Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Army											Date: March 2023	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**Cost To Complete**	**Total Cost**
Total Program Element	-	214.489	264.523	60.005	-	60.005	69.110	80.531	79.954	90.043	0.000	858.655
BK7: *Robotics for Engineer Operations Technology*	-	1.183	1.802	6.459	-	6.459	5.725	3.748	2.089	7.211	0.000	28.217
BL1: *Materials and Manufacturing Research Technology*	-	9.032	4.257	4.321	-	4.321	4.319	7.081	7.085	7.162	0.000	43.257
BL2: *Explosives Forensics Technology*	-	1.524	1.673	1.707	-	1.707	8.314	8.365	8.353	12.391	0.000	42.327
BL5: *Expedient Passive Protection Technology*	-	1.836	4.348	2.957	-	2.957	3.113	4.786	4.160	3.457	0.000	24.657
BL7: *Power Projection in A2AD Environments Technology*	-	3.036	1.871	2.963	-	2.963	2.157	3.611	2.567	1.948	0.000	18.153
BL9: *Protection from Advanced Weapon Effects Technology*	-	4.185	5.037	5.211	-	5.211	5.023	4.809	5.512	7.191	0.000	36.968
BN8: *Ground Technology Materials(CA)*	-	160.150	211.900	-	-	-	-	-	-	-	0.000	372.050
CG5: *Ground Vehicle Sensor Concepts and Technologies*	-	3.994	-	-	-	-	-	-	-	-	0.000	3.994
CG6: *Ground Vehicle Power and Energy Concepts and Tech*	-	2.583	2.526	2.605	-	2.605	4.669	6.049	6.003	6.049	0.000	30.484
CG7: *Ground Protection Concepts and Technologies*	-	14.033	12.194	10.473	-	10.473	13.687	16.384	17.893	16.620	0.000	101.284
CG8: *Human Autonomy Teaming*	-	8.285	9.036	9.263	-	9.263	9.265	9.327	9.334	9.449	0.000	63.959
CI2: *Ground Enabling University Applied Research*	-	4.648	3.682	3.906	-	3.906	5.522	4.621	4.624	4.675	0.000	31.678
CV3: *Engineer Enablers Maneuver, LOG, & Sustainment Apl*	-	-	2.518	2.195	-	2.195	1.254	4.171	3.022	4.070	0.000	17.230

Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Army											Date: March 2023	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602144A *I Ground Technology*							
DA1: *SAFR Alternatives for Readiness Applied Research*	-	-	3.679	5.171	-	5.171	6.062	7.579	9.312	9.820	0.000	41.623
DG1: *Development of Obscurants*	-	-	-	2.774	-	2.774	-	-	-	-	0.000	2.774

Note

Project CV3 (Engineer Enablers Maneuver, LOG, & Sustainment Apl) and Project DA1 (SAFR Alternatives for Readiness Applied Research) are New Start Projects for Fiscal Year 2023 (FY23). Project CG5 (Ground Vehicle Sensor Concepts and Technologies) is Terminated starting in FY23.

A. Mission Description and Budget Item Justification

This Program element (PE) researches efforts that support and enable the Army's modernization priority for the Next Generation of Combat Vehicles including systems for the deployment and sustainment of ground movement and maneuver. This PE designs and validates technologies that are necessary and foundational for legacy and future ground movement, maneuver and protection of Soldiers and systems.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas in support of the National Defense Strategy and the Army Modernization Strategy.

Work in this PE supports the Army Science and Technology Ground portfolio.

Work is performed by the United States (U.S.) Army Futures Command and the U.S. Army Engineer Research and Development Center.

Work in this PE complements PE 0602145A (Next Generation Combat Vehicle Technology), PE 0603119A (Ground Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0602143A (Soldier Lethality Technology) and PE 0603118A (Soldier Lethality Advanced Technology).

Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Army	Date: March 2023
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

B. Program Change Summary ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	216.550	52.848	59.131	-	59.131
Current President's Budget	214.489	264.523	60.005	-	60.005
Total Adjustments	-2.061	211.675	0.874	-	0.874
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	211.900			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.061	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	0.874	-	0.874
• FFRDC Transfer	-	-0.225	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Project: BN8: *Ground Technology Materials(CA)*		
Congressional Add: *Program increase: Advanced Polymers for Force Protection*	8.000	-
Congressional Add: *Program increase - High Performance Polymers*	5.000	-
Congressional Add: *Program increase - INTEGRITY OF TRANSPARENT ARMOR*	5.000	4.400
Congressional Add: *Program increase - ENVIRONMENTAL QUALITY ENHANCED COATINGS*	5.000	5.000
Congressional Add: *Program increase - Autonomous Digital Design and Manufacturing*	5.000	-
Congressional Add: *Program increase - MATERIALS RECOVERY TECHNOLOGIES FOR DEFENSE SUPPLY RESILIENCY*	10.000	10.000
Congressional Add: *Program increase - Additive Manufacturing Machine Learning Initiative*	5.000	-
Congressional Add: *Program increase - RAPID ADVANCED DEPOSITION*	5.000	10.000
Congressional Add: *Program increase - Defense Resiliency Against Extreme Cold Weather*	10.000	-
Congressional Add: *Program increase - Earthen Structures Soil Enhancement*	4.000	-
Congressional Add: *Advanced Manufacturing Materials Processes Initiative*	10.000	-
Congressional Add: *Advanced Materials Manufacturing*	8.000	-
Congressional Add: *Anti-Corrosion Materials*	7.000	-
Congressional Add: *Ceramic Materials for Extreme Environments*	8.000	-
Congressional Add: *Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing Research*	6.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Army	Date: March 2023
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Congressional Add: *Electrolyzer*	7.000	-
Congressional Add: *Flexible Hybrid Electronics and Environmental Sustainability*	12.000	-
Congressional Add: *PFAS Modeling*	5.000	-
Congressional Add: *Polar Proving Ground and Training Program*	2.000	-
Congressional Add: *Rapid Infrastructure Development and Engineering*	3.000	-
Congressional Add: *Program Increase - RARE EARTH INITIATIVE*	7.000	10.000
Congressional Add: *Solid Oxide Fuel Cell Development*	10.000	-
Congressional Add: *Tank Tracks*	3.150	-
Congressional Add: *Program Increase - VERIFIED INHERENT CONTROL*	10.000	10.000
Congressional Add: *Program Increase - ADVANCED CERAMIC TECHNOLOGIES*	-	2.000
Congressional Add: *Program Increase - ALTERNATIVE ENERGY RESEARCH*	-	20.000
Congressional Add: *Program Increase - AUTONOMOUS DIGITAL DESIGN*	-	5.000
Congressional Add: *Program Increase - CARBON NANOMATERIALS AS FUNCTIONAL ADDITIVES*	-	6.500
Congressional Add: *Program Increase - COLD REGION RESEARCH*	-	5.000
Congressional Add: *Program Increase - DEFENSE RESILIENCY AGAINST EXTREME COLD WEATHER*	-	11.000
Congressional Add: *Program Increase - DEFENSE RESILIENCY PLATFORM ADDRESSING EXTREME COLD WEATHER*	-	10.000
Congressional Add: *Program Increase - DETECTION AND DEFEAT OF BURIED MUNITIONS*	-	4.000
Congressional Add: *Program Increase - EARTHEN STRUCTURES SOIL ENHANCEMENT*	-	4.000
Congressional Add: *Program Increase - ELECTROLYZER*	-	7.000
Congressional Add: *Program Increase - EXTREME BATTERY TECHNOLOGIES*	-	10.000
Congressional Add: *Program Increase - FLEXIBLE HYBRID ELECTRONICS*	-	15.000
Congressional Add: *Program Increase - FUNCTIONAL POLYMERIC MATERIALS AND COMPOSITES FOR EXTREME TEMPERATURE ENVIRONMENTS*	-	5.000
Congressional Add: *Program Increase - GROUND TECHNOLOGY FOR CHEMICAL AND BIOLOGICAL DEFENSE*	-	1.000
Congressional Add: *Program Increase - HIGH PERFORMANCE POLYMER COMPOSITES AND COATINGS*	-	10.000
Congressional Add: *Program Increase - LIGHTWEIGHT HIGH ENTROPY METALLIC ALLOY DISCOVERY COLLABORATION*	-	5.000
Congressional Add: *Program Increase - LOGISTICS OVER-THE-SHORE CAPABILITIES*	-	10.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Army	Date: March 2023
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2022	FY 2023
Congressional Add: *Program Increase - POLAR PROVING GROUND*	-	5.000
Congressional Add: *Program Increase - PROTECTIVE COATINGS*	-	10.000
Congressional Add: *Program Increase - ULTRA-HIGH DENSITY STORAGE*	-	10.000
Congressional Add: *Program Increase - AI/ML materials for sensors and electronics*	-	7.000
Congressional Add Subtotals for Project: BN8	160.150	211.900
Congressional Add Totals for all Projects	160.150	211.900

Change Summary Explanation

Increased funding due to revised economic assumptions.

