Program Course Outline and Credit Allocation
rev. 2011

Semester 1 at DCTC			Semester 2 at DCTC			Semester 3 at DCTC			Semester 4 At Univ. of MN		
Course	Name	Credits	Course	Name	Credits	Course	Name	Credits	Course	Name	Credits
BIOL 1500	General Biology	4	CHEM 1500	Introduction to Chemistry	4	NANO 2101	Nano Electronics	3	MT 3111	Elem. of Micro Manufacturing	3
PHYS 1100	College Physics I	4	PHYS 1200	College Physics II	4	NANO 2111	Nanobiotechnology/ Agriculture	3	MT 3112	Elem. of Micro Mfg Lab	1
ENGL 1100	Writing & Research Skills	3	SPEE 1020	Interpersonal Communication	3	NANO 2121	Nanomaterials	3	MT 3121	Thin Films Deposition	3
MATS 1300	College Algebra	4	MATS 1250	Principles of Statistical Analysis	4	NANO 2131	Manufacturing, Quality Assurance	2	MT 3131	Intro to Materials Characterization	3
NANO 1100	Fund. of Nano I	3	NANO 1200	Fund of Nano II	3	NANO 2140	Interdisciplinary Lab	3	MT 3132	Materials Characterization Lab	1
			NANO 1210	Computer Simulation	1	NANO 2151	Career Planning and Industry	1	MT 3141	Principles and Applications of Bionanotechnology	3
			NANO 1222	Student Lab Experience and Research	3				MT 3142	Nanoparticles & Biotechnology Lab	1
									NANO 2970	Internship	2
Credits		18	Credits		19	Credits		15	Credits		17

DAKOTA COUNTY TECHNICAL COLLEGE

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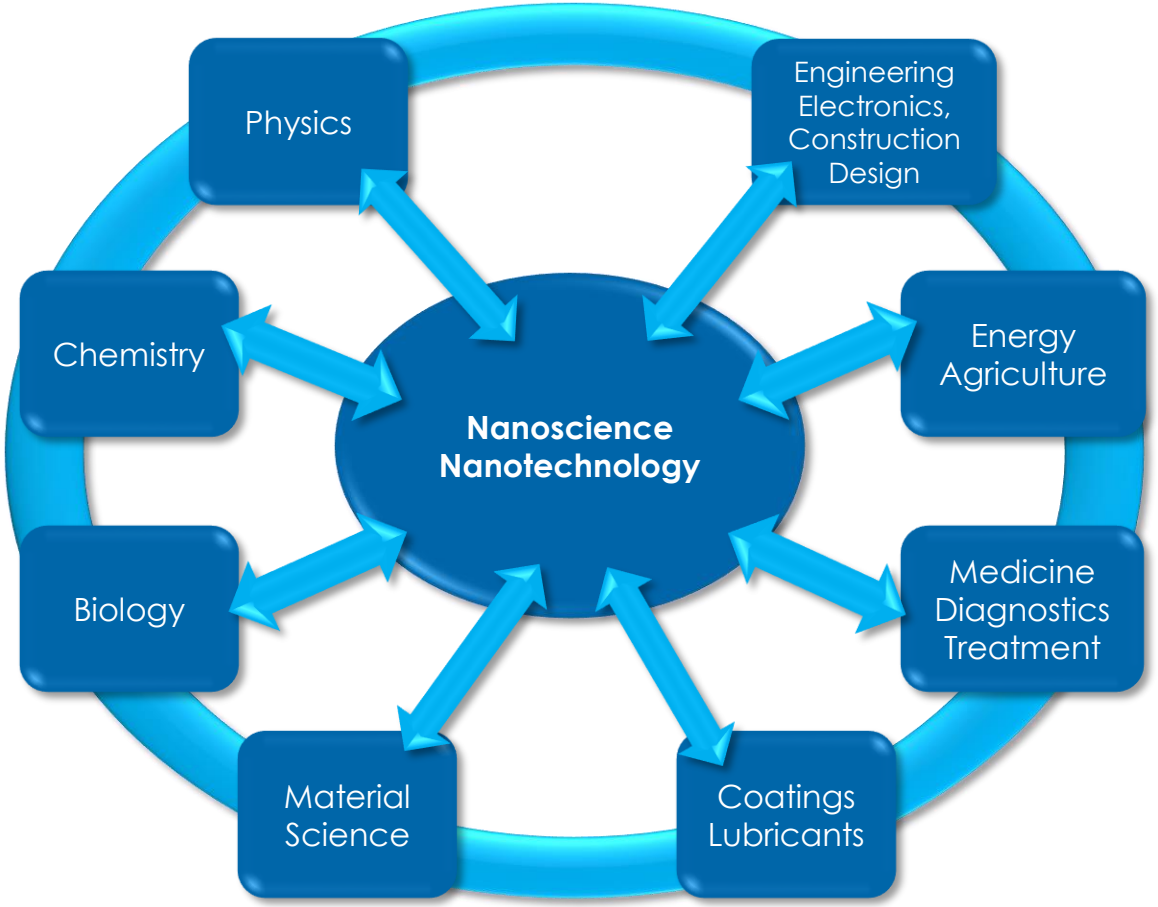
Evolution from 72 credit AAS degree program to a 60 credit AS degree program

