Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Army										DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: Research, Development, Test & Evaluation, Army BA 1: Basic Research	R-1 ITEM NOMENCLATURE PE 0601102A: DEFENSE RESEARCH SCIENCES

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
Total Program Element	196.921	195.845	213.942	-	213.942	219.116	223.721	227.464	233.405	Continuing	Continuing
305: ATR RESEARCH	2.321	2.401	2.433	-	2.433	2.462	2.508	2.554	2.597	Continuing	Continuing
31B: INFRARED OPTICS RSCH	2.648	2.721	2.787	-	2.787	2.831	2.887	2.946	2.996	Continuing	Continuing
52C: MAPPING & REMOTE SENS	2.744	2.841	2.915	-	2.915	2.979	3.038	3.097	3.150	Continuing	Continuing
53A: BATTLEFIELD ENV & SIG	3.195	3.341	3.435	-	3.435	3.530	3.611	3.697	3.760	Continuing	Continuing
74A: HUMAN ENGINEERING	5.627	6.971	8.019	-	8.019	8.227	8.361	8.718	9.005	Continuing	Continuing
74F: PERS PERF & TRAINING	5.643	5.549	6.766	-	6.766	7.023	7.148	7.266	7.389	Continuing	Continuing
F20: ADV PROPULSION RSCH	3.303	3.429	3.996	-	3.996	4.193	4.272	4.355	4.429	Continuing	Continuing
F22: RSCH IN VEH MOBILITY	0.554	0.576	0.588	-	0.588	0.601	0.612	0.624	0.635	Continuing	Continuing
H42: MATERIALS & MECHANICS	5.889	6.975	8.461	-	8.461	8.676	8.835	8.990	9.143	Continuing	Continuing
H43: RESEARCH IN BALLISTICS	8.042	8.318	9.063	-	9.063	9.224	9.395	9.563	9.726	Continuing	Continuing
H44: ADV SENSORS RESEARCH	6.241	9.695	10.005	-	10.005	10.148	10.319	10.662	11.046	Continuing	Continuing
H45: AIR MOBILITY	2.306	2.399	2.449	-	2.449	2.497	2.543	2.588	2.632	Continuing	Continuing
H47: APPLIED PHYSICS RSCH	2.894	5.009	5.087	-	5.087	5.187	5.258	5.540	5.996	Continuing	Continuing
H48: BATTLESPACE INFO & COMM RSC	11.200	13.685	15.726	-	15.726	17.250	18.285	18.890	19.211	Continuing	Continuing
H52: EQUIP FOR THE SOLDIER	1.026	1.078	1.105	-	1.105	1.134	1.158	1.181	1.201	Continuing	Continuing
H57: Single Investigator Basic Research	62.870	73.075	78.257	-	78.257	79.027	80.262	79.933	82.453	Continuing	Continuing
H66: ADV STRUCTURES RSCH	1.805	1.889	1.942	-	1.942	1.996	2.040	2.089	2.125	Continuing	Continuing
H67: ENVIRONMENTAL RESEARCH	0.886	0.967	0.997	-	0.997	1.018	1.039	1.072	1.090	Continuing	Continuing
S13: SCI BS/MED RSH INF DIS	10.296	10.652	10.900	-	10.900	11.121	11.348	11.447	11.445	Continuing	Continuing
S14: SCI BS/CBT CAS CARE RS	6.352	6.818	9.709	-	9.709	9.853	9.211	9.481	9.833	Continuing	Continuing
S15: SCI BS/ARMY OP MED RSH	7.003	8.839	6.320	-	6.320	6.687	7.628	7.655	7.592	Continuing	Continuing

Exhibit R-2, RDT&E Budget Item Justification: PB 2012 Army										DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*					R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*						
T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*	26.860	-	-	-	-	-	-	-	-	Continuing	Continuing
T22: *SOIL & ROCK MECH*	2.284	2.358	4.926	-	4.926	4.531	4.631	5.281	5.525	Continuing	Continuing
T23: *BASIC RES MIL CONST*	1.727	3.839	1.901	-	1.901	1.970	2.005	2.042	2.077	Continuing	Continuing
T24: *Signature Physics and Terrain State Basic Research*	1.508	1.573	1.616	-	1.616	1.660	1.693	1.727	1.756	Continuing	Continuing
T25: *Environmental Science Basic Research*	7.690	8.106	8.234	-	8.234	8.562	8.719	8.870	9.021	Continuing	Continuing
T61: *Basic Research Initiatives - MRMC (CA)*	1.592	-	-	-	-	-	-	-	-	Continuing	Continuing
T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*	1.181	1.463	1.857	-	1.857	1.935	1.969	2.001	2.035	Continuing	Continuing
T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*	1.234	1.278	2.198	-	2.198	2.794	2.846	2.895	2.937	Continuing	Continuing
VR9: *SURFACE SCIENCE RESEARCH*	-	-	2.250	-	2.250	2.000	2.100	2.300	2.600	Continuing	Continuing

Note

FY12 funding increase for high priority efforts.

A. Mission Description and Budget Item Justification

This program element (PE) fosters fundamental scientific knowledge and contributes to the sustainment of US Army scientific and technological superiority in land warfighting capability and military problems related to long-term national security needs, investigates new concepts and technologies for the Army's future force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. The PE fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision) and areas where there is no commercial investment due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigator research on Army areas of interest (e.g., high-density compact power and novel sensor phenomenologies). The in-house portion of the program capitalizes on the Army's scientific talent and specialized facilities to transition knowledge and technology into the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry.

The work in this PE is coordinated and integrated between four primary contributors: the Army Research, Development, and Engineering Command (RDECOM); the US Army Engineer Research and Development Center (ERDC); the Army Medical Research and Materiel Command (MRMC); and the Army Research Institute for

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	

Behavioral and Social Sciences (ARI). The basic research program is coordinated with the other Services via Defense Basic Research Advisory Group and other inter-Service working groups.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this PE is primarily managed by: the US Army Research Laboratory (ARL), Adelphi, MD; the RDECOM, Aberdeen, MD; the Medical Research and Materiel Command (MRMC), Ft. Detrick, MD; the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS; and the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

Projects T14 and T61 fund Congressional interest items.

B. Program Change Summary ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total
Previous President's Budget	197.471	195.845	188.160	-	188.160
Current President's Budget	196.921	195.845	213.942	-	213.942
Total Adjustments	-0.550	-	25.782	-	25.782
• Congressional General Reductions		-			
• Congressional Directed Reductions		-			
• Congressional Rescissions	-	-			
• Congressional Adds		-			
• Congressional Directed Transfers		-			
• Reprogrammings	3.053	-			
• SBIR/STTR Transfer	-3.603	-			
• Adjustments to Budget Years	-	-	25.782	-	25.782

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Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 305: *ATR RESEARCH*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
305: *ATR RESEARCH*	2.321	2.401	2.433	-	2.433	2.462	2.508	2.554	2.597	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project evaluates automatic target recognition (ATR) research to enhance the effectiveness of Army systems while simultaneously reducing the workload on the Soldier. This project focuses on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare scenarios including tagging, tracking, and locating (TTL) of non-traditional targets. This research enables Army systems that can act independently of the human operator to detect and track targets including clandestine tracking of non-cooperative targets. Such capabilities are needed for smart munitions, unattended ground sensors, and as replacements for existing systems, such as land mines. Critical technology issues include low depression angle, relatively short range, and highly competing clutter backgrounds. The resulting research will provide fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at evaluating the complexity and variability of target and clutter signatures and ultimately utilizing that knowledge to conceptualize and design advanced ATR paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. This research supports several technology efforts including multi-domain smart sensors, third generation Forward Looking Infrared, and advanced multi-function laser radar (LADAR).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: ATR Algorithms	1.318	1.387	1.417
Description: Investigate new algorithms to improve aided/unaided target detection and identification. *FY 2010 Accomplishments:* Enhanced hyperspectral anomaly detections and validated rapid reconstruction of hyperspectral images by using 3D compressed sensing techniques and developed novel fusion detection and classification algorithms based on learning theory. *FY 2011 Plans:* Develop restoration techniques for atmospheric turbulence distorted imagery and new anomaly detection algorithms based on novel computational imaging methods. *FY 2012 Plans:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 305: *ATR RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Will research automatic machine perception algorithms that provide enhanced situational awareness; will investigate fast algorithms for feature extraction and scene understanding from hyperspectral and multimodal data.			
Title: Tagging, Tracking and Locating (TTL) *Description:* Conduct basic research to support advances in state-of-the-art clandestine TTL for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are in accordance with the Hostile Forces TTL Capabilities Development Document and the TTL Science and Technology Roadmap. This effort will directly support ARL's efforts in applied research and the Communications-Electronics Research, Development, and Engineering Center's advanced research in clandestine TTL. *FY 2010 Accomplishments:* Conducted research that is leading to improvements in the performance of hyperspectral imaging against a variety of environmental and target conditions and further refined the design of the Micro Electro Mechanical Systems (MEMS) based tag; investigated Radio Frequency (RF) TTL enhancements and flexible ultrasonic tags; explored RF techniques and technologies for TTL, investigated advances in RF Integrated Circuits for an RF Tag and modeled an enhanced IR Tag. *FY 2011 Plans:* Investigate and validate an enhanced capability in hyperspectral imaging and target detection for tracking and locating. Fabricate an RF tag sample and validate an enhanced capability in hyperspectral target detection for tracking & locating. Complete investigations for the MEMS and flexible ultrasonic tags. *FY 2012 Plans:* Will begin research efforts in the areas of imaging and tagging for TTL enhancements and applications.	1.003	1.014	1.016
Accomplishments/Planned Programs Subtotals	2.321	2.401	2.433

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 31B: *INFRARED OPTICS RSCH*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
31B: *INFRARED OPTICS RSCH*	2.648	2.721	2.787	-	2.787	2.831	2.887	2.946	2.996	Continuing	Continuing

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification

This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems and radio frequency (RF) photonics. This research aims to generate new technologies for unprecedented battlefield situational awareness and to continue the dominance of Army units during night operations. To achieve these objectives, IR focal plane arrays (FPAs), and interband cascade lasers with significantly improved performance, lower cost, and increased operating temperatures are required. This research has direct application to Army ground vehicles, aviation platforms, weapon systems, and the individual Soldier. Research is focused on material growth, detector and laser design, and processing for large area multicolor IR FPAs and interband cascade lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semi-conductor materials to enhance the performance of lasers and IR FPAs. In the area of RF Photonics near-IR modeling and nanofabrication techniques are applied to the design and fabrication of IR photonic-crystal waveguide structures having customized IR properties. Micro Electro Mechanical System (MEMS) configurations are incorporated into the photonic-crystal waveguide structures to enable reconfigurable IR waveguide properties. Customized IR photonic materials and components in conjunction with fiber optic interconnects are applied to the control of microwaves. The technical goals are to manage and control defects in the raw, unprocessed materials, maintaining quality control in the fabrication of the devices and arrays, limiting introduction of impurities in the material, surface passivation of the devices so that they are resistant to degradation over time and thermal management, particularly as it applies to interband cascade lasers.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Conduct research into IR Focal Plane Arrays, RF Photonics, and to increase situational awareness in open and complex terrain. *Description:* Conduct research into IR Focal Plane Arrays, RF Photonics, and to increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance missile threat IR countermeasure (IRCM) protection. *FY 2010 Accomplishments:*	2.648	2.721	2.787

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 31B: *INFRARED OPTICS RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Used fiber optic integrated circuits to improve mode control of an ultra-low-noise microwave oscillator; measured Long Wave Infrared (LWIR) superlattice quantum efficiency and minority carrier lifetime (particles that carry an electric charge) at higher operation temperature. *FY 2011 Plans:* Apply fiber-optic RF-photonic techniques to the advancement of opto-electronic processing of military signals; develop nano-fabrication techniques in order to create a novel photonic waveguide structure that could be a substitute for a fiber optic cable; investigate large area dual color LWIR/Midwave Infrared detector arrays; investigate methods for the improvement of minority carrier lifetimes in the type II strained layer superlattice materials that will result in improved FPA performance. *FY 2012 Plans:* Will continue development on laser research for IR countermeasures to include detailed studies on the thermal characteristics of Midwave Infrared (MWIR) lasers for IRCM; will investigate environmental effects of RF-photonic devices and reduce their vibration and temperature sensitivity for improved reliability; will continue development of nano-fabrication techniques to achieve chip-scale RF photonic devices; and will investigate methodologies for quantum well infrared detector arrays to be fabricated up to 2K x 2K focal plane arrays.			
Accomplishments/Planned Programs Subtotals	2.648	2.721	2.787

C. Other Program Funding Summary ($ in Millions)
 N/A

D. Acquisition Strategy
 N/A

E. Performance Metrics
 Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 52C: *MAPPING & REMOTE SENS*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
52C: *MAPPING & REMOTE SENS*	2.744	2.841	2.915	-	2.915	2.979	3.038	3.097	3.150	Continuing	Continuing

Note
Not applicable to this item

A. Mission Description and Budget Item Justification
This basic research project increases knowledge of the terrain with a focus on improving the generation, management, analysis/reasoning, and modeling of geospatial data, and the exploitation of multi-sensor data. This fundamental knowledge forms the scientific "springboard" for the future development of applications, techniques, and tools to improve the tactical commander's knowledge of the battlefield. Results of this research are used to extract and characterize natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques; and to explore the potential of space technology and tactical geospatial sensor technology to provide real-time terrain intelligence, command and control, and targeting support. This research uses terrain and environmental data to improve situational awareness and enhance information dominance, leading to increased survivability, lethality, and mobility. The research provides the theoretical underpinnings for PE 0602784A (Military Engineering Technology), project 855 (Mapping and Remote Sensing).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Sensor Phenomenology and Spatial-Temporal Pattern Discovery	2.744	2.841	2.915
Description: Funding provided for the following research. *FY 2010 Accomplishments:* Examined the synthesis of high quantum yield optical reporters for remote sensing: also, created new interest measures for multi-scale spatial-temporal cascade patterns. *FY 2011 Plans:* Explore the relationship of magnetic core nanomaterials and the stand-off recovery of these materials as sensors using Surface-Enhanced Raman Scattering (SERS); also, investigate social network concepts to better assess important interaction within and between our adversaries, directly relating objects, events, actions, and trajectories within a spatial-temporal domain. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 52C: *MAPPING & REMOTE SENS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will investigate the effects of underground anomalies on the spectral properties of surface vegetation; also, will create a specific mathematical boundary for determining if a trajectory is an outlier.			
Accomplishments/Planned Programs Subtotals	2.744	2.841	2.915

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT 53A: *BATTLEFIELD ENV & SIG*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
53A: *BATTLEFIELD ENV & SIG*	3.195	3.341	3.435	-	3.435	3.530	3.611	3.697	3.760	Continuing	Continuing

