Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	0.000	0.000	35.199	-	35.199	29.837	31.647	30.220	27.700	0.000	154.603
BK7: *Robotics for Engineer Operations Technology*	-	0.000	0.000	9.998	-	9.998	6.271	3.246	2.433	1.770	0.000	23.718
BL1: *Materials and Manufacturing Research Technology*	-	0.000	0.000	8.127	-	8.127	10.280	10.509	10.828	10.953	0.000	50.697
BL2: *Explosives Forensics Technology*	-	0.000	0.000	1.542	-	1.542	1.573	1.604	1.636	1.655	0.000	8.010
BL4: *Countermine Technology*	-	0.000	0.000	4.244	-	4.244	4.369	4.497	0.000	0.000	0.000	13.110
BL5: *Expedient Passive Protection Technology*	-	0.000	0.000	4.119	-	4.119	1.468	2.432	5.953	5.110	0.000	19.082
BL7: *Power Projection in A2AD Environments Technology*	-	0.000	0.000	2.766	-	2.766	1.915	3.193	3.270	2.875	0.000	14.019
BL9: *Protection from Advanced Weapon Effects Technology*	-	0.000	0.000	4.403	-	4.403	3.961	6.166	6.100	5.337	0.000	25.967

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:
* 0602105A Materials Technology
* 0602622A Chemical, Smoke, and Equipment Defeating Technology
* 0602705A Electronics and Electronic Devices
* 0602712A Countermine Systems
* 0602720A Environmental Quality Technology
* 0602784A Military Engineering Technology

A. Mission Description and Budget Item Justification

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

All FY 2020 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground 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 the Project supports the Army Science and Technology Ground portfolio.

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

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

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	35.199	-	35.199
Total Adjustments	0.000	0.000	35.199	-	35.199
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	35.199	-	35.199

Change Summary Explanation

FY20 increase related to science and technology financial restructuring.

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK7: *Robotics for Engineer Operations Technology*	-	0.000	0.000	9.998	-	9.998	6.271	3.246	2.433	1.770	0.000	23.718

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project T41 Mil Facilities Eng Tec
* Project T45 Energy Tec Apl Mil Fac
PE 0602720A Environmental Quality Technology
* Project 048 Ind Oper Poll Ctrl Tec

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.

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 Portfolio.

All FY 2020 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

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

This effort is coordinated with PE 0603462A (NGCV Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Dynamic Site Characterization	-	-	2.172

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
Description: This effort develops the capability to dynamically characterize the environment in which robotic Engineer equipment will operate through implementation of multi-modal sensing, sensor data fusion, and object detection and classification. ***FY 2020 Plans:*** Will adapt, modify, and improve object detection and classification capability to specifically support Combat Engineer tasks as well as develop capabilities for detailed engineering characteristics for soils and classification of materials both on the surface and subsurface. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602784A (Military Engineering Technology) / Projects T41 (Mil Facities Eng Tech) and T45 (Energy Tec Apl Mil Fac) and PE0602720A (Environmental Quality Technology) / Project 048 (Ind Oper Poll Ctrl Tec) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Title: Mission Planning and Task Execution Control ***Description:*** This effort develops a mission planning and task execution control capability to enable unmanned robotic Engineer equipment operations. This capability will provide a near real time operational view of the area of interest and will convert mission planning directives into commands for the robotic equipment. ***FY 2020 Plans:*** Will develop the tools for the visualization of the site model to allow an operator to view, explore, and utilize site data. In addition, it will create a user interface for an operator to input mission planning directives, machine control, and view task status. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602784A (Military Engineering Technology) / Projects T41 (Mil Facities Eng Tech) and T45 (Energy Tec Apl Mil Fac) and PE0602720A (Environmental Quality Technology) / Project 048 (Ind Oper Poll Ctrl Tec) in FY20 as part of the financial restructure in support of Army Modernization Priorities.	-	-	3.172
Title: Integration Prototype Model Development ***Description:*** This effort develops remote control protocols and processes for testing of construction equipment to assess suitability for use during engineer operations; assesses commercially available autonomy solutions from transportation and construction industries to develop enhanced semi-autonomous and autonomous equipment technology; and develops simulation tools for coordinated, multi-equipment operations. ***FY 2020 Plans:***	-	-	4.654

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
Will build a hardware-in-the-loop synthetic environment for development and testing of control algorithms and adapt, modify, and expand semi-autonomous navigation capabilities to facilitate one operator controlling multiple types of equipment. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602784A (Military Engineering Technology) / Projects T41 (Mil Facities Eng Tech) and T45 (Energy Tec Apl Mil Fac) and PE0602720A (Environmental Quality Technology) / Project 048 (Ind Oper Poll Ctrl Tec) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	9.998

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army												Date: March 2019
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 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
BL1: *Materials and Manufacturing Research Technology*	-	0.000	0.000	8.127	-	8.127	10.280	10.509	10.828	10.953	0.000	50.697

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology
* Project XW4 Manufacturing Science
PE 0602705A Electronics and Electronic Devices
* Project H94 Electronics and Electronic Devices

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 and Next Generation Combat Vehicle Portfolio.

