

# One Medicine

## Reducing the Impacts of Disease on Animal and Human Health in Montana

MSU: Jovanka Voyich, Mark Jutila, Mark Quinn



# Integrated Approach to Human and Animal Research



Chronic  
Inflammation

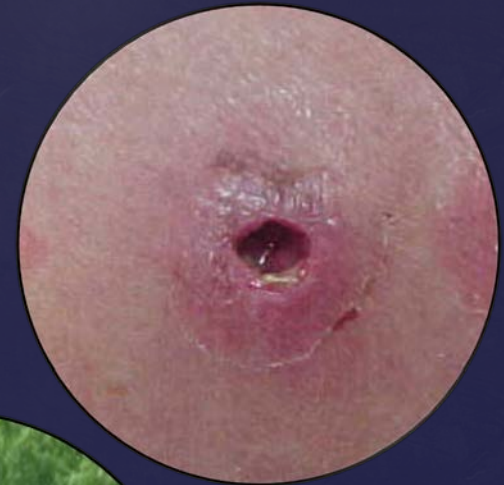
Arthritis

Infectious Diseases Drug Resistance  
(MRSA), Bovine Scours, *Brucella*



Enhancement of Immunity

Decrease Disease  
Prevent Disease (Vaccines)  
Reduce Antibiotic Use  
Manage Inflammation

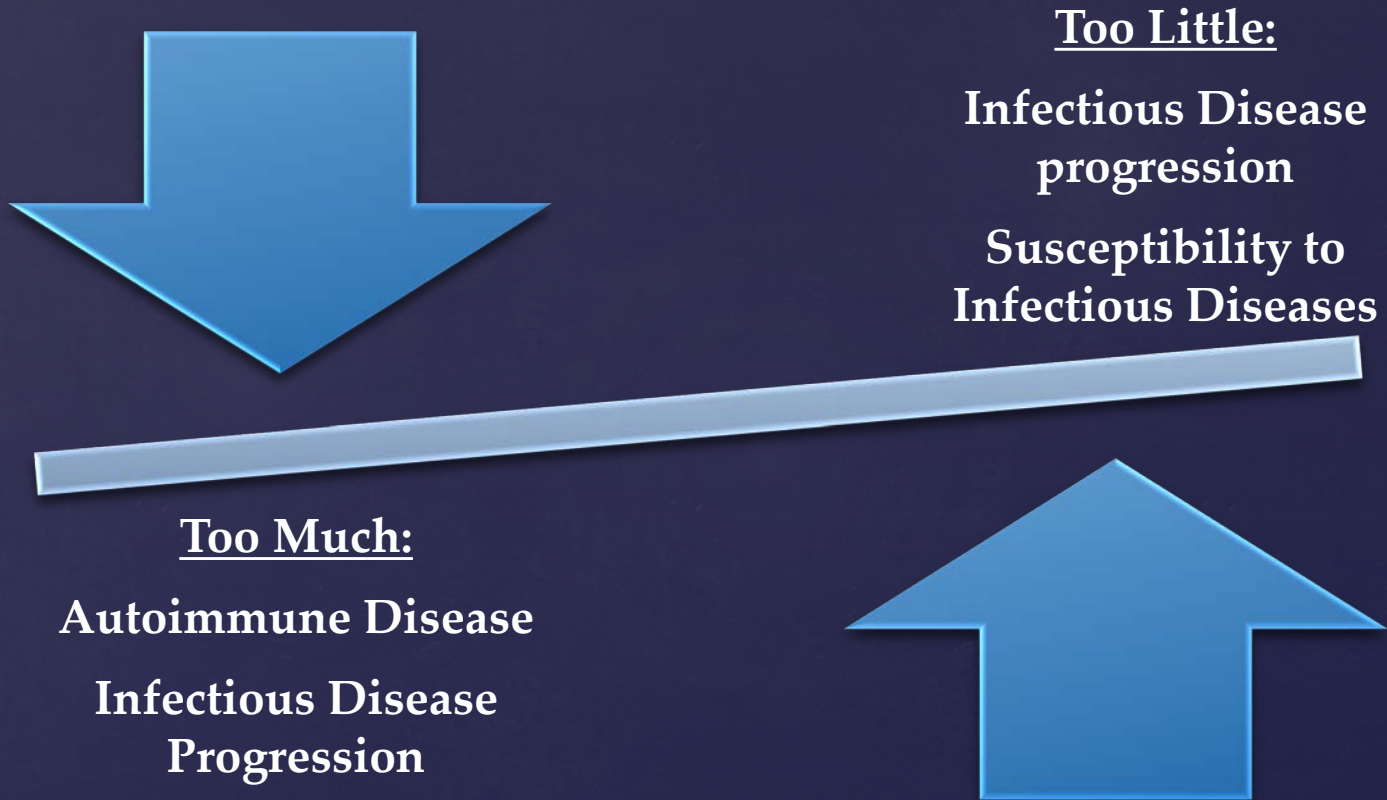


Spillover  
of infections to other  
animals and humans

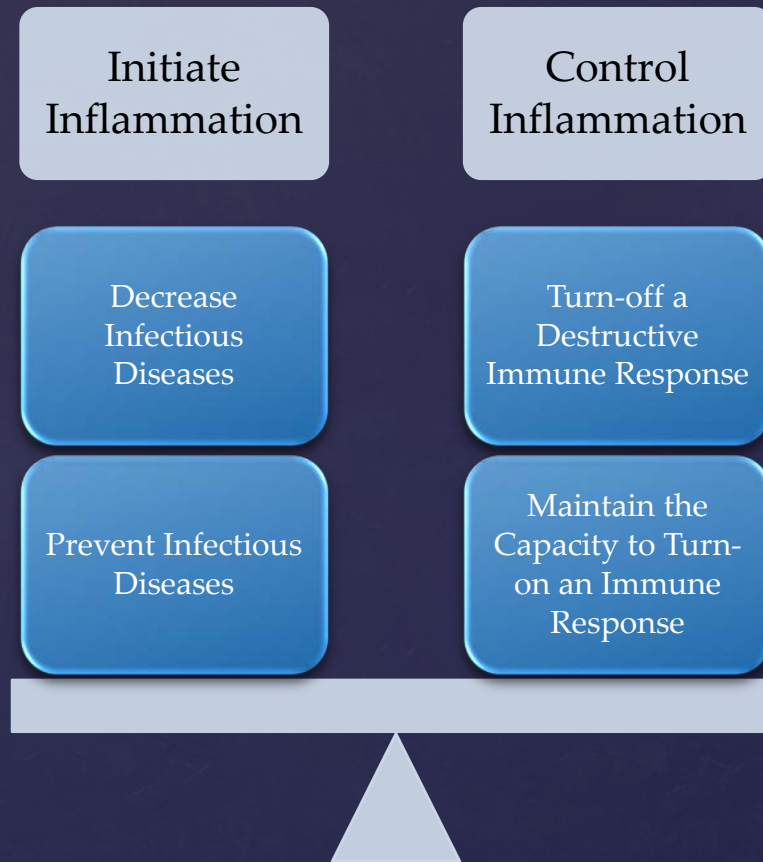


Q fever

# The Problem: Inflammation Imbalances Contribute Significantly to Disease



# Goal: Guide the Inflammatory Response To Be Protective



State Funding is Providing Resources to Develop Immunomodulators To Regulate the Immune System Leading to an Optimal Immune Response

# Progress

## Hires:

19 Research Positions Supported by State Funding

Research Technicians

Postdoctoral Scholars

Research Scientists

Undergraduate Students

Graduate Students

**ROI: State Investment on One Medicine = \$1,500,000**

Currently at 1:1

Funding received to date: \$1,510,741

## Publications:

4 papers in revision that will cite the MT State Initiative Funding

**Thank you!**

**Montana State Research Initiative**

# Enhancing Montana's Energy Resources: Research in Support of the State of Montana Energy Policy Goals

**Project Director: Lee H Spangler, Director, The Energy Research Institute, MSU**

## **Project Investigators:**

**Martha Apple, Department of Biological Sciences, Montana Tech**

**Al Cunningham, Civil Engineering and Center for Biofilm Engineering , MSU**

**Matthew Fields, Microbiology & Immunology and Center for Biofilm Engineering, MSU**

**Robin Gerlach, Chemical & Biological Engineering and Center for Biofilm Engineering , MSU**

**Ellen Lauchnor, Civil Engineering and Center for Biofilm Engineering, MSU**

**Brent Peyton, Chemical & Biological Engineering and Thermal Biology Institute , MSU**

**Adrienne Phillips, Civil Engineering and Center for Biofilm Engineering, MSU**

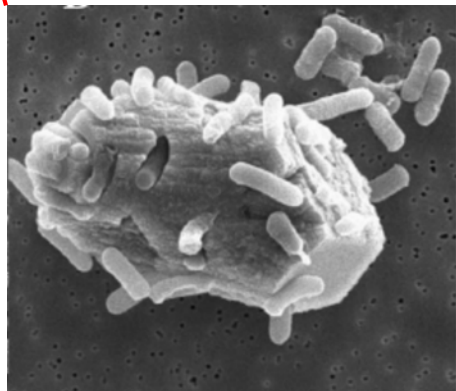
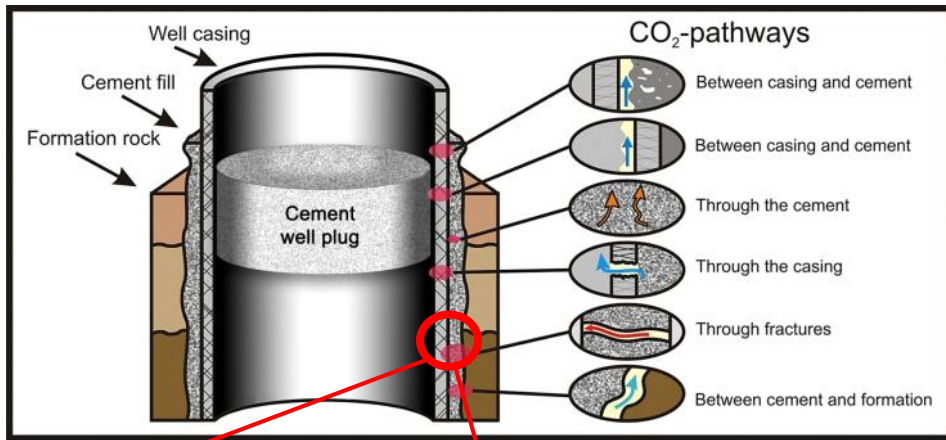
**Xiaobing Zhou, Geophysical Engineering, Montana Tech**