Note
  Not applicable for this item

A. Mission Description and Budget Item Justification

This project investigates an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology, the transport, dispersion, optical properties and characterization of chemical and biological aerosols, and the propagation of full-spectrum electro-magnetic and acoustic energy. The future Army will operate in very complex environments (e.g., urban, mountainous, forested and jungle terrain) requiring new approaches to understanding, characterizing, and depicting environmental phenomena and their effects on military systems, personnel and operations. The lack of a complete understanding of the meteorological aspects of the complex microscale boundary layer in which the Army operates continues to impact our abilities to provide predictable, actionable, accurate and timely tactical environmental intelligence to battlefield commanders. This project focuses on producing the foundational environmental science research to characterize the atmospheric boundary layer and deliver novel capabilities and techniques including urban turbulence characterization for its effects on micro platforms and sensor payloads, high resolution urban wind flow modeling for more efficient and accurate prediction of the transport and dispersion of obscurants and chemicals, battlefield aerosol characterization for soldier health, characterization and identification of bio-warfare agents, environmental effects on acoustic and electromagnetic signal propagation in urban and other complex domains for improved target location and imaging, exploration of previously unexploited regions of the acoustic and electro-optic spectrum, and formulation of objective analysis tools that can assimilate on-scene all-source weather observations and fuse this information with forecasts to provide immediate Nowcast products. These capabilities will have a direct impact on ensuring Soldier survivability, weapon system lethality, effective surveillance and reconnaissance, and the mobility required for future warfighter mission planning and execution operations.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD/White Sands Missile Range, NM.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Research in optical and acoustical propagation in the atmosphere	1.996	1.976	2.032
Description: Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance, and Reconnaissance capabilities for the future force to support situational understanding and rapid targeting. *FY 2010 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 53A: *BATTLEFIELD ENV & SIG*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Designed algorithms for atmospheric propagation of acoustic signatures in urban and complex terrain; developed processing techniques for enhancing target contrast and minimizing background clutter for infrared polarimetric imagery; and measured Raman spectra of individual particles. *FY 2011 Plans:* Develop acoustic propagation algorithms for complex urban domains accounting for multiple building structure effects; exploit broader frequency acoustic propagation including ultrasound; investigate and employ the capabilities of Two-dimensional Angular Optical Scattering and Ultra Violet-Laser Induced Fluorescence technologies for the characterization of hazardous particles in the atmosphere. *FY 2012 Plans:* Will characterize atmospheric propagation effects on emerging technologies including Terahertz spectroscopy and imaging systems; will perform investigations and analyses of environmental impacts on thermal and infrared polarimetric images; will investigate the use of high resolution, multi-spectra, Light Detection And Ranging techniques for the detection of atmospheric aerosols and trace gases; will investigate the effects of ozone and other atmospheric constituents on the fluorescence spectra of bioaerosols; will measure fluorescence and absorption cross sections of aerosolized bio-warfare simulants/agents using laser-induced fluorescence and photoacoustic spectroscopy; will investigate the use of active wind screens for infrasound sensors to reduce sensor footprint on the ground; will investigate whether the influence of acoustic waves on the ionosphere can be used for the detection of anomalous events.			
Title: Predictive Modeling of the Boundary Layer *Description:* Increase survivability and improve situational awareness through research to enhance accuracy of predictive modeling of the boundary layer and improve the ability to function effectively *FY 2010 Accomplishments:* Investigated methods for optimizing aircraft routes in adverse weather conditions; extended the physical interactions in the urban microscale 3 Dimensional Wind Field (3DWF) model to produce a 2D Atmospheric Boundary Layer Environment (ABLE) wind model that improves fidelity for simulation and prediction of wind fields in urban and complex terrain. *FY 2011 Plans:* Investigate ensemble modeling techniques leading to fine-scale battlefield probabilistic weather and effects forecasting; produce improved theory and characterization of atmospheric turbulence using sonic anemometer arrays for more realistic mechanical and optical turbulence models, develop biologically inspired approaches to improved environmental awareness and reactions for	1.199	1.365	1.403

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
autonomous systems; and extend the ABLE microscale wind model from 2D to 3D using advances in high-performance modeling to improve wake flow predictions in complex and urban terrain .			
FY 2012 Plans: Will verify and validate the 3D ABLE model against well established measured and modeled data from complex and urban domain; will investigate modeling techniques deriving probabilistic weather impacts forecasts for future decision support tools; and will develop new approaches to adverse weather route optimization algorithms for air and ground applications.			
Accomplishments/Planned Programs Subtotals	3.195	3.341	3.435

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army								DATE: February 2011		

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *HUMAN ENGINEERING*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
74A: *HUMAN ENGINEERING*	5.627	6.971	8.019	-	8.019	8.227	8.361	8.718	9.005	Continuing	Continuing

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project focuses on improving Soldier-system performance in future force environments. Research is on key phenomena underlying Soldier performance such as auditory spatial orientation (perception of azimuth, elevation and distance of sounds) within uncertain, degraded acoustic conditions; extending and protecting auditory and cognitive performance; human performance in automated, mixed-initiative (human control-machine control) environments; communications in hearing-degraded conditions; visual scanning and target detection; Soldier emotion and fatigue states; integration across multiple sensory modalities; perceptual-motor behavior ; collaborative (team) and independent multi-task, multi-modal, multi-echelon Soldier-system performance, all cast against the influx of emerging Transformation-driven technological solutions and opportunities. Technical barriers include lack of methods for describing, measuring, and managing the interplay of these relatively novel phenomena in the consequent task due to situational complexity and ambiguity that characterize operations in the future force. Technical solutions are being pursued in the areas of data generation and algorithm development in these emerging environments in order to update and improve our understanding of performance boundaries and requirements and enable neuroengineering. These solutions include multi-disciplinary partnerships, metrics, simulation capabilities, and modeling tools for characterizing Soldier-system performance, and provide a shared conceptual and operational framework for militarily relevant research on cognitive and perceptual processes. In the area of translational neuroscience, which is the transition of basic neuroscience research to relevant applications, research is carried out to examine leading edge methodologies and technologies to improve the measurement and classification of neural states and behavior in operationally-relevant environments, to examine the potential application of neuroscience theories to autonomous systems to improve Soldier-system interactions, to model the relationship between brain structure and cognitive performance for understanding individual differences and injury, and to assess how neural pathways implicated in functional processing can be enhanced through dynamic system interface technologies for improving in-theatre performance and training.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Research to characterize and enhance Soldier performance	1.300	1.991	1.952
Description: Characterize and enhance human auditory performance of the dismounted warrior in complex environments while protecting the hearing of the Soldier. *FY 2010 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74A: *HUMAN ENGINEERING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Investigated and determined optimum ear coverage by infantry helmets; investigated localization of impulse noises in a reverberant environment. *FY 2011 Plans:* Conduct initial experiments to quantify the contributions of visual, auditory, tactile, kinesthetic and narrative factors to an individual Soldier's immersive experiences; develop measures to capture how individuals perceive the effectiveness/contribution of immersion in simulation environments. *FY 2012 Plans:* Will determine the effects of ear coverage, from wearing infantry helmets, on auditory localization for modeling of Soldier mission performance.			
Title: Soldier performance *Description:* Characterize key issues underlying Soldier decision making such as computer modeling and social network analyses to investigate the quality of information flow in a defined command and control structure, investigations into situational understanding and prediction in uncertain environments, and identifying usability deficiencies and mismatches between battle command processes and technology enhancements. *FY 2010 Accomplishments:* Conducted investigations of situational understanding and prediction in uncertain environments; identified usability deficiencies and mismatches between battle command processes and technology enhancements; and investigated the effects of information presentation on the Soldier's ability to perceive information. *FY 2011 Plans:* Begin development of cognitive models predictive of team decision making; continue work on determining effects of information quality and presentation on Soldier system performance. *FY 2012 Plans:* Will transfer lessons learned from the development of a cognitive model-based architecture for robotics control to the Robotics Collaborative Technology Alliance; will continue studies which correlate electroencephalograph data with response times to perceptual stimulus events that will further the validation of the perceptual component of the cognitive model Adaptive Control of Thought-Rational (ACT-R).	2.180	2.294	2.205
Title: Translational Neuroscience *Description:* Integrating neuroscience with traditional approaches to understanding Soldier behavior to enable systems designs that maximize Soldier performance. Formerly titled Research in Neuroergonomics.	1.078	1.551	3.062

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 74A: *HUMAN ENGINEERING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
FY 2010 Accomplishments: Explored the feasibility of using dry, wireless neurophysiological sensors suitable for high-density arrays in operationally-relevant environments; identified and modeled specific neural processes underlying visual scanning and target identification. *FY 2011 Plans:* Advance state-of-the-art in data analytic capabilities to extract brain-relevant information from multi-dimensional data arrays obtained in operationally-relevant contexts; validate models of neural mechanisms underlying visual scanning and explore the neural processes underlying human interaction with autonomous systems. *FY 2012 Plans:* Will investigate closed loop interaction between emotional/fatigue state monitors and computer systems that adapt to the emotion/fatigue state of the user; will develop normative models that account for the variability in individual differences on performance; will explore functional connectivity of multivariate datasets for assessment of performance measures; will investigate predictive metrics for neural processing and/or cognitive performance that are linked to particular cognitive differences among individuals.			
Title: Cognition and Neuroergonomics *Description:* Devise and show fundamental translational principles for neuroscience-based research and theory to complex operations settings in three focus areas: Soldier-system information transfer, commander-level decision making, and individualized analysis and assessment of cognitive performance in operational environments. *FY 2010 Accomplishments:* Investigated perceptual-motor interactions, including those between sensory-perceptual channels and motor systems; explored the complex effects of information quality and quantity on physical and cognitive performance; explored the neural representations of command-level decision making through identification of information representation; examined factors leading to successful or faulty decisions, including biases, heuristics, implicit versus explicit knowledge, context and stressor; identified key individual differences, stressors, and investigated their impact on neural processing and cognitive performance; explored the appropriate neuro-sensing approaches for assessment in operational environments. *FY 2011 Plans:* Explore models of information presentation, including multi-modal and adaptive displays; examine the effects of information systems on physical and cognitive performance; examine how the nervous system filters large-scale, multi-dimensional data sets for decision making; identify individual differences in neural processing underlying successful and unsuccessful decision making; identify key individual differences and stressors and investigate their impact on neural processing and cognitive performance; explore the appropriate neuro-sensing approaches for assessment in operational environments; explore methods for state	1.069	1.135	0.800

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 74A: *HUMAN ENGINEERING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
detection and signal processing techniques for signal integration; develop static algorithms that account for the variability in individual differences and/or environmental stressors on performance. *FY 2012 Plans:* will investigate closed loop interaction between emotional/fatigue state monitors and computer systems that adapt to the emotion/ fatigue state of the user; will develop normative models that account for the variability in individual differences on performance; will explore functional connectivity of multivariate datasets for assessment of performance measures; and will investigate predictive metrics for neural processing and/or cognitive performance that are linked to particular cognitive differences among individuals.			
Accomplishments/Planned Programs Subtotals	5.627	6.971	8.019

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

E. Performance Metrics
   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74F: *PERS PERF & TRAINING*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
74F: *PERS PERF & TRAINING*	5.643	5.549	6.766	-	6.766	7.023	7.148	7.266	7.389	Continuing	Continuing

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification
This project funds behavioral and social science basic research in areas with high potential to improve personnel selection, training, leader development, human performance, and the human and social dynamics of network operations. Research covers areas such as assessment of practical intelligence as an aptitude that can be measured across job domains; develop principles and potential methods for training and sustaining complex tasks arising from digital, semi-automated, and robotic systems requirements; determine potential methods for faster learning, improved skill retention, and adaptable transfer of training to new tasks; discern likely methods for developing leader adaptability and flexibility as well as for speeding the maturation process; discover and evaluate the basic cognitive principles that underlie effective leader-team performance; better understand the role of emotions in regulating behavior; and improve the match between Soldier skills and their jobs to optimize performance. Research is focused on fundamental issues that will improve the Army's capability to: (1) select, classify, train, and/or develop Soldiers and leaders who are adaptable in novel missions and operational environments, can function effectively in digital, information rich, and semi-autonomous environments, can effectively collaborate in quickly formed groups and when distributed in high stress environments, and possess interpersonal and intercultural skills and attributes relevant to Joint-Service and multi-national operations; (2) accelerate the training of leadership, interpersonal, and emotional skills that traditionally develop over long periods of time and through direct experience; and (3) focus on the human cognitive and social domains - understanding individual, unit, and organizational behavior within the context of complex networked environments that will be essential for synergy between technology and human performance.

Research in this project is complementary to and fully coordinated with efforts funded in PE 0602785A (Project 790).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Human Behavior	3.784	3.764	4.770
Description: Funding is provided to better select, classify, train, and/or develop Soldiers and leaders.			
FY 2010 Accomplishments: Achieved a better understanding of the interplay between cognition and emotion in training, performance, and socio-cultural interactions; linked training methods and learning principles to performance; systematically examined how nonverbal behaviors			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT 74F: *PERS PERF & TRAINING*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
are encoded and decoded in human communications in a variety of settings (focus was on training, leadership, and negotiation settings); and determined whether and how nonverbal behaviors affected outcomes in these environments. *FY 2011 Plans:* Conduct basic research in the areas of psychological measures of individual abilities, implicit and explicit learning, cognition, and social influence. *FY 2012 Plans:* Will conduct research in the areas of the leadership and team performance in complex environments; will analyze the impact of training methods on learner performance; will investigate how a neurophysiologic state (i.e., affect) influences perception; identify cognitive strategies of experts that can be used to develop efficient training protocols.			
Title: Network-Human Science *Description:* Funding is provided for better understanding individual, unit, and organizational behavior within the context of complex networked environments. *FY 2010 Accomplishments:* Created new computational measures of leadership and organizational expertise in on-line networks and distinguished novices from experts in order to rate the reliability of the contributed information; researched matching individuals needing information to other individuals who were able to share it; investigated the dynamics that foster a thriving online community. *FY 2011 Plans:* Continue basic research on variables that influence the interaction of individuals and teams within distributed environments. *FY 2012 Plans:* Will conduct research to understand organizational dynamics and unit cohesion; will conduct research on how language usage influences social dynamics; will analyze the influences of human performance in complex networked environments.	1.859	1.785	1.996
Accomplishments/Planned Programs Subtotals	5.643	5.549	6.766

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** 74F: *PERS PERF & TRAINING*

E. Performance Metrics

   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: Research, Development, Test & Evaluation, Army BA 1: Basic Research	R-1 ITEM NOMENCLATURE PE 0601102A: DEFENSE RESEARCH SCIENCES	PROJECT F20: ADV PROPULSION RSCH

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
F20: ADV PROPULSION RSCH	3.303	3.429	3.996	-	3.996	4.193	4.272	4.355	4.429	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification
This project funds research to increase the performance of small air-breathing engines and power trains to support improved system mobility, reliability, and survivability, and ultimately serve to reduce the logistics cost burden for the future. Problems addressed include the need for greater fuel efficiency and reduced weight in these propulsion systems. Technical barriers to advanced propulsion systems are the inadequacy of today's materials to safely withstand higher temperature demands, the lack of capability to accurately simulate the flow physics and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead Service in these technology areas (under Project Reliance) and performs basic research in propulsion, as applicable to rotorcraft and tracked and wheeled vehicles. Technical solutions are being pursued through analysis, code generation, and evaluations to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, energy sources and conversion, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL) at the NASA Glenn Research Center, Cleveland, OH.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Thermal Materials *Description:* Investigates new materials needed to withstand the higher temperature regimen of advanced high performance engines, and evaluates improved tools and methods that will accurately simulate the flow physics and the mechanical behavior of future engines and drive trains which will contribute to the design of more fuel efficient and reliable propulsion systems. *FY 2010 Accomplishments:* Investigated optimum fiber architecture needed to fabricate uncooled turbine components for increased fuel efficiency and developed improved sand trajectory modeling methodology to improve the safety, durability, and reliability of turbine engines. *FY 2011 Plans:*	2.295	2.389	2.948

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** F20: *ADV PROPULSION RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Complete computational assessment of gear windage for various gear rotational conditions and compare with validation results to identify and mitigate power losses. ***FY 2012 Plans:*** Will develop a modeling and simulation capability that will be used to predict and compare the automotive, thermal, and electromechanical performance of next-generation Army wheeled tactical and combat vehicle power train concepts; and will investigate the design of more fuel efficient propulsion system.			
Title: Reliable Small Engines for Unmanned Systems ***Description:*** Develops improved tools and methods to enhance the reliability and fuel efficiency of small engines for air and ground vehicles and to enable the use of heavy fuels. ***FY 2010 Accomplishments:*** Utilized validated suite of system simulation tools to identify and improve component and system operation of current and potential Army small engine applications. ***FY 2011 Plans:*** Evaluate potential for improving fuel consumption and reliability of heavy fuel engine concepts for small (<100 HP) system applications. ***FY 2012 Plans:*** Will evaluate the performance of a representative Army unmanned vehicle engine at simulated altitude conditions.	1.008	1.040	1.048
Accomplishments/Planned Programs Subtotals	3.303	3.429	3.996