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BK7 / *Robotics for Engineer Operations Technology*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BK7: *Robotics for Engineer Operations Technology*	-	1.183	1.802	6.459	-	6.459	5.725	3.748	2.089	7.211	0.000	28.217

A. Mission Description and Budget Item Justification

This research investigates and develops standoff robotic capabilities for Combat Engineers to reduce Soldier/Engineer risks and fatalities while conducting activities essential to shaping the environment. It will close the gaps between commercial construction equipment and the requirements of the future Engineer Force to support maneuver, movement, and sustainment. This research will develop the capability to generate a near real-time site model with appropriate engineering details to allow unmanned shaping of the environment through physical interaction (e.g. push, pull, lift, or dig). This effort will also develop the requisite mission planner and task execution controller that accepts input from the user and provides suggestions and feedback based on updates to the site model, reporting from hardware agents, and resource allocation logic. The end state goal is the development of beyond visual line of sight teleoperation and semiautonomous capabilities allowing Engineer robotic support to match pace in near term and future combat environments. This effort will support the development, testing, and evaluation of prototypical robotic Combat Engineer equipment. This Project develops modeling and simulation tools that represent realistic states for Engineer robotic operations and develops and assesses semi-autonomous and autonomous construction equipment technologies needed for remote control Engineer operations.

Work in this Project complements Program Element (PE) 0603119A (Ground Advanced Technology) / Project BK8 (Robotics for Engineer Operations Adv Tech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is coordinated with Program Element (PE) 0603462A (Next Generation Combat Vehicle Advanced Technology).

Work in this Project is performed by the United States Army Engineer Research and Development Center.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Beyond-Visual-Line-of-Sight Teleoperated Engr Ops ***Description:*** This effort develops site characterization technologies, equipment localization technologies, equipment tools, and controls protocols to support remote control and semi-autonomous engineering operations and develops modeling and simulation tools to support remote operations.	1.138	-	-
Title: Semi-Autonomous Engineer Operations	-	1.802	6.459

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BK7 / *Robotics for Engineer Operations Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Description: This effort investigates and develops machine tool behaviors to perform semi-autonomous shaping of the terrain through physical interaction with the environment (push, pull, lift, and dig). The effort develops the necessary decision-making, data fusion, localization, and inter-platform communication to allow semi-autonomy on commercial off the shelf (COTS) equipment. ***FY 2023 Plans:*** Investigate instrumenting individual motors and movement joints on the heavy Engineer equipment for machine feedback to planning algorithms; develop the required sensor payload, onboard processing, and path planning and control algorithms on heavy Engineer equipment to enable semiautonomous navigation. ***FY 2024 Plans:*** Will adapt and validate autonomous path planning and movement control algorithms, developed during previous efforts, to apply to heavy Engineer equipment. Will enhance simulation environment with the design and development of machine-learning based terrain shaping algorithms to enable autonomous execution of a simple repetitive Combat Engineer task using single type of heavy Engineer equipment. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects investments required to conduct experiments to adapt and validate movement control algorithms developed for small robotic platforms to heavy Engineer equipment as well as beginning development of terrain shaping algorithms needed for heavy Engineer equipment.			
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638	0.045	-	-
Accomplishments/Planned Programs Subtotals	1.183	1.802	6.459

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL1 / *Materials and Manufacturing Research Technology*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BL1: *Materials and Manufacturing Research Technology*	-	9.032	4.257	4.321	-	4.321	4.319	7.081	7.085	7.162	0.000	43.257

A. Mission Description and Budget Item Justification

This Project links materials research, manufacturing processes, and design to enable higher quality additive manufacturing products for Army applications through the development of high performance feedstock materials (polymers, metals, and ceramics), physics-based process models, and in-situ process monitoring. Integration of these tools with process models enables real-time control and manipulation of materials structure and properties to produce three-dimensional hybrid electronics packaging, power and energy sources and converters and new materials/structures for protection. The goal of this work is to develop robust physics-based models to optimize material properties, structures, and manufacturing processes for Army applications in protection, maneuver, power, sensing, and signature management necessary to rapidly respond to emerging and unknown threats in a battlefield environment.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground, Next Generation Combat Vehicle, Long Range Protective Fires, and Soldier Lethality.

Work in this Project is performed by the United States (US) Army Futures Command.

This work is done in coordination with Program Element (PE) 0602145A (Next Generation Combat Vehicle Technology), 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Additive Manufacturing Research	8.162	3.348	3.382
Description: This effort Investigates new additive manufacturing (AM) capabilities that enable production of lightweight materials for protection, lethality, and maneuverability that cannot be produced through traditional manufacturing methods. Efforts include the design and development of new feedstock materials engineered specifically for low-volume additive processes to produce net-shape materials with desired properties and functionalities; integrated process models and real-time monitoring for closed-loop control and production of lightweight materials with optimal architectures, property gradients, and interfaces; and design optimization capabilities that connect materials and manufacturing to access the full design space enabled by additive manufacturing.			
FY 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Design and develop three-dimensional printed propellants, both rocket and gun charges, which yield optimized pressurization profiles to increase muzzle velocity for increased penetration in direct fire applications and/or increased range for large caliber munitions; conduct experiments of tailorable fragmentation schemes in metals AM printed parts, controlling size and size distribution of fragments as it is integrated with next generation explosive technologies (potentially integrated with AM explosives). ***FY 2024 Plans:*** Will validate machine learning guided process control for metal AM builds of munition components; design printed munition casings with microstructure driven fragmentation schemes using novel next generation alloys; validate modeling tools that predict the fragmentation behavior of printed metals based on process specific thermal history for precision control of lethality; validate full 3-Dimensional electronic processes, milled circuit traces, conductive traces, circuit component placement in microcontroller, and seeker circuits for Army-relevant applications; validate high accelerative loading conditions on printed electronics to determine that AM conformal electronics can withstand accelerative loading; finalize development of integrated circuits, fuze, and initiators for high g-force reliability. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase supports planned lifecycle of this effort.			
Title: Energy Sources and Storage ***Description:*** This effort focuses on the design and characterization of chemistries, materials, and components for advanced batteries, fuel reformers, and fuel cells. Potential Army applications include hybrid power sources, smart munitions, hybrid electric vehicles, and soldier power applications. This effort also investigates the applicability of photosynthesis to provide fuel and electricity for soldier power applications, and investigates silicon carbide power module components that could enable compact, high-efficiency, high-temperature, and high-power density converters for motor drive and pulse power applications. ***FY 2023 Plans:*** Investigate ability to incorporate chemically modify and dope silicon-based Li-ion battery anodes as a means to address reactivity to improve ultrahigh energy performance of Soldier-carried batteries; explore ability to combine with advanced high voltage electrolytes to mitigate risks of fire and thermal runaway in event of damage or abuse; investigate ability to enable fast charge / high power in high capacity anodes including nanostructured Si-, composite-, metal-oxides, and structured anodes; design and develop high ionic conductivity solid-state electrolytes and integral electrode structures as means to further mitigate safety risks in high energy, high rate rechargeable Li-ion battery. ***FY 2024 Plans:*** Will identify most promising compositions and methods for chemical modification of silicon as high capacity Li-ion battery anode; characterize the nature, quality, and robustness of the solid electrolyte interface layer forming at the silicon anode-electrolyte interface to determine its ability to provide necessary passivation (chemical process) of the Li-ion battery anode, and its impact	0.870	0.901	0.939