**The Energy Research Institute  
Montana State University**

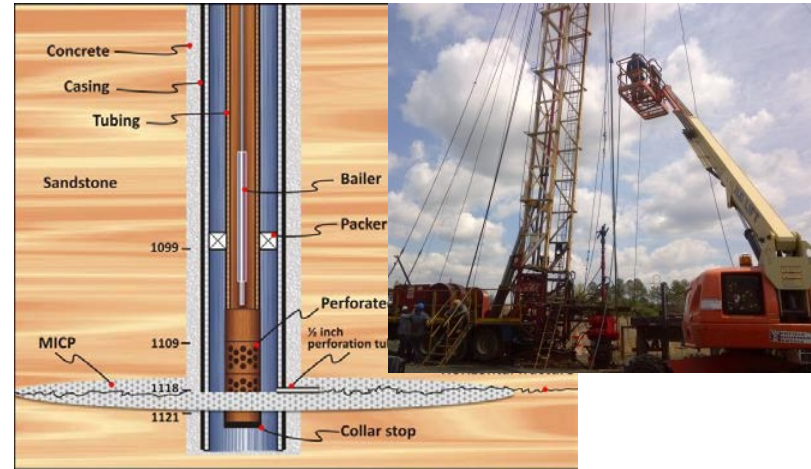
**Montana Tech**

# Well Sealing Technology

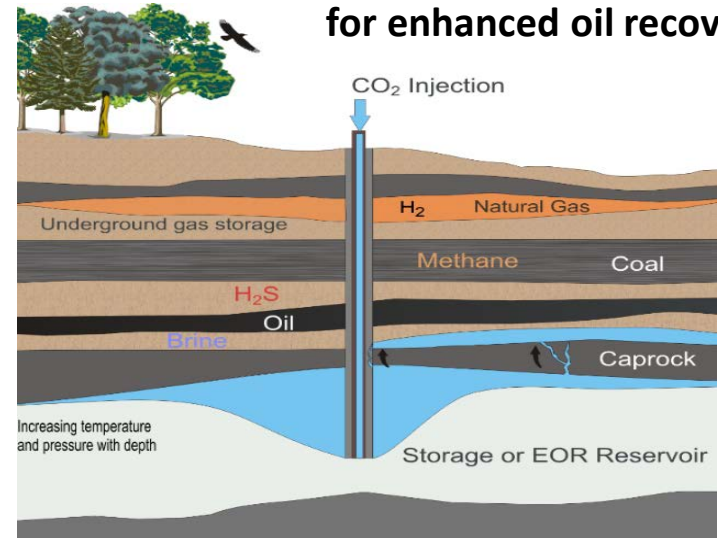
1. ERI studied bacteria that precipitate minerals and grow new rock. Performed lab work to show this can be used to seal small cracks in leaky oil and gas wells. Licensed to a MT company.



2. Performed a successful well demonstration



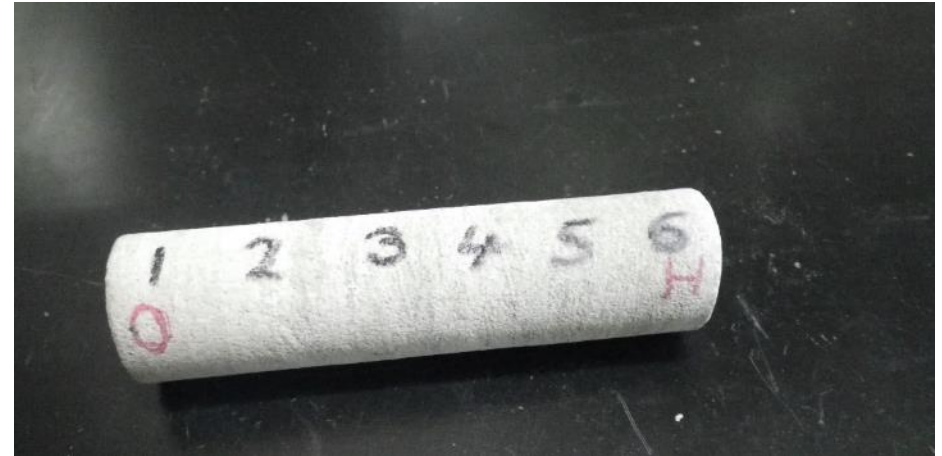
3. Now target deeper depths and thief zones for enhanced oil recovery



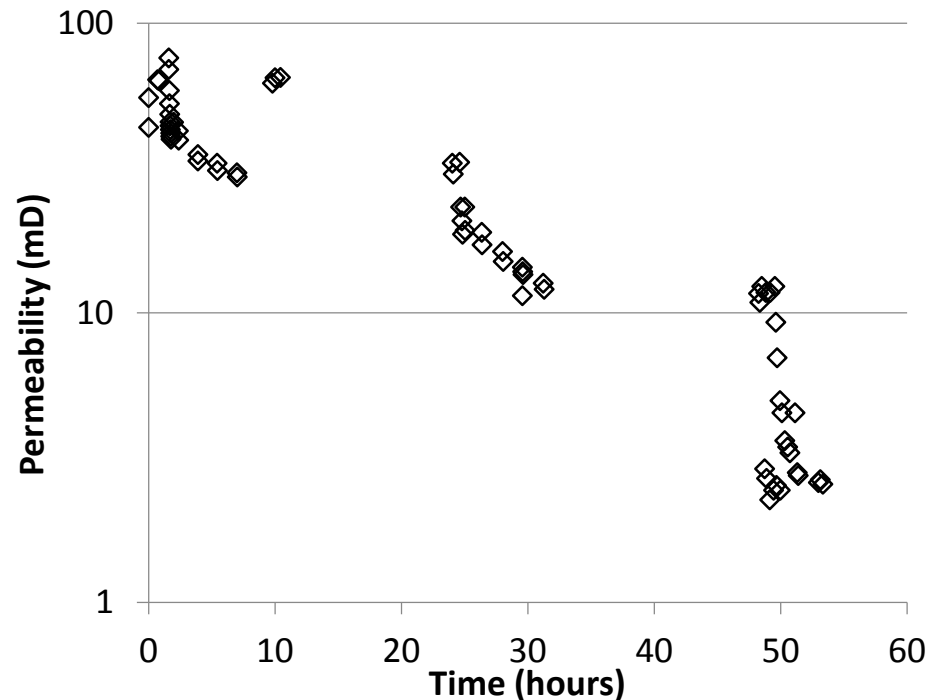


Objective 1: Develop methods for creating mineral seals at greater depths (> 5000 feet bgs) and higher ambient temperatures (>35°C) than current ERI biomineralization technology.

