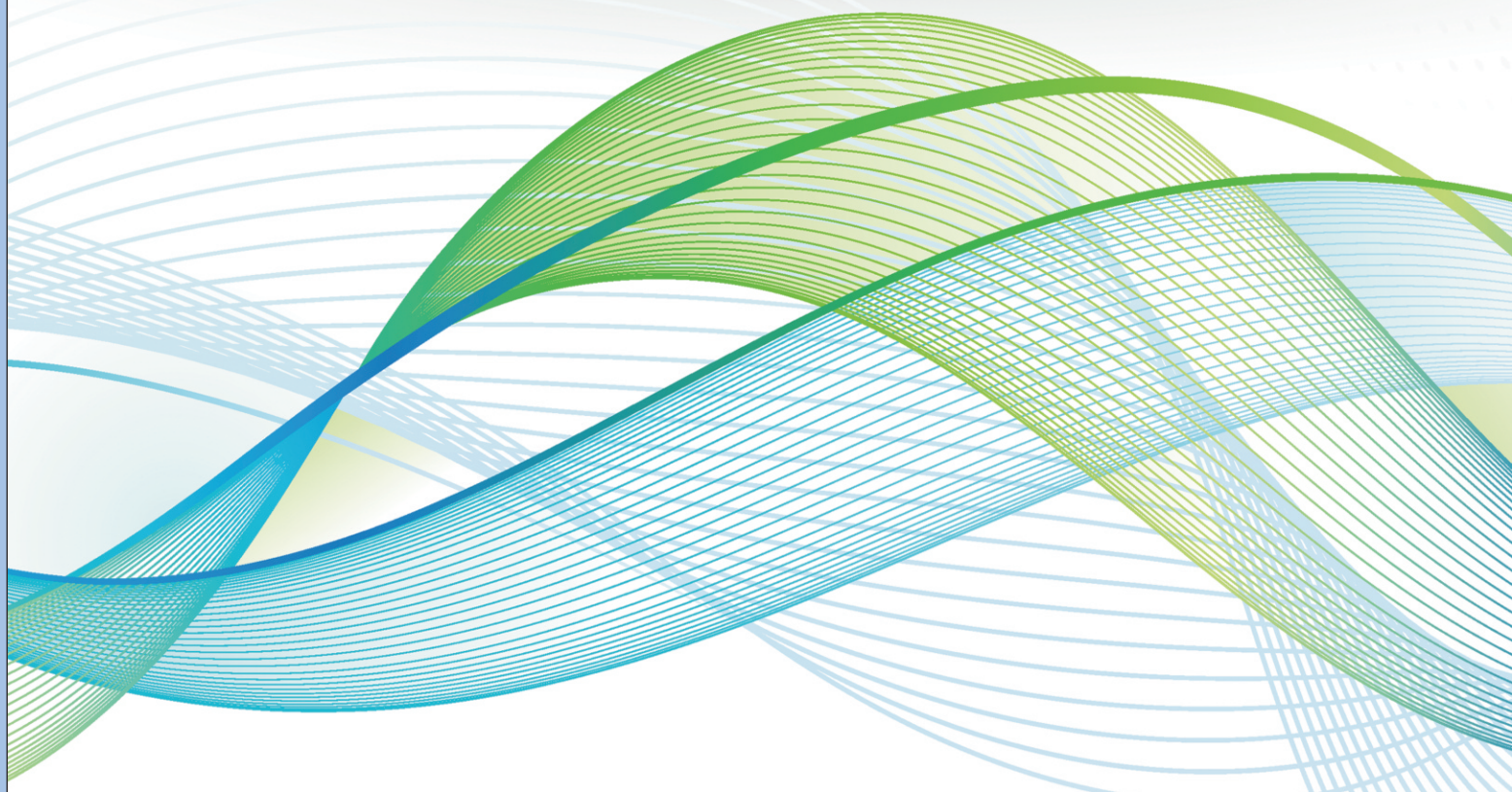

Bionanotechnology for Public Security and Environmental Safety

West Virginia **EPSCoR** Strategic Plan for RII Implementation **2010-2015**

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Acronyms

BRF	Bioengineering Research Facility
CI	Cyberinfrastructure
CTC	Community and Technical College
ELT	Executive Leadership Team
ETAB	External Technical Advisory Board
GFP	Graduate Fellowship Program
HPC	High Performance Computing
IRT	Interdisciplinary Research Team
LA	Learning Assistants program
MU	Marshall University
PUI	Predominantly Undergraduate Institution
RCF	Research Challenge Fund
SCF	Shared Computing Facility
TREK	Teacher Research Experience for advancing Knowledge
UREP	UnderREPresented Populations
WV	West Virginia
WVSU	West Virginia State University
WVU	West Virginia University

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West Virginia Strategic Plan for RII Implementation

A. Executive Summary

Introduction

Prior investments by NSF and the State of West Virginia in researchers and instrumentation have built a base competency in nanoscience through support of WVNano, the State of West Virginia's initiative for nanoscale science, engineering, education, and workforce and economic development. West Virginia University, Marshall University and West Virginia State University partnered with the WVEPSCoR office and external advisors to develop a program that would build upon prior investments and propel the West Virginia research enterprise forward in bionanotechnology.

In 2010, West Virginia was awarded a $20 million cooperative agreement with the National Science Foundation to develop national recognition for strong research and discovery in bionanotechnology for public security and environmental safety.

Strategy: The RII program is directed toward a number of complementary activities to enhance the competitive position of WV S&T to the benefit of its citizens. Specific infrastructure investments include:

1. Investing in Interdisciplinary Research Teams (IRTs) through new hires and advanced equipment to design and fabricate the critical components for next-generation devices to exploit opportunities in molecular recognition and cell-based platforms. The IRTs will serve as a model for interdisciplinary efforts across multiple WV institutions and we are building a cyber-enabled network of scientists and engineers.
2. Seeding new research opportunities in cellular biology. This research investment is helping leverage established and ongoing state and federal investments in bionanotechnology, thereby providing tools to explore cells and their environment at the nanometer scale. It is also providing a robust opportunity for student training in state-of-the art research experiences.
3. Enhancing student and faculty diversity by implementing a system-wide diversity action plan, the core of which is a WVI3 (Innovation through Institutional Integration) Think Tank which is bringing together key scientists and educators to direct, integrate, and fill gaps in currently funded K-20 programs.
4. Providing workforce training and development opportunities to a diverse group of students and institutions through a new PUI/CTC Incubator, piloting a business-science M.S. program, and engaging the private-sector through internships and entrepreneurial coursework.
5. Enhancing CI by providing researchers with advanced tools to predict nanoscale behavior. This activity is complementing the EPSCoR Track II (RII-T2) award, linking human resources in the state to leverage their intellectual capital.
6. Improving science teacher retention and competency through a pilot program, Teacher Research Experience for advancing Knowledge tied to research activities; recruiting teachers through a Learning Assistants program ; and providing underrepresented minority, disabled persons, first-generation college students and women the tools to be successful in future careers through a new graduate fellowship program.