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
on charge rate, temperature, and cycle life performance; explore Li-ion battery safety, through thermal, electrical short, and penetration assessments; investigate spinel, garnet, and monolithic solid electrolyte interphase (SEI), and complementary electrode integration for high energy Li-ion batteries; explore low-cobalt or cobalt-free, high-voltage, and high-capacity battery cathodes. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase supports planned lifecycle of this effort.			
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	-	0.008	-
Accomplishments/Planned Programs Subtotals	9.032	4.257	4.321

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL2 / *Explosives Forensics Technology*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BL2: *Explosives Forensics Technology*	-	1.524	1.673	1.707	-	1.707	8.314	8.365	8.353	12.391	0.000	42.327

A. Mission Description and Budget Item Justification

This Project investigates and develops analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for forensics attribution purposes. This project pursues research in signatures and algorithms required to provide improved residue analysis of explosives and precursor materials to enable integration into chemical and explosive hazard detection equipment for the warfighter.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is performed by the United States (US) Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Forensic Analysis of Explosives Signatures Applied Research	1.524	1.612	1.707
Description: This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution. ***FY 2023 Plans:*** Will mature concepts and technologies in analytical forensics methods leading to the design and development of portable tools and capabilities for the detection of explosives, drugs (synthetic opioids), and other chemical residue analysis for attribution. Further develop inkjet manufactured coupons for quantifiable threat assessments mimicking bulk and trace level hazards of contamination on surfaces to be utilized for assessment of optical and non-optical detection systems. Investigate multi-wavelength, multi-phenomenology orthogonal systems for low level surface detection characteristics. ***FY 2024 Plans:*** Will further mature collimated Raman system for real time detection of liquid and solid visual and non-visual contaminated surfaces; continue to examine surface-enhanced Raman spectroscopy nano-metallic substrates to augment normal Raman handheld devices for trace level detection of explosives and opioids, and continued development of chemical depositions systems for quantifiable test standards for point and standoff sensors. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: SBIR/STTR Transfer	-	0.061	-

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL2 / *Explosives Forensics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Description: Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638			
Accomplishments/Planned Programs Subtotals	1.524	1.673	1.707

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL5 / *Expedient Passive Protection Technology*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BL5: *Expedient Passive Protection Technology*	-	1.836	4.348	2.957	-	2.957	3.113	4.786	4.160	3.457	0.000	24.657

A. Mission Description and Budget Item Justification

This Project designs and develops rapidly deployable passive protective solutions; algorithms for decision support applications and software; and tactics, techniques, and procedures to increase the survivability of personnel, critical assets, and facilities. Through experimental and computational investigation and design, this project develops force protection technologies for complex and urban environments. This Project also develops expedient solutions and decision support applications for protection against advanced energetic threats and large caliber rockets, missiles, and other emerging weapons.

Work in this Project complements Program Element (PE) 0603119A (Ground Advanced Technology) / Project BL6 (Expedient Passive Protection Advanced Technology).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is performed by the United States (US) Army Engineer Research and Development Center.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Protection Against High Trajectory Large Caliber Rocket and Missile Threats ***Description:*** This effort investigates high trajectory large caliber rocket and missile weapon effects on critical assets and facilities and develops expedient force protection solutions for these new weapon threats. These solutions include the application of novel protective materials and designs. This effort develops and validates deployable protection systems against these threats and develops decision support tools to aid the warfighter in selecting protective positions.	1.766	-	-
Title: Assessments of Solutions for Survivability from Emerging Threats (ASSET) ***Description:*** This effort investigates emerging weapon threat effects on critical assets, theater of operation facilities, and existing protection technologies; designs and develops rapidly deployable passive protective solutions; algorithms for decision support applications and software; and tactics, techniques, and procedures to increase the survivability of personnel, critical assets, and facilities against emerging threats, such as high trajectory large caliber rockets and missiles as well as UAS threats. This effort integrates experimental and computational analysis. ***FY 2023 Plans:***	-	4.303	2.957

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL5 / *Expedient Passive Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Develop design concepts and models of rapidly deployable protection systems to protect critical semi-fixed assets and facilities from the effects of emerging threats, and develop fast-running algorithms to estimate the effects of emerging threats on legacy protective systems and new conceptual passive protection designs. ***FY 2024 Plans:*** Will conduct experiments of newly designed rapidly deployable protection systems against emerging threats, such as large caliber rockets and missiles and will enhance high-fidelity models and fast-running algorithms to predict emerging threat effects. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding decrease reflects the transition of technologies to PE 0603119A (Ground Advanced Technology) / Project BL6 (Expedient Passive Protection Advanced Technologies) / Task Assessments of Solutions for Survivability from Emerging Threats Demonstrations for maturation and demonstration.			
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	0.070	0.045	-
Accomplishments/Planned Programs Subtotals	1.836	4.348	2.957

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL7 / *Power Projection in A2AD Environments Technology*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BL7: *Power Projection in A2AD Environments Technology*	-	3.036	1.871	2.963	-	2.963	2.157	3.611	2.567	1.948	0.000	18.153

A. Mission Description and Budget Item Justification

This Project designs and develops remote assessment technologies to determine entry and maneuver corridors, develops site selection tools and decision support technologies for all climates in all season conditions including aviation site selection tools, enhanced automated route reconnaissance technologies, mobility models for extreme climates, and road capacity assessment technologies. These technologies reduce reliance on manned on-site reconnaissance for projection platform assessments and provide all season capacity predictions to ensure air and ground battlespace entry and maneuver. This Project also designs and develops material solutions to repair, rebuild and construct infrastructure required for movement and maneuver in highly contested, complex operational environments such as Anti-Access/Area Denial (A2/AD).

Work in this PE complements PE 0603119A (Ground Advanced Technology) / Project BL8 (Power Projection in A2AD Environments Adv Tech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is performed by the United States Army Engineer Research and Development Center.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Entry and Sustainment in Complex Contested Environments	1.275	-	-
Description: This effort designs and develops strategic and tactical level planning tools for assessing engineering behavior of ground surfaces as it relates to battlefield maneuver to include factors affecting on-and-off-road vehicle mobility as well as aviation assembly areas; applies new technologies for data acquisition to engineering design factors to rapidly assess vehicle and terrain interaction.			
Title: Engineering for Battlespace Maneuver	1.646	1.844	2.963
Description: This effort develops the capability to rapidly repair and upgrade damaged infrastructure along mobility corridors and restaging areas to maintain and enhance freedom of maneuver achieving overmatch and tactical advantage in contested complex environments.			
FY 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL7 / *Power Projection in A2AD Environments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Determine design and selection protocol for executing rapid soil hardening; conduct experiments to quantify effectiveness of equipment attachments for executing rapid route remediation; and perform simulations to identify requirements for mechanical stabilization systems to support heavy tactical wheeled vehicle loads. ***FY 2024 Plans:*** Will develop a framework for automated decision support tools that will determine requirements for planning tools to task route repair and upgrades; will develop optimization routine for selecting equipment and materials to perform repair missions. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects investments required to develop a framework for automated decision support tools that implement best practices for contingency repairs.			
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	0.115	0.027	-
Accomplishments/Planned Programs Subtotals	3.036	1.871	2.963

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL9 / *Protection from Advanced Weapon Effects Technology*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BL9: *Protection from Advanced Weapon Effects Technology*	-	4.185	5.037	5.211	-	5.211	5.023	4.809	5.512	7.191	0.000	36.968

A. Mission Description and Budget Item Justification

This Project designs and develops structural hardening, high-performance computing capabilities, and force protection technologies to enhance survivability of personnel and critical assets. This project investigates and develops advanced materials for protection against blast, fragmentation, and penetration through physical experiments and modeling and simulation. Additionally, this project investigates, designs, and develops passive protection technologies and protective design criteria to mitigate attack from emerging advanced threats.