## Urease 5" long core test

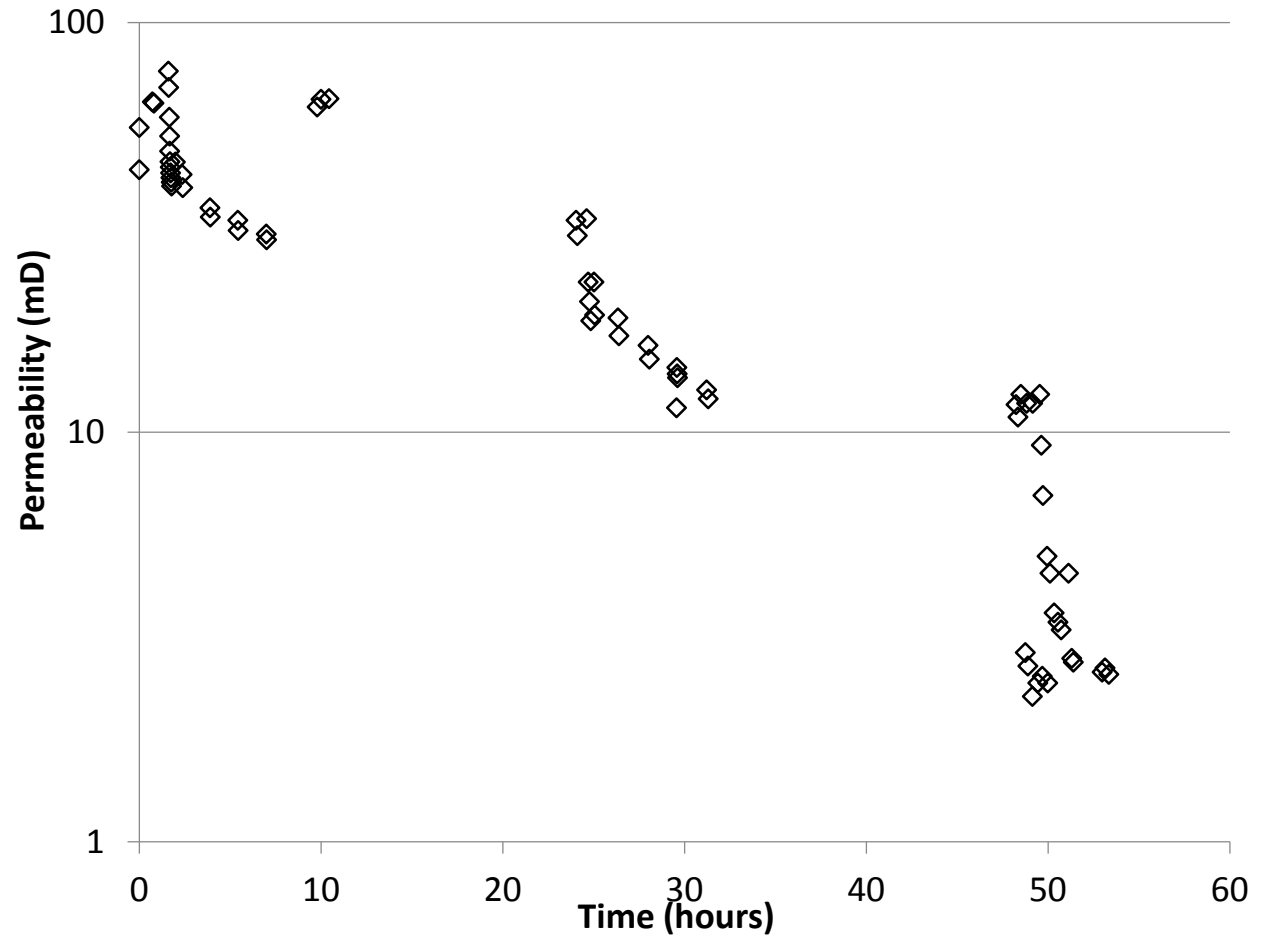


Use urease enzyme (Jack Bean Urease, Sigma Aldrich) to reduce permeability in Berea Sandstone cores at 60°C



# Permeability reduction

63 to 2.4  
md in three  
days



## Objective 2: Test use of MICP to remediate fly ash storage to comply with a new federal regulation



- EPA rule [40 CFR Parts 257 and 261] requires *mitigation of unlined fly ash ponds*.
- Southern Co. (US largest utility) contacted us to apply technology. We are also in contact with Montana companies.
- Use mineral precipitation to:
  - Co-precipitate heavy metals out of the water
  - Solidify fly ash & make impermeable
  - Develop spray technology for dust control

- Objectives:
  - Develop methods to reduce permeability in the CCR/soil interface (liner)
  - Develop injection strategies seal fractures in surface impoundment walls
  - Develop methods to reduce fugitive dust emissions

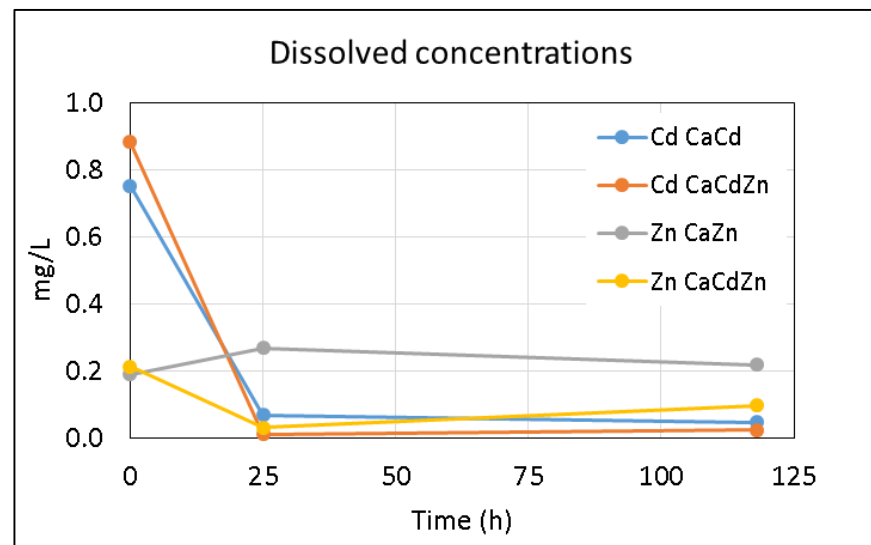
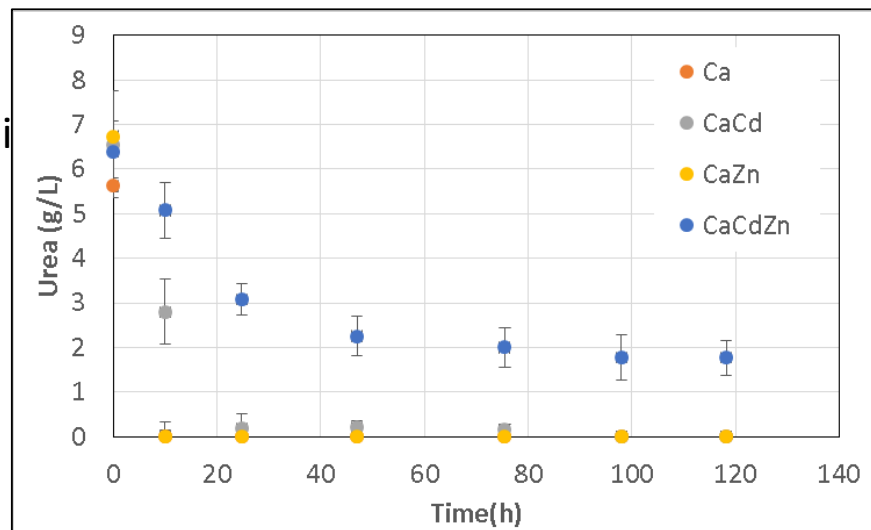
### Objective 3: Assess the potential to use bacterially driven mineral formation for removal of heavy metals from water produced by coal mining operations, coalbed methane, and enhanced oil recovery.

Shale oil production via hydraulic fracturing can produce large volumes of water with high total dissolved solids concentrations

- Up to 4 bbl water per bbl oil produced (*Clark and Veil, U.S. DOE report ANL/EVS/R-09/1, 2009*)
- Dissolved cations such as strontium ( $\text{Sr}^{2+}$ ), barium ( $\text{Ba}^{2+}$ ) and other metals can be present in produced water
  - New EPA regulations in progress for discharge of produced water
  - Contribute to scaling issues during reinjection (*Barbot et al., ES&T, 2013*)
- Strontium-90 is a radionuclide and product of uranium fission
  - Groundwater contaminant at U.S. DOE sites, such as Hanford, WA, as a result of nuclear waste disposal practices

# Contaminant mixtures – preliminary studies

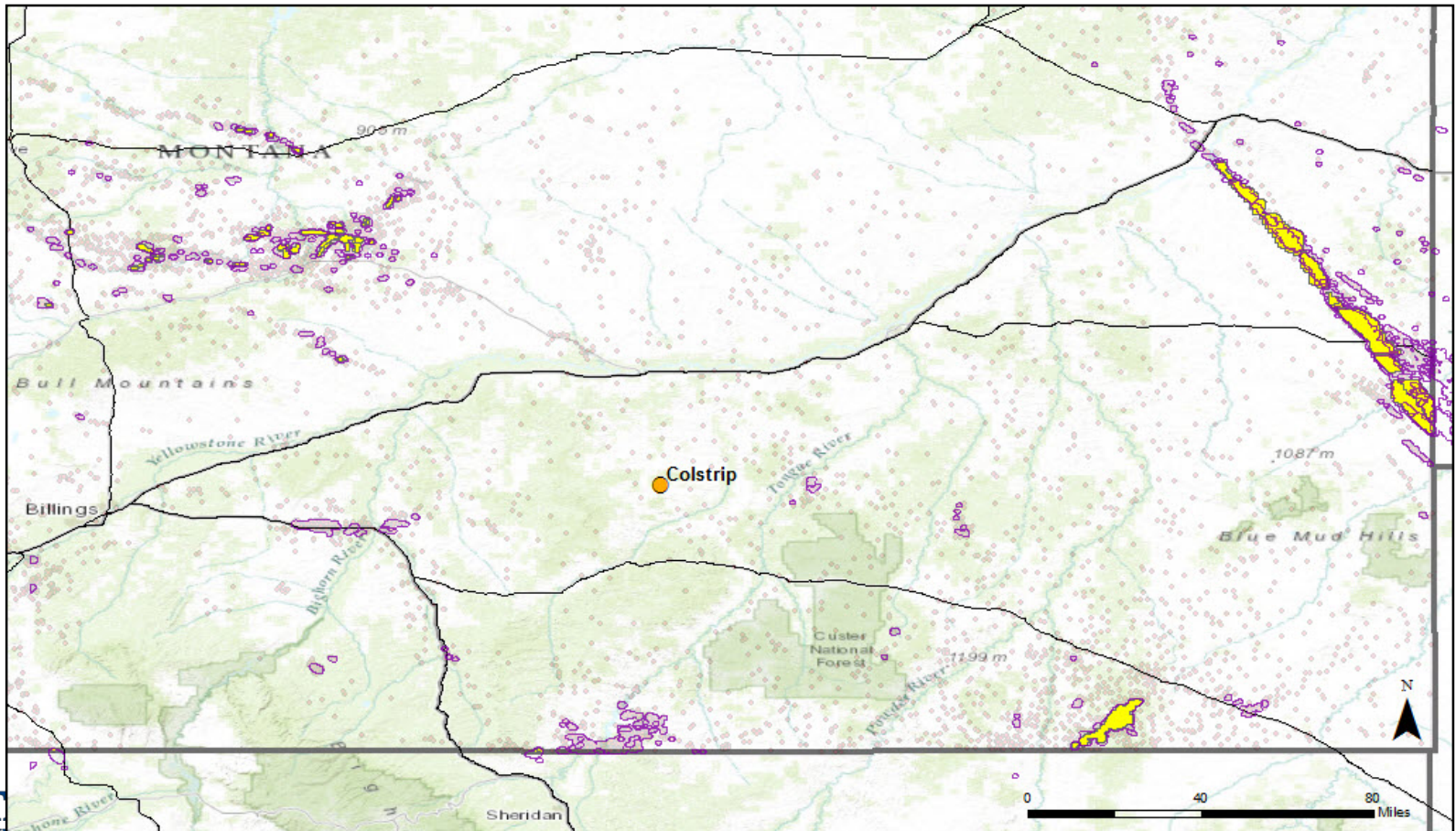
- Batch studies
- Artificial groundwater with calcium containing:
  1. Strontium and barium
  2. Zinc and cadmium
- Amended with *S. pasteurii* and urea