Collectively, these initiatives will strengthen the State's human resource base and provide needed tools to create integrated devices that will advance ongoing biometric identification efforts for public security, detect environmental toxins, and explore how cells can be used as a platform for more advanced diagnostic devices with private sector engagement.

Previous RII and state investment positioned WV to focus on bionanotechnology as a platform for future R&D. WV's investment in tools and human resources to build a bionanotechnology platform will advance 1) next-generation public security research, supporting state leadership in molecular recognition; 2) field deployable technology to promote environmental stewardship in support of green growth of WV's energy intensive economy; and 3) nanoscale cell-based devices that can be used to explore cellular responses to the environment. The WVNano Initiative, a State-wide organization enabled by the 2006 RII grant, coordinates the major scientific and educational activities and will be the catalyst for the Center's creation. The current effort is serving as the foundation for a sustainable, externally funded Center of research excellence in bionanotechnology benefiting from the State's established and emerging research and education programs in biometrics, nanotechnology, forensic science, and molecular biology at WVU, MU, and WVSU. Best practices will arise from a careful assessment of the program, and through dissemination will help transform, not only WV, but also other regions of the U.S. to move competitively into the future.

Vision

Within five years, the West Virginia RII program will build a nationally recognized and sustainable statewide center in Bionanotechnology for Public Security and Environmental Safety.

Mission

The West Virginia RII program will build the necessary human and physical research infrastructure and the needed educational and training programs to create a statewide center in Bionanotechnology for Public Security and Environmental Safety to advance a biotechnology platform consisting of:

1) Next-generation public security research, supporting state leadership in molecular recognition;
2) Field deployable technology to promote environmental stewardship in support of sustainable growth of WV's energy intensive economy; and
3) Nanoscale cell-based devices that can be used to explore cellular responses to the environment.

Alignment with State S&T Priorities

In FY2005, WVEPSCoR led academic and business leaders in the development of the state's Science &Technology (S&T) strategic plan, *Vision 2015*. The plan names identification sciences and bionanotechnology as two key industries for development in WV. Under the bionanotechnology umbrella, *Vision 2015* directs attention to developing public security and environmental safety technologies. The West Virginia RII program addresses these priorities in *Vision 2015* and will contribute to the economic development of the state.

The WV RII program provides the necessary infrastructure to stimulate innovative research and integrated education, workforce development and diversity programs around a platform of bionanotechnology for enhanced public security and environmental safety. Success will enhance the competitiveness of WV academic institutions and help transform the economy, creating new employment opportunities in the state.

Overview of Strategic Plan

This RII supports a number of integrated activities to enhance the competitive position of WV Science and Technology. Specific infrastructure investments include: 1) investing in Interdisciplinary Research Teams (IRTs) through new hires and advanced equipment to design and fabricate critical components for next generation devices to exploit opportunities in molecular recognition and cell-based platforms; 2) seeding new research opportunities in cellular biology to leverage established and ongoing investments in bionanotechnology, thereby providing tools to explore cells and their environment at the nanometer scale; 3) enhancing student and faculty diversity by implementing a system-wide diversity action plan, the core of which is a WVI3 Think Tank charged with bringing together key scientists and educators to direct, integrate, and fill gaps in currently funded K-20 programs; 4) providing workforce training and development opportunities to a diverse group of students and institutions through a new PUI/CTC Incubator, piloting a business-science M.S. program and engaging the private-sector through internships and entrepreneurial coursework; 5) enhancing cyberinfrastructure (CI) by providing researchers with advanced tools to predict nanoscale behavior; 6) improving student retention and science teacher recruitment and competency through a pilot program, Teacher Research Experience for Advancing Knowledge (TREK) and a Learning Assistants (LA) program tied to research activities; and 7) providing underrepresented minority, disabled persons, first-generation college students and women the tools to be successful in future careers through a new graduate fellowship program. To enhance research activities and move toward a Center, regional collaborations are being strengthened with universities and centers of excellence with complementary strengths and needs, such as NIOSH, Carnegie Mellon University, and the NSF-IUCRC, Center for Identification Technology Research, and its affiliates, e.g., DoD the FBI, and various industrial partners.

The WV RII project is congruent with the WV Science and Technology Strategic Plan, *Vision 2015*. Particularly, the outcomes of this investment in the West Virginia research enterprise will address several of the goals of that plan including building a nationally competitive research cluster, developing intellectual property that will help build tech-based businesses, and increasing STEM student retention (emphasizing broadening participation) and increasing STEM doctorates awarded.

Process

RII participants (including the leadership team and faculty) and members of the WV Science and Research Council met on November 3 and 4, 2010 at the WVU Alumni Center in Morgantown, WV to develop a strategic implementation plan for the WVEPSCoR RII project. Dr. Kevin DiGrigorio facilitated the strategic planning process and NSF Program Officer Dr. Maija Kukla was also present to observe and provide advice. After review and editing, and approval of the Science and Research Council, the WV RII Strategic Implementation Plan was provided via email to Dr. Kukla on February 2, 2011.

The Strategic Plan which follows is organized in sections that follow the proposal which was submitted by WVEPSCoR: Research (IRT 1, IRT2, IRT2 and Human and Physical Infrastructure), Diversity, Workforce Development, Cyberinfrastructure, External Engagement, Evaluation and Assessment, Sustainability, and Management. For each section, one or two Strategic Priorities were developed. For each Strategic Priority, groups of participants worked together to develop the plans that would allow them to reach the objective. They also developed a set of provisional metrics (Appendix B) that would allow evaluation of success and milestones (Appendix A) to gauge progress.

Strategic Priorities

Research:

IRT 1 - PORTABLE AND RAPID IDENTIFICATION PLATFORMS

IRT 1 targets approaches and component technologies that address key barriers to creating rapid, portable DNA analysis needed for biometric applications. To enable rapid and portable microfluidic systems capable of identifying humans by DNA fingerprinting, IRT1 is developing critical components: rapid PCR with nanofluidic/microfluidic interface (NMI) concentrators and photonic crystals (PhC) for sensitive and integrated fluorescence detection.