Work in this Program Element (PE) complements PE 0603119A (Ground Advanced Technology) / Project BM1 (Protection from Advanced Weapon Effects Adv Tech).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground Portfolio.

Work in this Project is performed by the United States Army Engineer Research and Development Center.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Defeat of Complex Attack ***Description:*** This effort designs and develops passive protection structural hardening designs and solutions against emerging large-caliber advanced weapons; investigates and validates computational models for predicting residual protective capacity for multi-hit threat scenarios; and designs and develops micro-mechanics-based models and material solutions matured by conducting high-rate experiments.	2.654	-	-
Title: Advanced Materials and Modeling for Force Protection ***Description:*** This effort designs and develops capabilities in the use of poorly-understood and indigenous materials. This effort develops multi-scale material modeling frameworks incorporating physics of deformation and damage mechanisms; a 3D multi-physics material modeling capability to allow for weapons effects models to be informed by remote sensing; and advanced material technologies for force protection. ***FY 2023 Plans:***	1.531	1.548	1.595

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Expand the multi-scale materials-by-design tools for unconventional / indigenous materials for force protection, investigate dynamic material simulation capabilities, multi-functional materials development for kinetic and non-kinetic force protection, and design and develop and conduct advanced high-rate dynamic experiments. ***FY 2024 Plans:*** Will implement thermodynamics-based geomaterial modeling into multi-scale modeling framework; investigate advanced composite, metal, and hybrid materials developed through materials-by-design approaches; and will investigate system-level integration of advanced materials into force protection systems. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort.			
Title: Protection from Advanced Penetrators ***Description:*** This effort designs and develops protective material solutions and enhances modeling and simulation (M&S) tools for designing, analyzing and improving these advanced protective materials to be used in large hardened protective structures; investigates and validates computational models and passive protective solutions for large hardened structures from advanced precision penetrating threat weapons. ***FY 2023 Plans:*** Investigate material solutions and structural component enhancements for use in hardened protective structures to mitigate weapons effects of advanced penetrators. ***FY 2024 Plans:*** Will design, develop and conduct sub-scale experiments to predict weapon effects from advanced penetrators on protective structures. Will update M&S based on experiments. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort.	-	3.489	3.616
Accomplishments/Planned Programs Subtotals	4.185	5.037	5.211

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BN8 / *Ground Technology Materials(CA)*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
BN8: *Ground Technology Materials(CA)*	-	160.150	211.900	-	-	-	-	-	-	-	0.000	372.050

Note

Congressional Interest Item funding provided for Ground Technology Materials.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Ground Technology Materials.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
Congressional Add: Program increase: Advanced Polymers for Force Protection ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Advanced Polymers for Force Protection	8.000	-
Congressional Add: Program increase - High Performance Polymers ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for High Performance Polymers	5.000	-
Congressional Add: Program increase - INTEGRITY OF TRANSPARENT ARMOR ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Integrity of Transparent Armor ***FY 2023 Plans:*** Congressional Interest Item funding provided for Integrity of Transparent Armor	5.000	4.400
Congressional Add: Program increase - ENVIRONMENTAL QUALITY ENHANCED COATINGS ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Environmental Quality Enhanced Coatings ***FY 2023 Plans:*** Congressional Interest Item funding provided for Environmental Quality Enhanced Coatings	5.000	5.000
Congressional Add: Program increase - Autonomous Digital Design and Manufacturing ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Autonomous Digital Design and Manufacturing	5.000	-
Congressional Add: Program increase - MATERIALS RECOVERY TECHNOLOGIES FOR DEFENSE SUPPLY RESILIENCY	10.000	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2022 Accomplishments: Congressional Interest Item funding provided for Materials Recovery Technologies for Defense Supply Resiliency ***FY 2023 Plans:*** Congressional Interest Item funding provided for Materials Recovery Technologies for Defense Supply Resiliency		
Congressional Add: Program increase - Additive Manufacturing Machine Learning Initiative ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Additive Manufacturing Machine Learning Initiative (Community Project Funding)	5.000	-
Congressional Add: Program increase - RAPID ADVANCED DEPOSITION ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Rapid Advanced Deposition ***FY 2023 Plans:*** Congressional Interest Item funding provided for Rapid Advanced Deposition	5.000	10.000
Congressional Add: Program increase - Defense Resiliency Against Extreme Cold Weather ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Defense Resiliency Against Extreme Cold Weather	10.000	-
Congressional Add: Program increase - Earthen Structures Soil Enhancement ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Earthen Structures Soil Enhancement	4.000	-
Congressional Add: Advanced Manufacturing Materials Processes Initiative ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Advanced Manufacturing Materials Processes Initiative	10.000	-
Congressional Add: Advanced Materials Manufacturing ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Advanced Materials Manufacturing	8.000	-
Congressional Add: Anti-Corrosion Materials ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Anti-Corrosion Materials	7.000	-
Congressional Add: Ceramic Materials for Extreme Environments	8.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2022 Accomplishments: Congressional Interest Item funding provided for Ceramic Materials for Extreme Environments		
Congressional Add: Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing Research ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing Research	6.000	-
Congressional Add: Electrolyzer ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Electrolyzer	7.000	-
Congressional Add: Flexible Hybrid Electronics and Environmental Sustainability ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Flexible Hybrid Electronics and Environmental Sustainability	12.000	-
Congressional Add: PFAS Modeling ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for PFAS Modeling	5.000	-
Congressional Add: Polar Proving Ground and Training Program ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Polar Proving Ground and Training Program	2.000	-
Congressional Add: Rapid Infrastructure Development and Engineering ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Rapid Infrastructure Development and Engineering	3.000	-
Congressional Add: Program Increase - RARE EARTH INITIATIVE ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Rare Earth Initiative ***FY 2023 Plans:*** Congressional Interest Item funding provided for Rare Earth Initiative	7.000	10.000
Congressional Add: Solid Oxide Fuel Cell Development ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Solid Oxide Fuel Cell Development	10.000	-
Congressional Add: Tank Tracks	3.150	-

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2022 Accomplishments: Congressional Interest Item funding provided for Tank Tracks		
Congressional Add: Program Increase - VERIFIED INHERENT CONTROL ***FY 2022 Accomplishments:*** Congressional Interest Item funding provided for Verified Inherent Control ***FY 2023 Plans:*** Congressional Interest Item funding provided for Verified Inherent Control	10.000	10.000
Congressional Add: Program Increase - ADVANCED CERAMIC TECHNOLOGIES ***FY 2023 Plans:*** Congressional Interest Item funding provided for Advanced Ceramic Technologies	-	2.000
Congressional Add: Program Increase - ALTERNATIVE ENERGY RESEARCH ***FY 2023 Plans:*** Congressional Interest Item funding provided for Alternative Energy Research	-	20.000
Congressional Add: Program Increase - AUTONOMOUS DIGITAL DESIGN ***FY 2023 Plans:*** Congressional Interest Item funding provided for Autonomous Digital Design	-	5.000
Congressional Add: Program Increase - CARBON NANOMATERIALS AS FUNCTIONAL ADDITIVES ***FY 2023 Plans:*** Congressional Interest Item funding provided for Carbon nanomaterials as Functional Additives	-	6.500
Congressional Add: Program Increase - COLD REGION RESEARCH ***FY 2023 Plans:*** Congressional Interest Item funding provided for Cold Region Research	-	5.000
Congressional Add: Program Increase - DEFENSE RESILIENCY AGAINST EXTREME COLD WEATHER ***FY 2023 Plans:*** Congressional Interest Item funding provided for Defense Resiliency Against Extreme Cold Weather	-	11.000
Congressional Add: Program Increase - DEFENSE RESILIENCY PLATFORM ADDRESSING EXTREME COLD WEATHER ***FY 2023 Plans:*** Congressional Interest Item funding provided for Defense Resiliency Platform Addressing Extreme Cold Weather	-	10.000
Congressional Add: Program Increase - DETECTION AND DEFEAT OF BURIED MUNITIONS ***FY 2023 Plans:*** Congressional Interest Item funding provided for Detection and Defeat of Buried Munitions	-	4.000
Congressional Add: Program Increase - EARTHEN STRUCTURES SOIL ENHANCEMENT ***FY 2023 Plans:*** Congressional Interest Item funding provided for Earthen Structures Soil Enhancement	-	4.000
Congressional Add: Program Increase - ELECTROLYZER	-	7.000

