Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Navy											Date: February 2018	
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602782N *I Mine & Exp Warfare Applied Res*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	0.000	31.256	32.733	37.545	-	37.545	36.273	30.457	31.058	31.689	Continuing	Continuing
0000: *Mine & Exp Warfare Applied Res*	0.000	31.256	32.733	37.545	-	37.545	36.273	30.457	31.058	31.689	Continuing	Continuing

A. Mission Description and Budget Item Justification

The activities described in this program element (PE) address future Navy and Marine Corps capabilities needed to maintain maritime superiority and ensure national security. They are based on input from Naval Research Enterprise stakeholders (including the Naval enterprises, the combatant commands, OPNAV and Headquarters Marine Corps) and are designed to exploit breakthroughs in science and technology in order to deliver maximum warfighting benefit to our sailors and marines. These efforts are aligned with shared priorities throughout the whole of RDT&E in order to quickly advance new capabilities from discovery to deployment across the warfighting domains.

This PE provides technologies for Naval Mine Countermeasures (MCM), Expeditionary Warfare, U.S. Naval sea mining, Naval Special Warfare (NSW), and Joint Tri-Service Explosive Ordnance Disposal (EOD) as well as continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable applied research at sea. This program is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capability Objectives through the development of technologies to achieve military objectives with minimal casualties and collateral damage. Within the Naval Transformation Roadmap, this investment will achieve one of three "key transformational capabilities" required by "Sea Shield" as well as technically enable the Ship to Objective Maneuver (STOM) key transformational capability within "Sea Strike" by focusing on technologies that will provide the Naval Force with the capability to dominate the battlespace, project power from the sea, and support forces ashore with particular emphasis on rapid MCM operations. These efforts concentrate on the development and transition of technologies for the MCM-related and Urban Asymmetric/Expeditionary Warfare Operations (UAEO)-related Future Naval Capabilities (FNC) Enabling Capabilities (ECs). The Mine and Obstacle Detection/Neutralization efforts include technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting and neutralization/breaching. The Urban Asymmetric Operation effort includes critical warfighting functions such as Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), fires, maneuver, sustainment, etc. The Naval Special Warfare and Explosive Ordnance Disposal technology efforts concentrate on the development of technologies for safe near-shore mine detection, diver mobility and survivability, and ordnance disposal operations.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

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B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	33.916	32.733	37.919	-	37.919
Current President's Budget	31.256	32.733	37.545	-	37.545
Total Adjustments	-2.660	0.000	-0.374	-	-0.374
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.058	0.000			
• SBIR/STTR Transfer	-0.602	0.000			
• Program Adjustments	0.000	0.000	-0.110	-	-0.110
• Rate/Misc Adjustments	0.000	0.000	-0.264	-	-0.264

Change Summary Explanation

The increased funding from FY2018 to FY2019 represents additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects.

The FY 2019 funding request was reduced by $0.152 million to reflect the Department of Navy's effort to support the Office of Management and Budget directed reforms for Efficiency and Effectiveness that include a lean, accountable, more efficient government.