# Objective 4: Assess geologic carbon sequestration potential via EOR in oil and gas fields and storage in saline formations near Colstrip, MT

## EOR Progress:

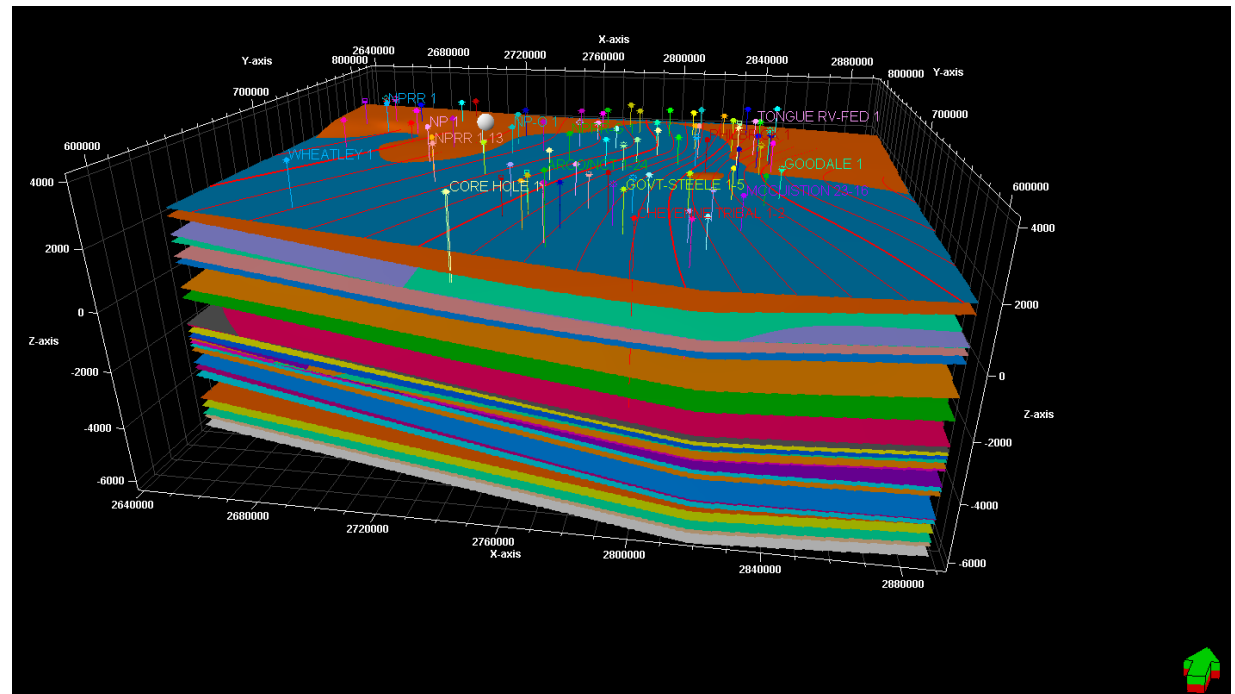
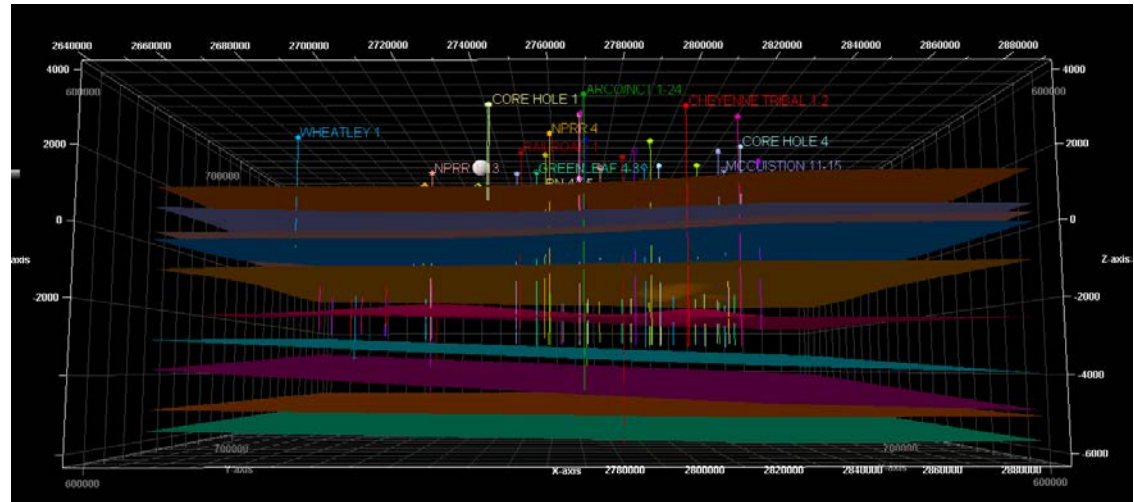
1. Compiled data for 190 fields, >500 reservoirs (~60 units with EOR)
2. Created geospatial database with well and reservoir data, QA/QC
3. Conducted initial screening
4. Conducting literature review to fill in data gaps



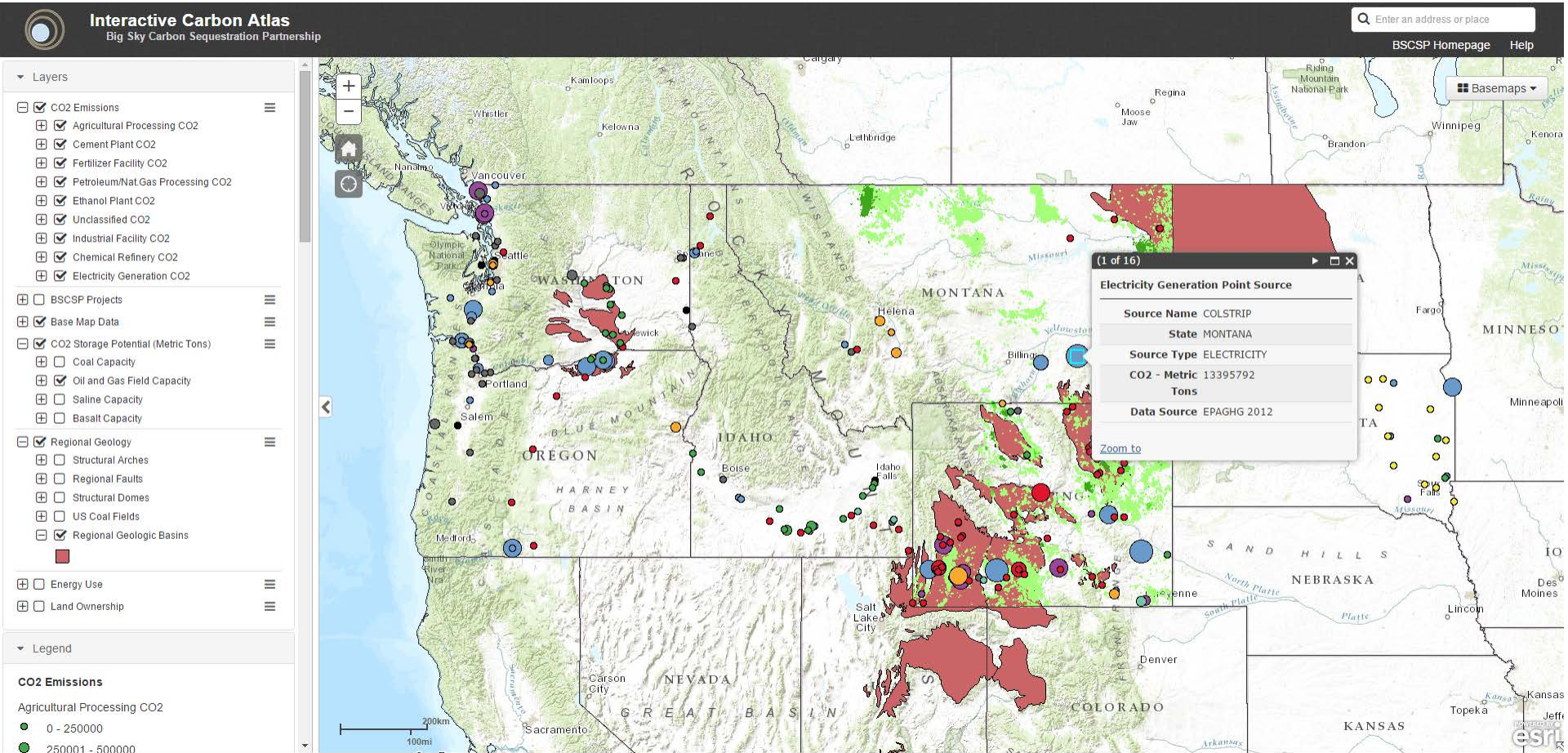
# Objective 4: Assess geologic carbon sequestration potential via EOR in oil and gas fields and storage in saline formations near Colstrip