- What is happening
  - Students going for a biology, chemistry, environment or energy degree are looking at nanotechnology as a minor or enhancement to their planned degree
- Sustainability aspects are included in all offered courses
- Focus on environmental aspects (due to student interest)



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Nanobiotechnology

- Computer simulations of potential interactions (drug and protein)
- Students do simulations and also assess validity and cost
- Assess impact of doing computer simulations versus in lab experiments – drug disposal

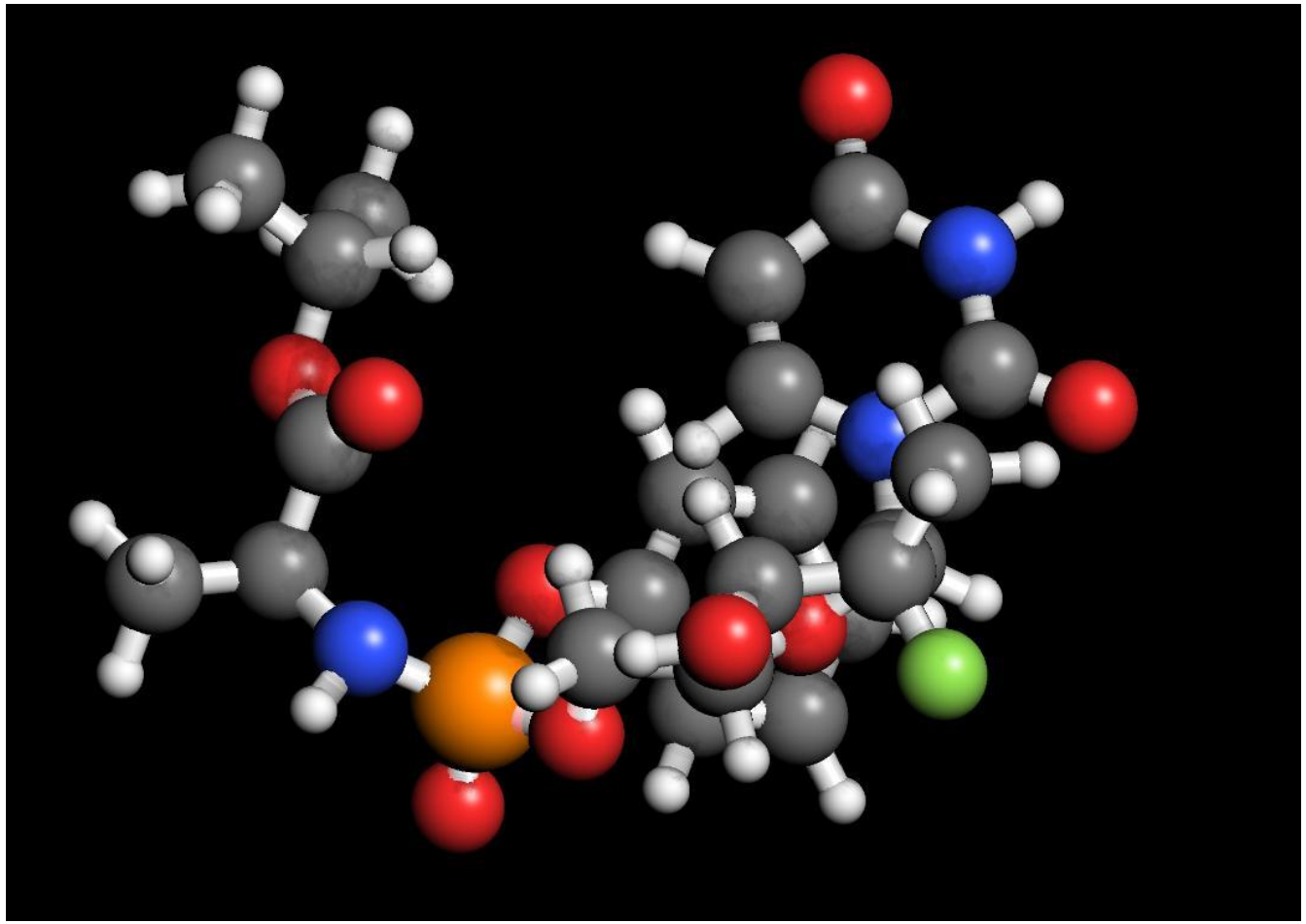

Image Courtesy of Sandra Porter

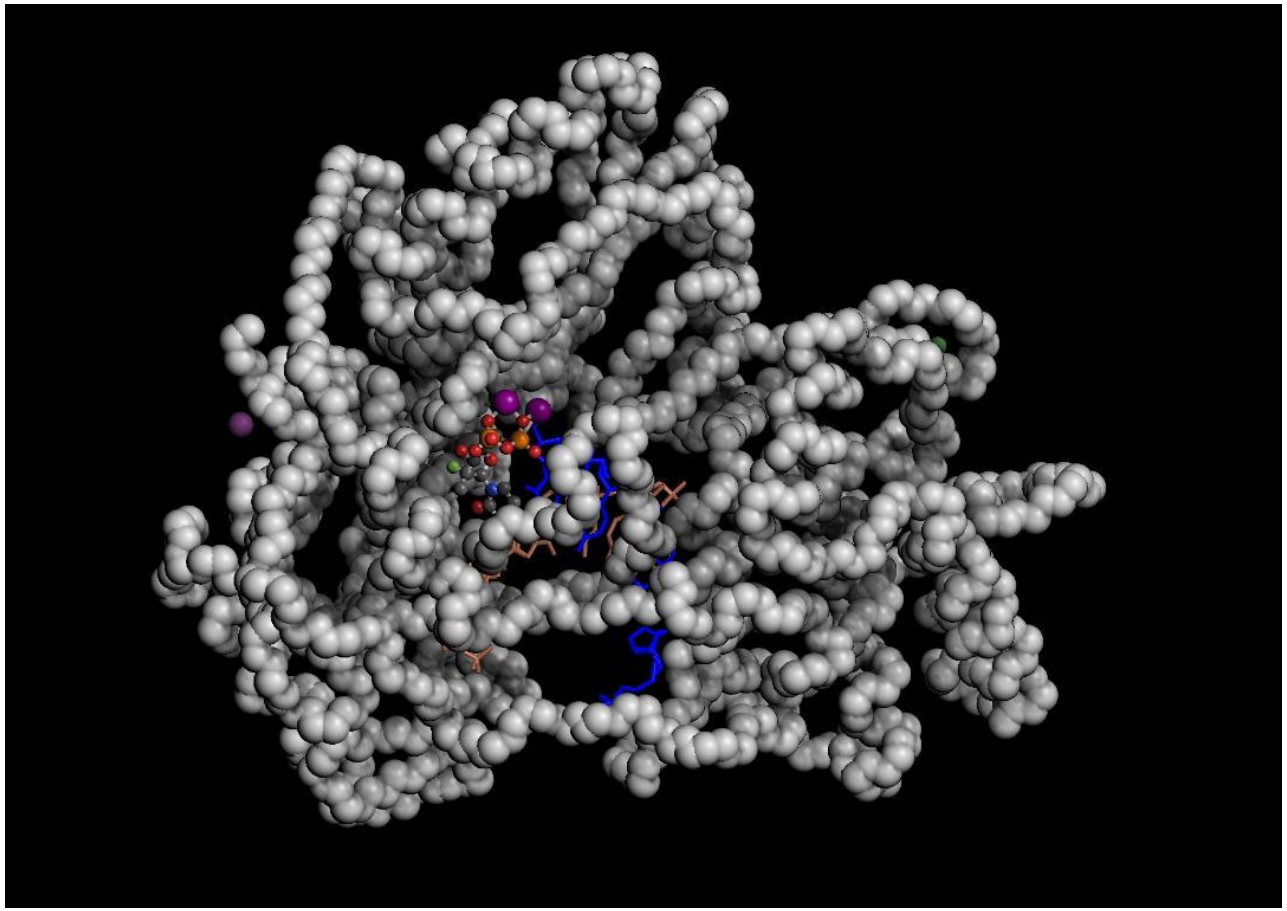

Image Courtesy of Sandra Porter

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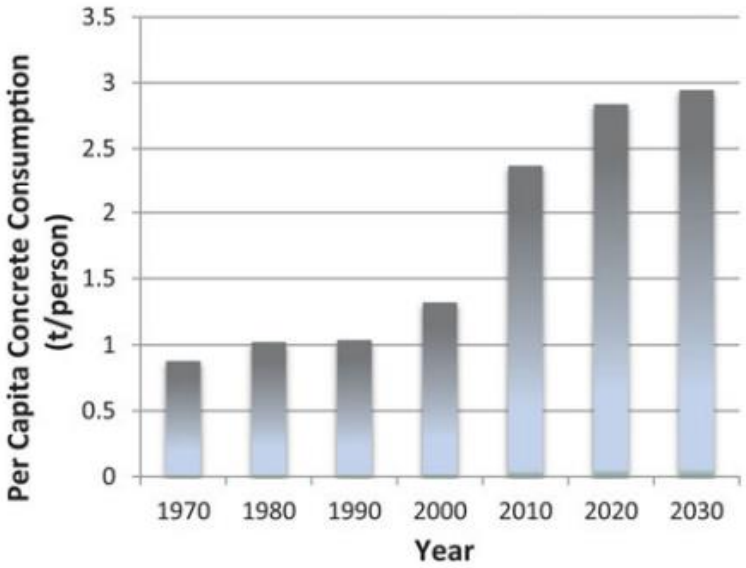

Figure 1. The rate of consumption of concrete outpaces the rate of population growth (based on data from References 1 and 2).

Figure 2. Because of tidal conditions and cold weather exposure, the natural weathering station maintained by the US Army Corps of Engineers at Treat Island, Maine, is useful for assessing the long-term durability of emerging concrete technologies, including alternative binders and blends of portland cement and supplementary and alternative supplementary cementitious materials.

Nanoscale properties of concrete define
The physical properties, lifetime, environmental impact and more….

Ref: MRS Journal Dec 2015
Innovations in Cement Based Materials

Nanocrete Module

Students/faculty mix different grain size materials (including some CNTs and graphene) Into concrete mixtures – then after setting, test and measure physical properties.

Study not only properties but price and environmental considerations

Another New Module : Water filtration based on the LifeStraw

As we continually add new modules and modify existing ones Including more sustainability aspects

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Pȟahíŋ – porcupine quills

- *Pȟahíŋ* (porcupine quills) are used to decorate clothing and ceremonial items.
- They are often dyed with various plants to create vivid colors. However, some plants and plant parts work more effectively than others.
- Question: Can we show why certain plants work better than others? Can we predict which plants will make a better dye for pȟahíŋ? Pore size? Can we show the barbs that make them so dangerous?

