EXECUTIVE SUMMARY

(See Appendix C for an explanation of acronyms)

A river is any natural stream of water that flows in a channel with defined banks. There are 113 major river system basins in the world. They carry on average over 15% of the world's commerce. "Approximately 80% of the world's population (4.8 billion people) lives within 100 kilometers of the world's major river basins."[1] Control of the river ways is vital to commerce and national security. In the aftermath of the 9/11 atrocities perpetrated against the United States, the US began the Global War on Terrorism (GWOT). The riparian environments are strategically important in support of GWOT. They can be used for shipment of weapons, contraband, and illegal drugs to support terrorist and insurgent operations.

Over the past several years it has become apparent that the US Navy needed a brown water capability to better combat today's threats. "The Chief of Naval Operations Strategic Studies Group 24 recommended expanding the Navy's green and brown water capability to rebalance the force so the United States Navy can better combat today's green and brown water threat."[2] Addressing the National Defense Industry Association Expeditionary Warfare Conference in October 2005, the Chief of Naval Operations (CNO), Admiral Mike Mullen emphasized the new landward push. "There are great opportunities for the global security environment. Maritime Domain Awareness -- that is where we are really going in respect to operations in green water and brown water as we evolve that over time."[3] The CNO followed his comment a few months later when he established the Naval Expeditionary Combat Command in Little Creek, Virginia.

"The U.S. Navy established the Navy Expeditionary Combat Command (NECC) in January 2006 to serve as a single functional command to centrally manage current/future readiness, resources, manning, training and equipping of the Navy's expeditionary forces."[4] The NECC's mission is to integrate all war fighting requirements for expeditionary combat and combat support elements. In May of 2006 the NECC established Riverine Group One to serve as administrative command over three riverine squadrons. According to Rear Admiral Donald Bullard, NECC's commander,

”we know there are many areas around the world where rivers are the main lines of communication. We, the Navy, need to expand in order to go into that brown water environment, to be able to train and work with our combined allies and neighbors and make those lines of communication secure.”[5]

The focus of the Navy’s riverine group will be on conducting maritime security operations (MSO) and theater security cooperation (TSC) in riparian areas of operations or other suitable areas. This might entail protecting critical infrastructure, securing the area for military operations or commerce, preventing the flow of contraband, enabling power projection operations, joint, bi-lateral or multi-lateral exercises, personnel exchanges, and humanitarian assistance.[6] MSO entails policing the maritime domain to prevent and/or disrupt terrorism, drug trafficking, piracy, environmental destruction and human trafficking. Conducting exercises with other navies and providing Humanitarian Assistance/Disaster Relief (HADR) typify cooperative TSC operations. The Riverine Force (RF) will be capable of deploying world-wide within 96 hours in support of MSO and TSC missions.

The 2007 Naval Postgraduate School (NPS) Systems Engineering and Analysis (SEA) Integrated Project titled “Riverine Sustainment 2012” was a joint product developed by eight NPS SEA students and 17 National University of Singapore (NUS) Temasek Defense Systems Institute (TDSI) students. The two cohorts combined students from various professional and academic backgrounds to form the Riverine Sustainment Team (RST). The purpose of the RST was to define, analyze, and recommend alternatives for supply, repair, and force protection that increase sustainability of the riverine force in the riparian environment utilizing technologies currently in use or available for use by 2012.” Additionally, a study was conducted into the potential for use of developing commercial technologies which could advance the riverine force communications capacity to handle the multiple types and high volumes of information necessary in modern tactical environments.

Systems engineering is a top-down, problem solving process that captures stakeholders’ needs, analyzes alternatives and advocates a solution. “Systems engineering is a management technology to assist and support policy making, planning,

decision making, and associated resource allocation or action deployment. Systems engineers accomplish this by quantitative and qualitative formulation, analysis, and interpretation of the impacts of action alternatives upon the needs perspectives, the institutional perspectives, and the value perspectives of their clients or customers."[7]

The RST started with the RF's operational concept and utilized a combination of the physical and functional architectures to develop the operation architecture. Modeling and simulation enabled the RST to measure physical architecture alternatives that achieved RF sustainment functional objectives. The RST utilized both deterministic and stochastic models for analyzing the riverine sustainment problem. During the analysis models were developed Extend, SIMKIT, MATLAB, Excel and MANA to evaluate the performance and effectiveness of the various alternatives.

The key findings of the functional groups are described as follows:

Supply Group

- Key factors of riverine sustainment supply success are supply ship cycle time, basing alternative, logistics connector survivability, operational availability of the SURC's and cost. Given the supply ship cycle time, basing alternative, and number of assets used, the RST was able to determine the most effective configuration of connectors.

- Helicopters add very little to the overall performance of the configuration of connectors, but they increase the cost significantly. If the RF operates from a FOB with a supply ship cycle time between 4-7 days, then the most effective connector is the LCU-2000. This is because the LCU-2000 can carry the entire supply load in one run. When the supply ship cycle time increases to 8-9 days, then the LCU-2000 can no longer carry the entire supply load in one run. Instead, the Jim G becomes the most effective connector. This is assuming that the RF would have to procure an LCU-1610 and LCU-2000. If the procurement of the two crafts is not necessary, then the LCU-2000 with an LCU-1610 would be the most cost effective configuration. If only one vessel is used, then the Jim G will allow the maximum supply ship cycle time to maintain a 95% operational availability of SURC's due to fuel if the supply ship cycle time is not specified.