## Saline Storage Update:

1. Compiled logs and/or data for 61 wells
2. QA/QC well data, formation tops
3. Created preliminary 3D model



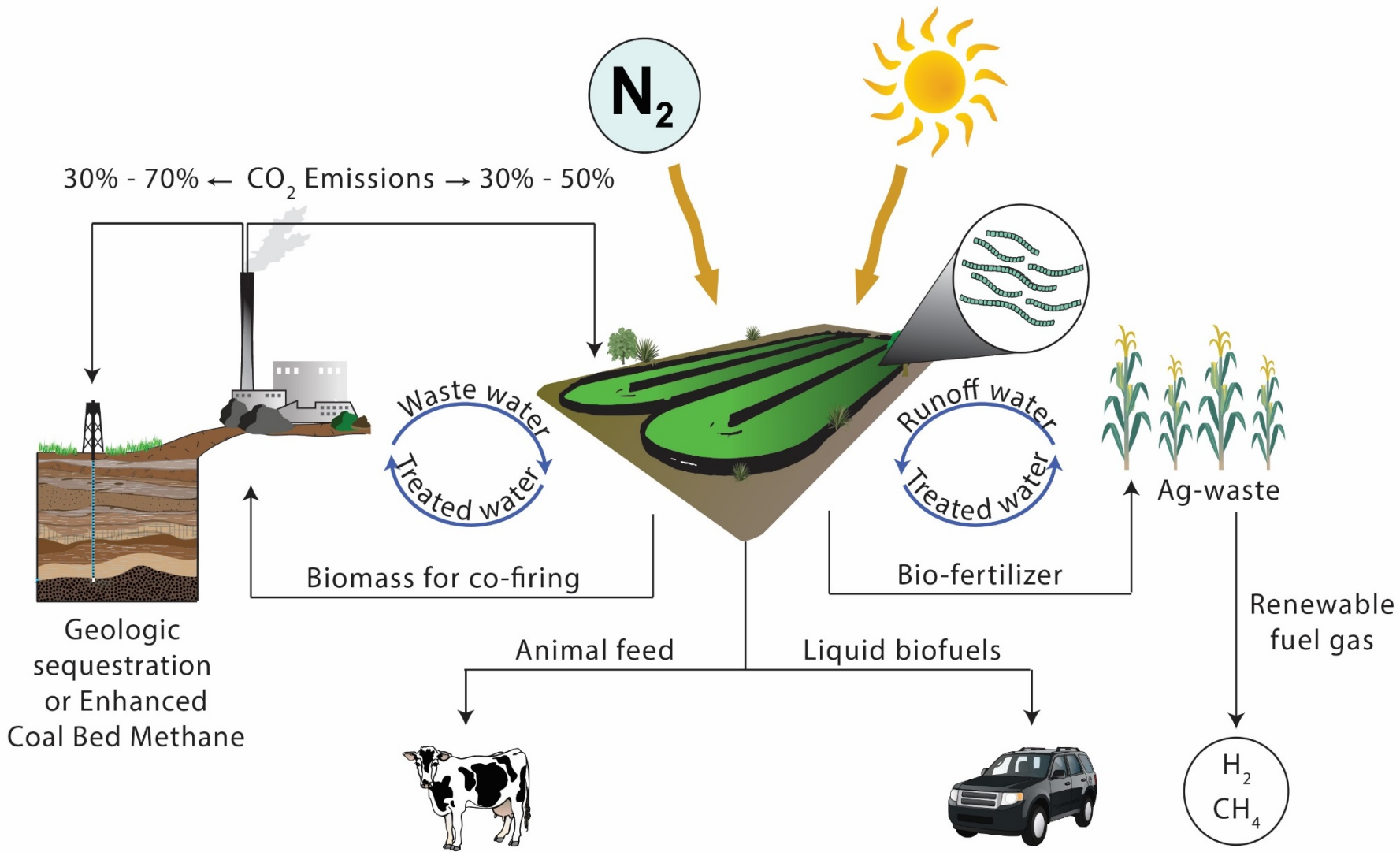
# Develop Interactive Map



Final Report and data package



# Objective 5: Develop methods to integrate phototrophic microbe based air capture of CO<sub>2</sub> and evaluate potential byproducts



# Objective 5

Assess growth characteristics under outdoor conditions (temperature and sunlight) in meso-scale ponds will be determined

- The MSU team has been characterizing the growth of an algal isolate in CBM production water for CO<sub>2</sub> capture and production of biomass and lipids. Experiments have begun to determine community dynamics during cultivation and biomass accumulation.
- For outdoor cultivation, new lab space with adjacent outdoor space was identified, and lab conditions are being established. Equipment such as water tanks, air diffusers, temperature probes, and light probes were purchased and are being tested.

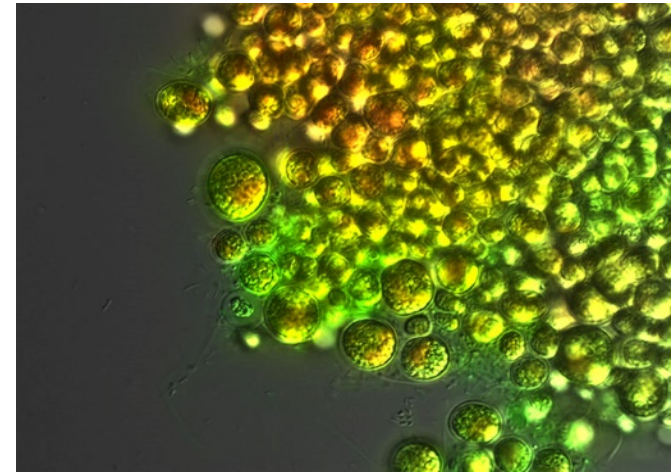
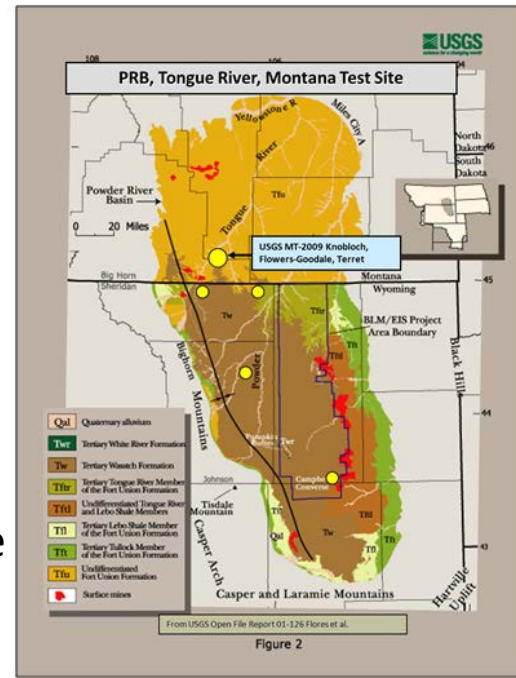
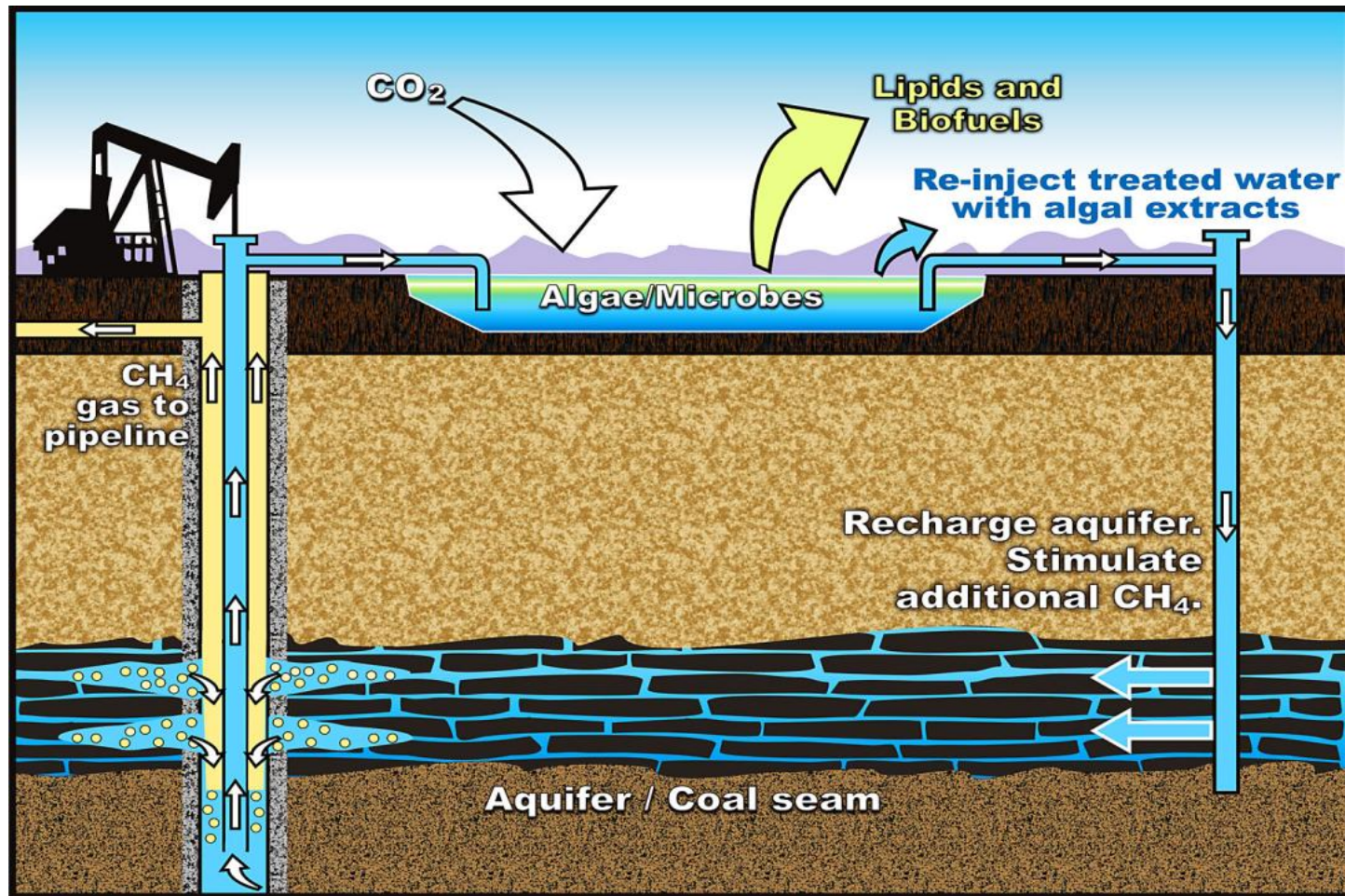