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Navy			Date: February 2018
Appropriation/Budget Activity 1319 / 2	R-1 Program Element (Number/Name) PE 0602782N / *Mine & Exp Warfare Applied Res*	Project (Number/Name) 0000 / *Mine & Exp Warfare Applied Res*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
0000: *Mine & Exp Warfare Applied Res*	0.000	31.256	32.733	37.545	-	37.545	36.273	30.457	31.058	31.689	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project focuses on reducing the time involved in conducting MCM operations and increasing safe standoff from minefields. It develops and transitions technologies for MCM-related and UAEO-related Future Naval Capability Enabling Capabilities (FNC ECs). The MCM effort includes technologies for clandestine and overt minefield reconnaissance, organic ship self-protection, organic minehunting, neutralization/breaching and clearance. The Littoral Warfare effort includes critical warfighting functions such as C4ISR, fires, maneuver, sustainment, etc. The sea mining effort emphasizes technologies for future sea mines. The Naval Special Warfare and Explosive Ordnance technology efforts concentrate on the development of technologies to enhance diver capabilities including: safe near-shore mine sensing, mobility and survivability, and ordnance disposal operations.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Title: MINE TECHNOLOGY	2.504	3.777	8.293	0.000	8.293
Description: This activity assesses advanced sea mine technologies to maintain expertise in this Naval Warfare area. An acoustic sensing capability for the naval mine Target Detection Device (TDD) is being addressed. Future mine and minefield concepts are being addressed. The increased funding from FY2018 to FY2019 represents additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects ***FY 2018 Plans:*** Conduct applied research in remote control, advanced minefield concepts, minefield planning, and advanced sensors / signal processing. Efforts involved in this area include developments in advanced sensors and algorithmic capabilities that are applicable toward existing target detection devices (TDDs), analysis of intermediate and deep water minefield concepts, development of concepts for semi-autonomous and remote controlled mines and minefields, and assessment of sea mine technologies in order to maintain a level of expertise in naval mines. ***FY 2019 Base Plans:*** Conduct applied research in remote control, advanced minefield concepts, minefield planning, and advanced sensors / signal processing. Efforts involved in this area include developments in advanced sensors and					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
algorithmic capabilities that are applicable toward existing target detection devices (TDDs), analysis of intermediate and deep water minefield concepts, development of concepts for semi-autonomous and remote controlled mines and minefields, and assessment of sea mine technologies in order to maintain a level of expertise in naval mines. Initiate applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The increased funding from FY2018 to FY2019 represents additional investment and effort associated with technologies supporting applied research in modeling and applying novel mine sensing modalities and modeling and development of advanced minefield effects.					
Title: MINE/OBSTACLE DETECTION ***Description:*** This activity focuses on applied research to enable longer detection ranges and precise mine location with fewer false alarms in a variety of challenging environments. It supports Discovery and Invention (D&I) and MCM-related FNC ECs. Efforts in Synthetic Aperture Sonar (SAS) technologies for longer range detection and classification of mine-like targets and magnetic gradiometer sensing and electro-optic (EO) technology for buried mine identification, and sensor integration onto Autonomous Underwater Vehicles (AUVs) are being addressed. EO sensor research develops algorithms to enable image processing for rapid overt reconnaissance from an Unmanned Aerial Vehicle (UAV). Other processing, classification and data fusion techniques to reduce operator workload, and a mine burial prediction "expert system" are also being developed. Efforts also support development of MCM Mission Modules for Littoral Combat Ships (LCS). ***FY 2018 Plans:*** Conduct Undersea Warfare applied research that investigates and creates new solutions to enable naval forces to conduct more rapid and effective mine detection and classification of moored, proud, and buried mines in high reverberation and man-made clutter environments. The capability to provide effective mine hunting and mine counter-measures from deep water through the beach requires innovative sensor technology, innovative processing techniques, and knowledge and exploitation of the complex operational environments. The advancement of using autonomous underwater vehicles requires investments in underwater acoustic communications, navigation techniques, improved energy densities, hydrodynamics, and vehicle control technologies.	17.283	17.754	17.969	0.000	17.969

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Conduct applied research in synthetic aperture sonar (SAS) technologies for longer range detection and classification of mine-like targets, magnetic gradiometer sensing, electro-optic (EO) technology for surface / near-surface mines, buried mine hunting technologies, and sensor integration onto Autonomous Underwater Vehicles (AUVs). Efforts involved in this area include investigations in advanced processing, classification, and data fusion techniques to reduce operator workload; development of automatic mine detection and classification algorithms for integrated forward-looking iPUMA sonar and side-looking sonars; development of drifting mine detection concepts; high source level, single crystal based projector technologies; thermal engine for unmanned underwater vehicles powered by thermal gradients; modeling of data fusion and mine contact handling; and extension of electro-optical imaging resolution in underwater environments. Complete effort to double underwater optical imaging range via the use of time-resolved LIDAR pulse propagation.					
FY 2019 Base Plans: Conduct applied research in novel minehunting technology areas that will ultimately enable unmanned systems to operate flexibly across a wide range of dynamic and unstructured environments and operations. Research thrusts include development of new algorithms, coding schemes, prototype hardware, and problem domain understanding for acoustic communications between unmanned MCM systems in the dynamic environments unique to minehunting; new transduction designs and sensor concepts appropriate for miniaturizing MCM capabilities onto substantially smaller unmanned systems and operating with increased autonomy; algorithmic approaches and new hardware designs that consolidate and optimize sensing, navigation, and communications for smaller autonomous mobile mine hunting and neutralization systems. Conclude development of a high source level projector that can extend the maximum detection range of the Low Frequency Broadband (LFBB) Mine Identification System. Conclude Phase 2 of Advanced Mission Module Technology Development. Conclude development of system concepts for wide area detection of surface and submerged drifting mines. Initiate joint sensing and communication approaches for multi-vehicle mine hunting. Initiate performance estimation for automatic target recognition on non-imaging systems. Continuing support to research vessels of the U.S. Academic Research Fleet for operations and maintenance that enable science at sea. Undersea Warfare: Perform laboratory, field, and theoretical/numerical studies that creates new solutions to enable naval forces to conduct more rapid and effective mine detection and classification such as: the development of unmanned underwater vehicle (UUV) autonomy to interactively sense and exploit the ambient environmental conditions to optimize performance; and to characterize the flow generated by biomimetic					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
propulsion approaches leading to development of tools to inform the design of future UUVs utilizing such propulsion mechanisms. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Title: MINE/OBSTACLE NEUTRALIZATION ***Description:*** Activity includes applied research to support selected MCM related FNC ECs for rapid mine and obstacle neutralization and sea mine jamming techniques to increase surface ship safe standoff from threat mines. It includes various lethality, vulnerability and dispensing computational tools, models and assessments to support the various far-term Surf Zone (SZ) and Beach Zone (BZ) mine and obstacle breaching concepts. ***FY 2018 Plans:*** Conduct applied research in rapid mine and obstacle neutralization and mine sweeping techniques to increase surface ship safe standoff from threat mines. Efforts involved in this area include various lethality, vulnerability, and dispensing models, assessments, and algorithmic approaches to support surf zone (SZ) and beach zone mine and obstacle breaching concepts; techniques for neutralization of buried mines; techniques for emulation sweep; and investigating the coupling of reacquire & identify capabilities with precision neutralization for buried mines. ***FY 2019 Base Plans:*** Conduct applied research in rapid mine and obstacle neutralization and mine sweeping techniques to increase surface ship safe standoff from threat mines. Efforts involved in this area include various lethality, vulnerability, and dispensing models, assessments, and algorithmic approaches to support surf zone and beach zone mine and obstacle breaching concepts; techniques for neutralization of buried mines; techniques for emulation sweep; and investigating the coupling of reacquire & identify capabilities with precision neutralization for buried mines. Conclude development of system concepts for autonomous neutralization of surface and submerged drifting mines. ***FY 2019 OCO Plans:*** N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.439	0.428	0.445	0.000	0.445