Work is performed by the U.S. Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Agile Expedient Manufacturing	-	-	2.350
Description: This effort researches developing manufacturing processes to accelerate the rate of innovative material adaptations (protection, power, sensing, and signature management) necessary to rapidly respond to emerging and unknown threats in a battlefield environment. Efforts include the development of innovative materials technologies through combinations of additive and subtractive manufacturing, direct write processes, coupled electro-magnetic fields, and other hybrid processes, as well as the development of robust predictive modeling and simulation tools linking manufacturing processes with materials structure,			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
properties, and performance to enable the design and production of optimal materials at the point of need using available materials, energy sources, etc. ***FY 2020 Plans:*** Will develop novel chemistries and incorporate into ambient reactive extrusion processes to print energetic polymer propellants with optimal architectures. Will develop material processes to control and modify interfaces to enable three-dimensional hybrid electronics packaging that integrates microprocessors, amplifiers, three-dimensional antennas, and sensors for Army applications. Will investigate coupling electromagnetic fields to metal additive manufacturing processes to control specific microstructures in Magnesium alloys. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602105A (Materials Technology) / Project XW4 (Manufacturing Science) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Title: Power and Energy ***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 investigate 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 2020 Plans:*** Will develop electrolytes for high-voltage cathodes that will enable the transition of next generation high-energy batteries to the North Atlantic Treaty Organization (NATO) standard 6T format; will explore the feasibility of using biomimetic electrochemical devices for neuromorphic computing to enable artificial intelligence; will develop more efficient oxygen evolution catalysts for water electolyzers to generate hydrogen for fuel cells; and will investigate thermal and liquid reserve battery chemistries that extend operational duration of the battery while maintaining the 30-year shelf life requirement. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602105A (Materials Technology) / Project XW4 (Manufacturing Science) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.	-	-	1.732
Title: Additive Manufacturing Research	-	-	4.045

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
Description: This effort researches 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 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 2020 Plans:*** Will quantify processing-structure-property relationships in additively manufactured ultra-high strength steel alloys designed specifically for laser-based AM processes; will validate continuum scale model of laser-metal powder bed AM process and mesoscale phase field model of microstructure development; will develop optimal non-laser based AM process to retain unique micro/nanostructures in nanocrystalline metal feed stocks; will create novel additive processes to incorporate novel particulate and high aspect ratio fillers into AM polymer composites. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602105A (Materials Technology) / Project XW4 (Manufacturing Science) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	8.127

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL2: *Explosives Forensics Technology*	-	0.000	0.000	1.542	-	1.542	1.573	1.604	1.636	1.655	0.000	8.010

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602622A Chemical, Smoke and Equipment Defeating Technology
* Project 552 Smoke/Novel Effects Munitions

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. Project BL2 (Explosives Forensics Technology) 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 and Next Generation Combat Vehicle Portfolio.

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

Work in this Project is related to, and fully coordinated with PE 0603119A (Ground Advanced Technology), Project BL3 (Explosive Forensics Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Forensic Analysis of Explosives Signatures Applied Research	-	-	1.542
Description: This effort investigates forensics analytical methods for military explosives, HME, HME precursors, and residue analysis for attribution.			
FY 2020 Plans: Will investigate Photonic Integrated Circuits (PIC) for chemical sensing of explosives, narcotics, and other chemicals of interest for forensic analysis and personnel borne detectors. Will investigate novel materials to enhance selectivity in explosives detection.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602622A (Chemical, Smoke and Equipment Defeating Technology) / Project 552 (Smoke/Novel Effects Munitions) in FY20 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	1.542

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL4 / *Countermine Technology*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL4: *Countermine Technology*	-	0.000	0.000	4.244	-	4.244	4.369	4.497	0.000	0.000	0.000	13.110

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602712A Countermine Systems
* Project H24 Selectable Neutralization and Breaching Technology

A. Mission Description and Budget Item Justification

This Project designs and develops selectable explosive hazard (i.e., mine, minefield, improvised explosive device) neutralization technologies combined with detection confirmation sensor capabilities to provide a future integrated detection and neutralization capability in support of both manned and unmanned mounted route clearance and conventional mine breaching operations.

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 Army Science and Technology Next Generation Combat Vehicle, and Soldier Lethality modernization priorities.