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

E. Performance Metrics
   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army								DATE: February 2011		
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*				**PROJECT** F22: *RSCH IN VEH MOBILITY*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
F22: *RSCH IN VEH MOBILITY*	0.554	0.576	0.588	-	0.588	0.601	0.612	0.624	0.635	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project conducts research in support of advanced military vehicle technology with emphasis on advanced propulsion, sophisticated vehicle dynamics and simulation, and advanced track and suspension concepts. Advanced propulsion research will dramatically improve power density, performance and thermal efficiency for advanced adiabatic diesel engines, transient heat transfer, high temperature materials and thermodynamics. This project also supports state-of-the-art simulation technologies to achieve a more fundamental understanding of advanced high-output military engines. The subject research is directed at unique, state-of-the-art phenomena in specific areas such as: non-linear ground vehicle control algorithms, using off-road terrain characteristics; and instantaneous diesel engine optimizations, using advanced analytical and experimental procedures.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

This work is performed at the Tank and Automotive Research, Development and Engineering Center (TARDEC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Advanced Mathematical Algorithms for Improved Vehicle Efficiency **Description:** Funding is provided for the following effort: **FY 2010 Accomplishments:** Developed engineering models for JP-8 ignition and combustion profiles; explored reduced chemical kinetics JP-8 ignition models; and further investigated vehicle-human interaction dynamics. **FY 2011 Plans:** Continue developing JP-8 engineering models for combustion and ignition as a function of fuel ignition quality; continue exploring e vehicle-human interaction dynamics; and study better modeling techniques for vehicle-terrain interaction dynamics. **FY 2012 Plans:** Will expand JP-8 ignition models to include wide varying ignition quality fuels; will explore and develop robust multidisciplinary design optimization techniques with advanced materials for reducing ground vehicle weight while improving or maintaining ground vehicle mobility, reliability and survivability.	0.554	0.576	0.588
Accomplishments/Planned Programs Subtotals	0.554	0.576	0.588

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** F22: *RSCH IN VEH MOBILITY*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

| APPROPRIATION/BUDGET ACTIVITY
2040: *Research, Development, Test & Evaluation, Army*
BA 1: *Basic Research* | | | | R-1 ITEM NOMENCLATURE
PE 0601102A: *DEFENSE RESEARCH SCIENCES* | | | | PROJECT
H42: *MATERIALS & MECHANICS* | | |

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H42: *MATERIALS & MECHANICS*	5.889	6.975	8.461	-	8.461	8.676	8.835	8.990	9.143	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds the Army's basic research in materials science, which includes research into key phenomena enabling the creation and production of revolutionary materials that will provide higher performance, lighter weight, lower cost, improved reliability, and environmental compatibility for Army unique applications. The current approach of using materials to gain added functionality for Army systems is to use a layered approach, whereby each layer provides added capability (i.e. ballistic, chemical/biological, signature, etc.) but ultimately makes the system too heavy and too expensive. Technical solutions are being pursued through understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, and advanced metals, with the goal of creating hierarchically organized materials systems that possess multifunctional attributes at greatly reduced weight and cost. These advanced materials will enable revolutionary lethality and survivability technologies for the future. This research supports materials technology applied research in PE 0602105A, project H84.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Microscopic/Nanostructural Materials	2.235	2.759	2.481
Description: Devise new materials and design capabilities, based upon fundamental concepts derived at the microscopic and nano-structural levels, for the future force. *FY 2010 Accomplishments:* Researched grain boundary engineering of ceramics to improve fracture tolerance at low and high rates and characterized materials using a combination of electron microscopy and crystallographic orientation tools to identify optimum microstructures for ballistic protection. *FY 2011 Plans:* Research novel processing method concepts for improved armor ceramics; and characterize multifunctional materials systems seeking performance at minimum weight. *FY 2012 Plans:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H42: *MATERIALS & MECHANICS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will provide a theoretical basis for the selection of kinetically stabilizing alloying elements in nanocrystalline materials; and will prove grain size stabilization in nanocrystalline metallic systems by experimental methods..			
Title: High Deformation Rate Materials **Description:** Develop fundamental understanding necessary to design, process and characterize materials specifically intended for high loading rate applications. **FY 2010 Accomplishments:** Investigated the relationships existing between high rate properties and prior processing and characterized nanoscale materials using high resolution microscopic analytical methods for feedback to processing and modeling research for protection materials. **FY 2011 Plans:** Perform research relating high rate properties and microstructures to ballistic property observations; and use model results of static and transient electric/magnetic/flow fields to identify new materials and mechanisms. **FY 2012 Plans:** Will model and experimentally determine property relationships in piezoelectric materials; and will describe the chemical state of emerging high rate materials with a view toward optimizing materials properties for ballistic environments.	1.838	2.124	2.465
Title: Materials Research and Processing at Small Scale **Description:** Elucidate and exploit unique structure, processing, and property relationships that occur in materials at small length scales and develop methods to tailor the physical, chemical and mechanical response of these materials to enable unprecedented performance improvements in materials properties. **FY 2010 Accomplishments:** Performed materials research to relate properties observed at small scale to microstructure and performed research relating ballistic model output to processing, properties and microstructure. **FY 2011 Plans:** Determine the relationship between textile properties and fabrication methods; and characterize novel protective materials using state of the art microscopy tools. **FY 2012 Plans:**	1.816	2.092	3.515

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H42: *MATERIALS & MECHANICS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will develop tools for the characterization of hierarchically structured materials for an understanding of the synthesis and mechanics of bio-inspired materials; and will determine quantum effects on materials design to enable unprecedented performance improvements in materials properties.			
Accomplishments/Planned Programs Subtotals	5.889	6.975	8.461

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H43: *RESEARCH IN BALLISTICS*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H43: *RESEARCH IN BALLISTICS*	8.042	8.318	9.063	-	9.063	9.224	9.395	9.563	9.726	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification
This project seeks to improve the understanding of the chemistry and physics controlling the propulsion, launch, and flight of gun launched projectiles and missiles, and to understand the interaction of these weapons with armored targets. This research results in basic new knowledge, which allows the formulation of more energetic propellants, more accurate and non-lethal (NL)/lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems. This effort supports the Office of the Secretary of Defense Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use. This research supports survivability and lethality technology applied research in PE 0602618A, project H80.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Aberdeen Proving Ground, Adelphi, MD, and Research Triangle Park, NC.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: National Advanced Energetics Initiative	2.518	2.672	2.963
Description: Expand and confirm physics-based models and validation techniques to enable design of novel insensitive propellants/explosives with tailored energy release for revolutionary Future Force survivability and weapons effectiveness. *FY 2010 Accomplishments:* Provided new theoretical descriptions, quantum mechanical models, and real-time, in-situ validation measurements of energy storage and release mechanisms in non-traditional condensed phase materials such as structural nano-reactives, metastable polymerics, strained crystals, and diamond-like explosives. *FY 2011 Plans:* Link atomistic descriptions of disruptive energy storage and release mechanisms to new mesoscale models to describe space-time fluctuating microstructure behavior critical to understanding reactive behavior at the continuum modeling level. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H43: *RESEARCH IN BALLISTICS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will investigate rapid energy release from new classes of materials subjected to extreme physical constraints and characterize through high performance computer models and experiments.			
Title: Launch and flight of gun launched projectiles as well as missiles *Description:* mprove the fundamental understanding of the mechanisms controlling the launch and flight of gun launched projectiles and missiles, and understand the interaction of these weapons with armored targets. *FY 2010 Accomplishments:* Identified the controlling mechanisms through modeling and validation that are responsible for the ballistic effectiveness of ceramic materials; expanded the reactive material ignition model to include a variety of reactive materials with different terminal effects; and adjusted the urban material failure model to account for numerous urban construction materials. *FY 2011 Plans:* Establish a validation technique that directly probes and quantifies the fundamental mechanism responsible for brittle material ballistic performance; develop suitable post-ignition thermal and equation of state models for reactive material ignition products; and quantify the terminal ballistic effects of a variety of urban construction materials impacting the human body through extensive modeling and sub-scale experiments. *FY 2012 Plans:* Will explore non-linear aerodynamics of complex shapes to advance next generation extended range precision munitions; Will explore non-traditional modeling techniques for using on-board projectile flight information to enable affordable non-GPS guidance; and will perform first generation mapping of the shock and blunt impact effects on the mechanical state of human bone and tissues and the effects on specified connective centers in the human brain.	2.580	2.686	2.479
Title: Extramural research in non-lethal (NL) control methods *Description:* Extramural research in non-lethal (NL) control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities. *FY 2010 Accomplishments:* Conducted research on high rate response of biological materials, cause of injury, and injury mechanisms for development of novel protection concepts; researched energy flow processes at interfaces to develop precise control of explosive effects; and focused on the analysis and understanding of hyper-spectral image data and the development of rigorous mathematical models and hierarchical statistical techniques to characterize impacts. *FY 2011 Plans:*	0.927	0.932	0.996

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H43: *RESEARCH IN BALLISTICS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Develop fast hierarchical Bayesian inference algorithms and fusion techniques to combine results obtained from analyzing hyper-spectral imagery with information obtained from other sources such as biological validation or knowledge base for increased battlefield awareness. *FY 2012 Plans:* Will focus on the development of new models for automated image analysis and understanding with emphasis on crowd behavior analysis through examining the spatio-temporal pattern of crowd behavior as well as abnormal event detection in crowds for situation awareness and crowd control; will also study relationships between molecular structure, decomposition pathways, and potential energy surfaces for ground and excited electronic states of energetic compounds using laboratory-based spectroscopic and advanced electronic structure methods to enable more accurate predictions of the performance properties of speculative energetic compounds.			
Title: Armor Research *Description:* Develop fundamental knowledge of mechanisms that can be exploited to ensure the next generation of lightweight and efficient armor technologies. *FY 2010 Accomplishments:* Developed models for armor plate acceleration that do not utilize explosive materials; obtained laboratory derived mesoscale modeling parameters for ceramic materials to enable modeling of ceramic armor materials at the micro-structural level; and studied a thermodynamically-consistent equation of state theory. *FY 2011 Plans:* Formulate and validate explosive-free plate acceleration models and equation of state models into continuum mechanics codes; and will use the mesoscale modeling approach to identify ceramic material microstructures that will result in their improved ballistic resistance. *FY 2012 Plans:* Will evaluate novel reactive armor and electromagnetic armor mechanisms to include inferring real-time geometry of penetration into thick armor sections induced with electromechnical stresses.	2.017	2.028	2.625
Accomplishments/Planned Programs Subtotals	8.042	8.318	9.063

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H43: *RESEARCH IN BALLISTICS*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H44: *ADV SENSORS RESEARCH*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H44: *ADV SENSORS RESEARCH*	6.241	9.695	10.005	-	10.005	10.148	10.319	10.662	11.046	Continuing	Continuing

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project conducts basic research to produce future generations of sensors with capabilities beyond those currently being employed. Technical barriers include the fundamental speed and bandwidth limitations of current materials and devices, the efficiency of current algorithms, current computing architectures, organic material lifetimes, the understanding of the fundamental concepts of quantum cryptography, and spatial resolution of current radio frequency (RF) sensors. The technical approach is to exploit large scale electromagnetic (EM) models to predict and explain target and clutter scattering behavior, digital and image processing modules and algorithms, beam propagation and material modeling of nonlinear optical effects, hazardous material detection, remote sensing and intelligent system distributive interactive simulations, unique sensor development, sensor data feature and information fusion, and battlefield acoustic signal processing algorithms. Research performed under this project supports survivable sensor systems, organic thin film transistor technology and organic light emitting diode technology for affordable rugged flexible displays. Payoffs include low cost compact flexible displays for the Soldier and for the Army, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband radar technology for detection of explosives including mine detection, through the wall sensing and robotics perception, improved sensor approaches and signal processing techniques for enhanced acoustic/seismic sensing systems in noisy environments, distributed sensor data fusion in ad hoc networks, improved cryptography techniques, and hazardous material and event sensing. This project also funds research in the development of biologically inspired materials for use as sensors as well as for power generation and storage.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Adaptive, Active, and Intelligent Optical Systems	1.708	1.761	1.779
Description: Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications. *FY 2010 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H44: *ADV SENSORS RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Explored long range atmospheric laser beam propagation paths for military reconnaissance, laser communications, and directed energy applications. *FY 2011 Plans:* Devise target-in-loop (TIL) laser beam control techniques for Army long range and tactical scenario engagements. *FY 2012 Plans:* Will develop image processing software that includes super resolution, fusion, and adaptive optics for application to enhance laser communication technologies; and will validate image processing software in realistic battlefield conditions to improve real-time situational awareness through greater fidelity of battlefield imagery.			
Title: Improving Sensor and Display Capabilities *Description:* Create more survivable and secure systems and displays, improve hazardous material monitoring, and investigate new magnetic sensor technologies for personnel and improvised explosive device (IED) detection. *FY 2010 Accomplishments:* Integrated conductive organic materials and high stability organic light emitting diode (OLED) with flexible backplanes and conducted experiments with a Micro Electric Mechanical System (MEMS) low-noise magnetic sensor; modeled metamaterial antennas and explored their theoretical limits. *FY 2011 Plans:* Optimize conducting organic materials for flexible display and electronics, investigate 3-D Synthetic Aperture Radar imaging using wide-angle simulation data of complex buildings for through-the-wall sensing research, develop conductive organic materials and thin film transistors and integrate into flexible electronic devices. Research networked fusion concepts across distributed multimodal sensor nodes and develop novel magnetic sensors with enhanced performance. Fabricate and evaluate metamaterial inspired antennas based on theoretical simulations. *FY 2012 Plans:* Will fabricate and further investigate metamaterial inspired antennas based on theoretical simulations; will develop, apply and validate advanced computational models of 3-dimensional realistic ground surfaces to aid in defining theoretical performance limits of low frequency wideband radar technology for the detection of landmines and IEDs; will research phenomenology of features associated with sensing human motion and concepts for fusion of new features to reduce false alarms; will continue optimization of conductive organic materials and high stability OLEDs for transition into OLED displays to include development of thin-film transistors and transparent electrodes for flexible electronics applications.	2.500	2.644	2.685
Title: Biologically-Inspired Sensing and Power Generation	2.033	2.290	3.052

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H44: *ADV SENSORS RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Description: Investigate biological systems to develop biologically-inspired materials for use as sensors as well as for power generation and storage. *FY 2010 Accomplishments:* Investigated bacteria that remediate energetic materials and produced small organic molecules useful as fuels, bio-inspired structural materials for energy absorption, bio-inspired batteries, and biologically directed assembly of electronic structures. *FY 2011 Plans:* Manipulate bacteria for improved remediation of energetic materials and generation of organic fuels, investigate electric properties of bio-assembled materials for battery applications, investigate mechanical properties of bio-inspired structural materials, and investigate the electronic properties of bio-assembled electronic structures. *FY 2012 Plans:* Will investigate methods to redesign cellular proteins to converge the signaling from different cellular receptors to a common output signal suitable for electronic device detection; will manipulate bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterize the resulting complexes; will complete characterization of 2-D assembly of nucleic acid templates in non-aqueous solvents for patterning of semiconductor seed particles for IR and photovoltaic devices; will continue iterative modeling and experimental evaluation of models for remediation of energetics and generation of organic fuels to reflect new information collected from systems biology approaches.			
Title: Multi-Scale Modeling for Novel Materials *Description:* Funding is provided for the following efforts: *FY 2011 Plans:* Perform fundamental studies of materials to identify and model physics and atomic interactions that define the electronic properties and characteristics, such as bandgap structure and control material deformation, progressive / catastrophic failure, and phase response across length scales; evolve interface physics between nano- and meso-scales up to the continuum; create new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects and at interfaces, and response under extreme conditions. Supporting computational research investigates and develops scalable interdisciplinary data models to address spatial one-way coupling of software on massively parallel petaflop systems, and multi-core computing systems. *FY 2012 Plans:* Will continue to perform fundamental studies of materials to identify and model physics and atomic interactions that define the electronic and optical properties and characteristics, such as bandgap structure, carrier transport, diffusion rates, defects, control	-	3.000	2.489