Image of the algal isolate from CBM production water

USGS Birney Test Site



# Objective 6: Develop methods to stimulate repeated methane production in coal bed methane (CBM) projects



1. Test Algal Extract for stimulation of methane production (MSU)
2. Test Algal Byproduct for fertilizer properties (MT Tech)
3. Determine pond growth potential by remote sensing (MT Tech)

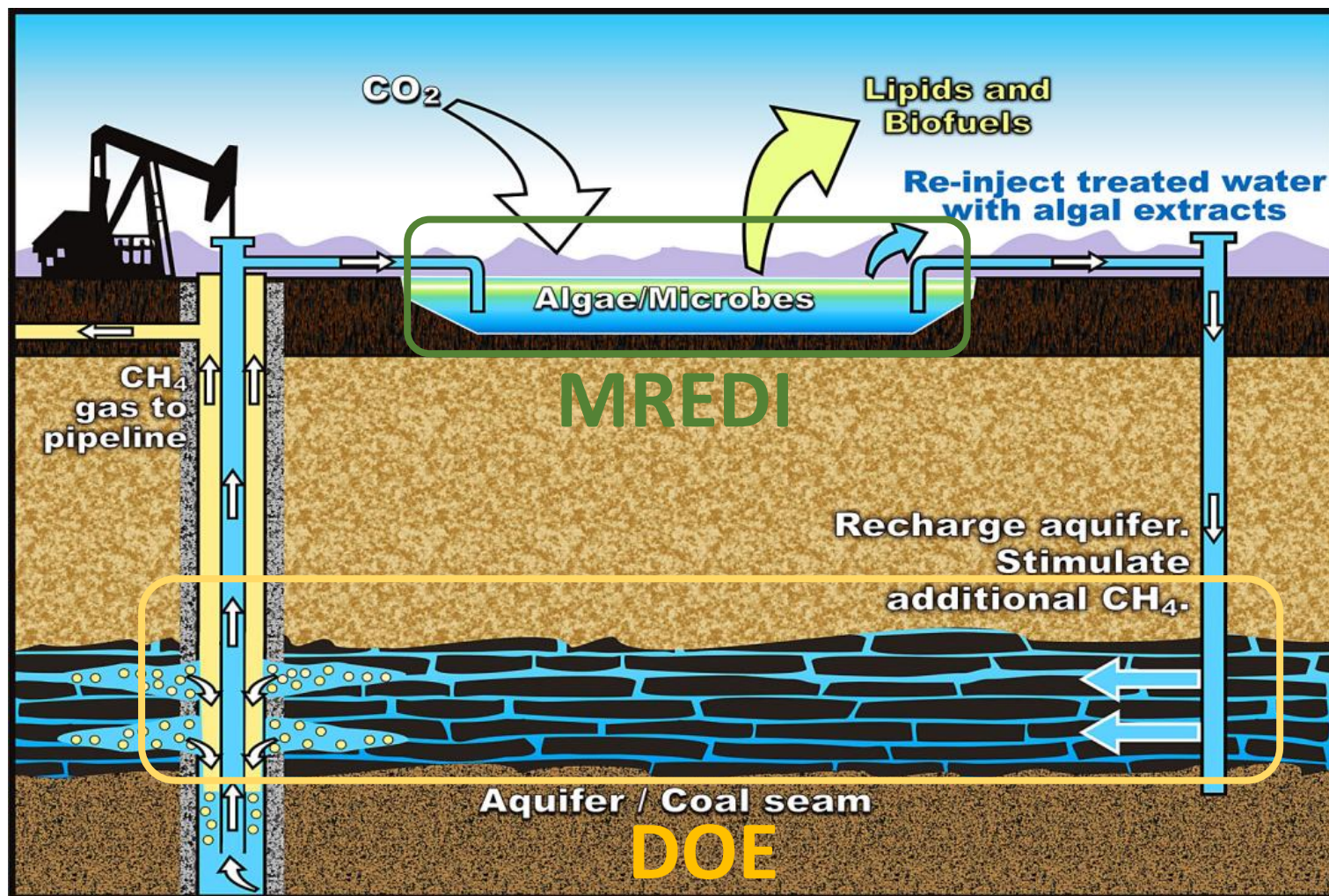
# Engagement / ROI: Fly Ash

- Meetings were held at Colstrip and fly ash samples acquired.
- Southern Company invited a small proposal (\$40,000 pending) for fly ash work. They are considering building a pilot scale facility to test promising technologies.



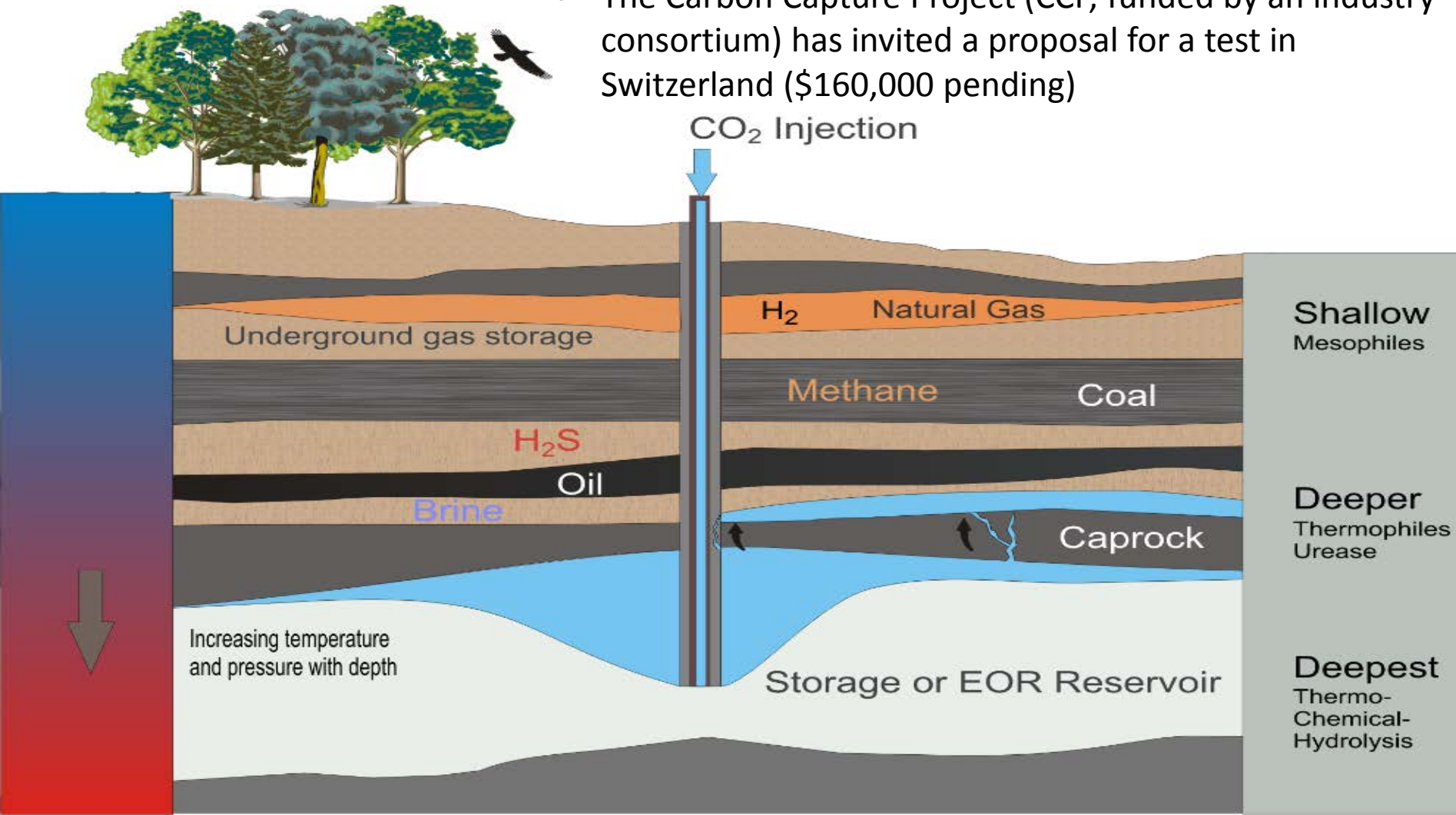
# ROI: Microbially Enhanced Coal Bed Methane (MECBM)