- If the RF operates from a Nobriza+Barge MOB with a supply ship cycle time between 4-7 days, then the most cost effective connector is the LCU-2000. Similar to the FOB, the Nobriza+Barge requires a seven day supply load that

can fit in the LCU-2000. When the supply ship cycle time increases to 8-9 days, then the LCU-2000 with an LCU-1610 is the most effective configuration. Unlike the FOB, the Nobriza+Barge requires a slightly greater supply load that would require a LCU-2000 and a Jim G to do multiple runs. If only one vessel is used, then the Jim G will allow the maximum supply ship cycle time to maintain a 95% operational availability of SURC's due to fuel if the supply ship cycle time is not specified.

- If the RF operates from the RCSS, Endurance, or Sri Inderapura MOB with a supply ship cycle time between 4-7 days, then the most effective configuration of connectors is a Jim G with an LCU-1610. The increase in supply load compared to the other basing alternatives requires multiple runs when a single Jim G or two LCU-1610's are used. When a Jim G and an LCU-1610 are combined, they can re-supply the MOB in one run. When the ship cycle time increases to 8-9 days, then two Jim G's is the most effective configuration. If only one vessel is used, then the Jim G will allow the maximum supply ship cycle time to maintain a 95% operational availability of SURC's due to fuel if the supply ship cycle time is not specified.

- For a single connector, the Jim G supported the best supply ship cycle time.

Repair Group

- Increasing personnel, maintenance bays, or SURC did not have a significant effect on improving operational availability in the repair model, and with this in mind it is recommended that the status quo remain in place. However, when considering the RST scenario constraint of maintaining at least 9 mission ready SURC's at all times, the alternative of increasing both personnel and maintenance bays was cheaper than procuring additional SURC's. Also, the model indicated that MSRT was the biggest factor that affected SURC operational availability. MSRT's exceeding 24-hours drove operational availabilities below 80%. Given a logistically barren environment as presented in the RST scenario, it is vital that an exhaustive PUK is developed for the RF. This PUK must not only contain high failure rate items, but also items that fail at moderate rates.

- The model developed by the Repair Group can serve as a planning tool for a wide variety of future riverine warfare operations. As key parametric changes can be easily implemented within the model, such as environmental concerns, Commander's discretion, medical problems, and so forth, the Repair Group's model has established a foundation upon which such studies can be made. Since every alternative, including the status quo, is very sensitive to MSRT,

the repair model may serve as a tool for repair re-supply planning and evaluation of logistics alternatives that involve faster connectors such as airlift.

Force Protection Group

- Current mortar defenses proposed by the RF are insufficient. The analysis conducted in this study was with the aide of a host nation providing security beyond the FOB's perimeters out to the expected mortar range. Even though the best alternative improved on the baseline by severely decreasing the number of mortar rounds that hit the base, the modeling showed that three mortar rounds still struck the base. This means that even with the mortar defenses proposed in this study, the FOB could expect to be hit by mortar rounds each time they are attacked. If the RF is based at the a FOB ashore, then the host nation needs to provide robust perimeter defense. For the decision maker deciding which basing alternative to consider, this is a major consideration because a MOB can move and prove less susceptible to mortar fire, especially with as wide a river as the Kampar.

- The analysis also revealed that the ROSAMs were an excellent resource for force protection in two different scenarios. The ROSAMs provide a reduction in manpower, which decreased the RF footprint and also promoted greater RF survivability when the FOB was attacked.

- The MOB boat attack scenarios revealed that the Nobriza and Barge were the most cost effective means to defend the RF when they were operating from a MOB. The Nobriza provided excellent firepower without added exposure of personnel, which was discovered to be a draw back for a patrol boat.

- For perimeter defenses, IR illuminators coupled with the NVG's are very valuable assets. The RF should also consider using acquiring RDFW units for the creation of bunkers.

Communications Technology

- Communications equipment in use by riverine forces requires modernization and increased capacity.

- Worldwide Interoperability for Microwave Access (WiMAX) technology showed the greatest potential for addressing riverine force communications needs utilizing commercially available equipment currently in use in industry.

Because of the short duration of this study there were numerous areas that were not examined. Chapter 10 has a complete list of areas for further study.

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[1] Naval Expeditionary Combat Command, *U. S. Navy Riverine Group, Concept of Operations* (Little Creek, VA: GPO, 2006), 22.

[2] James Beaver and others, "Systems Analysis of Alternative Architectures for Riverine Warfare in 2010" (MS diss., Naval Postgraduate School, 2006), 19.

[3] Chief of Naval Operations remarks as delivered at the National Defense Industry Association Expeditionary Warfare Conference, Panama City, Fla., 26 Oct. 2005, http://www.navy.mil/navydata/leadership/mist.asp?x=S.

[4] Naval Expeditionary Combat Command, "About Us," *Naval Expeditionary Combat Command*, http://www.necc.navy.mil/

[5] Navy Newsstand. "Navy Establishes First Riverine Group", *Navy.mil,* http://www.navy.mil/search/display.asp?story_id=23854.

[6] Naval Expeditionary Combat Command, *U. S. Navy Riverine Group, Concept of Operations*, (Little Creek, VA: GPO, 2006), 7.

[7] Andrew P. Sage and James E. Armstrong Jr., *Introduction to Systems Engineering* (New York: John Wiley & Sons, 2000), 8-9.