Strategic Priority: Develop rapid and portable microfluidic systems capable of identifying humans and pathogens based on unique DNA signatures while training students and post-docs in these research areas. Responsible party: IRT1 Leader, Jeremy Dawson

Plans

- Integrate modular components for cell lysis, DNA extraction, separation and optical detection technologies
- Validate bench-top, PCR-based detection and fingerprinting of human and pathogenic DNA
- Develop and optimize microfluidic interfaces
- Refine application-specific rapid, high-resolution electrophoretic DNA separation
- Integrate nanophotonic structures for optical detection of DNA markers into microfluidic architectures
- Collaborate with other regional centers as needed and appropriate
- Educate and train post-docs, PhDs and other students

IRT 2 - FIELD-DEPLOYABLE MICROFLUIDIC ELECTROCHEMICAL SENSORS FOR MULTIPLEXED DETECTION OF HEAVY METALS AND SMALL MOLECULE TOXINS

The goal of IRT2 is to develop the fundamental scientific knowledge and engineering approaches required to fabricate a highly sensitive, selective, and portable field-deployable microfluidic electrochemical sensor for heavy metals (Hg, Pb and As) and pesticides/herbicides (malathion, atrazine, propanil). This sensor will eventually achieve detection and analysis time comparable or better than commercial large-scale analytical instruments. The IRT's approach will leverage a sensor element and signal transduction device, developed by Wu and co-workers at WVU that are sensitive and analyte specific.

Strategic Priority: Develop lab-on-a-chip devices for detection of environmental toxins and extend to clinical diagnostic tools while training students and post-docs in these research areas. Responsible Party: IRT2 Leaders Nick Wu and Pete Gannett

Plans

- Develop aptamer selection methods for environmental toxins
- Optimize molecular recognition probe (aptamer/protein/antibody, binding mechanism of detection)
- Develop and optimize nanoelectrode arrays (NEA) for lab-on-a-chip devices
- Fabricate and optimize microfluidic systems for blood-target separation and analyte capture
- Develop a modular system for on-chip fluids control
- Integrate and test devices
- Develop lab-on-a chip devices (for example, for high-throughput drug screening, cancer marker detection, heavy metal detection)

RESEARCH: IRT 3 - EX VIVO AND IN VITRO BIOMIMETICS FOR CELLULAR RESPONSE MONITORING

The goal of IRT 3 is to develop groundwork for a cell-based sensor platform that seeks to replicate the complexity of cell behavior in a chip-based component. These cell-based sensors will advance analytical investigations beyond composition to determine fundamental effects of materials in the environment. To achieve these goals, microfluidic technology that supports in vitro (from cultured cells) and ex vivo (from fresh biopsies) culture will be developed and combined with optical microscopy and downstream integrated nanosensors for analysis of cells that naturally grow in vivo as monolayers.

Strategic Priority: Develop microfluidic cell-based platforms to assess real time physiological responses to external agents and stimuli while training students and post-docs in these research areas. Responsible parties: Yon Rojanasakul at WVU, Elmer Price at MU

Plans

- Design and fabricate microfluidic chips for the growth and study of epithelial or endothelial monolayers
- Develop extracellular matrix (i.e. fibronectin), antibody-coated or surface- derivatized growth areas (MU and WVU)
- Grow cell lines and primary cultures on chips to optimize function and longevity
- Optimize functional assays (NO release for endothelial cells, transepithelial barrier properties, calcium transients or mucus release for epithelial cells)
- Determine the effects of nanoparticles and toxins on monolayer properties
- Integrate chips into instruments for optical and electrical detection and downstream sensors

HUMAN AND PHYSICAL INFRASTRUCTURE

Strategic Priority: Increase research capability by strategic faculty hiring and investment in advanced instruments. Responsible Parties: John Maher (MU), Curt Peterson (WVU), Ulises Toledo (WVSU)

Plans

- Hire faculty with expertise in organismal development (MU)
- Hire faculty with expertise in molecular mechanisms underlying cellular differentiation (MU)
- Purchase and install advanced genome sequencer (MU)
- Hire faculty with expertise in computational biology (WVSU)
- Purchase and install a suite of shared equipment – HPLC, GC-Mass Spec, protein analyzer, light scanner, microprobe (WVSU)
- Purchase and install 576 cores to expand the Shared Computational Facility (SCF) (WVU)
- Purchase and install suite of shared equipment in BRF (WVU)

Diversity

WVEPSCoR's diversity plan is initially designed to address student retention issues of underrepresented populations in the STEM enterprise. As WV is an unusually ethnically homogenous state (< 5% minority), its underrepresented populations (UREP) include minorities, women, persons with disabilities, first-generation and/or economically disadvantaged students. WVEPSCoR has established working relationships with state leaders and key diversity recruitment and retention programs on partner campuses including CTCs. Through an ongoing team approach, diversity strategies and initiatives will be conducted, supported and evaluated throughout the project to ensure use of best practices and that benchmarks and milestones are met.

Strategic Priority: Increase undergraduate UREP student retention rates in STEM degrees to achieve the same completion rates as majority students. Responsible parties: Brittan Hallar (WVEPSCoR), Tina Cartwright (MU), Aniketa Shinde (WVU), Dedrielle Taylor (WVSU)

Plans

- Determine and categorize the baseline level of UREP STEM students
- Collect data on barriers, gaps, and best practices for UREP STEM student retention
- Periodically disseminate successful programs throughout the state with state-wide coordination through WVI3 Think Tank and Chancellor's Diversity Initiative
- Leverage WVI3 and CDI Council to form campus networks and a Statewide network to foster communication and collaboration between campuses, communities, and industry throughout West Virginia

- Involve PUIs and CTCs in learning about best practices to increase UREP STEM student retention at their respective institutions
- Secure new external funding to implement academic support programs at our institutions that enhance student success and increase UREP STEM student retention
- Involve UREP undergraduate students in science research, targeting IRT projects while not excluding other research projects
- Periodically identify existing institutional support programs (HELP Center, others) and utilize them to enhance student retention as appropriate
- Create a statewide reporting system or assessment tool for UREP students in STEM

Workforce Development

Through this RII, WVEPSCoR is complementing the Governor's investments in workforce development (WFD) by focusing on building a diverse workforce in STEM fields, specifically in bionanoscience and biotechnology. WV's objective is to increase technically competent graduates from the state's colleges, universities and community colleges.

Strategic Priority: Increase the annual number of STEM graduates from the state's colleges, universities, and community colleges. Responsible parties: Paul Hill (WVEPSCoR), John Maher (MU, Curt Peterson (WVU) , Ulises Toledo (WVSU)
Plans

- Create a "workforce development plan" for STEM fields focusing on nanobio science and biotechnology (HEPC)
- Implement Summer Teacher/Student Research Program (TREK) (MU, WVSU, WVU)
- Continue support of PROMISE and HEG Scholarships (HEPC)
- Create PUI/CTC Incubator Program (MU, WVSU, WVU)
- Design and implement MS/Business degree (MU, WVSU)
- Implement Summer Institutes for HPC (also under CI)
- Implement Graduate Fellowship Program (WVU)
- Implement Learning Assistant (LA) Program (MU, WVSU, WVU)
- Strengthen articulation agreements between CTCs and colleges and universities

Cyberinfrastructure

CI efforts will support both broad CI goals and specific objectives of Vision 2015 which encourages deployment of sustainable resources and expansion of advanced network infrastructure, enhanced HPC and data storage resources, acquisition of inter-institutional collaboration tools, and development of advanced applications and tools for the research community. Expansion of the Shared Computational Facility will allow increased computational and modeling integration into RII research and will establish the path for future growth of CI-enabled research and discovery. It will also serve as a magnet for future computational research group hires.