A \$650,000 project titled “Optimization, Scale-up, and Design of Coal-Dependent Methanogenesis in Preparation for in situ Field Demonstration” was funded by DOE.



# ROI: Well Sealing Technology

- A \$2.0 M project titled “Wellbore Leakage Mitigation using Advanced Mineral Precipitation Strategies” was funded by DOE
- The Carbon Capture Project (CCP, funded by an industry consortium) has invited a proposal for a test in Switzerland (\$160,000 pending)



# State Engagement and ROI

- A \$2.0 M project titled “Wellbore Leakage Mitigation using Advanced Mineral Precipitation Strategies” was funded by DOE to explore advanced and alternate mineral precipitation strategies in both laboratory and field settings.
- Conversations have commenced with Montana Emergent Technologies (Butte, Montana) about possible wells and field deployment strategies for well sealing
- The Carbon Capture Project (CCP, funded by an industry consortium) has invited a proposal for a test in Switzerland (\$160,000 pending)
- Meetings were held at Colstrip and fly ash samples acquired.
- Southern Company invited a small proposal (\$40,000 pending) for fly ash work. They are considering building a pilot scale facility to test promising technologies.
- Meetings with Talen Energy engineers at the Colstrip Power Plant provided insight and direction on contaminants of concern, such as selenium, and data on the water quality at the power plant.
- A \$650,000 project titled “Optimization, Scale-up, and Design of Coal-Dependent Methanogenesis in Preparation for in situ Field Demonstration” was funded by DOE.
- USGS has expressed strong interest in the MECBM work



**MONTANA**  
STATE UNIVERSITY

Center for Mental Health  
Research & Recovery

# **Synergistic Improvement in the Diagnosis and Treatment of Mental Illness, Dementia, and Chronic Pain**



## **Mission**

To improve the mental health and wellbeing of the people of Montana.

## **Vision**

To establish an academic center of excellence that addresses the mental health challenges of Montana and similar rural states by advancing mental health prevention, diagnosis, treatment, and workforce development.

# Interdisciplinary Research, Clinical, Commercial Team

- **Principal Investigators:** Matt Byerly, M.D. and Frances Lefcort, Ph.D.
- **Academic Co-Investigators:** Rebecca Brooker, Ph.D., Aurélien Mazurie, Ph.D., David Yeomans, Ph.D.
- **Montana Industry:** Neuralynx Inc., (Casey Stengel); SiteOne Therapeutics Inc., (Stan Abel) Western Montana Mental Health Center-Butte (Natalie McGillen)
- **Additional Partners:** NAMI Montana (Matt Kuntz, J.D.)

## Expertise and Experience

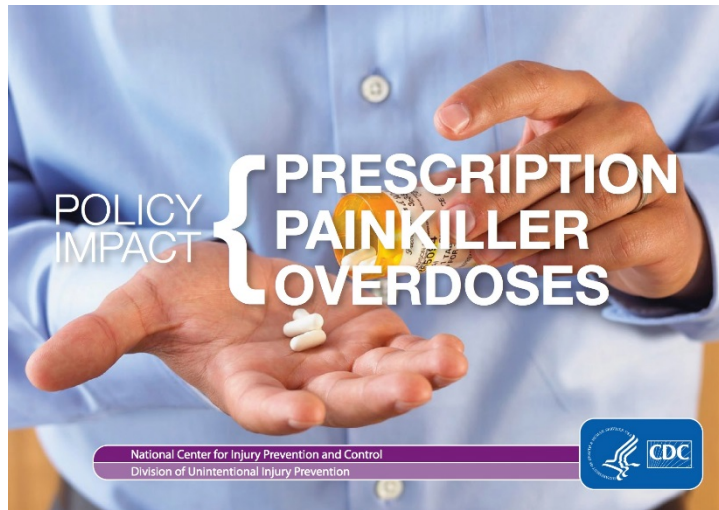
**Neuroscience, Clinical and Cognitive Psychology, Psychiatry, Electrical and Mechanical Engineering, Computer Science, Bioinformatics**

**Strong track record of NIH-NSF-Funded research**

**Bringing innovative neurotechnology to market**

**Serving Challenging State-Funded Patient Populations**

# Project 1: SiteOne/Montana State University Collaboration



- Overdose from opioid pain medications results in nearly 19,000 deaths annually in the US (CDC, 2015)
- There is a significant link between chronic pain, opioid abuse, depression and suicide
- SiteOne is developing drugs that selectively block a nerve cell channel that is the source of pain signals without the addictive qualities of opioid medications

**Vitalsigns™**  
CDC

**“The United States is in the midst of a prescription painkiller overdose epidemic”**

**SiteOne Therapeutics’ technology has the potential to fundamentally transform the treatment of pain**

# Suicide in Montana Youth

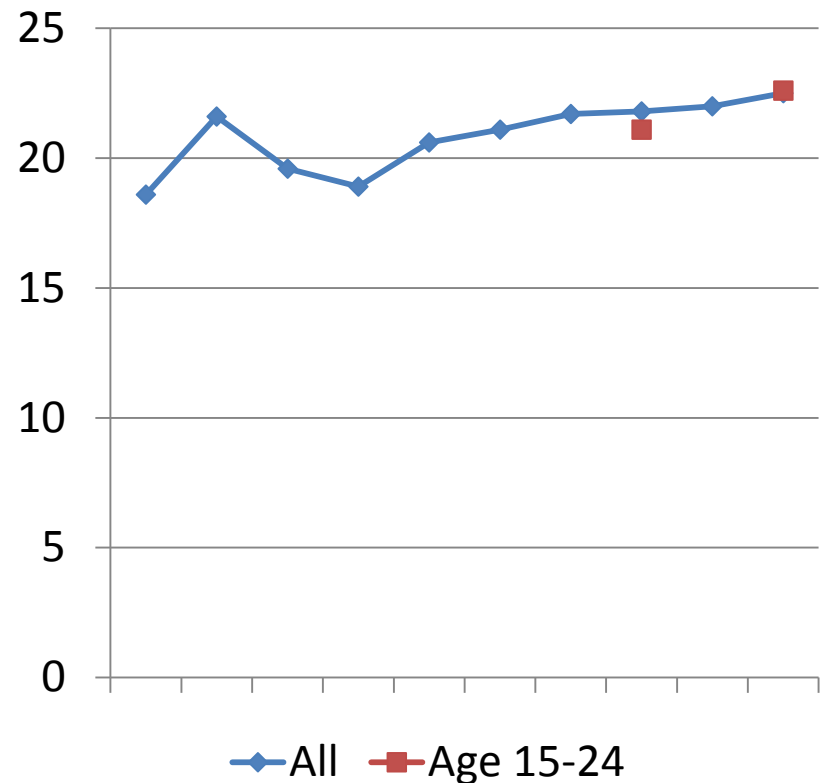
## Suicide Facts

- For all age groups for data collected for the year 2011, Montana was tied for the highest rate of suicide in the United States (American Association of Suicidology, June. 2014).
- Montana has been in the top five for suicide rates for nearly 40 years.
- Suicide is the 2nd leading cause of death for 15 to 24 year olds (62 deaths in Montana in 2013)

Age Adjusted Suicide Rates (per 100,000)