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2023 Plans: Congressional Interest Item funding provided for Electrolyzer		
Congressional Add: Program Increase - EXTREME BATTERY TECHNOLOGIES ***FY 2023 Plans:*** Congressional Interest Item funding provided for Extreme Battery Technologies	-	10.000
Congressional Add: Program Increase - FLEXIBLE HYBRID ELECTRONICS ***FY 2023 Plans:*** Congressional Interest Item funding provided for Flexible Hybrid Electronics	-	15.000
Congressional Add: Program Increase - FUNCTIONAL POLYMERIC MATERIALS AND COMPOSITES FOR EXTREME TEMPERATURE ENVIRONMENTS ***FY 2023 Plans:*** Congressional Interest Item funding provided for FUNCTIONAL POLYMERIC MATERIALS AND COMPOSITES FOR EXTREME TEMPERATURE ENVIRONMENTS	-	5.000
Congressional Add: Program Increase - GROUND TECHNOLOGY FOR CHEMICAL AND BIOLOGICAL DEFENSE ***FY 2023 Plans:*** Congressional Interest Item funding provided for GROUND TECHNOLOGY FOR CHEMICAL AND BIOLOGICAL DEFENSE	-	1.000
Congressional Add: Program Increase - HIGH PERFORMANCE POLYMER COMPOSITES AND COATINGS ***FY 2023 Plans:*** Congressional Interest Item funding provided for High Performance Polymer Composites and Coatings	-	10.000
Congressional Add: Program Increase - LIGHTWEIGHT HIGH ENTROPY METALLIC ALLOY DISCOVERY COLLABORATION ***FY 2023 Plans:*** Congressional Interest Item funding provided for Lightweight High Entropy Metallic Alloy Discovery Collaboration	-	5.000
Congressional Add: Program Increase - LOGISTICS OVER-THE-SHORE CAPABILITIES ***FY 2023 Plans:*** Congressional Interest Item funding provided for Logistics Over-The-Shore Capabilities	-	10.000
Congressional Add: Program Increase - POLAR PROVING GROUND ***FY 2023 Plans:*** Congressional Interest Item funding provided for Polar Proving Ground	-	5.000
Congressional Add: Program Increase - PROTECTIVE COATINGS ***FY 2023 Plans:*** Congressional Interest Item funding provided for Protective Coatings	-	10.000
Congressional Add: Program Increase - ULTRA-HIGH DENSITY STORAGE	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023
FY 2023 Plans: Congressional Interest Item funding provided for Ultra-High Density Storage		
Congressional Add: Program Increase - AI/ML materials for sensors and electronics	-	7.000
FY 2023 Plans: Congressional Interest Item funding provided for AI/ML materials for sensors and electronics		
Congressional Adds Subtotals	160.150	211.900

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG5 / *Ground Vehicle Sensor Concepts and Technologies*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
CG5: *Ground Vehicle Sensor Concepts and Technologies*	-	3.994	-	-	-	-	-	-	-	-	0.000	3.994

A. Mission Description and Budget Item Justification

This Project investigates, designs, fabricates, assesses, and characterizes advanced sensor protection technologies, components, and concepts that will enable the future Soldier to see and operate through a laser directed energy weapon attack. Both active and passive protection technologies will be investigated to protect Army sensors that operate in the visible, short-wave infrared, mid-wave infrared, and long-wave infrared spectra from battlefield laser threats. Areas of research include passive optical limiters such as nonlinear organic dyes, semiconductors, and meta-materials, as well as fast active switches and tunable filters. As new laser technologies are developed, effects of those threats will be studied and assessed to determine vulnerability of Army sensor systems and sensor system materials.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle portfolios.

Work in this Project is performed by the United States (US) Army Futures Command.

Work in this Project is coordinated with Program Element (PE) 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Laser Protection Technologies	3.994	-	-
Description: This effort designs and develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental differences in sensors operating over different frequency ranges. Passive optical limiting materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active meta- material-based solutions will be investigated for uncooled sensors in the long-wave infrared. Vulnerability of sensors and optical sensor systems will be investigated against high-power and ultra-short pulsed laser threats to determine protection requirements.			
Accomplishments/Planned Programs Subtotals	3.994	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG5 / *Ground Vehicle Sensor Concepts and Technologies*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG6 / *Ground Vehicle Power and Energy Concepts and Tech*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
CG6: *Ground Vehicle Power and Energy Concepts and Tech*	-	2.583	2.526	2.605	-	2.605	4.669	6.049	6.003	6.049	0.000	30.484

A. Mission Description and Budget Item Justification

This Project investigates and develops advanced power and energy technologies for combat ground vehicles that are necessary for parallel hybrid, series hybrid, and all- electric vehicle systems. This Project investigates, designs, and develops electric conversion technologies to reduce size and weight of military vehicles while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle portfolios.

Work in this Project is performed by the United States (US) Army Futures Command.

Work in this Project is coordinated with PE 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Advanced Distributed Power for Autonomous Systems	1.371	2.504	0.955
Description: This effort designs and develops technologies for electrification of both manned and unmanned Next Generation Combat Vehicle platforms. Electrification of these platforms will enable advanced lethality and protection systems, reduced battlefield fuel consumption, and provide new capabilities such as burst acceleration, extended silent mobility, and silent watch. The effort investigates, designs, and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on high power/ temperature power electronics, magnetic gears, electric drive motors, and adaptive device and component level control that optimized operation in real time. Investigation of advanced control methods at the module and conversion component levels provides an understanding of the impact real time optimization and energy tracking can have on power conversion optimization and mission effectiveness. The research enables the integration of component state and behavior into system level management algorithms that support non-autonomous and autonomous operations while providing modular and scalable electrification architectures. Efforts will also investigate non-contact magnetic gear technologies coupled with electrical motors and generators to reduce size and weight with an increase in reliability and performance through increased torque and			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG6 / *Ground Vehicle Power and Energy Concepts and Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
speed operational range. Results of the research inform PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Tech). ***FY 2023 Plans:*** Experimentally validate high torque magnetic gear designs and optimization strategies. Investigate and analyze advanced control methods to improve fast battery charging. Investigate advanced power module concepts through the use of co-design and co-engineering methodologies to increase efficiency, power transfer, and reliability through improved device and thermal control. Investigate and analyze energy storage / battery technologies with an order of magnitude increase in energy densities. Research advanced control methodologies at the module and component levels providing higher efficiency and reliability through energy optimization. Research advanced transformer designs and fabrication to enable high frequency switching with improved thermal management in smaller more efficient packages. ***FY 2024 Plans:*** Will experimentally validate battery charger and characterize battery charger performance. Will validate battery management concepts and characterize effect of battery management concepts. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** In FY 2024, a portion of this funding has been realigned to Power Conversion for Platforms within this Project.			
Title: Power Electronic Components and Materials ***Description:*** This effort investigates, designs, and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on semiconductor power switches, power switch modules/packaging, and power switch module thermal management. Investigation of high voltage/high frequency power semiconductor materials and devices is concentrated on efficient power switching under militarily relevant temperatures. Design and development of multi-disciplinary parametric design optimization software tools and multi-functional package structures provides advances in device packaging technology to fully realize device performance improvements. Results of the research inform 0602145A BH5 Platform Electrification and Mobility Tech.	1.212	-	-
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:***	-	0.022	-