Strategic Priority:: Increase discovery and innovation through computational research and the collaboration of theoretical, experimental, and computational researchers. Responsible party: James Lewis

Plans

- Integrate seamlessly with RII Track 2
- Build CI-enabled shared facilities
- Manage a moderately sized HPC cluster to enable computational research
- Sustain resources via increased research competitiveness
- Enable a sustainable CI workforce by offering HPC-related Summer Institutes, system-wide faculty mentoring, and campus-level HPC specific workshops
- Link instrumentation remotely using CI
- Create a virtual science collaboratory

External Engagement - Outreach, Communication and Dissemination

The overall goal of WVEPSCoR's Outreach, Communication and Dissemination Plan is to effectively communicate results, benefits and processes of science to WV's citizens at all education levels. These efforts will help build scientific literacy in the state and strengthen education and research capacity.

Strategic Priority: Communicate and disseminate the importance, outcomes, and innovations from the RII and other STEM activities to West Virginia stakeholders, policy makers, and citizens. Responsible party: Kelly Merritt (WVEPSCoR)

Plans

- Continue publication of the Neuron
- Bring in Nanooze-The Exhibition and create ancillary learning activities to extend the experience into the classroom
- Develop a regional edition of the Nanooze magazine
- Advertise in the statewide business magazine, WV Executive
- Continue the biennial statewide STaR Symposium
- Enhance DSR website with a "Discovery" tab highlighting findings of WV researchers
- Create a Press Room on the website to facilitate media access to information
- Contract with MetroNews Radio Networks or other venues for a year-long statewide radio campaign to increase awareness of the benefits of the research in this proposal and others
- Communicate regularly with NSF EPSCoR via telephone, email and/or personal meetings to coordinate NSF involvement in Outreach and Communication activities

Evaluation and Assessment

Success in the RII program will be measured through a variety of mechanisms all nucleated around a comprehensive evaluation and assessment plan utilizing qualitative and quantitative approaches to provide both formative feedback and summative assessment. Process use (self-assessment, collective knowledge generation and collaborative action) will encompass institutional perspectives and will create a learning process for the management team that will help build capacity, sustainability and institutionalization. The management team will be actively engaged in identifying the information needed to make decisions, and in interpreting and using the evaluative data. The management team will respond to external evaluation and External Technical Advisory Board (ETAB) and focus on how recommendations will be incorporated into practice along with a timeframe for the appropriate actions.

Evaluation findings will be used by the project's management team to inform processes and practices, decrease barriers to research competitiveness and develop strength for the formation of intra/interjurisdiction collaborations to address scientific issues of regional relevance and national importance.

Strategic Priority: Provide both formative feedback and summative assessment of overall program implementation, milestones, benchmarks, and deliverables. Responsible party: Rose Shaw

Plans

- Refine and expand the comprehensive evaluation and assessment plan with input from the grant leadership
- Integrate recommendations of the external evaluation and the External Technical Advisory Board (ETAB) to inform processes and practices and decrease barriers
- Collect and provide metric data to NSF and stakeholders
- Develop uniform data collection protocols
- Utilize the existing metric collection and reporting system (GO!)

Sustainability

Infrastructure improvements will be sustained through: 1) human infrastructure and equipment secured by State [RCF ~$4M annually and RTF] and university funds; 2) continuing efforts to increase the RCF; 3) increasing number and competitiveness of individual, group and large-scale, multidisciplinary proposals from all faculty, research clusters and partners; 4) building stronger research collaborations; 5) setting up university-wide undergraduate research education offices; and 6) setting up a post-doc and junior faculty mentoring system that will increase success of all faculty. Cyber-enabled mentoring and continued implementation of Vision 2015 will improve policies, and financial and infrastructure support for workforce and research enterprise. The BRF and Cyber Facilities will be sustained as part of the WVNano Shared Facilities. A senior faculty member will be hired at WVU to be permanent WVNano director, will be sustained by the university and lead the transition of the program to Center status.

Strategic Priority 1: Sustain and advance the state-wide infrastructure improvements in bionanotechnology beyond the duration of the RII. Responsible parties: Paul Hill (WVEPSCoR), John Maher (MU), Curt Peterson (WVU), Ulises Toledo (WVSU)

Plans

- Secure human and physical infrastructure, including equipment, by State (RCF ~$4M annually and RTF) and university funds
- Double the percentage of state video lottery funds dedicated to the RCF
- Increase the number and competitiveness of individual, group and large-scale, multidisciplinary proposals from all faculty, research clusters, and partners
- Promote stronger research collaborations among various institutions
- Set up university-wide undergraduate research education offices
- Set up a post-doc and junior faculty mentoring system that will increase success of all faculty

Strategic Priority 2: Develop additional competitive research areas through seed funding of new ideas related to the focus of the RII and through developing an emerging area of interdisciplinary research in cell biology and biotechnology. Responsible parties: Elmer Price (MU), David Lederman (WVU), Tim Ruhnke (WVSU)

Plans

- Hold annual competition for seed funding
- Develop junior faculty through mentoring and grantsmanship training
- Purchase and install advanced instrumentation at Marshall and West Virginia State Universities
- Develop collaborative research between Marshall and West Virginia State faculty.

Management

Strategic Priority: Provide leadership oversight and resources and ensure timely completion of milestones and deliverables through a multi-level management approach. Responsible party: Paul Hill (WVEPSCoR)

Plans

- Operate a multi-level management team with defined roles and responsibilities
- Conduct quarterly Science and Research Council Meetings to review major areas of project progress
- Conduct quarterly Executive Leadership Team meetings to review budget milestones and deliverables and provide feedback
- Conduct reverse site visit
- Solicit feedback from faculty and staff involved in project and use to evaluate and modify plans and activities
- Conduct annual ETAB program evaluation and use results to modify plans and activities

Plan Revision

This strategic plan will be modified as needed throughout the course of the project, including revising activities, goals, and metrics based on experience and learnings to best fulfill the Vision and Mission.

We will conduct an Annual Review of the entire Strategic Plan with the full team.

Each team will meet at least quarterly to review and revise plans and will disseminate results, updates, and changes in Quarterly Reports.

Anticipated Impacts of the RII

This RII will not only advance technology important to national security, but also provide significant research and education experiences for a diverse group of students, post docs, high school teachers and institutions in the state. Research discoveries, education and workforce development programs will enhance the prosperity of the state and the nation by preparing our citizens for the increasingly knowledge-based economy. Existing and developing partnerships with small technology companies, large industry and government agencies such as DoD ensure that discoveries will be applied beneficially to the problems of the state and nation.