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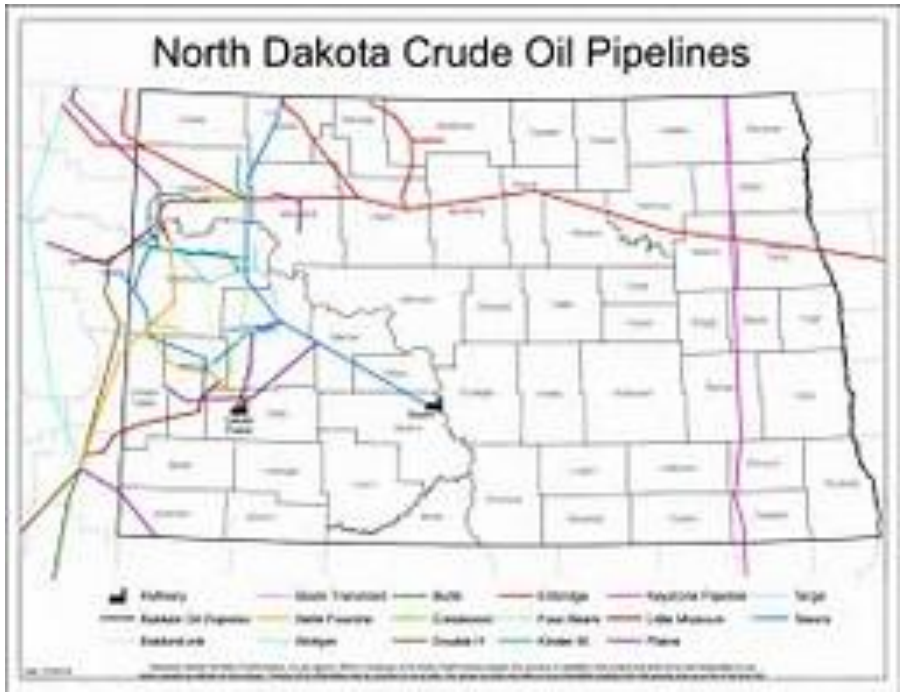
Because of the potential oil pipeline in ND

Students are asking to study the impact of crude oil on lakes, rivers and other water sources.



Undergraduate Research Project

- TiO_2 nanoparticle impact on freshwater bi-valve mollusks
- Multi year effort
- Students from 3 community colleges involved
- All aspects of the 3 legged stool of sustainability included
- Environment, economy and society

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Undergraduate Research

- **Impetus**
- Started looking for a topic multiple years ago
  - Did not require expensive or extensive equipment
  - Related to nanoscience in a strong way and included a combination of multiple disciplines
  - Wanted a longer term project – not just a 1 or 2 semester activity
- Dual use
  - Teach technical skills, techniques and concepts
  - Teach "21st Century skills": Critical thinking, problem solving, planning complex projects, program management, teamwork, time management

- Selected TiO2 nanoparticle impact on freshwater bi-valve mollusks – based on PhD work by John Doyle

  - Start – August 2017
  - 8 students
  - Reading and prepatory work completed, material list created, water collection sites selected, baseline schedule generated