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
There is no significant change from FY 2018 to FY 2019.					
Title: SPECIAL WARFARE/EOD	11.030	10.774	10.838	0.000	10.838
Description: The goal of this effort is to develop technologies to extend stand-off of special operations and EOD forces in clandestine hydrography, mine clearance and port security missions while increasing the range and effectiveness of divers. Advanced technologies are needed to gain access to areas contaminated by area-denial sensors and/or booby traps. Developed technologies will transition to the Joint Service EOD Program, the Naval EOD Program, or the DOD Technical Response Group. This activity includes applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems to increase detection range and accuracy in harsh environments. Other efforts include mission support technology improvements for AUVs and human divers - such as communications, navigation and life support. ***FY 2018 Plans:*** Conduct applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems, mission support technology improvements for AUVs and human divers (e.g., communications, navigation, and life support), and threat identification, exploitation, and remediation technologies. Efforts involved in this area include development of technologies to excavate buried IEDs, dual manipulator robots for complex underwater EOD missions, technologies to enhance diver situational awareness and autonomous inspection of ship hulls, support of Joint Service Explosive Ordnance Disposal (JSEOD) applied research, and detection of trace and bulk explosive materials. ***FY 2019 Base Plans:*** Conduct applied research in sensor technology for NSW and EOD autonomous and handheld sonar systems, mission support technology improvements for AUVs and human divers (e.g., communications, navigation, and life support), and threat identification, exploitation, and remediation technologies. Efforts involved in this area include development of technologies to excavate buried IEDs, dual manipulator robots for complex underwater EOD missions, technologies to enhance diver situational awareness and autonomous inspection of ship hulls, support of Joint Service Explosive Ordnance Disposal (JSEOD) applied research, and detection of trace and bulk explosive materials. Conclude investigation of multi-modal signature reduction technologies for wet/dry-submersibles and semisubmersibles. Initiate modeling and development of concepts to increase mobility efficiency for combat divers. ***FY 2019 OCO Plans:***					

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Appropriation/Budget Activity 1319 / 2	**R-1 Program Element (Number/Name)** PE 0602782N / *Mine & Exp Warfare Applied Res*	**Project (Number/Name)** 0000 / *Mine & Exp Warfare Applied Res*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
N/A ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is no significant change from FY 2018 to FY 2019.					
Accomplishments/Planned Programs Subtotals	31.256	32.733	37.545	0.000	37.545

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

The overall metrics of this applied research program are the development of technologies which focus on the Expeditionary Warfare challenge of speeding the tactical timeline and increasing safe standoff from minefields. Individual project metrics include the transition of 6.2 technology solutions into 6.3 advanced technology programs.