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H44: *ADV SENSORS RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
material deformation, progressive / catastrophic failure, and phase response across length scales; will evolve interface physics between nano- and meso-scales up to the continuum; will expand upon and continue to create new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects and at interfaces, and response under extreme conditions; will develop web-based security scheme for external and internal project users; will develop multi-scale computational science environment to facilitate coupling of different software; will establish methods to support high performance computing users and software developers.			
Accomplishments/Planned Programs Subtotals	6.241	9.695	10.005

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

E. Performance Metrics
   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army										DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*				**PROJECT** H45: *AIR MOBILITY*			

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H45: *AIR MOBILITY*	2.306	2.399	2.449	-	2.449	2.497	2.543	2.588	2.632	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification
This project supports basic research in aerodynamics for manned and unmanned rotary wing aircraft. The goal of this effort is to develop improved tools and methods to analyze, evaluate, and assess rotorcraft unique aerodynamic properties in conventional helicopter and tilt rotor aircraft. The efforts in this project will result in a better understanding of rotorcraft aeromechanics and will result in improved performance, safety and, ultimately, improved combat effectiveness of the manned and unmanned rotorcraft in the future force. This project supports the future force by providing research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing aircraft.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Aviation & Missile RDEC, Aero-Flight Dynamics Directorate at NASA Ames Research Center, CA and Langley Research Center, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Rotary Wing Aerodynamics	2.306	2.399	2.449
Description: Funding is provided for the following effort			
FY 2010 Accomplishments: Investigated interacting vortex wakes for rotors in close proximity and identified the high speed aeromechanics boundaries of compound helicopter configurations.			
FY 2011 Plans: Develop improved and validated hover performance methods, investigate the ability of pressure sensitive paint to acquire unsteady pressure measurements for both fuselage and rotor blades.			
FY 2012 Plans: Will assess facility effects on existing highest quality single rotor hover data; will investigate natural laminar flow wings for improved rotorcraft performance; and will explore high performance computing methodology for difficult rotorcraft phenomenon.			
Accomplishments/Planned Programs Subtotals	2.306	2.399	2.449

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H45: *AIR MOBILITY*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H47: *APPLIED PHYSICS RSCH*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H47: *APPLIED PHYSICS RSCH*	2.894	5.009	5.087	-	5.087	5.187	5.258	5.540	5.996	Continuing	Continuing

Note
  Not applicable for this item

A. Mission Description and Budget Item Justification

  This project performs basic research on electronic materials and structures as well as energetic batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes nanoelectronic devices for low-power and high-frequency applications; sensors, emissive nonlinear and nanophase electrode, and electronic materials; thin heterostructure systems where quantum confinement effects are important; advanced batteries and more efficient fuel cells for hybrid power; and the manipulation of cold atoms on a chip for application to very sensitive sensors and ultra-stable atomic clocks. These investigations will impact the development of power sources and specialty electronic materials for the Army's future force, including improved wide band gap semiconductor performance in electric vehicles and advanced radar systems. Applications of cold atom chips include gyroscopes and accelerometers for inertial navigation units in global positioning system (GPS) denied environments, gravitational sensors for detecting underground facilities, very-low-phase noise precision oscillators for low-velocity Doppler radar, and atomic clocks for GPS denied environments as well as for future space-based timing applications. Technical barriers affecting performance, weight, cost, and power consumption will be addressed.

  The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

  Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Research Focuses on Nanoelectronic Devices and Sensors *Description:* Materials for advanced batteries; fuel cells and reformers for Soldier and vehicle power; electronic materials structures and defects of high-temperature wide-band-gap semiconductors for high-power electronic applications; cold-atom chip devices for advanced sensors and ultra-stable atomic clocks; and integration of nanoenergetics and micro electro mechanical system (MEMS) for fusing and microrobotic applications. *FY 2010 Accomplishments:* Loaded and launched cold atoms into an atom waveguide; integrated nanoporous energetic silicon with MEMS acceleration switch and investigated carbon based materials for application to nanoelectronic devices; used computer modeling to understand	2.894	3.002	3.086

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H47: *APPLIED PHYSICS RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
ionic transport within membranes for electrochemical devices; developed mechanisms for Solid Electrolyte Interface formation to aid in designing battery components. *FY 2011 Plans:* Attempt to split a cold atom cloud in an atom chip waveguide. Integrate nanoporous energetic silicon with MEMS microthruster devices and develop nanoelectronic devices. Develop new battery electrode prospects by bio-inspired processes from Institute for Collaborative Biotechnologies, PE 0601104A/project H05. *FY 2012 Plans:* Will study the coherence properties of a split cold atom cloud in an atom chip waveguide; will investigate energetic energy conversion methods for on-chip pulsed power; will examine existing models for graphene materials growth for potential use in nanoelectronic devices; will investigate next generation wide band gap power device materials such as Aluminum Nitride and diamond, will conduct modeling of electron transport in alkaline membrane electrode assemblies, and will model physical properties of Silicon (Si) anodes for Lithium ion batteries and structure property relationships of Si anodes.			
Title: Advanced Energy Science Research *Description:* Conduct materials research and multi-scale modeling that will lead to advances in energy storage, harvesting, and conversion for a wide range of Army applications. *FY 2011 Plans:* Conduct research to advance novel materials by design approach of modeling and theoretical computations to predict characteristics and performance a priori for energy storage and conversion materials; investigate multidisciplinary approaches for novel energy harvesting (light, heat, vibration, isotope, biological energy, sources); investigate emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications. *FY 2012 Plans:* Will conduct research to design, fabricate and characterize materials properties in coordination with planned modeling and theoretical computations for energy storage and conversion materials; will conduct research in developing computational tools in multi-scale modeling supporting electrochemical energy materials development; will design and experiment novel energy harvesting (light, heat, vibration, isotope, biological energy, sources) methods; will investigate, emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications.	-	2.007	2.001
Accomplishments/Planned Programs Subtotals	2.894	5.009	5.087

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H47: *APPLIED PHYSICS RSCH*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H48: *BATTLESPACE INFO & COMM RSC*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H48: *BATTLESPACE INFO & COMM RSC*	11.200	13.685	15.726	-	15.726	17.250	18.285	18.890	19.211	Continuing	Continuing

Note

Not applicable to this item

A. Mission Description and Budget Item Justification

This project supports basic research to enable intelligent and survivable command and control, communication, computing, and intelligence (C4I) systems for the future force. As the combat force structure decreases and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. This research supports the Army's new Network Science initiative and in the process addresses the areas of information assurance, the related signal processing for wireless battlefield communications, document and speech machine translation, and intelligent systems for C4I. Major barriers to achieving the goals are the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, resource-constrained sensor networks, diverse networks with dynamic topologies, high-level multi-path interference and fading, jamming and multi-access interference, levels of noise in speech signals and document images, new low-density languages, and information warfare threats. The intelligent systems for C4I research will focus on providing the agent technology capabilities that will produce highly relevant tactical events for mounted or dismounted commanders, leaders and soldiers; improve the timeliness, quality and effectiveness of actions; and speed the decision-making process of small teams operating in complex natural or urban terrain.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Communication for Tactical Networks	1.671	1.568	1.687
Description: Perform research to provide communications capability for a fully mobile, fully communicating, and situationally aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds to thousands of networked nodes. *FY 2010 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H48: *BATTLESPACE INFO & COMM RSC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Performed validation analysis to extract tractable models of network behavior to enhance military network design tools. *FY 2011 Plans:* Use network behavior models and scaling laws to develop cognitive networking protocols to enhance the performance of tactical mobile networks. *FY 2012 Plans:* Will develop techniques to characterize the quality of information and develop an understanding and potential metrics for impact on network behavior.			
Title: Data to Knowledge to Support Decision Making *Description:* Design and implement a laboratory scale common information-processing infrastructure, inclusive of service oriented architecture for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty. *FY 2010 Accomplishments:* Extended scene recognition algorithms to mobile platforms to support biologically inspired collaborative behaviors; investigated local and global policy aware information exchange and information exploitation algorithms in collaboration with the Network Science CTA initiative. *FY 2011 Plans:* Conduct validations in a laboratory environment to assess the impact of scene recognition algorithms on Situation Understanding. *FY 2012 Plans:* Will extend scene recognition to scene understanding algorithms, assessing them and their associated machine learning approaches on collaborating mobile platforms.	1.480	1.636	1.761
Title: Information Processing for Mobile Ad-Hoc Networks (MANET)s *Description:* Perform research in protecting information in highly mobile wireless tactical environments with severe bandwidth, energy, and processing constraints and operating without reliance on centralized security services. *FY 2010 Accomplishments:* Refined and evaluated the dynamic security services architecture for mobile tactical networks for assured Soldier communications. *FY 2011 Plans:*	1.710	1.765	1.899

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H48: *BATTLESPACE INFO & COMM RSC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Investigate techniques for incorporating security constraints in networking protocols. *FY 2012 Plans:* Will investigate and develop techniques for securing information flows in mobile wireless tactical environments.			
Title: Multi-Lingual Computing Research *Description:* Establish formal methods for bridging language barriers in tactical environments, incorporating state of the art techniques in machine translation and natural language processing. *FY 2010 Accomplishments:* Developed and assessed novel metrics for evaluating new multi-engine machine translation architectures. *FY 2011 Plans:* Conduct laboratory validations to assess multi-engine machine translation concepts, addressing scalability and robustness in noisy environments. *FY 2012 Plans:* Will formalize techniques for adapting data flows to increase the effectiveness of multi-engine translation techniques; and will develop methods to support decision making from machine translated segments.	1.082	1.222	1.315
Title: Network Science for MANETs and Tactical Communications *Description:* Study the behavior of mobile ad-hoc networks (MANETs) as part of the Army's Network Science initiative. Emphasis is on mobile communications networks research with the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnology at the University of California - Santa Barbara. *FY 2010 Accomplishments:* Developed and compared component based analytical models with executable models to enable the design of robust tactical networks. *FY 2011 Plans:* Develop algorithms, techniques and metrics for robust local/global network optimization using cognitive and communication network metrics. *FY 2012 Plans:* Will develop algorithms for the analysis of complicated large-scale network structures.	1.001	1.036	1.114
Title: Advanced Computing	2.500	2.599	3.797

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H48: *BATTLESPACE INFO & COMM RSC*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Description: Investigate computing and networking architectures, algorithms, as well as visualization for advanced battle command applications of C4I system. *FY 2010 Accomplishments:* Investigated algorithms, approaches, and methodologies for battle command applications that exploit emerging mobile hybrid computing architectures. Battle command applications included large-scale battlefield network modeling; real-time algorithms to assist network emulations; comprehensive data representation, models and analysis techniques; information fusion of different data types; and engineering design based approaches. *FY 2011 Plans:* Implement large-scale battlefield network modeling; develop real-time algorithms to assist network emulations; develop models and analysis techniques; establish information fusion of different data types for battle command applications that exploit emerging mobile hybrid computing architectures. *FY 2012 Plans:* Will validate battle command applications developed on mobile hybrid computing architectures, namely, large-scale network electromagnetic propagation; will develop real time algorithms for network emulations, and network simulators; will develop new methods for battle command information visualization; will explore programming models and battle command applications for the next generation Intel High Performance Computing architectures, namely, cloud on a chip, and secure enclaves.			
Title: Network Science Technology Experimental Center *Description:* Supports in-house Network Science studies in conjunction with the Network Science and Technology Research Center (PE 0601104A/project J22) and is coordinated through the Network Sciences CTA (0601104A/project H50). *FY 2010 Accomplishments:* Devised advanced computing based tools to accelerate scenario/model development that allowed coupling of different models, verification and validation, and enhanced multi-disciplinary collaboration through common user interfaces, scalable library routines, pre-processing, scalable optimization routines, and post-processing analysis tools. *FY 2011 Plans:* Extend the wireless emulation and simulation tools to support the modeling of networks of 1000s of nodes with high-fidelity propagation models and realistic traffic models. The simulation and emulation tools are linked to field validations to extend the scale of the network evaluated. These efforts significantly improve the understanding of network behaviors under a full range of operational conditions, significantly improving the design of NCW technologies. *FY 2012 Plans:*	1.756	3.859	4.153

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H48: *BATTLESPACE INFO & COMM RSC*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will expand capabilities toward extensive integration of wireless communications emulation with academic and industrial experimental facilities developed under the Network Sciences CTA; will initiate a comprehensive program of multi-disciplinary experiments with wireless emulation utilized as hardware in the loop; will document experimental and theoretical results describing and predicting impact of mobility and adversarial attacks on the dynamics of information quality delivered through mobile communication networks to include observed phenomena of the characteristics of network reliability perceptions and trust on battle command decision making; will research social network analysis metrics and techniques for integrating these with traditional communications and information network analysis methods.			
Accomplishments/Planned Programs Subtotals	11.200	13.685	15.726

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

E. Performance Metrics
   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H52: *EQUIP FOR THE SOLDIER*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H52: *EQUIP FOR THE SOLDIER*	1.026	1.078	1.105	-	1.105	1.134	1.158	1.181	1.201	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification

This project supports basic research to achieve technologies for the Soldier of the future which focus on core technology areas that include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research. Effort is targeted on enhancing the mission performance, survivability, and sustainability of the Soldier by advancing the state-of-the-art in the sciences underlying human performance, clothing, and protective equipment to defend against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and ration shortfalls.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work is performed and managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Equipment for the Soldier **Description:** This project supports basic research to achieve technologies for the Soldier of the future which include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research. **FY 2010 Accomplishments:** Used novel computational methodologies to understand techniques necessary to simulate dynamics/interactions of fluid structure systems undergoing topology change as would be found in parachutes, parafoils and flexible structures. **FY 2011 Plans:** Continue fundamental work in supporting the goals of understanding cognition while performing multiple tasks; explore novel approaches to representing body geometry in biomechanical applications to address fundamental errors in measurement and analysis techniques of earlier human limb mass property studies; and conduct experiments to improve the understanding of the basic phenomena of the biomimetic approach to metal oxide formation for the production of novel multifunctional materials. **FY 2012 Plans:**	1.026	1.078	1.105

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H52: *EQUIP FOR THE SOLDIER*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will investigate the aerodynamics and structural behavior of permeable structures under dynamic loads; will explore the cognitive behavior of non-spatial influences on navigation through complex environments; and will do fundamental biomechanical research on exoskeleton design and human sciences towards optimization of user performance.			
Accomplishments/Planned Programs Subtotals	1.026	1.078	1.105

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT H57: *Single Investigator Basic Research*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H57: *Single Investigator Basic Research*	62.870	73.075	78.257	-	78.257	79.027	80.262	79.933	82.453	Continuing	Continuing