APPENDIX A

MILESTONES

Solicitation area Research	Year 1	Year 2	Year 3	Year 4	Year 5
Research IRT 1	1. New partners and collaborators identified 2. Proof of concept for component technologies begun	1.Proof of concept for component technologies completed 2. Successful component demonstration with sponsor-identified targets	1. Agreements with partners/sponsors for cooperative research and research initiated	1. Successful component integration into functional subsystem 2. Agreements with partners/sponsors for cooperative research and research initiated	1. Successful integration of modules into system-level architecture 2. System-level functionality achieved 3. Tech transfer plan developed
Research IRT 2	1. Aptamer selection method selection method begun 2. Development of nanoelectrode arrays begun 3. Fabrication of microfluidic systems begun		1. Aptamer selection methods developed for environmental toxins 2. Nanoelectrode arrays developed and optimized 3. Microfluidic systems for blood-target separation and analyte capture fabricated and optimized		1.Modular system of on-chip fluids control developed 2. Lab-on-chip devices developed and successfully tested.
Research IRT 3	1. Microfluidic chip design begun 2. Fluidic condition experiments for long-term cell culture begun	1. Microfluidic chips designed and fabricated for growth/study of epithelial/endothelial monolayers 2.Successful integration of electrodes into microfluidics chips for Transepithelial Electrical Resistance measurement (TEER) (WVU)	1. Successful integration of NO probes into microfluidic chips for NO release quantification (MU) 2. Successful integration of chips into fluorescence microscope platform for real time NO detection in fluorescently-labeled live cells		1. Fluidic conditions for long-term culturing of cells in chips optimized 2. Approaches for high-throughput TEER measurement optimized (WVU) 3. Effects of nanoparticles and toxins on cell monolayers quantified as function of toxin concentration.

Solicitation area Research	Year 1	Year 2	Year 3	Year 4	Year 5
			3. Conditions for NO and TEER measurement for endothelial and epithelial cells optimized 4. Cellular function successfully correlated with cell-specific biomarkers		4. Biophysical parameters of test agents determined 5. Microchips successfully integrated with optical and down-stream sensors
Human and Physical Infrastructure	1. Genome sequencer installed and operational (MU) 2. Cell biology instrumentation installed and operational (WVSU)	1. Organismal development faculty hired (MU) 2. Computational biology faculty hired (WVSU)	1. Molecular mechanisms faculty hired (MU) 2. Shared bioengineering research facility completed (WVU) and operational		1.Shared computational facility upgrade completed and operational
Diversity	1.WVI^3 Think Tank Advisory Board created and active 2. Baseline data for underrepresented (UREP) STEM students collected 3. Data on existing campus programs for UREP STEM students collected.	1.Campus networks of UREP STEM programs created and coordinated 2. Statewide network of campuses and industry created and active 3. At least one external grant funded for supporting UREP STEM retention 4. Report on UREP STEM students and programs completed and distributed to institutions.	1. Progress of institutional change supporting UREP student retention tracked. 2. Comprehensive diversity plan implemented		1. Retention data for STEM students through graduation, workforce, grad school collected and analyzed. 2. System-wide reporting mechanism for STEM UREP students and programs developed and implemented successfully

Solicitation area Research	Year 1	Year 2	Year 3	Year 4	Year 5
Diversity Cont.		5. Comprehensive diversity plan developed 6. Think Tank recommendations on supporting and improving UREP STEM student retention and programs provided to institutions			
Workforce Development	1. Workforce Development Committee developed and convened 2. RFP for PUI incubator released 3. PUI Incubator Grant awarded 4. MS/business emphasis degree program designed 5. Campus Education Coordinators hired 6. Three new courses developed and scheduled for TREK teachers 7. Teachers and students successfully recruited for TREK 8. Research plans developed and implemented for TREK teachers	1. STEM workforce development plan developed 2. PUI Incubator Grants awarded 3. MS/business emphasis degree program implemented 4. Teachers and students successfully recruited for TREK 5. TREK implemented 6. LA participants and faculty successfully recruited and trained 7. LA program Implemented 8. Graduate Fellows recruited and fellowships awarded	1. PUI Incubator Grants awarded 2. Teachers and students successfully recruited for TREK 3. TREK implemented 4. LA participants and faculty successfully recruited and trained 5. LA program implemented 6. Graduate Fellows recruited and fellowships awarded	1. PUI Incubator Grant awarded 2. Teachers and students successfully recruited for TREK 3. LA participants and faculty successfully recruited and trained 4. LA program implemented 5. Graduate Fellows recruited and fellowships awarded	1. Teachers and students successfully recruited for TREK 2. TREK implemented 3. LA participants and faculty successfully recruited and trained 4. LA program implemented

Solicitation area Research	Year 1	Year 2	Year 3	Year 4	Year 5
Workforce Development Cont.	9. Approval of education plans by campus IRBs 10. Baseline data collected for TREK and LA programs 11. Pedagogy course developed for LA participants 12. LA participants and faculty successfully recruited and trained 13. Graduate Fellows recruited and fellowships awarded				
Cyber-infrastructure	1. Summer Institute for HPC developed 2. First 128 nodes for Share Computing Facility (SCF) installed	1. Summer Institute for HPC held 2. Next 128 nodes (funded by RII Track 2) installed 3. Campus research-specific HPC workshops held 4. Suitable instrumentation remotely linked via CI 5. Virtual Science Collaboratory created and in use	1. Summer Institute for HPC held 2. Next 64 nodes installed 3. Campus research-specific HPC workshops held	1. Summer Institute for HPC held 2. Next 128 nodes installed 3. Campus research-specific HPC workshops held	1. Summer Institute for HPC held 2. Final 192 nodes installed 3. Campus research-specific HPC workshops held

Solicitation area Research	Year 1	Year 2	Year 3	Year 4	Year 5
External Engagement	1. The Neuron published quarterly 2. RII Ads published in WV Executive magazine 3. STaR Symposium held 4. Press Room created on DSR website	1. The Neuron published quarterly 2. Discovery tab highlighting WV research created on DSR website 3. Statewide radio campaign with RII research spots implemented	1. The Neuron published quarterly 2. Nanooze-The Exhibition brought in to tour WV schools 3. Regional Nanooze magazine created and distributed 4. STaR Symposium held	1. The Neuron published quarterly 2. Regional Nanooze magazine published and distributed	1. The Neuron published quarterly 2. Regional Nanooze magazine published and distributed 3. STaR Symposium held
Evaluation and Assessment	1. Comprehensive evaluation plan refined and expanded 2. Recommendations provided to leadership and external advisors 3. Uniform data collection protocols developed 4. Evaluation data collected	1. Recommendations provided to leadership and external advisors 2. Evaluation data collected	1. Recommendations provided to leadership and external advisors 2. Evaluation data collected	1. Recommendations provided to leadership and external advisors 2. Evaluation data collected	1. Recommendations provided to leadership and external advisors 2. Evaluation data collected
Sustainability	1. Post-doc mentoring program established 2. Inter-university collaborations established 3. Grantsmanship training implemented	1. State lottery funds dedicated to the Research Challenge Fund doubled 2. University-wide undergraduate research offices established 3. Junior faculty mentoring program implemented	1. Inter-university collaborative proposals submitted	1. Inter-university collaborative proposals submitted 2. Inter-university collaborative proposals submitted	1. Inter-university proposals funded 2. Inter-university collaborative proposals submitted