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

This Project is coordinated with PE 0602145A (NGCV Technology), 0602143A (Soldier Lethality Technology), 0603462A (NGCV Advanced Technology) and 0603118A (Soldier Lethality Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Countermine Technology	-	-	4.244
Description: Designs and develops selectable explosive hazard neutralization technologies combined with detection confirmation sensor capabilities to provide a future integrated detection and neutralization capability in support of both manned and unmanned mounted route clearance and conventional mine breaching operations. Products of this effort include sensor components for high reliability confirmation, cueing algorithms that produce repeatable and accurate registration coordinates for neutralization, and trade off analysis of candidate neutralization techniques to achieve a desired neutralization order of magnitude (low or high order detonation).			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL4 / *Countermine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Will design EH neutralization techniques and set parameters of confirmation sensors; will mature laser, radio frequency and microwave sources to validate neutralization techniques. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602712A (Countermine Systems) / Project H24 (Selectable Neutralization and Breaching Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	4.244

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL5: *Expedient Passive Protection Technology*	-	0.000	0.000	4.119	-	4.119	1.468	2.432	5.953	5.110	0.000	19.082

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602720A Environmental Quality Technology
* Project 835 Military Med Environ Crit
PE 0602784A Military Engineering Technology
* Project T40 Mobility/Weapons Effects Technology

A. Mission Description and Budget Item Justification

This Project evaluates technologies to design and develop 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 the complex, urban environment. This Project also develops expedient solutions and decision support applications for protection against advanced energetic threats and large caliber rockets and missiles.

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 Army Engineer Research and Development Center.

Work in this PE complements PE 0603119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Integrate Novel Materials for Tone Down Applications	-	-	0.337
Description: This effort utilizes native vegetation as an unconventional countermeasure for Army concealment. Work includes identification of spectral properties for infrared disruption, and inclusion of additive materials for tone-down applications.			
FY 2020 Plans: Will produce libraries of native vegetation, soil, materials, and spectral signal property information for incorporation into tone-down applications to provide enhanced living concealment based on geographical regions. Will deliver suite of fully characterized			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
formulations for use in unconventional countermeasures to include risk guidance on application hazards associated with material debris. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602720A (Environmental Quality Technology) / Project 835 (Military Materials in the Environment Research and Development) and PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY20 as part of the financial restructure in support of Army Modernization Priorities.			
Title: Force Protection in the Urban Environment ***Description:*** This effort develops force protection solutions for urban environments and computational test bed capabilities to develop advanced materials and expedient protective solutions; This effort develops rapidly deployable protection systems; decision support applications and software; and tactics, techniques, and procedures to provide protection with consideration for a complex three-dimensional threat. ***FY 2020 Plans:*** Will conduct investigations to develop blast stagnation, blast reduction, overhead cover design, and ballistic protection algorithms; will develop an expedient retrofit kit for existing buildings and rapidly deployable force protection; will investigate a methodology for rapidly closing subterranean features. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602720A (Environmental Quality Technology) / Project 835 (Military Materials in the Environment Research and Development) and PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY20 as part of the financial restructure in support of Army Modernization Priorities.	-	-	3.782
Accomplishments/Planned Programs Subtotals	-	-	4.119

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL7: *Power Projection in A2AD Environments Technology*	-	0.000	0.000	2.766	-	2.766	1.915	3.193	3.270	2.875	0.000	14.019

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project T40 Mobility/Weapons Effects Technology

A. Mission Description and Budget Item Justification

This Project 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).

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 Army Engineer Research and Development Center.

Work in this PE complements PE 0603119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Entry and Sustainment in Complex Contested Environments	-	-	2.766
Description: This effort 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.			
FY 2020 Plans: Will conduct experiments on engineering properties of ice and snow to investigate remote sensing technologies for off-road mobility in extreme environments; will explore Light Detection and Ranging and photogrammetric data exploitation for			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
characterizing lines of communication; will design and develop computational framework for rapid determination of road structural capacity. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	2.766

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army			Date: March 2019
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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL9: *Protection from Advanced Weapon Effects Technology*	-	0.000	0.000	4.403	-	4.403	3.961	6.166	6.100	5.337	0.000	25.967

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project T40 Mobility/Weapons Effects Technology

A. Mission Description and Budget Item Justification

This Project 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.

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 Army Engineer Research and Development Center.

Work in this PE complements PE 0603119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: Materials and Modeling for Force Protection	-	-	1.422
Description: This effort develops advanced composite and other protective materials and multi-scale modeling techniques to reduce material weight and increase resistance against blast and penetration threats; develops innovative virtual material design procedures and optimized manufacturing processes supported by computational modeling and simulation.			
FY 2020 Plans: Will scale up optimized protective material systems including new composite materials for expeditionary protective systems and use multi-scale modeling to develop protective materials for structural hardening using foreign indigenous materials.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Title: Defeat of Complex Attack ***Description:*** This effort 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 develops micro-mechanics-based models and material solutions matured by conducting high-rate experiments. ***FY 2020 Plans:*** Will validate algorithm and design methodology for enhancing practical material solutions used in structural hardening and will develop and conduct high-rate and high-pressure experiments for micromechanical and continuum scale computational models. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.	-	-	2.981
Accomplishments/Planned Programs Subtotals	-	-	4.403

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A