Note
   Not applicable

A. Mission Description and Budget Item Justification

This extramural research project discovers and exploits new scientific opportunities and technology breakthroughs, primarily from universities, that will improve the Army's Transformational Capabilities. Current technologies are unable to meet the operational requirements of the future force. The Army Research Office of the Army Research Laboratory (ARL) maintains a strong peer-reviewed scientific research program through which leap-ahead technological solutions may be discovered, matured, and transitioned to overcome the technological barriers associated with next generation capabilities. Included are research efforts for increasing knowledge and understanding in fields related to long-term future force needs in the physical sciences (physics, chemistry and biology), the engineering sciences (mechanical sciences, electronics, materials science and environmental science (atmospheric and terrestrial sciences), and mathematical and information sciences (mathematics, computer, and information sciences), and network science. Targeted research programs in nanotechnology, smart structures, multifunctional and microminiature sensors, intelligent systems, countermine, compact power, and other mission-driven areas will lead to a Future Force that is more strategically deployable, more agile, more lethal, and more survivable. The breadth of this basic research program covers approximately 900 active, ongoing research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, supporting research at nearly 250 institutions in 50 states.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed extramurally by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Basic research in molecular, physiological, and systems biology	5.729	6.351	6.899
Description: Pursues fundamental discoveries with the ultimate goal of facilitating the development of novel biomaterials to greatly enhance Soldier protection and performance. More specifically, i) molecular genetics research pursues fundamental studies in molecular and systems biology, and genetics, ii) neurosciences research investigates the physiology underlying perception, neuro-motor output, and potential methods of monitoring cognitive states during activity, iii) biochemistry research focuses on studies in structural and cell biology, metabolic processes, and biophysics; iv) research in microbiology pursues studies in microbial physiology, ecology, and evolution, and v) social science research aims to elucidate the social, cultural, and other influences to human actions.			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
FY 2010 Accomplishments: Basic research efforts were aimed at the design of bioinspired nanodevices, the use of biomimetics to create new protective materials, the discovery and characterization of microbial species for potential bioremediation (e.g., degradation of toxic pollutants), and the discovery of potential animal metabolic pathways that could ultimately allow the modulation of oxidative stress as applied to Soldier health and performance; pursued concurrent transition and focus towards field use in these research areas; began new initiatives in non-invasive modulation of neural systems with the goals of bridging the living/nonliving interface in peripheral nerves and sensing of brain signals; expanded biofuel development studies; improved methods to convert operating base biological waste to energy; and investigated development of methodologies to convert sunlight 'directly' to biofuels. *FY 2011 Plans:* These research efforts are continuing to further advance their applicability and ultimately enable and facilitate development of new biotechnologies and bio-nano engineering applications for new Army capabilities and material. Research is also continuing to compare the potential for various non-invasive methods to reproducibly interpret brain signals. *FY 2012 Plans:* Efforts will continue to improve Soldier protection; will investigate potential mechanisms to improve Soldier cognitive and physical performance; and will explore methods to harness biological mechanisms for energy and fuel production.			
Title: Basic research in environmental science *Description:* Basic research in environmental science possesses three areas: atmospheric science research to measure, model, and theoretically understand the nighttime atmospheric boundary layer; terrestrial science research to enable the Army to operate effectively in all military operating environments by understanding fundamental terrain and land-based phenomena; and military habitation science, basic research to allow military power projection that meets operational needs in a sustainable manner. *FY 2010 Accomplishments:* Addressed Army-unique atmospheric operational needs and investigated automated terrain navigation by autonomous vehicles and used geographic information systems (GIS)-based approaches for cognitive understanding and utilization of geospatial information, analysis, representation, and modeling of multiple types of geospatial data. *FY 2011 Plans:* Examine small-scale processes of the diurnal continental atmospheric boundary layer, investigate the overlapping topics of network science and geographic information science research as related to social networks, and improve operational sustainment through basic research in military habitation science. *FY 2012 Plans:*	2.030	2.474	3.679

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Environmental sciences will address the knowledge and capability gap between current operational weather prediction models and local atmospheric conditions affecting soldiers and systems through basic research in atmospheric dynamics and observational capability; research will further examine the evolution of the nocturnal boundary layer structure using up to three Tethered Lift Systems with multiple, redesigned, sensor packages trailing from each; the focus will be on quantifying the turbulent processes as a function of separation scales; both experimental and modeling work will continue to be performed that investigates the effects of both soil heterogeneity plus water and heat flux conditions at the soil surface on subsurface moisture distribution at different spatial scales in the unsaturated zone.			
Title: Basic research in chemical sciences	6.920	8.373	9.970

Description: Focuses on the ultimate goals of achieving advanced energy control, improved threat detection, and novel responsive materials for Soldier protection. Research efforts in advanced energy control involve the study of electrochemistry and electrocatalysis, and physical and theoretical chemistry, which can lead to light-weight, reliable, compact power sources for the Soldier and more effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage. Research in protective materials involves discoveries in polymer, inorganic, and organic chemistry, which can provide new approaches for shielding the Soldier and Army platforms from ballistic, chemical, and biological threats, and reducing signatures for identification by the enemy. Threat detection research involves studies in the fields of physical, theoretical, and inorganic chemistry, which can lead to advances that provide advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals.

FY 2010 Accomplishments:
Research was focused on functionalized morphology, novel reactive monomers, environmentally stable self-assembled materials, and reactions in extreme media.

FY 2011 Plans:
Research efforts continue on functionalized morphology, novel reactive monomers, environmentally stable self-assembled materials, and reactions in extreme media; discovering and designing mechanophores (mechanically active molecules): never-before-created molecules that provide automatic conversions between mechanical, thermal and chemical energy, and synthesizing and incorporating these compounds into polymers and polymeric materials.

FY 2012 Plans:
Will investigate how material and morphology can effect electron transfer and electrocatalysis; will investigate novel approaches and designs for functionalized morphology, novel reactive monomers, and environmentally stable self-assembled materials; novel

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
mechanophores previously integrated into composites will be evaluated for responses to mechanical damage; and will initiate modeling and experimental studies to begin to uncover the physical properties that control chemical reactivity.			
Title: Basic research in physics *Description:* Focuses on superior optics, signature management properties, ultra-sensitive sensors, precision guidance, quantum computing, and secure communications. Research efforts in superior optics, signature management properties, and ultra-sensitive sensors are made possible through discoveries in many subfields of physics, including optical physics and imaging science, and atomic and molecular physics. Research efforts in precision guidance involve the study of atomic and molecular physics, while the pursuit of the quantum computing and secure communications research topics is made possible from specific studies in the fields of quantum information sciences and condensed matter physics. *FY 2010 Accomplishments:* Research demonstrated ultra-light negative-index optical components; simulated intractable condensed matter theories with optical lattices; devised ultra-cold chemistry concepts heralding novel chemical synthesis routes; engineered artificial oxides to stimulate a second electronics revolution; and explored cross-platform qubit entanglement. *FY 2011 Plans:* Efforts continue on transformation optics for cloaking and omni-directional light collection; devising models and guiding materials development for next generation electronics using optical lattices; engineering artificially layered oxides to enable disruptive electronic technology; studying quantum entanglement-enhanced metrology and stealth imaging; studying techniques to exploit quantum entanglement and controllable quantum physics effects for imaging; researching new spin-based electronics technology (spintronics) and 'cold atom' spintronics. *FY 2012 Plans:* Research will continue advancing transformation optics toward eventual uses in cloaking applications and omni-directional light collection; will develop new ultra-cold chemistry concepts heralding novel chemical synthesis routes; will explore cross-platform qubit entanglement and evaluate potential applications in quantum entanglement-enhanced metrology and stealth imaging; will assess and improve theories to better understand and control defects in complex oxides, especially at interfaces.	9.325	12.457	10.788
Title: Basic research in electronics and photonics for situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency. *Description:* Focuses on situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency. *FY 2010 Accomplishments:*	12.242	14.474	11.554

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Generated small avalanche photodiode arrays of the (Ga,In)(As,Sb) family providing low noise/high gain for night vision applications in mid infrared spectral region; showed feasibility of electrically-injected room temperature continuous-wave mid-infrared semiconductor lasers based on group IV-VI lead salt materials for optical communications; validated optical subwavelength sensing on biomolecules for Chem/Bio analysis; and showed proof of concept for a single-chip 2.4GHz transceiver on silicon with integrated antenna for improved radio communications. *FY 2011 Plans:* Determine feasibility of quantum cascade superlattice IR detector; create wide-bandgap ZincOxide(ZnO)/GaN based semiconductor lasers; tunable composition nanowire visible lasers with improved efficiencies/scalable power for low cost applications; and determine effects of polarization field upon ferromagnetic and optical properties of magnetically doped GaN for sensing/information processing. Study theory, materials growth and characterization of complex oxides that exhibit strong electron correlations leading to emergent phenomena not possible with semiconductors. Research non-invasive techniques to interface electronics with the brain. *FY 2012 Plans:* Will determine the effect of antidote lattices (a novel material structure) on the bandgap in graphene; will evaluate vertical lasing based on photonic crystal Fano resonances using nanomembrane broadband reflectors; will investigate photonic bandgap structures for use in multifunctional radio, radar, and sensor systems; will explore controlled nanogaps in nanowire waveguides to form the basis of a nanoscale spectrometer.			
Title: Basic research in mechanical and material sciences *Description:* Covers survivable armor, more lethal anti-armor, improved mobility, and flexible displays for Soldier systems. *FY 2010 Accomplishments:* Investigated topological optimization strategies to devise tools to optimize structures based on damage tolerance; validated new vorticity-based computational methods for rotorcraft flows capable of convecting the wake without the deleterious effects of numerical diffusion for improved model accuracy; researched implementation of reduced hydrocarbon combustion kinetics codes into engine models for future fuel flexible engines and devised physical understanding of hypergolic ignition to enable gel-propellant rocket propulsion. *FY 2011 Plans:* Devise a comprehensive understanding of the propagation of intense stress-waves in adaptive media with random, locally varying, and discontinuous properties for unprecedented armor material designs. Investigate novel/emerging composite materials system that mimics biological adaptive and self-healing characteristics for novel structural materials. *FY 2012 Plans:*	12.187	12.385	14.254

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Will develop understanding at the microscopic level (single layer) for reaction processes and kinetics of reactive materials undergoing high speed impact; will develop materials with stress-activated molecules that enhance macroscopic properties of interest when elastic force is applied; will investigate a predictive theoretical framework to identify promising 2D free -standing crystalline oxides/ nitrides and nanocomposites; will characterize how the instantaneous 3-D structure of a turbulent boundary changes in the presence of an adverse pressure gradient for the understanding of dynamic stall processes.			
Title: Basic research in mathematical and computer sciences *Description:* Provides the backbone for performing complex, multi-system analysis, modeling and simulation for understanding information systems. Advancements in mathematical and computer sciences have a direct impact on enhancing the warfighters' decision-making, situation awareness, command and control, as well as on the overall performance of weapon, intelligence, transportation and logistics systems. *FY 2010 Accomplishments:* Experimentally validated the effectiveness of the devised products and tools on swarming and sensor fusion in laboratory test-beds; new methods helped to identify attacks against information systems, protecting information systems from attacks; devised techniques for inherently hardened software; the new understanding and knowledge gained from these efforts contributed to the development of robust and resilient information systems that addressed the processing and delivery of authentic, secure, reliable, and timely information to the warfighters, regardless of threat conditions. *FY 2011 Plans:* Use the results of the evaluation and validation efforts from FY10 to refine and improve tools and an enhance theory. Improved tools and enhanced theory developed in FY10 on cyber situation awareness is being investigated leveraging advances in cognitive science, adversarial reasoning, and decision sciences to establish new capabilities in effectively predicting, preventing, and detecting cyber intrusions, in sustaining mission critical functions and services, and in rapid recovering from damage. Studies are underway for creating then assessing efficient (optimal and nearly optimal) changepoint detection procedures and spatiotemporal image processing techniques for clutter rejection, and nonlinear filtering methods for tracking dim targets in IR/ video data. *FY 2012 Plans:* Will investigate trusted computing that is adaptive to both social and culture influences, and develop new capabilities for warfighters deployed in areas of different social and culture interactions; will investigate adaptive change detection procedures for composite hypotheses in cyber security for comparison of several changepoint detection methods; will develop computer network security and surveillance, clutter rejection and nonlinear filtering algorithms.	12.279	11.273	11.298
Title: Basic research in network science	2.158	3.623	3.224

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Description: Focuses on gaining an understanding of the fundamental aspects of how networks develop, function, and adapt to the environmental and the rate of information flow in manmade and naturally occurring networks. This understanding will have a direct impact on net-centric force operations, such as better communication system design and operations, and more efficient logistics or communications support. *FY 2010 Accomplishments:* Defined and conducted first order laboratory experiments and simulations that refined network representations. *FY 2011 Plans:* Develop the theory to understand the non-stationary, non-ergodic statistics of complex biological, social and cognitive networks observed in the experiments of FY10; understand the limitations of traditional statistical theory on which predictions have been historically based and how it impacts the capabilities of the net-centric force; specifically, the influence of intermittent uncertainty on situation awareness and decision-making in a networked environment is being determined. *FY 2012 Plans:* Emphasis will be on understanding human networks and, in particular, how information mathematically spreads through a network; the impact of the proposed work will be a better understanding of how decisions are made in groups, and network effects of hard-line members of a group; will investigate the commonalities between communication and human networks, and how they can be analyzed in tandem.			
Title: Basic Research in bioforensics and microscale manipulation with bacteria *Description:* Covers the understanding of microbe adaptations, and micro-scale locomotion and controls for micro-bio-robots. The long term goal of this research is to improve the scientific understanding of how microbes adapt to an environment, enabling the ability to determine where microbes originated, how closely related they are, and their recent growth environment, which could ultimately reveal the identity and feasibility of bacterial signatures that could be used to trace the history of an organism to provide a means of tracking the cause, potential danger, and source of a biological event, whether naturally occurring or nefarious; and understand how micro-scale locomotion and manipulation is possible, with potential applications in bacteria propelled micro-structures for engineering of micro-manipulators and micro-robotics. *FY 2011 Plans:* Efforts are underway for investigating the detection limits of bacterial poles (i.e., cell structures acting as 'age markers' within bacteria); and studying micro-scale locomotion and manipulation using flagellated bacteria for actuation; and extending theory to address the use of attractants for controlling the trajectory of bacteria-propelled barge. *FY 2012 Plans:*	-	1.665	1.997

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Efforts will determine the locations and compositions of palindromic repeats (i.e., structures acting as bacterial 'gene memory'); and will investigate methods to control of individual bacteria with external stimuli (chemical, optical or electrical) with appropriate spatial and temporal resolution; will create stochastic mathematical models for various control modalities and model abstraction techniques will be created to reduce the model complexity in order to achieve accurate automatic steering for the position and orientation of the micro-bio-robots.			
Title: Basic research in oxide electronics and brain-electronic interfaces *Description:* Focuses on advancing the theory, materials growth, and characterization of artificially-layered complex oxides with the ultimate goal of discovering emergent phenomena in this material system that may ultimately provide far-reaching opportunities for new technological capabilities, and deciphering the coding of neural systems with the long-term goal of discovering and developing methods for the non-invasive decoding and modulation of neural systems, the sensing and decoding the complex brain signals responsible for specific muscle movements, and ultimately the bridging of the living/nonliving interface in peripheral nerves that may lead to future applications in silent communication and mental control of equipment such as the natural and full control of prosthetic limbs. This research effort is an enhancement of the activities conducted under Electronics and Photonics and emerges as a new research area starting FY12. *FY 2012 Plans:* Research will expand predictive theories to accurately model materials and then verify accuracy; will continue to expand heteroepitaxial capabilities; will explore solutions to eliminating or mitigating dominant defects; will pursue luminescence diagnostic studies of material defects; will develop and examine experimental methods for potential to 'decode' brain signals to determine how particular thoughts can be used as control inputs for engineered systems; and will investigate potential methods for interfacing electronics with the brain.	-	-	1.997
Title: Basic research in quantum imaging and defect state enabled spintronics *Description:* Research aimed at advancing foundational theory and experiments to utilize quantum resources such as superposition and entanglement for beyond-classical capabilities in imaging that could ultimately enable sub-wavelength imaging, single-photon and low-power illumination, and improved covert detection using entanglement, and pursuing breakthroughs demonstrating that defect states contribute to long-range order in wide band-gap semiconductor systems, which could ultimately be exploited to develop magnetic semiconductors as the basis for the long-sought-after new spin-based electronics technology. This research effort is an enhancement of the activities conducted under physics and emerges as a new research area starting FY12. *FY 2012 Plans:*	-	-	2.597

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H57: *Single Investigator Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Research efforts will conduct additional experiments that build on the foundational theory and early experiments, which will enable the exploration of the advantages of entanglement in ghost imaging, two color ghost imaging, aberration cancellation in quantum interferometry, and optical materials to implement quantum lithography; will incorporate previously developed results of bright entangled sources in experiments; and will evaluate new techniques for directly manipulating with electrical fields the spins states associated with individual defect centers in diamond materials using quantum manipulation techniques.			
Accomplishments/Planned Programs Subtotals	62.870	73.075	78.257