Solicitation area Research	Year 1	Year 2	Year 3	Year 4	Year 5
Management	1.Quarterly Science and Research Council meetings held 2. Quarterly ELT meetings held 3. Evaluator's recommendations implemented 4. Quarterly campus visits conducted	1.Quarterly Science and Research Council meetings held 2. Quarterly ELT meetings held 3. Reverse site visit successfully concluded 4. ETAB program evaluation held 5. ETAB recommendations implemented 6. Evaluator's recommendations implemented 7. Quarterly campus visits conducted	1.Quarterly Science and Research Council meetings held 2. Quarterly ELT meetings held 3. ETAB program evaluation held 4. ETAB recommendations implemented 5. Evaluator's recommendations implemented 6. Quarterly campus visits conducted	1.Quarterly Science and Research Council meetings held 2. Quarterly ELT meetings held 3. Reverse site visit successfully concluded 4. ETAB program evaluation held 5. ETAB recommendations implemented 6. Evaluator's recommendations implemented 7. Quarterly campus visits conducted	1.Quarterly Science and Research Council meetings held 2. Quarterly ELT meetings held 3. ETAB program evaluation held 4. ETAB recommendations implemented 5. Evaluator's recommendations implemented 6. Quarterly campus visits conducted

APPENDIX B

WVEPSCoR RII Metrics

(baseline is year one of the grant due to mismatch with faculty and projects in last grant)

Strategic Priority Area	Provisional Metrics	Baseline	5-Yr Target
Research	Number of peer-reviewed research publications	5	10
All IRTs and Sustainability Priority 2	Number of citations in nationally recognized peer reviewed research publications	TBD, citations will appear Yr 2	doubled
	Number of invited talks	8	15
	Employment of program graduates in academic, industrial, and government organizations	TBD, data collected Sept. '11	+50%
	Number and dollar value of extramural research grants awarded	$2.90M (18)	$5.80M (36)
	Number of scientific outreach and education grants awarded	$1.17M (1)	2.3M (2)
	Number of undergraduate degrees awarded	21	30
	Number of PhDs awarded	13	16
	Number of post-docs trained	2	8
	Number of undergraduates matriculating to graduate school	TBD, data collected Sept. '11	+25%
	Number of invention disclosures	3	+50%
	Number of patents	2	3
Human and Physical Infrastructure	Successful faculty hiring when planned	faculty hires completed Yr 2&3	New hires retained
	Timely installation of equipment		Equipment installed in Yrs 1-3
Diversity	Graduation rates for UREP students in STEM	Fall 2009 enrollment: 847	At the same rate as their majority counter-parts
	UREP students participating in LA program	Fall 2011 data	50% of LAs
	Completion rates of UREP students receiving a C or better in LA-supported courses	Fall 2011 data	90%
	Grant submitted to support UREP STEM student retention	1	2
	Number of participating PUIs and CTCs participating in statewide UREP STEM student retention initiatives	TBD Year 2	TBD
	Number of UREP undergraduate students in IRT project research	1	5
	A statewide reporting system or assessment tool for UREP students in STEM	0	developed and in use
Workforce Development	Number of new courses developed (TREK, LA, GFP)	0	4

Strategic Priority Area	Provisional Metrics	Baseline	5-Yr Target
Workforce Development Cont..	Degree program developed (MS/Business)	0	2
	Number of persons completing TREK	30	120
	Number of persons completing LA Program	22	176
	Number of persons completing MS/Business degree	0	10/yr.
	Number of Graduate Fellows completing PhD	0	total 24 by yr 5
	Workforce Development Plan created	0	1
	Number of PUIs receiving PUI Incubator awards	1	total 4, by yr 5
	Number of proposals resulting from Incubator grants	0	8 by yr 5
	Number of awards resulting from Incubator grants	0	total 3 by yr 5
	Number of publications resulting from Incubator grants	0	5 by year 5
Participation by UREP (TREK, LA, GFP, MS/Business)	Number of graduate fellows mentored	6	total 30, byYr 5
	Employment/collaboration of program graduates at academic, industry and government organizations (GFP, MS/Business)	0	75%
	Number of Internships established (MS/Business)	TBD, begins Yr 2	10
Cyberinfrastructure	Increase in the overall number of computational community members	6	50
	Increase in the number of interdisciplinary computational/experimental grants	3	10
	Increase in the number of interdisciplinary computational/experimental publications	3	10
	Amount of hardware resources obtained beyond those provided by the RII	0	100%
	Increase in number of computational (only) grants	3	15
	Increase in number of computational (only) publications	4	20
External Engagement	Number of students participating in Nanooze exhibits	0	500
	Number of classrooms and students using ancillary learning activities	0	20/500
	Number of WV Executive readers	90,000	100,000
	Number of participants in STaR Symposium	135	200
	Listenership of WV MetroNews Radio Network	TBD, begins Yr 2	100,000

Strategic Priority Area	Provisional Metrics	Baseline	5-Yr Target
External Engagement Cont.	Number of unique and repeat visitors to DSR website, particularly to Discovery and Press Room	Unique IPs 20,639 Total Visitors 54,366 total visitors to new tabs 9,113	+25%
	Number of print and other media pieces on RII activities	16	24 in Yr 5
Evaluation and Assessment	External evaluator reports		annually
	On-site review summaries (ETAB reports)		annually
	Timely submission of program reports		annually
	Plans and activities modified in response to evaluations		annually
Sustainability Strategic Priority 1	Number of WV Nano shared facilities users, including internal and external users and those from academic, industrial, and government organizations	97	120
	Number of external users of shared facilities	5	10
	Number of academic users	94 (2 external)	115
	Number of industrial users	2	3
	Number of government users	1	2
	Number of proposals that include user fees for the shared facilities	11	all that make use of shared facilities
	Number of collaborative and interdisciplinary proposals submitted	5	10 annually
	Number and dollar value of awards obtained	$4.1M (19)	8.2M (38)
	Percentage of video lottery funds dedicated to RCF	0.50%	double
	Dollars per year available from RCF	$3.1M	$6.2M
	Creation of undergraduate research offices on all three campuses	yes	sustained
	Number and type of IP actions and commercialization	2	3 licenses /start-ups
Management	Budget expenditures on schedule and accurate	quarterly	
	Deliverables reported on schedule		annually
	Reverse site visit successful	yes	all successful
	ETAB program evaluations provided in writing and used by management and research teams		annually