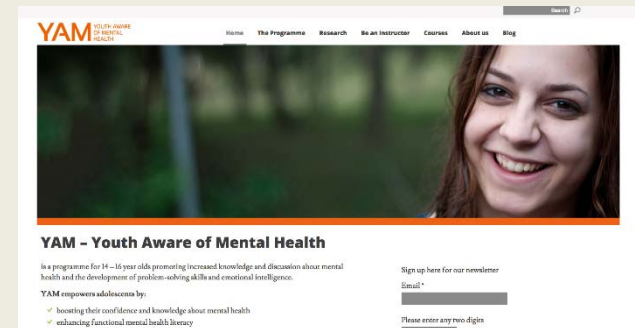
Montana Residents, 2004-2013

Office of Epidemiology and Scientific Support



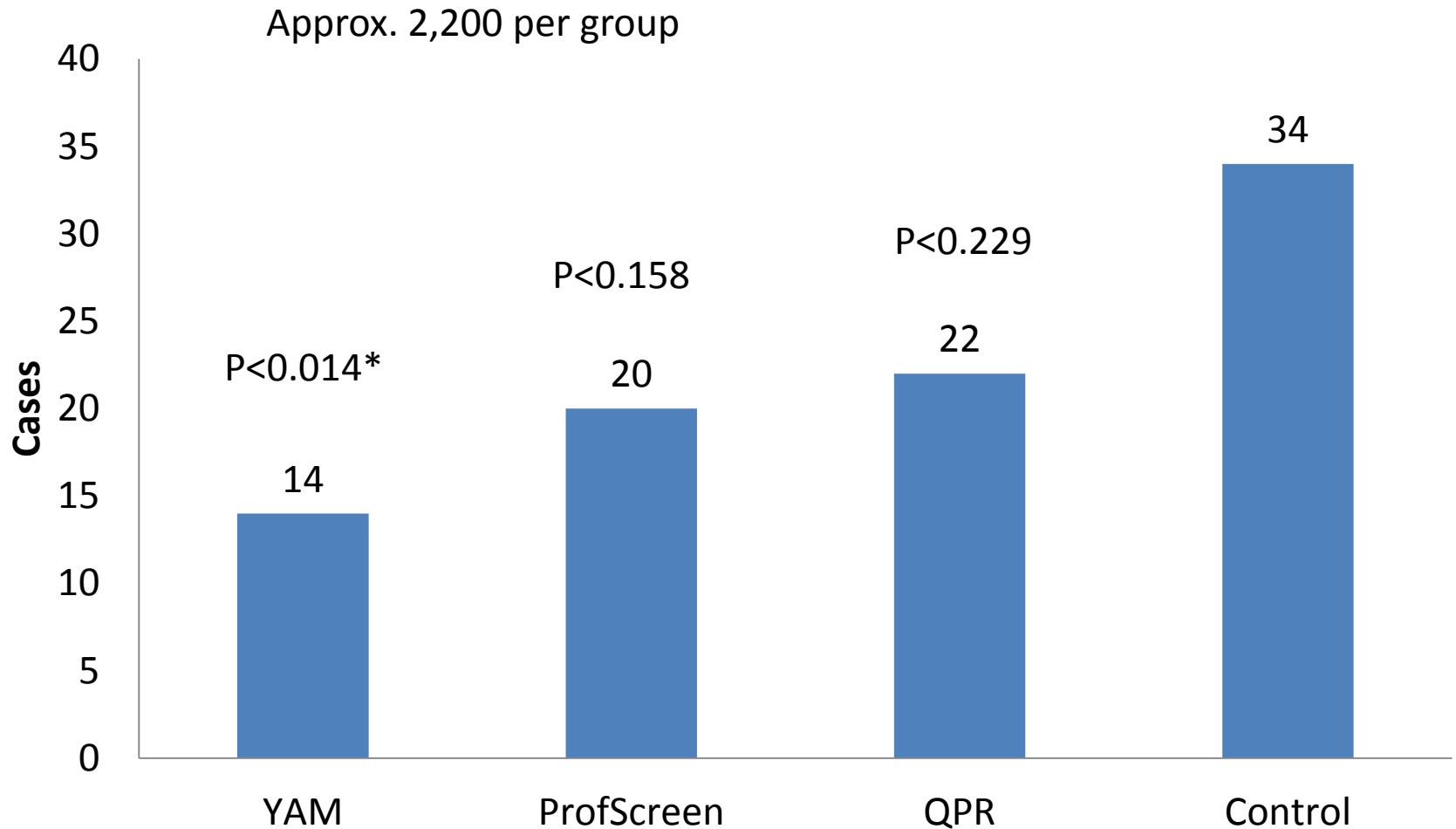
# YAM YOUTH AWARE OF MENTAL HEALTH

is a culturally sensitive program promoting increased knowledge and discussion about mental health and the development of problem-solving skills and emotional intelligence for adolescents



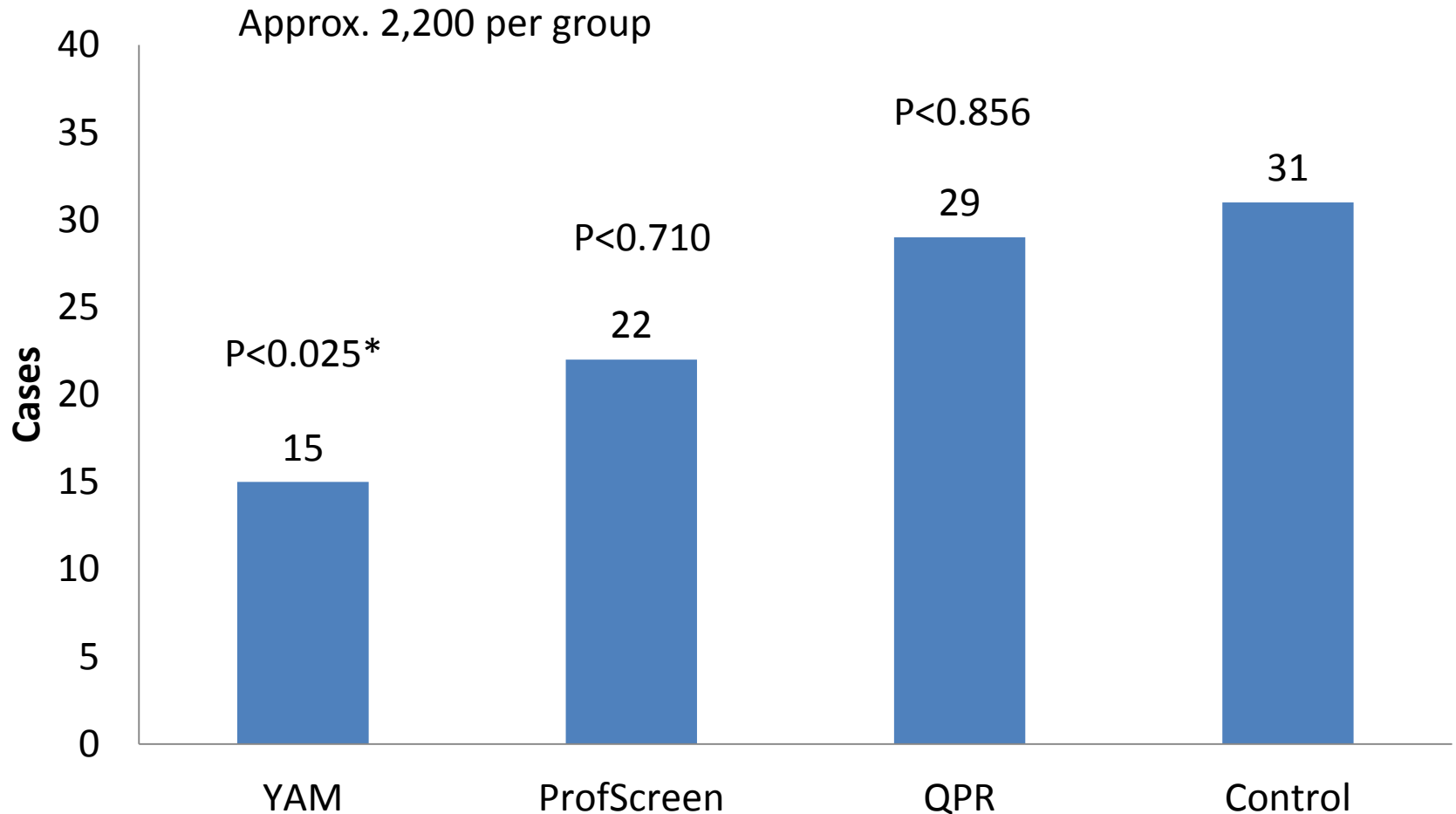
[www.y-a-m.org](http://www.y-a-m.org)

# Suicide Attempts at 12 Months



Wasserman et al, Lancet 2015

# Severe Suicidal Thoughts at 12 Months



Wasserman et al, Lancet 2015

# Project 2. Enhancing Youth Mental Health Resiliency with YAM

- Uncontrolled trial of YAM in 11 Montana and 4-5 Texas schools
- First group in the U.S. to have access to YAM
- Primary goal: assess feasibility/acceptability of YAM in Montana/Texas for next-step “definitive” study
  - Adapt YAM to 3 Montana youth cultures



# Update on YAM Project

- 11/11 schools in Montana
- 15 facilitators in training this week!
- Cultural adaptations underway
- Start feasibility/acceptability study in fall
- Planning underway for next-step, definitive studies

# Immediate Return on Investment: Montana Jobs

- Hiring for projects
- New sector for [Neuralynx-EEG-fNIRS](#)  
(\$60,000/unit - expected sales over \$5 million)
- SiteOne's build out of the company in MT

# Long-Term Return on Investment: Montana Jobs

- FDA approval of SiteOne agent could lead to multi-billion \$ revenue
- SiteOne and Neuralynx experience could spur additional MSU-biotech collaborations
- Alzheimer's trial at Western Montana Mental Health Center in Butte will create expertise in dTMS treatment for Alzheimer's disease
- New federal grant applications

# Address Montana issues/needs – solve Montana Problems with Montana solutions

- Address mental health needs
- Use academic, private, clinical program collaboration
- Support the development of the CMHRR