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army										DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H66: *ADV STRUCTURES RSCH*			
COST ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012 Base**	**FY 2012 OCO**	**FY 2012 Total**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Cost To Complete**	**Total Cost**
H66: *ADV STRUCTURES RSCH*	1.805	1.889	1.942	-	1.942	1.996	2.040	2.089	2.125	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification
This project funds basic research for improved tools and methods to enable the structural health monitoring capabilities and condition-based maintenance for rotorcraft and ground vehicles. This research also enables the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms identified by the Army Modernization Strategy. Ultimately, these technologies result in safer, more affordable vehicles with a greatly reduced logistics footprint. This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic modeling and simulation; helicopter vibration (rotating and fixed systems); and the design and analyses of composite structures with crashworthiness as a goal. The problems in structures are inaccurate structural analysis and validation methods to predict durability and damage tolerance of composite and metallic rotorcraft structures and inadequate structural dynamics modeling methods for both the rotating and fixed system components to address reliability issues for future aircraft. The technical barriers include a lack of understanding of failure mechanisms, damage progression, residual strength, high-cycle fatigue, the transfer of aerodynamic loads on the rotor to the fixed system, and impact of these unknown loads on aircraft components. Technical solutions are focused on: advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, long-term investigation of integrated stress-strength-inspection, advanced methods for rotor system vehicle vibratory loads prediction, improved methods to predict vehicle stability, and improved analyses to address Army Aviation requirements. These advancements will extend service life, reduce maintenance costs, enhance durability, and reduce the logistics footprint of existing and future Army vehicles. As agreed under Project Reliance, this is the only project for rotorcraft and ground vehicle structures basic research within DoD.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Army Research Laboratory (ARL), located in facilities at the NASA Langley Research Center, Hampton, VA, and at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Title: Structural Analysis and Vibration Methods	1.805	1.889	1.942

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H66: *ADV STRUCTURES RSCH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Description: This research devises new structural analysis and validation methods to more accurately predict durability and damage tolerance of composite and metallic rotorcraft structures and evaluates structural dynamics modeling methods to address critical reliability issues in the rotating and fixed system components of future aircraft. *FY 2010 Accomplishments:* Completed characterization evaluation for materials used in finite element models for delamination fatigue life prediction and validated life prediction tools for dynamic rotorcraft sub-components. *FY 2011 Plans:* Develop predictive tools for residual strength after impact for thin-skin structural concepts; develop damage resistant and damage tolerant core and skin concepts; and validate residual strength prediction tools for stiffened skin components. *FY 2012 Plans:* Will use enhanced and selected Fatigue Crack Growth algorithms to validate damage tolerance (DT) methods through analytical redesign of a full-scaled rotorcraft component to meet DT requirements for Joint Future Theater Lift; will investigate Prognostics & Diagnostics (P&D) framework(s) for remaining useful life computations using flight evaluation data; will validate emerging P&D methods to establish probability of damage/flaw detection, develop usage credits, and establish fracture mechanics-based P&D technology.			
Accomplishments/Planned Programs Subtotals	1.805	1.889	1.942

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army								DATE: February 2011		

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT H67: *ENVIRONMENTAL RESEARCH*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
H67: *ENVIRONMENTAL RESEARCH*	0.886	0.967	0.997	-	0.997	1.018	1.039	1.072	1.090	Continuing	Continuing

A. Mission Description and Budget Item Justification

The objective of this project is to focus basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army production base and weapon systems as well as non-stockpile chemical warfare (CW) site remediation. The pollution prevention work invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater and reduced corrosive and more environmentally benign decontamination of biological warfare (BW) agents on field equipment and weapon systems. The goal is to reduce the cost of remediating a site by at least 50% versus the use of conventional methods. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. Pollution prevention thrusts include: environmentally acceptable, advanced, non-toxic processes to manufacture lightweight alternative structural materials to enhance weapon system survivability; clean synthesis of more powerful and improved energetic compounds to eliminate the use of hazardous materials and minimize the generation of wastes; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces.

This project is linked to the Army Environmental Requirements Technology Assessment (AERTA) requirements. The program element contains no duplication with any effort within the Military Departments.

The cited work is consistent with Strategic Planning Guidance, the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan and the defense Technology Area Plan (DTAP).

Work is under the direction of the U.S. Army Armament, Research, Development and Engineering Center.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Industrial Pollution Prevention	0.886	0.967	0.997
Description: This effort conducts research on innovative environmentally- friendly technologies that support the warfighter (focusing on pollution prevention technologies). *FY 2010 Accomplishments:* Developed environmentally benign approaches to nitration reaction in microreactors (ARDEC); synthesized environmental and human safe polysiloxane:nanoclay composites with enhanced thermal stability and gained an understanding of siloxane:clay interactions (NSRDEC); investigated new plasma enhanced magnetron technologies for ordnance coatings (Benet Labs);			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** H67: *ENVIRONMENTAL RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
developed polysiloxane nanocomposites for environmental and human safe flame-retardant materials (NSRDEC);conducted research on anaerobic hydrogen production from a variant of clostridium phytofermentans (ECBC); completed experimental work to patent chemistry of novel bio-based monomers for replacement of unsaturated polyesters (ARL); and continued joint synthetic/ theoretical efforts in identifying, synthesizing, characterizing new, stable dense energetic materials as potential ammonium perchlorate replacements (AMRDEC/ARL).			
FY 2011 Plans: Continue research efforts in FY10 that were reviewed by the Peer Panel during the Gate Reviews in September 2010.			
FY 2012 Plans: Will begin a new three year cycle of projects with a full call for proposals sent to the RDECOM laboratories.			
Accomplishments/Planned Programs Subtotals	0.886	0.967	0.997

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S13: *SCI BS/MED RSH INF DIS*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
S13: *SCI BS/MED RSH INF DIS*	10.296	10.652	10.900	-	10.900	11.121	11.348	11.447	11.445	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project supports basic research that provides for healthy, medically protected Soldiers. This project funds basic research leading to medical countermeasures for naturally occurring diseases impacting military operations. Basic research contained in this project provides understanding of the mechanisms that make organisms infectious and the effective human body response, which prevents disease. Understanding the biological characteristics of infectious organisms also enables the development of point-of-care and laboratory-based diagnostic tools. Understanding of disease transmission by insects and other organisms helps in developing new interventions to prevent disease. Infectious disease threats from malaria, diarrhea, and dengue (a severe debilitating disease transmitted by mosquitoes), which are common in Africa, Central, European, Southern, and/or Pacific Commands, are the highest priorities for basic research.

Research conducted in this project focuses on the following four areas:

(1) Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases
(2) Bacterial Threats
(3) Viral Threats
(4) Diagnostics and Disease Transmission Control

Work is managed by the US Army Medical Research and Materiel Command in coordination with the Naval Medical Research Center (NMRC). The Army is responsible for programming and funding all DoD naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the co-located Walter Reed Army Institute of Research (WRAIR) and Naval Medical Research Center (NMRC), Silver Spring, MD, and their overseas laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Prevention/Treatment of Parasitic (symbiotic relationship between two organisms) Diseases	5.745	5.829	3.709
Description: This effort conducts basic research to better understand the biology of malaria and leishmaniasis (a skin-based disease transmitted by sand flies) parasites, and to gain the necessary foundation for discovering medical countermeasures to protect military personnel from infection. Malaria, which can cause fatal and chronic disease, is the most significant military			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army	DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S13: *SCI BS/MED RSH INF DIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
infectious disease threat. Since the malaria parasite becomes resistant to drugs over time, it is necessary to continually search for parasite weaknesses that can be exploited with new, effective, user-friendly drugs and vaccines. *FY 2010 Accomplishments:* Applied new tools for discovery of promising compounds as potential leads to new classes of antimalarial drugs and for potential vaccine components. *FY 2011 Plans:* Continue iterative approaches for the discovery, design and synthesis of promising new antimalarial drug compounds and potential vaccine components. *FY 2012 Plans:* Will identify compounds to down-select for advance screening studies and evaluate their potential for future development as anti-parasitic drugs.			
Title: Vaccines for Prevention of Malaria *Description:* This effort conducts basic research to better understand and identify new proteins in the design of candidate vaccines for various types of malaria including the severe form of malaria (Plasmodium falciparum) and the less severe but relapsing form (Plasmodium vivax). A highly effective vaccine could reduce/eliminate the use of antimalarial drugs and the development of drug resistance to current/future drugs. *FY 2012 Plans:* Will identify new protein molecules as vaccine candidates against malaria to down-select for advance screening studies and evaluate their potential for future development; will study the mechanism of developing antibodies against these new molecules in animal models; will conduct research to develop methods of formulating new vaccine candidates for effective delivery inside the human body by using cutting-edge technologies.	-	-	2.244
Title: Bacterial Threats *Description:* This effort conducts research to better understand the biology of bacterial organisms and their effects on humans, as well as how to prevent wound infections, diarrhea (a significant threat during initial deployments) and scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics). *FY 2010 Accomplishments:*	1.468	1.724	1.476

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S13: *SCI BS/MED RSH INF DIS*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Assessed and improved selected proteins and other components identified from diarrheal-causing bacteria as potential components of candidate vaccines; conducted exploratory studies to evaluate methods to prevent wound infection from combat injuries. *FY 2011 Plans:* Develop further knowledge of the epidemiology (study of factors affecting the health and illness of populations) of diarrhea and wound infections in military personnel; assess basic wound management measures (concentrated oxygen, nutritional supplements and wound cleansing) to minimize the need for antimicrobials (a substance that kills or inhibits the growth of microbes such as bacteria, fungi, or viruses) and reduce antimicrobial resistance. *FY 2012 Plans:* Will assess results of epidemiologic studies (studies of factors affecting the health and illness of populations) of bacterial diarrhea and wound infections to ensure formulation of the best vaccine candidates for diarrhea and the best prevention practices to mitigate wound infections; will transition best basic wound management measures to preclinical (animal model) testing.			
Title: Viral Threats Research *Description:* This effort conducts research to better understand highly lethal or incapacitating viruses, including those that cause hemorrhagic diseases (severe viral infection that causes internal bleeding), such as dengue hemorrhagic fever and hantaviruses (severe viral infection that causes internal bleeding and is contracted from close contact with rodents). Basic research includes understanding risk of disease prevalence to the Warfighter, viral biology (including structure, function, lifecycle, and interactions with the environment), the disease process, and disease interaction with the human body. *FY 2010 Accomplishments:* Conducted basic research to better understand the biological basis of disease and protection in humans from naturally occurring viruses of military importance; developed a better understanding of which parts of the immune system are needed to provide a protective response in humans. *FY 2011 Plans:* Continue to study and evaluate the basis of disease and how the immune system reacts to diseases of interest. *FY 2012 Plans:* Will continue to study and evaluate the basis of the dengue disease and how the immune system reacts to it; will conduct research on defining factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals	1.757	1.764	1.736

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S13: *SCI BS/MED RSH INF DIS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
only; will also develop methods of distinguishing between protective and non-protective antibodies that will be used as surrogate markers of protection when evaluating vaccines against dengue infection.			
Title: Diagnostics and Disease Transmission Control *Description:* This effort conducts research to investigate the biology of biting insects (including mosquitoes and leishmaniasis-infected sand flies) and other organisms that transmit disease (disease vectors) and their control. Expand medical diagnostic and disease surveillance capabilities in the field. This research will help to direct new interventions into preventing disease transmission. *FY 2010 Accomplishments:* Conducted studies on the diversity, description and classification of medically-important insects (including mosquitoes, ticks and sand flies) as the scientific foundation for a web-based guide to identification. Explored new designs for devices to collect insects, and assessed medical threats from disease-carrying insects in deployed areas. *FY 2011 Plans:* Conduct mosquito identification within US Northern Command region using DNA markers to identify specimens. Conduct research leading to a new generation of detection assays for diagnosis of Rickettsial disease (carried by ticks, fleas, and lice) and lethal virus infectious agents within insect vectors (carriers of disease). *FY 2012 Plans:* Will develop new trapping methods to improve sand fly surveillance; will develop tools to identify mosquito species that transmit malaria parasites; will develop a detection method for scrub typhus (a debilitating mite-borne disease that is developing resistance to currently available antibiotics) in the Pacific Command?s area of operation.	1.326	1.335	1.735
Accomplishments/Planned Programs Subtotals	10.296	10.652	10.900

C. Other Program Funding Summary ($ in Millions)

   N/A

D. Acquisition Strategy

   N/A

E. Performance Metrics

   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S14: *SCI BS/CBT CAS CARE RS*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
S14: *SCI BS/CBT CAS CARE RS*	6.352	6.818	9.709	-	9.709	9.853	9.211	9.481	9.833	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research to understand the basic mechanisms of severe trauma to advance treatment and surgical procedures to save lives and improve medical outcomes for the Soldier. Experimental models are developed to support in-depth trauma research studies. This project includes studies of predictive indicators and decision aids for life-support systems, studies to heal and repair burned or traumatically injured tissue, Traumatic Brain Injury (TBI), sight and face trauma, and transplant technology. Such efforts will minimize lost duty time from and provide military medical capabilities for far-forward medical/surgical care of injuries, as well as post-evacuation restorative and rehabilitative care.

Research conducted in this project focuses on the following five areas:

(1) Damage Control Resuscitation
(2) Combat Trauma Therapies
(3) Combat Critical Care Engineering
(4) Clinical and Rehabilitative Medicine
(5) Traumatic Brain Injury (TBI)

Starting in FY10, S19 (T-Medical/Soldier Status) funding is merged into project S14.
Promising results identified in this project are further matured under PE 0602787A, project 874.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the US Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX; and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Damage Control Resuscitation	1.017	0.962	1.345
Description: This effort conducts studies of genetic pathways and metabolic mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma. *FY 2010 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S14: *SCI BS/CBT CAS CARE RS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Extended survival studies to determine the biochemical and genetic relationships between blood clotting and inflammation, which are factors causing death following severe bleeding. ***FY 2011 Plans:*** Investigate genetic components of the response to hemorrhage (bleeding) in specific strains of rats. ***FY 2012 Plans:*** Will conduct studies of immune system interaction with the coagulation (blood clotting) system and the effect of trauma on fibrinogen (a blood clot component) formation.			
Title: Combat Trauma Therapies ***Description:*** This effort conducts studies of trauma to tissues and organs, and ways to mitigate and/or repair this damage. Research addresses cellular repair/growth mechanisms to treat TBI, dental injuries, extremity wounds and fractures, and burns. ***FY 2010 Accomplishments:*** Realigned vision restoration efforts to the Clinical and Rehabilitative Medicine program area; conducted penetrating ballistic-like brain injury (PBBI) protein and gene regulation, as well as neuroprotection mechanism studies; investigated PBBI biomarkers as surrogate markers to show effectiveness of neuroprotection drugs; refocused dental disease research to repair of maxillofacial ((head, neck, face and jaw) bone and soft tissue injury repair; began research in eye trauma to understand the cellular and neuronal mechanisms of eye injuries. ***FY 2011 Plans:*** Continue gene regulation and neuroprotection mechanism studies including studies to understand cellular mechanisms of cell death; characterization of a poly-trauma (multiple injuries) model; discovery of novel pharmaceuticals to mitigate TBI brain hypothermia (drop in temperature); investigate new therapies based upon dentally-derived stem cells for traumatic dental wound healing and repair; explore causes of low vision from head trauma. ***FY 2012 Plans:*** Will realign neuroprotection research to the TBI program area, and regenerative efforts in craniomaxillofacial trauma (soft tissue and skeletal injuries to the face, head and neck) to the Clinical and Rehabilitative Medicine Research Program; will research potential bone defect models to find one that is clinically relevant to combat trauma.	1.347	2.038	0.956
Title: Combat Critical Care Engineering ***Description:*** This effort conducts basic science studies of vital sign responses to trauma as predictors of medical outcomes and as a basis for developing life-saving interventions. This research area starts in FY12.	-	-	0.769

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S14: *SCI BS/CBT CAS CARE RS*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
FY 2012 Plans: Will begin basic research studies to investigate differences in physiological responses between individuals with high- and low-tolerance to blood loss.			
Title: Traumatic Brain Injury *Description:* This effort conducts basic research in poly-trauma (multiple injuries)/TBI model, cellular mechanisms of cell death and the discovery of novel drugs to mitigate TBI. *FY 2012 Plans:* Will realign neuroprotection research from the Combat Trauma Therapies task area to the TBI task area; will continue basic research in poly-trauma (multiple injuries)/TBI model, cellular mechanisms of cell death and discovery of novel drugs to mitigate TBI.	-	-	0.986
Title: Clinical and Rehabilitative Medicine *Description:* This effort conducts basic studies of mechanisms of tissue growth and traumatic injury to gain an understanding that will assist or facilitate the healing or transplantation process. The focus is placed on severe blast trauma to the limbs, head, and face (including eye), as well as burns. *FY 2010 Accomplishments:* Began research in eye trauma to understand the cellular and neuronal mechanisms of eye injuries; explored different innovative regenerative tissue strategies to include scaffold-like tissue mats containing blood vessels, cell-based therapies to augment regenerative tissue approaches that yield a pool of responding cells that can be biologically queued to specific cell types, and biomaterials that direct cell growth. *FY 2011 Plans:* Continue the iterative process of exploring innovative regenerative tissue strategies and advancing promising approaches to the applied research phase. *FY 2012 Plans:* Will continue research in eye trauma to understand the cellular and neuronal mechanisms of eye injury; will continue the process of exploring innovative regenerative tissue strategies and advancing promising approaches to the applied research phase.	3.988	3.818	5.653
Accomplishments/Planned Programs Subtotals	6.352	6.818	9.709

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S14: *SCI BS/CBT CAS CARE RS*

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT S15: *SCI BS/ARMY OP MED RSH*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
S15: *SCI BS/ARMY OP MED RSH*	7.003	8.839	6.320	-	6.320	6.687	7.628	7.655	7.592	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds basic research on physiological and psychological factors limiting Soldier effectiveness and on the characterization of health hazards generated by military systems and resulting as a consequence of military operations. This includes research on the neurobehavioral aspects of post traumatic stress and suicide, and developing concepts for medical countermeasures to prevent or mitigate the effects of muscle and bone injury as well as to reduce the effects of sleep loss and other stressors on Warfighter performance. The hazards of exposure to directed energy, repetitive use, fatigue, heat, cold, and altitude are also investigated under this project.