APPENDIX C. WVEPSCOR RII RISK MITIGATION ANALYSIS MATRIX

Component	Condition	Consequence	Impact	Likelihood	Mitigation
Research – General	IRT management does not facilitate truly interdisciplinary work.	Research goals are not met, putting us in a less competitive position for advancing research and research funding. Although the research may be valid, it would not be research that really requires a group interdisciplinary environment to support.	Medium	High	Program management has increased mentoring of IRT leaders to improve communication and collaboration; however, unproductive and/or dysfunctional IRTs will require replacement of IRT leadership or termination of the IRT. Seed projects have been strategically selected to provide alternative research areas in case this happens.
IRT1: Traveling Wave Eletrophoresis (TWE)	TWE is not capable of performing high resolution DNA separations	DNA sensor would be missing central functionality	High	High	Use TWE for concentration and purification; Use thermally reversible thermo-gel as sole separation component
	Multi-layer TWE architecture is not structurally reliable	System prone to leakage and increased likelihood of failure	Medium	Medium	Develop single-electrode layer architecture
IRT1: Thermally reversible thermo-gel	Polymer gel exhibits large performance discrepancy dependent on base-pair-size range of input sample	Overall separation resolution dependent on sample type (human STRs vs. pathogen)	Medium	Low	Perform functional testing to optimize resolution for wide range of sample types
	Channel materials not compatible with other system component architectures	Increased system complexity Consequence	Low	Medium	Evaluate functionality in a variety of material system; Develop hybrid system with simple fabrication and high reliability
IRT1: Photonic crystal-based fluorescence enhancement	Enhancement in lattice defects not experimentally measureable	No improvement in limit of detection and associated number of PCR cycles needed	High	Medium	Utilize lattice surface as main enhancement mechanism

Component	Condition	Consequence	Impact	Likelihood	Mitigation
IRT 2: Aptamer selection	Refractive index of materials used for other system components does not create index contrast sufficient to set up optical bandgap necessary for enhancement	Functionality of molded lattice structures compromised	Medium	High	Evaluate molding process in wide range of microfluidic materials to determine those best for bandgap creation and system integration
	The actual realization of the computer-designed aptamer does not bind as predicted by the computer design.	Decrease in sensor specificity may render sensor less competitive with alternative technologies.	Medium	Medium	NMR measurements will be used to understand the nature of failure to bind. Because there are many aptamer conformations that differ very slightly, small changes in structure could resolve the problem. Though less novel, SELEX is a high-probability-of-success alternative.
IRT2: Nano-electrode Array IRT3: Cellular Sensors Component	To make dot size smaller and distance larger requires etching large spheres in the template used for nanoelectrode array fabrication; however, the spheres could be melted during etching.	Once spheres are melted during etching, desired dot size and inter-dot spacing cannot be obtained, and dot shape may be degraded. Only NEAs with large size and small distance can be fabricated. Sensitivity of the sensor will be diminished.	High	High	a. Reduce the power of plasma etching to lower the etching rate; b. Do not perform continuous etching. Instead, etch for a short period of time and then cool for a period of time. c. Develop a new etchant recipe. Mitigation
IRT3: Cellular Sensors (WVU)	Difficulty growing three-dimensional cell structures within the microfluidic channels	The sensor cannot be fabricated without the three-dimensional cell structures	Medium	High	Although ways of developing the cellular structures have been developed, they are time consuming and the epithelial cell layers produced are not always as continuous as required for the sensor to work. If we cannot decrease the time and increase the coherence, we will investigate bringing in a visiting research with expertise in this area to assist us in developing an alternative procedure.

Component	Condition	Consequence	Impact	Likelihood	Mitigation
IRT3: Cellular Sensors (WVU) Cont.					The research of the seed by Dinu and Rojanasakul proposes an alternate way of developing this sensor, and could be incorporated into IRT 3 to provide an alternate path to the final goal.
	Lack of novelty or breadth of detection	Will make it difficult to fund project and less useful to potential consumers	Medium	High	Will consult with NIOSH about the ideal configuration for the specific types of tests they believe are most important. This will help focus the effort and make the final device more marketable and useful to researchers and consumers.
IRT3 (MU)	Endothelial cells do not survive for a sufficient time frame	Device will not have an adequate "shelf life"	High	Low	Provide adequate pH control with buffers, rather than CO2 gas; provide slow circulation of media, rather than static incubation
	Endothelial cells will not respond to query substance	Device will not detect unknowns	High	Low	If cells do not respond directly to compound, develop a linked signal transduction based on engineered detectors (such as aptamers)
	Endothelial cells lack sufficient sensitivity	Device will not be superior to existing methods	Moderate	Moderate	Develop a means to amplify the signal, such as horseradish peroxidase conjugated antibody-based luminescence
Seed: Dinu/ Rojanasakul	A drop in resistance upon cell exposure to single walled carbon nanotubes can be attributed to both changes in cell morphology as well as cell death.	Hard to distinguish between the cell population undergoing morphological changes and cells undergoing apoptosis. This could lead to non-valid conclusions about nanotube toxicity.	High	High	Additional toxicity experiments will be performed. Specifically, cells will be incubated with single walled carbon nanotubes for 0, 12, 24, 48, and 72 h, subsequently stained using life and death cell assays and observed via fluorescence microscopy.

Component	Condition	Consequence	Impact	Likelihood	Mitigation
Seed: Dinu/ Rojanasakul Cont.	It can be difficult to determine the mechanisms of nanotube cellular uptake in real-time.	If we cannot distinguish between cellular uptake by piercing vs. by endocytosis, it will be difficult to develop strategies to mitigate the carbon nanotube toxicity and/or further pursue the mechanisms for specific toxicity.	High	High	Additional experiments will be performed using atomic force microscopy to determine changes in the cell morphology upon exposure. Cell morphology upon nanotube exposure will be compared with cell morphology of control samples. High morphological changes or "holes" into cell membrane would confirm cellular endocytosis.
Seed: Holland/ Sooter	Limitations in aptamer selection make the sensor applicable to a small number of steroidal compounds	Will limit the applicability of the sensor.	Medium	Medium	In related work, the PIs have found that the selection can be engineered to detect explosives in environmental samples, giving the project an alternative viable target that is also of great concern for security and environmental applications.
Emerging theme	Proposals are not competitive	Proposals are not funded	High	Moderate	Implement in-house and extramural pre-submission review
	Manuscripts not published	Grants will not be competitive		Low	Provide mentorship and teaching release for RII supported faculty
Collaboration and Visualization	Collaborative tools not responsive to community needs	Collaborative framework is underutilized	High	Medium	Insure that tool prototypes are demonstrated early and iteratively improved
	Collaborative tools are proprietary or not extensible	Collaborative framework is underutilized	High	Medium	Build on proven expertise, e.g., the Worktools experience and the CHEF team
	Feature creep in collaborative or visualization tool scope	Community requests for function exceed funding	Moderate	Low	Communicate feature set description and demonstrate working prototypes; document desired features not included and communicate them to the Consortium.