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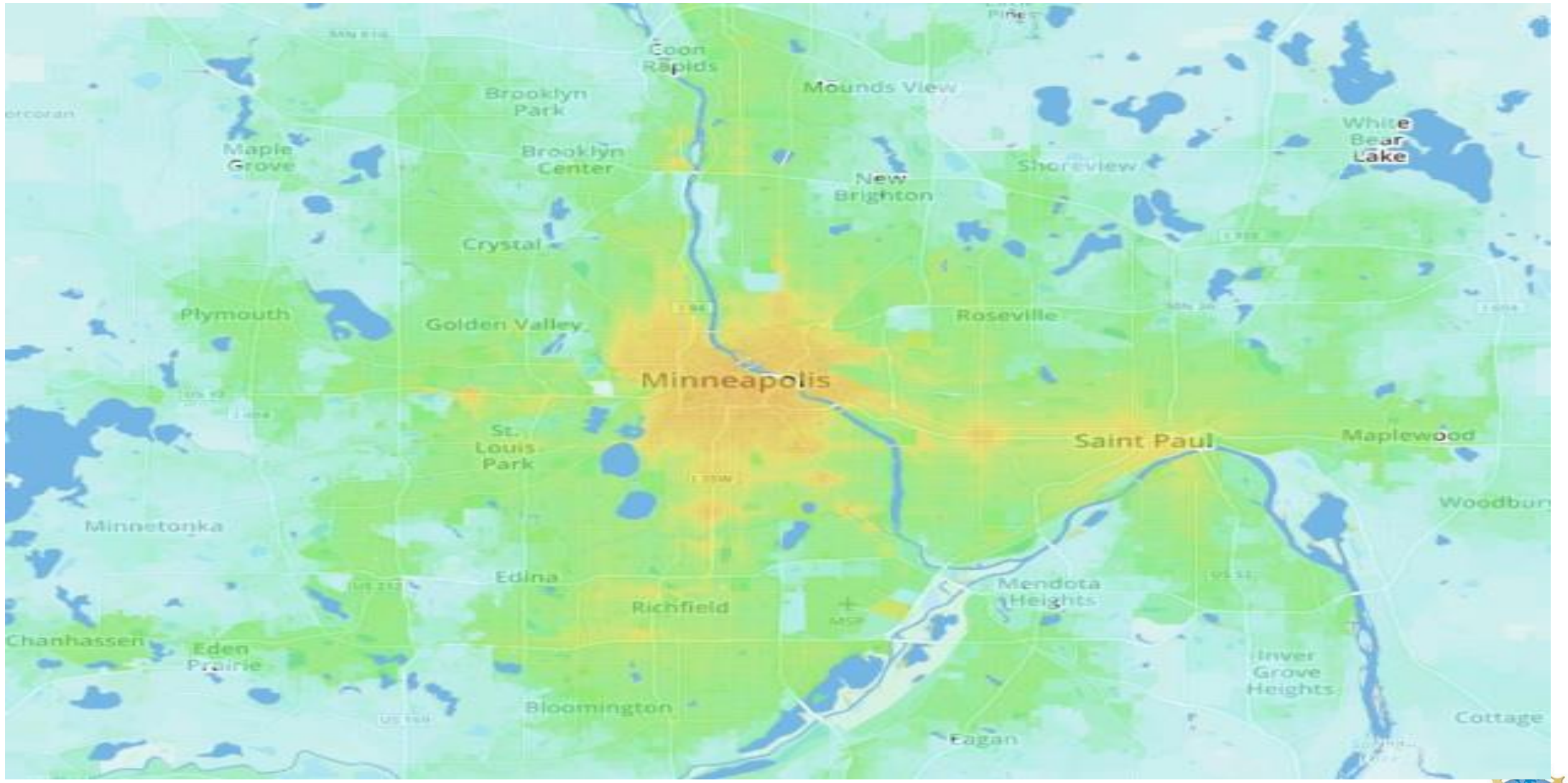

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Planning

- **TASKS**
- Develop overall project plan
- Define mission
- Define tasks and schedule
- Research: Zebra mussels and location
- Research, review and study previous
- fresh water work
- Define water collection sites
- Order materials

- **TECHNICAL**
- Learn program management SW
- Create and understand Gantt charts
- Evaluate interdependencies of tasks
- Develop process flow charts
- Learn new vocabulary (and use it)

- **NON TECHNICAL**
- Material cost
- Environmental aspect of water collection sites
- Learn teamwork
- Assess individual and group strengths
- and weaknesses
- Practice communication (oral and written (graphing)

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Water and NP Characterization

- **TASKS**
- Learn container preparation
- Define and practice collection methodology
- Document collection location and other data
- Determine properties and measurement approach
- Determine instruments required
- Learn instrument operation
- Measure and evaluate water properties
- Assess tolerance values
- Test and characterize nanoparticles
- Define aggregates and process

- **TECHNICAL**
- Understand properties to be measured
- In water - pH, chemical composition, total suspended solids, dissolved organic carbon
- In nanoparticles - Surface area, zeta potential, hydrodynamic diameter, crystalline structure
- Understand and calculate tolerance allowances, statistical variation, equipment accuracy

- **NON TECHNICAL**
- Appropriate documentation and data collection
- Environment and life cycle considerations
- Optimize data presentation and interpretation
- Practice critical thinking
- Practice problem solving
- Develop time management skills

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Thank you!!!!