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG6 / *Ground Vehicle Power and Energy Concepts and Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Funding transferred in accordance with Title 15 USC §638			
Title: Power Conversion for Platforms	-	-	1.650
Description: This effort investigates, designs, and assesses technologies for platform electrification that will reduce Army impact to the environment through electrified systems that more effectively utilize energy and improve resiliency. Transitioning to hybrid electric and all electric platforms provides improved energy utilization while reducing emissions providing the Warfighter increased capabilities. Reduction in impact to the environment also improves Warfighter survivability by reducing emissions that can be used for tracking and locating. Research focuses on material and design concepts for compact high-power transformers required by power conversion components, fabrication of new power semiconductor packaging, and advances in control and component power management methods. ***FY 2024 Plans:*** Will utilize co-design and co-engineering methodologies and laboratory experiments to validate performance of advanced power packaging concepts to increase efficiency, power transfer, and reliability. Will experimentally validate component level monitoring and control concepts and determine performance of prediction and optimization control algorithms. Will validate advanced transformer designs and thermal performance under high power. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** In FY 2024, funding realigned from Advanced Distributed Power for Autonomous Systems within this Project.			
Accomplishments/Planned Programs Subtotals	2.583	2.526	2.605

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CG7 / *Ground Protection Concepts and Technologies*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
CG7: *Ground Protection Concepts and Technologies*	-	14.033	12.194	10.473	-	10.473	13.687	16.384	17.893	16.620	0.000	101.284

Note

In FY 2024, particle funding realigned to PE 0602145A Project BK5 Advanced Direct In-Direct Armament System (ADIDAS)

A. Mission Description and Budget Item Justification

This Project investigates advanced materials and mechanisms to defeat the most common and most dangerous threats that are expected to be encountered by our ground forces in near-, mid-, and far-term. This Project also designs and develops experimental and computational tools and techniques (high resolution instrumentation to observe impact events, theories, and algorithms to explain these phenomena and numerical implementation of these algorithms) for the development of mass-efficient armor mechanisms. This project designs and develops armor mechanisms that will be integrated to create multi-threat armor technologies and form the building blocks for Adaptive and Cooperative Protection Technologies in the Advanced Concepts for Active Defense Project (Program Element (PE) 0602145A Next Generation Combat Vehicle Technology). Additionally, research will focus on subcomponent/component models to predict performance of early concepts and the means to assess effectiveness on ground platforms. The Project will balance designs and developments of active threat defeat measures with the necessary advanced passive and reactive components that will ultimately provide for full system solutions which meet the requirements of current and next generation ground tactical and combat vehicles.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle.

Work in this Project is performed by the United States (US) Army Futures Command portfolios.

This Project is coordinated with and transition to Projects in PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0602145A (Next Generation Combat Vehicle Technology), and builds upon weapon target interaction research in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Advanced Armor and Protection Technologies	7.868	7.136	5.241
Description: This effort designs and develops the next generation of lightweight protective concepts and technologies for defeat of current and future threats by utilizing real-time information, combined with threat knowledge, to provide increased protection. This effort investigates the fundamental physics of new terminal effects concepts and provides an understanding of interaction			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG7 / *Ground Protection Concepts and Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
between the platform's defeat mechanism and the threat . The effort also investigates the ability to analytically simulate complex threat interactions. Experiments will be conducted to validate the efficacy of the designs. ***FY 2023 Plans:*** Investigate armor mechanism and protection concepts for the robotic combat vehicles to survive direct-fire engagements; refine methodology to conduct small scale armor survivability experiments to reduce the number of full sized experiments required; design and develop high throughput ballistics metrics and scaling to enable terminal effects research. ***FY 2024 Plans:*** Will validate the predictive modeling capability of advanced armor with an emphasis on hybrid armor systems and armor efficiency; incorporate machine learning (ML) / high-throughput data directly into simulations to design new materials for specific threats; explore coupling laser shock experiments to reduce uncertainty in material behavior. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding realigned from PE 0602144A Project CG7 ($2,151) to PE 0602145A Project BK5 Advanced Direct In-Direct Armament System (ADIDAS) to support research into Decisive Lethality.			
Title: Computational and Experimental Capability ***Description:*** This effort will design and develop computational design tools along with diagnostic and experimental capabilities that support the development of advanced protection systems. Such systems include passive, active, and hybrid solutions for defeating (multiple) anti-armor threats and exploit solid-dynamic, explosive-driven, and magneto-hydrodynamic target interactions. This work allows for predicting armor performance and understanding mechanisms, regardless of vehicle platform, with improved and quantified confidence. This effort leverages the Department of Defense and Department of Energy (DOE) Technical Coordination Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics. ***FY 2023 Plans:*** Design and develop physically accurate and robust modeling and simulation tools for explosive effects to inform armor development; continue to mature the capabilities of the multi-physics models needed to rapidly assess threats and develop protection solutions to defeat those threats; continue to mature our ballistics and explosive effects diagnostics to better assess terminal ballistics. ***FY 2024 Plans:*** Will design and develop combined explosive effects mechanism software which, coupled with experimental data, will enable the rapid assessment of threats against existing and future armor designs; explore experimental diagnostics for explosive effects to improve understanding of threat loading on armor solutions; conduct computational studies of armor mechanisms to assess	6.165	5.058	5.232

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG7 / *Ground Protection Concepts and Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
the defeat of current and future shape charge threats; develop multi-physics model enhancements to continue to improve the capability to assess threats and armor mechanisms to defeat those threats. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase supports planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	14.033	12.194	10.473

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army										Date: March 2023		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*				Project (Number/Name) CG8 / *Human Autonomy Teaming*			
COST ($ in Millions)	**Prior Years**	**FY 2022**	**FY 2023**	**FY 2024 Base**	**FY 2024 OCO**	**FY 2024 Total**	**FY 2025**	**FY 2026**	**FY 2027**	**FY 2028**	**Cost To Complete**	**Total Cost**
CG8: *Human Autonomy Teaming*	-	8.285	9.036	9.263	-	9.263	9.265	9.327	9.334	9.449	0.000	63.959

A. Mission Description and Budget Item Justification

This Project performs applied research for capabilities that support teams of Soldier and Artificial Intelligence (AI)-enabled systems to execute missions in complex, dynamic, multi-domain operations environments. Centered on ground vehicle mission planning and operations, this Project is focused on core technologies to enable Soldiers and AI-enabled systems to function as a team, to perform at high levels, and to adapt to adversarial actions and new mission requirements. This Project will enable future Soldiers with AI-enabled systems to perform complex missions with increasingly sophisticated technologies, and in increasingly complex, dynamic, socio-technical environments. The applied research will provide the fundamental technologies to enable scalable Soldier-AI teams and team-centered dynamic tasking to effectively utilize the full capabilities of team and technologies. The research will include considerations to reduce data requirements for AI adaptation, increasing appropriate Soldier trust and use of technology, and ensuring ethical behaviors by teams of Soldier and AI-enabled systems. The capabilities created by this research will lead to increased overall Soldier-AI team mission performance, improved Soldier-centric situation awareness technologies, and units that can effectively integrate within a multi-domain battlefield.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Army Science and Technology Ground and Next Generation Combat Vehicle portfolios.

Work in this Project is performed by the United States Army Futures Command.

Work in this Project is coordinated with PE 0602145A (Next Generation Combat Vehicle Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and PE 0602143A (Soldier Lethality Technology) .