Research conducted in this project focuses on the following six areas:

(1) Injury Prevention and Reduction
(2) Physiological Health
(3) Environmental Health and Protection
(4) Computational Biology
(5) Psychological Health and Resilience

Promising results identified in this project are further matured under PE 0602787A, project 869.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the US Army Institute of Surgical Research (USAISR), San Antonio TX; and the US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Injury Prevention and Reduction	1.300	1.392	1.428
Description: This effort conducts research on the body's effects from non-ionizing radiation and directed energy (laser), as well as the physiological mechanisms of musculoskeletal injury. *FY 2010 Accomplishments:* Investigated hormone and cell-level adaptations in skeletal muscle in response to military-relevant training and injury to include mechanisms of skeletal muscle repair, regeneration, and adaptation; explore how bone components are associated with stress			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT S15: *SCI BS/ARMY OP MED RSH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
fracture risk; identified laser eye injury thresholds in an animal model for single short-duration pulses and repetitive pulse exposures for small and large retinal spot sizes to enhance risk-assessment tools for eye protection. *FY 2011 Plans:* Identify specificity of hormonal fatigue markers in Soldiers during states of physical exertion and energy status; investigate responses to physical fatigue to prevent musculoskeletal injury; examine dose-response relationships to blood and tissue changes, and model results for visible and infrared wavelengths as a risk assessment tool for laser eye injury. *FY 2012 Plans:* Will examine effectiveness of topical applications of drugs to prevent further nerve degeneration from eye trauma and high-risk military environmental exposures. For example, an intervention could be applied through an eye dropper as a treatment against laser eye injury.			
Title: Physiological Health *Description:* This effort conducts research on the physiological mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being. *FY 2010 Accomplishments:* Investigated the extent individual resilience generalizes across various types of sleep loss; explored the relative effects of countermeasures for reversing deficits caused by fatigue; investigated and modeled optimal recovery sleep and recycle rate following missions; identified healthy weight-management strategies to improve Soldier health and retention. *FY 2011 Plans:* Investigate the extent to which the recuperative value of recovery sleep and the rate of recuperation can be enhanced through use of medication; identify the nutritional strategies required to sustain health in the modern training environment; explore the impact of micronutrient (nutrients essential in small quantities to orchestrate a whole range of physiological functions) status on performance and immune function during military training. *FY 2012 Plans:* Will identify menus, food service practices, labeling and educational materials to promote healthy eating behavior in military dining facilities; will identify the hormonal and metabolic responses of human fat tissue during periods of underfeeding, followed by overfeeding.	2.364	2.237	2.190
Title: Environmental Health and Protection *Description:* This effort conducts research on the physiological mechanisms of exposure to extreme heat, cold, altitude and other environmental stressors.	1.263	1.239	1.378

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** S15: *SCI BS/ARMY OP MED RSH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
FY 2010 Accomplishments: Explored rodent models of heat stroke to evaluate and enhance long-term recovery and return-to-duty; investigated dose-response of medication countermeasures for the effectiveness of preventing altitude illness compared to the probability and severity of adverse side-effects. *FY 2011 Plans:* Explore molecular mediators of tissue, organ and skeletal muscle injury associated with exertional heat injury and/or heat stroke in the rodent model; expand the investigation of dose-response of medication countermeasures for the effectiveness of preventing altitude illness at moderate altitude (3,000 meters). *FY 2012 Plans:* Will identify clinical measures (blood and molecular changes within tissue) of heat stroke.			
Title: Computational Biology *Description:* This effort conducts research, using tools that combine biology, computer sciences and mathematics to solve biological problems that would be difficult or impossible to solve solely through testing in traditional laboratory experiments, animal models or human trials. Research in this area starts in FY11. *FY 2011 Plans:* Conduct computational biology modeling to advance the development of protein-protein interaction models for the prediction of host-pathogen interaction networks.	-	0.923	-
Title: Psychological Health and Resilience *Description:* This effort conducts research into the basic mechanisms of psychological resilience (i.e., mental toughness and the ability to overcome traumatic events) and post-concussion related mental and physical challenges. Studies also include determination of suicide risk, as well as protective factors and treatment for Post-Traumatic Stress Disorder (PTSD). *FY 2010 Accomplishments:* Investigated a behavioral screening tool to induce and evaluate PTSD-like symptoms in rodents; investigated potential correlations between anti-depressant medication use and suicidal behaviors; investigated neuropsychological performance evaluations/batteries as a diagnostic for concussion in Soldiers; identified factors that predict or correlate severity of post-concussion symptoms. *FY 2011 Plans:* Induce and evaluate PTSD-like symptoms in rodents for potential drug and behavioral intervention to treat combat-related PTSD; further explore associations of completed and attempted suicides with the use of anti-depression medication; investigate the	2.076	3.048	1.324

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
predictive value of neuropsychological and neurological measures for prediction of likelihood and/or severity of subsequent post-concussion symptoms. ***FY 2012 Plans:*** Will identify deployment-related measures to assess intervention effectiveness (e.g., mitigating functional impairment, transition, risky behaviors) for the treatment of PTSD.			
Accomplishments/Planned Programs Subtotals	7.003	8.839	6.320

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*	26.860	-	-	-	-	-	-	-	-	Continuing	Continuing

Note
   Not applicable for this item

A. Mission Description and Budget Item Justification
   Congressional Interest Item funding provided for Defense Research Sciences.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Perpetually Assailable and Secure Information System (PASIS) **Description:** This is a Congressional Interest Item. **FY 2010 Accomplishments:** Developed technologies that directly impact the Army's and DoD's capabilities, including secure information processing, transmission and storage; Educated and trained scientists and engineers in the areas of information assurance, reliable software engineering, and network science.	3.182	-	-
Title: Cyber Threat Analytics **Description:** This is a Congressional Interest Item. **FY 2010 Accomplishments:** Conducted research to accelerate the ability of organizations to defend against large scale network threats by creating the underlying technologies to enable next-generation privacy-preserving digital threat analysis centers.	2.388	-	-
Title: Integrated Flexible Electronics **Description:** This is a Congressional Interest Item. **FY 2010 Accomplishments:** Developed flexible electronics materials enabling improved organic light emitting diode and thin film transistor performance. The devices were integrated with flexible active matrix backplanes from the Flexible Display Center.	1.592	-	-
Title: Organic Semiconductor Modeling and Simulation **Description:** This is a Congressional Interest Item.	0.875	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
FY 2010 Accomplishments: Developed modeling and simulation for organic electronics. The modeling results were used to design and advance electronic devices fabricated at University of Texas Dallas and the Flexible Display Center.			
Title: Nanocrystal Source Display ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Developed novel quantum dot (QD) light emitting devices. The QD devices were advanced for improved efficiency and stability. The device will be integrated with active matrix backplanes from the Flexible Display Center.	0.756	-	-
Title: Sustainable Alternative Energy for DoD ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Developed methods for generating JP-8 Diesel fuel from bio waste, including tree pulp and other vegetation materials.	1.990	-	-
Title: High Frequency Devices and Circuits for Nanotubes and Nanowires ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Developed carbon nanotube- and silicon nanowire-based high frequency components. Research supports fully organic (plastic) electric and electronic circuits, which are lightweight, low loss, durable, easy to carry and bend, and provide more battery life.	1.433	-	-
Title: Lightweight Polymer Designs for Soldier Combat Optics ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Developed a sturdy polymer based material that can be used for low-cost, lightweight eyewear and day optics that can withstand the rigors of difficult climate.	0.796	-	-
Title: Secure Open Systems Initiative ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:***	2.388	-	-

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Established a national Secure Open Systems Institute (SOSI) that will be a global center for Open Source security research and development.			
Title: Bioactive Polymers and Coating Systems for Protection Against Bio-Threats ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Developed a family of novel antimicrobial coatings that can be embedded on fabrics to block toxins, kill bacteria and control pathogenic biological agents. The fabrics will be used in the manufacture of items such as tents and chem-bio shelters.	3.581	-	-
Title: Understanding Blast Induced Brain Injury ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Researched blast induced brain injuries.	2.387	-	-
Title: Security Protection Using Ballistic CORE Technology ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Researched technology to provide enhanced protection against blast fragmentation.	3.900	-	-
Title: Maine Center for Toxicology and Environmental Health, Toxic Particles Research and Equipment ***Description:*** This is a Congressional Interest Item. ***FY 2010 Accomplishments:*** Developed data to inform risk assessments of the toxicity of depleted uranium, chromates and nanoparticles.	1.592	-	-
Accomplishments/Planned Programs Subtotals	26.860	-	-

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T14: *BASIC RESEARCH INITIATIVES - AMC (CA)*

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army	DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T22: *SOIL & ROCK MECH*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T22: *SOIL & ROCK MECH*	2.284	2.358	4.926	-	4.926	4.531	4.631	5.281	5.525	Continuing	Continuing

A. Mission Description and Budget Item Justification

This basic research project correlates the effects of the nano- and micro-scale behavior on the macro-scale performance of geological and structural materials to provide a foundation for the creation of future revolutionary materials and to revolutionize the understanding the sensor data within a heterogeneous geological systems. This research encompasses geologic and structural material behavior, structural systems, and the interaction with dynamic and static loadings. Research includes: underlying physics and chemistry that controls the mechanics and electromagnetic behavior of geological and structural materials, new techniques that provide measurements at the fundamental scale, and fundamental theories for relating nano- and micro-scale phenomena to macro-scale performance. This research provides the basis for applied research in PE 0602784A (Military Engineering Technology), project T40 (Mobility/Weapons Effects Technology), that supports the civil engineering technologies for adaptive protection, scalable weapons effects, near surface computational evaluation platform, and austere entry and maneuver for the future force.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Military Engineering Basic Research	2.284	2.358	2.438
Description: Funding is provided for the following effort *FY 2010 Accomplishments:* Developed a model for ultra high strength fiber reinforced concrete (FRC) subjected to highly dynamic loading conditions (e.g., blast, impact, and penetration events); gained an understanding of the rate effects in high performance concrete to determine if mesoscale models under development inherently generate the strain rate effects seen in macroscopic concrete response. *FY 2011 Plans:* Develop a mathematical technique to create continuum models for engineering-level analysis at coarser scales using discrete variables from nanoscale models. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T22: *SOIL & ROCK MECH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will complete a particle scale model to study the effects of two naturally occurring bonding agents on the suspension of particulates from naturally occurring soils.			
Title: Materials Modeling for Force Protection	-	-	2.488
Description: This effort moves from PE 0601102 Project T23 in FY 11 to this Project T22 in FY 12. **FY 2012 Plans:** Will continue to perform fundamental research to explore characteristics of natural materials with exceptional mechanical properties in order to develop the foundational understanding that will lead to advances in blast and ballistic protection through engineered material models. This work moves from PE0601102A-T23 Facilities Research in FY12.			
Accomplishments/Planned Programs Subtotals	2.284	2.358	4.926

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

E. Performance Metrics
   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T23: *BASIC RES MIL CONST*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T23: *BASIC RES MIL CONST*	1.727	3.839	1.901	-	1.901	1.970	2.005	2.042	2.077	Continuing	Continuing

Note
Not applicable for this item

A. Mission Description and Budget Item Justification

This basic research project supports facilities research initiatives. The project is focused on forming an explicit and mathematically robust set of algorithms for geometrical reasoning; assessing the conceptual feasibility of applying nanoparticle technology to real-time sensors, thermal conductivity, and high strength materials; and developing novel and advanced concepts for mitigating the effect of chemical and biological agents in built structures. These efforts provide basic research leading to improved design in a range of facilities to optimize facility mission performance, enhance facility security, reduce design and construction errors and omissions, reduce resource requirements, and reduce the environmental burdens over the facility's life. This project provides leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustainment of deployed facilities, and energy and utility infrastructure. This project supports exploratory development efforts in PE 0602784A (Military Engineering Technology), projects T41 (Military Facilities Engineering Technology) and project T45 (Energy Technology Applied to Military Facilities).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Facilities Research	1.727	3.839	1.901
Description: Funding is provided for the following effort. *FY 2010 Accomplishments:* Investigated mechanisms for on-demand release of biocides and free radicals to determine photolytic degradation phenomena; developed a fundamental understanding of the use of electrophoresis in producing new composite materials for present and future military applications. *FY 2011 Plans:* Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to the next generation nanotechnology research initiatives of military interest. Also, complete investigation of electric field effects on chemical reactions in confined nanoporous geometries. Conduct basic research to explore characteristics of natural materials with exceptional			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T23: *BASIC RES MIL CONST*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
mechanical properties in order to develop the foundational understanding that will lead to advances in blast and ballistic protection, base sustainment, and readiness through engineered material models. In FY12, this work moves to 0601102A T22, Materials Modeling for Force Protection; explore atomistic- and poly-crystalline-level mechanical properties of materials such as graphene or carbon nanotube (CNT) - ceramic composites for use in optimal performance designs that scale to macro-system levels. The goal is to discover the properties and relationships that lead to a means to create new bio-inspired composite materials that are lighter and better performing. ***FY 2012 Plans:*** Will explore the controlled dissociation of either methane or ammonia in order to produce pure hydrogen gas; will determine the effects of temperature on the quantum dot output spectrum in order to increase understanding for improved sensor development.			
Accomplishments/Planned Programs Subtotals	1.727	3.839	1.901

C. Other Program Funding Summary ($ in Millions)
   N/A

D. Acquisition Strategy
   N/A

E. Performance Metrics
   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army				**DATE:** February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T24: *Signature Physics and Terrain State Basic Research*

COST ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012 Base**	**FY 2012 OCO**	**FY 2012 Total**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Cost To Complete**	**Total Cost**
T24: *Signature Physics and Terrain State Basic Research*	1.508	1.573	1.616	-	1.616	1.660	1.693	1.727	1.756	Continuing	Continuing