Component	Condition	Consequence	Impact	Likelihood	Mitigation
Faculty Hiring: Bioinformatics Professor (WVSU)	Hiring of this faculty member does not occur until 12-24 months later from original proposed date	Curriculum in bioinformatics is not available to students / Research and associated activities are not conducted as proposed.	Moderate	Medium	While this permanent faculty position is filled, the need can be temporarily met by hiring a post-doctoral employee to provide support to the proposed activities in relation to this position.
Two faculty (MU) Cellular/Molecular Mechanisms	Delays in hiring	Collaborations and research productivity metrics are not met	Medium	Medium	Add targeted recruitment to widely-advertised approach
Shared Facilities	Lack of ability to recover costs via user fees and cost share	Ability to retain staff and service contracts on instruments is jeopardized; sustainability is not achieved	Medium	High	Instituted new system for charging that takes direct costs into account for each instrument, including staff time, service contracts, consumables, and training. Will revise rates in October 2011 and project for rest of fiscal year to ensure sustainability.
Next Generation Sequencer (MU)	Insufficient funds to develop new users and projects	Investment in "field biology genomics" will not bear fruit	Medium	Moderate	Seek intramural and extramural funding
Cyber-infrastructure	Lack of users	Investment not fully utilized and computations nanomaterials community does not develop	Medium	Medium	Additional workshops will be scheduled to expose faculty to the enhanced CI, and to demonstrate that computational studies can be valuable to their research programs. Computational faculty hires in physics, chemistry and engineering in 2012 will help increase facility usage. Seed funding may be used to encourage collaboration between experimentalists and computational scientists.

Component	Condition	Consequence	Impact	Likelihood	Mitigation
Learning Assistants (LA)	An insufficient number of learning assistants are recruited.	The program cannot operate at full strength and thus its impact is muted, as not as many students are reached.	Medium	Medium	The Education/Outreach coordinators will increase efforts to work closely with the participating departments and faculty leader to ensure the selection of sufficient quality and quantity of students to staff the program. Recruitment strategies such as Society of Physics Students meetings, Association of Women in Science meetings, and other meetings of highly motivated undergraduates will be used.
	LAs selected do not perform to the satisfaction of faculty overseeing courses.	Departments cancel or decrease participation in the LA program and/or the program faces faculty opposition.	High	Medium	LA Faculty leaders and Education/ Outreach coordinators will improve the preparation conditions of the LAs to ensure that they are adequately prepared to execute their duties.
TREK Teacher and Student Summer Research program	Lack of interested and committed teachers to participate	Reduced impact of program	Low	Moderate	Open positions will be filled the following summer with a max. Of 1 additional teacher/student pair/ year. Additional recruitment through high school visits and cross project planning/ coordination for placement of researchers from multiple programs will improve the process.
	Lack of ability to recruit students to participate	Teacher participant without student could reduce classroom support	Low	Moderate	Money from missing students will be utilized for additional support mechanism in the classroom. Additional recruitment mechanisms will focus recruitment on teachers closer to participating campuses
	Lack of RII Researchers willing to accept TREK participants	Lack of labs to place teacher/student pairs for TREK reduces the number of	Low/ moderate	Moderate	Researchers outside of the RII have been utilized this first summer at WVU. Future coordination efforts between this and other

Component	Condition	Consequence	Impact	Likelihood	Mitigation
TREK Teacher and Student Cont.		participants we are capable of accepting			undergraduate/graduate/outreach research programs will pre-accept participants into labs in an attempt to distribute the participating across a broad range of faculty.
Workforce: M.A. Biotech / Business Track (WVSU)	Business courses are not made available at WVSU within the next 24 months	The proposed track will be delayed and not immediately available to new enrolled students in the Biotech program at WVSU	Medium	High	While courses are being developed at WVSU, other sources, to temporarily supplement the need, can be explored through MU and other institutional partnerships.
	Business courses are not made available at WVSU	The proposed track will have to be offered using external resources	Medium	Low	Long-term arrangements to supplement these courses will have to be made through MU and other institutional partnerships.
MBA Program for science grads (MU)	Insufficient enrollment	Administrative withdrawal of institutional support	Moderate	Moderate	Implement outreach activities to across the state to inform STEM-based businesses of the opportunities at Marshall
PUI/CTC Incubator	Support does not lead to new extramural funding or increases productivity	Long term sustainability at WV's CTCs and PUIs will not be achieved	High	Moderate	Increase mentoring efforts with PUI/CTC PIs and with corresponding institutional administration (to negotiate reduced teaching loads and grant administration)
Graduate Fellowship Program (GFP)	Graduate Fellows do not make sufficient progress on coursework, and/or research.	Fellowships are not renewed and/or Fellows do not continue with nanomaterials research	High	Medium	Weekly group meetings are being implemented to ensure that students are monitored. If a student starts to fall behind in courses and/or research, the Education/ Outreach coordinator will develop an individualized plan that identifies the areas in which the student is struggling and provides assistance in terms of tutoring and/or mentoring.

Component	Condition	Consequence	Impact	Likelihood	Mitigation
Graduate Fellowship Program (GFP) Cont.	The GFP cohort lacks diversity.	We fail to fulfill our commitment and responsibility to increase the diversity of STEM researchers	High	High	We have identified intensifying recruiting of underrepresented groups for the summer undergraduate research programs as a priority. Coupled with increased recruiting of those students to graduate school, we can maximize diversity, as the undergraduate research students are significantly more diverse than the graduate student body.
Diversity	UREP STEM Student retention not increased	We fail to fulfill our commitment and responsibility to increase the retention of diverse undergraduate STEM students	High	Medium	Central office staff will increase efforts to work closely with Commission leadership to ensure the coordination of the Chancellor's Diversity Initiative and WVI3 Think Tank efforts as well as utilize the experience and expertise of national leaders in STEM student retention to develop better retention efforts across institutions. Central office staff will apply for external funding to support STEM retention initiatives as well as coordinate tracking of STEM students with the Division of Policy and Planning.
Management	Unexpected departure of leadership personnel	Lack of guidance for project implementation	High	Low	Train young central office staff and tenured faculty at universities in leadership. Succession plan in place.