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Soldier-AI Team Mission Planning for Dynamic Complex Environments	1.218	1.313	1.357
Description: Planning in multi-domain operations environments is complex and has increased temporal and spatial sensitivities for Soldiers to integrate with AI-enabled systems to plan and execute missions. This effort investigates the fundamental concepts and technologies to enable Soldier and AI to team together to plan for multidomain operations from a ground vehicle perspective. This effort determines planning enablers to maximize manned-unmanned team performance across squads and platoons and includes mid- to far-term crew station-based emerging technologies in the areas of human- interaction with AI technologies and human-guided machine intelligence. Designs and develops models of both Soldier and AI capabilities and their limitations as a function of the mission environment and mission requirements, and applying those models to form mission plans.			
FY 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG8 / *Human Autonomy Teaming*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Design and develop capability to leverage multiple forms of Soldier feedback to enable mission-to-mission adaptation of intelligent system behaviors to meet evolving mission needs. ***FY 2024 Plans:*** Will design and develop route/mission planning tools that incorporate operator load and autonomous system interaction cost functions to improve performance from mission to mission. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle of this effort.			
Title: Dynamic Soldier-AI Team Resource Allocation ***Description:*** This effort designs and develops the concepts and technologies necessary to dynamically allocate Soldiers and unmanned systems during missions to adapt mission plans to adversarial actions and other events at a squad and platoon level, including responding to degradation or loss of team capabilities, changes in mission goals or priorities, and responding to adversarial actions. The effort investigates the allocation of Soldiers, platforms, and platform sub-system capabilities with the focus to ensure that future AI and automation capabilities are focused on the circumstances and conditions where they are most likely to be successful, and to ensure that the Soldier's cognition is focused appropriately to ensure mission success. ***FY 2023 Plans:*** Mature algorithms to generate task allocations across a distributed heterogeneous team to enable flexible team reorganization to improve team performance in dynamic environments; design and develop initial methods to create algorithms that provide a Commander with suggested courses of action to coordinate actions of distributed team through a library of preset formations and crew configurations. ***FY 2024 Plans:*** Will investigate approaches to mitigate performance penalties due to task switching in a human-autonomy team to enable rapid team reconfiguration and improve team performance in dynamic environments; refine methodology and algorithms designed to provide a Commander with suggested courses of action to reconfigure the team based on changes in operator or agent state, mission requirements, and environment. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle of this effort.	2.368	2.562	2.638
Title: Soldier Cognition-Centric Interface Technologies ***Description:*** This effort designs and develops cognitive-centric displays that ensure Soldiers are focused on aspects of situational awareness, mobility, target engagements, and communications that are critical to mission performance as future crew stations and displays provide vast amounts of multi-domain information that has the potential to distract, overwhelm, and mislead Soldiers. This effort ensures that our systems do not capture and misdirect Soldier attention and/or cognition, maximizing the utility of AI-	1.555	1.677	1.772

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG8 / *Human Autonomy Teaming*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
enabled systems to the Soldier. This effort also enables Soldiers to better understand the actions, goals, intents, and general reasoning of the AI systems to ensure they are effectively used, but not inappropriately relied upon. ***FY 2023 Plans:*** Conduct experiments to investigate the impact of enabling Soldiers to rapidly train autonomous systems on an individual Soldier's trust in autonomous systems; conduct experiments to investigate the ability for Soldier guided adaptation of autonomous systems to capture individual Soldier knowledge, skills, and abilities. ***FY 2024 Plans:*** Will conduct experiments to assess the effectiveness and impact of integrating Soldier-trained autonomous systems into reconfigurable human-autonomy teams; create and empirically validate team assessment toolkit for measuring human-autonomy team trust and cohesion from data collected during the mission. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle of this effort.			
Title: Enabling Soldier-AI Technology Adaptation ***Description:*** This effort designs and develops technologies to rapidly adapt and upgrade AI-enabled system capabilities in response to advancements in AI in the commercial and adversary environments. Focus areas include enabling rapid technology adaption during Soldier experimentation and enabling data to be collected during these events for rapid development of technology updates and modifications. This effort has four goals: 1) increasing the ability of Soldier-AI teams to rapidly adapt to adversarial actions, new technologies, environmental changes, and mission requirements; 2) decreasing the data requirements to train and adapt AI-enabled systems; 3) increasing appropriate Soldier trust and use of technology; and 4) ensuring ethical decisions by using Soldiers to guide the actions and in-field adaptations of Soldier-AI team behaviors. ***FY 2023 Plans:*** Mature algorithms that learn from natural interactions to allow Soldiers to communicate intent for adaptation and training of autonomous systems; mature algorithms for using interactive machine learning to enhance the robustness of algorithms for assessing effectiveness of Soldier-AI teams; conduct experiments to investigate effectiveness of leveraging initial algorithms that infer Soldier intent from natural Soldier-system interactions to enhance capability to rapidly train autonomous systems with reduced data requirements. ***FY 2024 Plans:***	3.144	3.400	3.496

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CG8 / *Human Autonomy Teaming*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Will design and develop capability to use unobtrusively-sensed information from Soldier-based sensors to adapt autonomy behavior; validate autonomy adaptation methods leveraging multiple forms of Soldier interactions. Will mature and validate the effectiveness of algorithms that infer Soldier intent from natural Soldier-system interactions in order to adapt team dynamics. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects the planned lifecycle of this effort.			
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	-	0.084	-
Accomplishments/Planned Programs Subtotals	8.285	9.036	9.263

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CI2 / *Ground Enabling University Applied Research*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
CI2: *Ground Enabling University Applied Research*	-	4.648	3.682	3.906	-	3.906	5.522	4.621	4.624	4.675	0.000	31.678

A. Mission Description and Budget Item Justification

The Project leverages applied research from academia, in the focus areas of ground autonomy, Artificial Intelligence/Machine Learning (AI/ML) and robotics, occupant/vehicle survivability and other ground platform technologies of importance to the Army. This Project performs discovery research efforts to focus more on mid to far-term Army modernization priorities while also maintaining delivery of near-term technologies critical to the next generation combat vehicles. This Project focuses on employment of research technologies originating from extramural applied research in academia pertaining to navigation/routing, autonomous robotic vehicles with the use of artificial intelligence and machine learning as applied to ground mobility and maneuver, and other innovative ground enabling applied research technologies. This effort conducts applied research and development leading to potential emerging technologies in areas of strategic importance to the Army in autonomy, robotics and AI/ML, protection of both platform and occupant, and other ground platform technologies in propulsion, survivability, powertrain, etc., by bringing competitively selected Universities with research and development teams into Technical Alliances.

Work in this Project complements Program Element (PE) 0603119A (Ground Advanced Technology), PE 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

The work cited is consistent with Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Robust autonomous capabilities for ground vehicles	3.132	1.879	2.059
Description: This effort investigates AI/ML and autonomous mobility-enabled ground vehicles to conduct off-road maneuvers to transition from tele-operated to either autonomous, or semi-autonomous scenarios. Research is conducted in collaboration with university partners to advance autonomous mobility and protection of both occupant and platform in optionally manned and autonomous ground vehicles.			
FY 2023 Plans: Will mature AL/ML methods to enable robust, autonomous, and tactical behaviors for multi-agent air and ground vehicle teams beyond existing behaviors such as leader-follower (e.g., flanking, occupying); as well as increase performance through effective			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CI2 / *Ground Enabling University Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
navigation and route planning using techniques to extract terrain features from imagery and transfer of simulator-learned behaviors to developmental ground platforms within academia. ***FY 2024 Plans:*** Will continue to investigate and develop multi-robot long-term autonomy, ML for autonomous navigation, off-road autonomy software. Will investigate and develop multi-layered situational awareness, cooperative tactical reasoning, and communication frameworks solutions for multiple autonomous air and ground vehicles used for route and area reconnaissance. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort.			
Title: Human-robot/AI interactions ***Description:*** This effort designs and develops systems involving physical and cognitive levels of interactions between humans and robots, with the use of reinforcement learning (an area of ML research) from human feedback, learning from demonstration, and safe human-aware controllers. Work is conducted in collaboration with university partners to advance autonomous mobility as well as other areas of ground platform technologies in propulsion, survivability, powertrain, etc. ***FY 2023 Plans:*** Will investigate and mature AI/ML methods to improve autonomous systems by capturing and learning from human teleoperation command gestures, human interventions, and other forms of human interaction (e.g., spoken language, augmented reality). Will mature tactics and algorithms on common software platforms which enable robots to deal with complex environments in real time while working autonomously around humans for extended periods of time. ***FY 2024 Plans:*** Will continue to investigate AI/ML research for robust autonomous capabilities, real-time basic feature extraction, multi-robot long-term autonomy, human-AI collaboration, human-in-the-loop ML for autonomous navigation. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects planned lifecycle of this effort.	1.516	1.669	1.847
Title: SBIR/STTR Transfer ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	-	0.134	-
Accomplishments/Planned Programs Subtotals	4.648	3.682	3.906

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CI2 / *Ground Enabling University Applied Research*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) CV3 / *Engineer Enablers Maneuver, LOG, & Sustainment Apl*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
CV3: *Engineer Enablers Maneuver, LOG, & Sustainment Apl*	-	-	2.518	2.195	-	2.195	1.254	4.171	3.022	4.070	0.000	17.230

A. Mission Description and Budget Item Justification

This effort designs and develops software tools to modernize the Army's logistics planning capability. The project researches planning of logistics resupply via distributed supply routes through complex terrain and environmental conditions within a contested environment, while also improving the efficiency of logistics planning, enabling planners to develop and compare courses of action, and simulate logistics activities using complex algorithms. This effort links the engineer applications into a geospatial framework and enables planners to better understand the dynamic scenario development providing a simple and clear critical vulnerabilities assessment, easy visual comparison of inventories available, supply needs within the battlespace, and the logistics options to mitigate potential issues.