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This basic research project increases knowledge in the areas of terrain state and signature physics. It investigates the knowledge base for understanding and assessing environmental impacts critical to battlespace awareness. Projects include fundamental material characterization, investigation of physical and chemical processes, and examination of energy/mass transfer applicable to predicting state of the terrain, which control the effects of the environment on targets and target background signatures and mobility in support of the materiel development community. The terrain state area of terrestrial sciences investigates weather-driven terrain material changes and sensing/inferring subsurface properties. The signature physics area of terrestrial sciences focuses on understanding the dynamic changes to electromagnetic, acoustic and seismic signatures, and energy propagation in response to changing terrain state and near surface atmosphere. This project supports exploratory development efforts in PE 0602784A (Military Engineering Technology), Project 855 (Topographical, Image Intel and Space) and T42 (Terrestrial Science Applied Research).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Title: Terrain State and Signature Physics	1.508	1.573	1.616
Description: Funding is provided for the following effort. *FY 2010 Accomplishments:* Observed, characterized, and modeled the variation of forward scattering at near to grazing angles for both vertical and horizontal polarization to determine if significant geometric roughness will deteriorate, rather than not affect, the forward scattering of RF energy; investigated the controlling influences of radio signal energy loss in deserts and thus poor depth penetration into low clay soils through examination of gypsum and carbonates by determining the complex permittivity spectra and attenuation rates at clay			

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T24: *Signature Physics and Terrain State Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
through sand size; evaluated hypothesis that urban ambient sound and vibration signals can be characterized as a baseline for actionable warnings for future sensor arrays. *FY 2011 Plans:* Investigate the topography and morphology of a high relief mountain basin as a major factor driving the spatial distribution of snow melt onset as measured by passive microwave sensors. Devise a calculation method for sound wave propagation and coherence over random spatial variations in terrain surface elevation and ground properties (such as permeability, porosity, grain size, and water content) and identify the characteristics and significance of random terrain effects on wave scattering. *FY 2012 Plans:* Will determine if radars can better detect subsurface disturbances through improved coherent waveform detection, and understanding of volume scatter loss rates; will formulate methods for near real-time calculation of sound fields in complex environments; also will construct a 3D numerical model of gas transport in soil that incorporates convection and diffusion and will determine the role of soil microstructure in gas movement through porous media in the near-surface ground, which will support emerging methods of subsurface target detection; will investigate a novel approach to represent terrain state spatial and temporal patterns and relationships to significantly reduce computational complexity and intensity required to model soil moisture and surface temperature.			
Accomplishments/Planned Programs Subtotals	1.508	1.573	1.616

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*				PROJECT T25: *Environmental Science Basic Research*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T25: *Environmental Science Basic Research*	7.690	8.106	8.234	-	8.234	8.562	8.719	8.870	9.021	Continuing	Continuing

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This basic research project investigates fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army sustainment issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts include: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment, or neutralization of organics in water, soil, and sediments resulting from military activities; adhering to applicable federal, state, and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; reducing pollution associated with military activities; and the study of ecosystem genomics and proteomics in support of the Army's new Network Science initiative. The project supports applied research under PE 0602720A (Environmental Quality Technology), project 048 (Industrial Operations Pollution Control Technology), project 835 (Military Medical Environmental Criteria), and project 896 (Base Facilities Environmental Quality).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants	3.661	3.923	3.985
Description: Funding is provided for the following effort. *FY 2010 Accomplishments:* Completed new computational chemistry equations to predict solubility and other physical characteristics of munitions constituents (MC); established biological models of soil invertebrate neurotransmission networks as affected by less-than-lethal doses of RDX; constructed computational biology models of the physiological reaction of bacteria to explosives contaminants; investigated the use of engineered proteins as cell-based toxicology sensors of MCs; explored the use of endophytes (microorganisms living inside plants) as biosensors of MC contamination. *FY 2011 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to the environmental and ecological fate of contaminants of military interest. Continued investigations of degradation and transformation mechanisms of insensitive munitions and emerging contaminants. *FY 2012 Plans:* Will investigate bioassay response to climate and contaminant stress on a standard laboratory organism (Daphnia) to elucidate impacts on other species of concern to Military installations; will characterize metals-rich granules (MRG) produced by lead (Pb) exposed soil invertebrates to determine bioavailability and potential for bacteria to release the Pb back into the environment in a biologically available form; will construct a neuro-endocrine feedback mechanism ex vivo to replicate the neuroendocrine system in environmental monitoring species (fish) for advancement of high throughput screening and analyses, and computation modeling of contaminates; also, will investigate the linkage of oxidative stress to behavior and animal survival impacts using real time-time imaging of gene expression and behavioral tracking.			
Title: Remediation of Explosives, Energetics, and UXO *Description:* Funding is provided for the following effort. *FY 2010 Accomplishments:* Completed investigations of degradation of and by nanomaterials. Investigated the chemical composition of metal-rich granules (MRG) produced by soil invertebrates when exposed to MC to reduce uncertainty factors in environmental risk assessment; determined the potential for abiotic and biotic degradation of new insensitive explosives to determine their potential for transport in soils and environmental affects. *FY 2011 Plans:* Continue to establish a base of understanding of the physical, chemical, and biological phenomena specific to the remediation of explosives and energetics on training ranges. *FY 2012 Plans:* Will determine the potential for abiotic and biotic degradation of insensitive explosives, NTO and FOX-7, potential insensitive replacements for RDX; will investigate non-traditional concentration response relationships for prediction of environmental risks supporting development of novel energetics.	2.302	2.360	2.395
Title: Training Land Natural Resources *Description:* Funding is provided for the following effort. *FY 2010 Accomplishments:*	0.721	0.735	0.750

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Defined the fundamental properties of pollination networks on Army ranges; investigated environmentally benign bioadhesion resistant coatings (modification of surface microstructure) as a means to reduce transport of invasive species. *FY 2011 Plans:* Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to ecosystem maintenance, mitigations, and rehabilitation. Investigate the mechanisms of accumulated oxidative stress affects on altered animal behavior and survival to provide a model of linking animal responses across large spatial and temporal scales for landscape, river, coastal and climate management. *FY 2012 Plans:* Will define multiple-stressor assessment techniques to identify and evaluate the relative contribution of interacting stressors that impact military lands and critical natural resources; will investigate how geographical fragmentation affects the pollination dynamics and gene flow within species populations to advance the fundamental knowledge for management of rare and endemic plant and pollinator species on Army ranges; also, through dermal and dietary exposure in plant and animal tissue will determine the magnitude of tungsten bioavailability impacting firing range sustainability as well as to advance ecological assessment capabilities.			
Title: Network Science *Description:* Funding is provided for the following effort. *FY 2010 Accomplishments:* Identified metabolic network control structures that govern the degradation / transformation of RDX; determine the relationship of complex biological network architecture to fragility in hormone production. *FY 2011 Plans:* Continue to establish a basic understanding of physical, chemical, and biological phenomena specific to network science applications. Evaluate alternative compositions of heterogeneity in population vigilance affording resilient/adaptive behavior at reduced cost. Develop cognitive elements to dynamically elicit the emergence of desired composition in heterogeneity. Define the network structure involving steroidogenesis genes using time series analysis. Develop approaches using genetic tools to perturb network dynamics by gene silencing or over expression. *FY 2012 Plans:* Will investigate first principle phenomenology describing spontaneous formation of highly regular biological networks by bacteria to determine spatial pattern relationships in bacteria colonies; will determine cognitive elements associated with attention	1.006	1.088	1.104

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T25: *Environmental Science Basic Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
and memory allowing heterogeneity in vigilance across a population to emerge naturally in a form conducive to social network resilience and adaptive behavior under predatory threat.			
Accomplishments/Planned Programs Subtotals	7.690	8.106	8.234

C. Other Program Funding Summary ($ in Millions)
  N/A

D. Acquisition Strategy
  N/A

E. Performance Metrics
  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army			DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T61: *Basic Research Initiatives - MRMC (CA)*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T61: *Basic Research Initiatives - MRMC (CA)*	1.592	-	-	-	-	-	-	-	-	Continuing	Continuing

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Medical Basic Research Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Combat Mental Health Initiative *Description:* This is a Congressional Special Interest Item *FY 2010 Accomplishments:* This Congressional Interest Item collected data from a random sampling of Ohio National Guard members for a study to better understand why some people develop Post Traumatic Stress Disorder (PTSD) and others do not.	1.592	-	-
Accomplishments/Planned Programs Subtotals	1.592	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

D. Acquisition Strategy

N/A

E. Performance Metrics

Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*	PROJECT T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*	1.181	1.463	1.857	-	1.857	1.935	1.969	2.001	2.035	Continuing	Continuing

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification

This project funds basic research in technical areas that will expand the autonomous capabilities, utility, and portability of small robotic systems for military applications, with a focus on enhanced intelligence, biomimetic functionality, and robust mobility, to permit these systems to serve as productive tools for dismounted Soldiers. The ability of the Warfighter to command a suite of small unmanned systems (air, ground, and hybrid vehicles) will reduce exposure of the Soldier to harm and will improve the efficiency by which a dismounted unit achieves tactical objectives such as securing a targeted zone. Example missions requiring enhanced autonomy, manipulation, and man-portability include rapid room clearing and interior structure mapping; detection of human presence, chemical/biological/nuclear/radiological/explosive (CBNRE), and booby-traps; surveillance; and subterranean passage detection and exploration. Because of their relatively small size, light weight, and service in dismounted environments, small unmanned systems have unique challenges in perception, autonomous processing, mobility mechanics, propulsive power, and multi-functional packaging that transcend similar challenges associated with large unmanned systems. The Army Research Lab will conduct research in related disciplines, including machine perception, intelligent control, biomimetic robotics, manipulator mechanics, and propulsive power and drives to foster the development of technologies for lightweight, small-volume, environmentally-harsh robotics applications. Machine perception research includes the exploration of lightweight ultra-compact sensor phenomenology and the maturation of basic machine vision algorithms that enable small unmanned systems to more fully understand their local environment. Intelligent control research includes the maturation of autonomous processing capabilities and the advancement of artificial intelligence techniques that lead to reliable autonomous behavior in a large-displacement, highly-dynamic environment and permit unmonitored task performance. Research in biomimetic robotics and manipulator mechanics includes the advancement of mechatronic and biomimetic appendages to enable agile high-speed locomotion, dexterous task-performance, and environmental-manipulation; and the maturing of nonlinear control algorithms to support robust, stable mobility. Propulsion power and drives research includes investigations of engine cycles and alternative hybrid energy conversion techniques to provide compact, lightweight, quiet, low-emission, high-density power sources that support highly-portable unmanned systems capable of performing long-endurance missions.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Defense of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed internally by the Army Research Laboratory (ARL) at the Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Robotics autonomy and human robotic interface research	1.181	1.463	1.857

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T63: *ROBOTICS AUTONOMY, MANIPULATION, & PORTABILITY RSH*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Description: In-house research with a focus on enabling robust autonomous mobility for small robotic systems, including autonomous operations in Global Positioning System (GPS) denied areas, planning, behaviors, intelligent control, and the interface of perception technologies to accomplish Army missions in the area of unmanned systems. These efforts will include research activities in micromechanics conducted in association with the Micro Autonomous Systems and Technology Collaborative Technology Alliance. *FY 2010 Accomplishments:* Developed dexterous manipulation systems with high density sensors and intelligent control algorithms to support complex task performance such as opening doors and moving objects or impediments. These manipulation systems were studied statically and in combination with highly mobile robots. *FY 2011 Plans:* New combinations of advanced sensor data are being fused in real time to provide enhanced dynamic situation awareness for small robotic systems, increasing the speed and agility of operation. *FY 2012 Plans:* Will evaluate novel modes of air and ground mobility for micro-mechanical systems.			
Accomplishments/Planned Programs Subtotals	1.181	1.463	1.857

C. Other Program Funding Summary ($ in Millions)

   N/A

D. Acquisition Strategy

   N/A

E. Performance Metrics

   Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army									DATE: February 2011	
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*				**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*				**PROJECT** T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*		

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*	1.234	1.278	2.198	-	2.198	2.794	2.846	2.895	2.937	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project funds research to conduct studies through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies. The information gained from these studies provides a better understanding of the overall biological system and its molecular network of interactions, which leads to improved early strategic decision-making in the development of preventive and treatment solutions to diseases. This approach establishes a model for application of systems biology processes and knowledge of biological networks to discover medical products that prevent and/or treat diseases or medical conditions. This more complex, yet integrated approach, to studying biological systems could potentially reduce both the time and expense of medical product development for the Army.

Funding for this research is in project S15 prior to FY10.

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

Work in this project is performed by the US Army Medical Research and Material Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Network Sciences Initiative	1.234	1.278	2.198
Description: This effort supports research to conduct studies through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies. *FY 2010 Accomplishments:* Completed development of mathematical models that predict host-pathogen (infectious agent or germ) networks. These mathematical models can be used to predict environmentally-produced observable responses induced by external stimuli at the molecular level: genomic (DNA-based) and proteomic (protein-based). Established and evaluated mathematical and computational models that address identified gaps in network biology. *FY 2011 Plans:* Validate these models animals. *FY 2012 Plans:*			

Exhibit R-2A, **RDT&E Project Justification:** PB 2012 Army		**DATE:** February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** T64: *SCI BS/SYSTEM BIOLOGY AND NETWORK SCIENCE*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2010**	**FY 2011**	**FY 2012**
Will validate the accuracy of the models and apply the models to identify markers for traumatic brain injury.			
Accomplishments/Planned Programs Subtotals	1.234	1.278	2.198

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army										DATE: February 2011	

APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*			R-1 ITEM NOMENCLATURE PE 0601102A: *DEFENSE RESEARCH SCIENCES*			PROJECT VR9: *SURFACE SCIENCE RESEARCH*					

COST ($ in Millions)	FY 2010	FY 2011	FY 2012 Base	FY 2012 OCO	FY 2012 Total	FY 2013	FY 2014	FY 2015	FY 2016	Cost To Complete	Total Cost
VR9: *SURFACE SCIENCE RESEARCH*	-	-	2.250	-	2.250	2.000	2.100	2.300	2.600	Continuing	Continuing

Note
  Not applicable for this item.

A. Mission Description and Budget Item Justification

  This project begins in FY12 and benefits the Army by establishing and maintaining a core research capability to enable a molecular level understanding of properties and behaviors of materials relevant to the Army; by developing understanding and ability to manipulate nanostructured materials as a means to tune properties which meet desired performance requirements; by advancing the scientific understanding of surface properties and interfacial dynamics of complex materials; and by providing scalable processes grounded in a molecular understanding of materials. This project funds basic research in the characterization of chemical and biochemical phenomena occurring at or near solid surfaces and interfaces; the interactions between chemical reactions and transport processes on surfaces; theory and modeling of processes at complex surfaces; and the synthesis and characterization of catalysts that function at the nanoscale. Investment in basic research centered on the surface science disciplines will enable growth of a knowledge base that will result in improved understanding of the interactions of complex materials in real world environments.

  The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Department of Defense Basic Research Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

  Work in this project is performed by the Edgewood Chemical and Biological Center (ECBC), Research, Development and Engineering Command, in Aberdeen, Maryland.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
Title: Surface Science Research *Description:* The activities in this program are related to performing basic and early applied research in chemistry, biology and physics on fundamental problems related to surfaces, interfacial dynamics, thin film materials, chemical-biological catalysis and opto-electronic/sensory technologies. *FY 2012 Plans:* Base FY 2012 Description: Will investigate the complex behavior of mass transport in microporous systems; will design rational molecular and nano-system functional abiotic structures; will conduct fundamental studies and modeling of the interfacial	-	-	2.250

Exhibit R-2A, RDT&E Project Justification: PB 2012 Army		DATE: February 2011
APPROPRIATION/BUDGET ACTIVITY 2040: *Research, Development, Test & Evaluation, Army* BA 1: *Basic Research*	**R-1 ITEM NOMENCLATURE** PE 0601102A: *DEFENSE RESEARCH SCIENCES*	**PROJECT** VR9: *SURFACE SCIENCE RESEARCH*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2010	FY 2011	FY 2012
phenomena of particulate matter (solid/liquid) with surfaces and the interaction of matter and mechanisms of transfer of energy at the nanoscale and at biological interfaces.			
Accomplishments/Planned Programs Subtotals	-	-	2.250

C. Other Program Funding Summary ($ in Millions)

  N/A

D. Acquisition Strategy

  N/A

E. Performance Metrics

  Performance metrics used in the preparation of this justification material may be found in the FY 2010 Army Performance Budget Justification Book, dated May 2010.