Work in this Project complements PE 0603119A (Ground Advanced Technology) / Project CV5 (Engineer Enablers Maneuver, LOG, & Sustainment Adv).

The work cited is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work is performed at the United States Army Engineer Research and Development Center.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Planning Logistics Analysis Network System Applied Research	-	2.426	2.195
Description: This effort will design and develop new engineering applications and methodologies that support improved logistics planning via distributed networks, investigate methods to link existing data describing complex environmental features that impact planning into the engineer applications, and design new automated algorithm technologies to improve the efficiency and effectiveness of the planning decision making.			
FY 2023 Plans: Investigate new algorithms that describe the operating environment as a series of nodes and routes that consider complex battlespace concerns and terrestrial issues such as terrain complexity or weather impacts; mature components of a multi-modal transportation network model.			
FY 2024 Plans: Will design and develop transportation throughput options for feasible nodes and routes and investigate routing options based on weather and terrain concerns, and investigate cross-country movement options within the transportation network.			
FY 2023 to FY 2024 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CV3 / *Engineer Enablers Maneuver, LOG, & Sustainment Apl*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Funding decrease reflects the transition of technologies to PE 0603119A (Ground Advanced Technology) / Project CV5 (Engineer Enablers Maneuver, LOG, & Sustainment Adv) for maturation and demonstration.			
Title: SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	-	0.092	-
Accomplishments/Planned Programs Subtotals	-	2.518	2.195

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) DA1 / *SAFR Alternatives for Readiness Applied Research*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
DA1: *SAFR Alternatives for Readiness Applied Research*	-	-	3.679	5.171	-	5.171	6.062	7.579	9.312	9.820	0.000	41.623

A. Mission Description and Budget Item Justification

This Project will develop safer alternative technologies that enable Army readiness, support supply chain resilience, improve Soldier and worker safety and reduce environmental impacts, including reduction of greenhouse gas emissions. The Project investigates alternatives for cross-cutting materials, undergoing or threatened by regulatory scrutiny, found in ground vehicles and all other types of Army weapon systems. Research areas of focus include alloys, ceramics, composites, textiles, maintenance fluids, propellants, explosives, and pyrotechnics. This work addresses increasing threats to readiness associated with carcinogenic, toxic, and restricted materials such as lead, beryllium, perchlorates, volatile organic compounds and per- and polyfluoroalkyl substances (PFAS) (forever chemicals), which can diminish Soldier and community health, restrict training and interrupt critical maintenance activities. Future liabilities and risks are characterized early in the life cycle of material development to ensure truly sustainable alternatives. This Project also investigates, develops and designs technologies to allow Soldiers to rapidly prioritize risk for PFAS to enable informed, timely and cost-effective solutions.

The cited work is consistent with the Army Modernization Strategy and provides enabling technologies in support of all Cross Functional Teams.

Work in this Project is performed by the United States (U.S.) Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory, Aberdeen Proving Ground, MD; the Armaments Center, Picatinny Arsenal, NJ; the Aviation and Missile Center, Huntsville, AL; the Soldier Center, Natick, MA; the Ground Vehicle Systems Center, Warren, MI; and the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC). It is coordinated with the U.S. Army Futures Command.

This Project complements and transitions technologies to Program Element (PE) 0603119A (Ground Advanced Technology) / Project DA2 (SAFR Alternatives for Readiness Advanced Tech).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: PFAS Risk Reduction Applied Research	-	0.756	1.201
Description: This effort will design and develop a novel rapid risk characterization framework that will be validated with a rapid fate and transport screen, a break through toxicity screening, and treatment approaches.			
FY 2023 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** DA1 / *SAFR Alternatives for Readiness Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Design and develop a framework for case studies to detail per- and polyfluroroalkyl substance (PFAS) toxicity through outdoor experimental system studies of the natural environment under controlled conditions (mesocosms) that examine toxicity in various geophysical conditions. ***FY 2024 Plans:*** Will develop a rapid risk prioritization database tool validated with per- and polyfluroroalkyl substance (PFAS) case studies. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects investments required to develop the database design.			
Title: Safer Alternatives for Readiness (SAFR) Applied Research ***Description:*** Design and develop novel cross-cutting solutions to eliminate Soldier and worker exposure to airborne lead from energetic materials; efficiently and safely demilitarize materiel; support the next generation of enhanced and sustainable munitions; reduce the use of toxic and hazardous chemicals in cleaners, degreasers, lubricants and fluids to ensure Soldier and ground vehicle readiness; and minimize the life cycle health and safety risks associated with emerging high-performance materials. ***FY 2023 Plans:*** Research green chemistry approaches to energetic material synthesis methods; explore novel non-metallic and non-energetic initiation techniques to replace lead-based primary explosives; investigate non-chemical surface cleaning and preparation techniques for relevant substrates. ***FY 2024 Plans:*** Will research PFAS-free surface treatment for coatings and textile applications; investigate material alternatives for critical energetic materials; and explore lead-free rocket propellants. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding increase reflects the planned life cycle for this project	-	2.817	3.970
Title: SBIR/STTR Transfer ***FY 2023 Plans:*** Funding transferred in accordance with Title 15 USC §638 ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC §638	-	0.106	-
Accomplishments/Planned Programs Subtotals	-	3.679	5.171

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** DA1 / *SAFR Alternatives for Readiness Applied Research*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army			Date: March 2023
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) DG1 / *Development of Obscurants*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
DG1: *Development of Obscurants*	-	-	-	2.774	-	2.774	-	-	-	-	0.000	2.774

Note

In Fiscal Year (FY) 2024, funding realigned from Program Element 0602145 / Project BG8 (Obscuration Technology)

A. Mission Description and Budget Item Justification

This Project investigates and evaluates obscurant technologies that degrade threat force surveillance sensors and defeat the enemy's target acquisition devices, missile guidance, and directed energy weapons. This Project focuses on advanced infra-red and multi-spectral obscurant materials that provide effective, affordable, and efficient screening of deployed forces, while being safe and environmentally acceptable.

Work in this Project is related to and fully coordinated with Program Element 0603119 (Ground Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering Priority focus areas and the Army Modernization Strategy.

Work in this Project supports the Next Generation Combat Vehicle (NGCV) Army Modernization Priority.

Work in this Project is performed by the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Obscuration Enabling Technologies	-	-	2.774
Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment across the electromagnetic spectrum. This effort also provides vulnerability assessments against enemy threat systems. ***FY 2024 Plans:*** Will explore medium range obscurant systems and work towards using novel materials to maximize performance; explore the potential of medium range obscurant systems to disseminate counter unmanned aerial obscurant-based materials; provide further enhancement and support for screening and obscuration module systems. ***FY 2023 to FY 2024 Increase/Decrease Statement:*** Funding realigned from Program Element 0602145 / Project BG8 (Obscuration Technology)			
Accomplishments/Planned Programs Subtotals	-	-	2.774

Exhibit R-2A, RDT&E Project Justification: PB 2024 Army		Date: March 2023
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** DG1 / *Development of Obscurants*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A