Plan to Manage Artemis II Crew and Capsule Recovery

Dr. Michael Graul
ISEN 665 Group 15
Mohammed Irfan, Didier Sanchez, Donovan Tran, Will Vass

May 2, 2026

“On our honor as Aggies, we have neither given nor received unauthorized aid on this academic work.”

Signed: Group 15

Submitted to fulfill the requirement for the Final Project
ISEN 665, Spring 2026
Department of Industrial & Systems Engineering
Texas A&M University

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1. EXECUTIVE SUMMARY

The Artemis II recovery effort addresses a mission critical planning problem defined by fixed splashdown timing, demanding crew safety requirements, spacecraft preservation needs, environmental uncertainty, and the need for coordinated action across NASA, the United States Navy, and supporting recovery stakeholders. The recovery scope extends from atmospheric reentry through crew recovery, spacecraft securement, and post recovery transfer. Within that scope, the effort is guided by four technical objectives. These objectives address recovery process definition, engineering factor assessment, crew safety planning, and decision support with contingency planning. The effort is therefore not limited to operational response at splashdown. It is a structured planning and readiness activity intended to establish the conditions under which recovery can be executed safely and in a controlled manner.

In response to this challenge, the report develops a complete planning basis for the Artemis II recovery effort. The Project Charter defines the purpose, scope, stakeholders, technical objectives, delivery schedule, and major constraints that shape the effort. The Concept of Operations establishes the operational context of splashdown recovery and post recovery transfer. The Project Management Plan then provides the administrative basis for requirements, organization, work definition, schedules, budget, quality, risk, testing, change control, documentation, procurement, implementation, health and safety, communications, and financial control. The Systems Engineering Management Plan complements that structure by defining the technical basis for requirements development, common technical processes, additional systems engineering functions, technical integration, and compliance management. In combination, these sections establish the management and engineering foundation required to support recovery planning as a disciplined project rather than as an isolated operational event.

A major outcome of the effort is the generation of an integrated recovery planning baseline organized around five principal recovery functions. These functions are scope and organization, team preparation, readiness programs, recovery operations strategy, and post recovery planning. This structure provides the basis for the work package architecture and milestone logic that guide implementation from initial planning through final integration. Within that structure, the work definition allocates responsibility for technical objective refinement, team qualification, readiness procedure development, assessment planning, mitigation development, landing zone definition, naval positioning, crew disembarkation planning, transportation routing, and post mission debrief planning. The milestone roadmap then translates these functions into a sequence of planning accomplishments that can be reviewed, assessed, and controlled as the recovery baseline matures.

The report also establishes a requirements and stakeholder framework that gives the recovery effort technical direction and operational discipline. NASA recovery needs emphasize safe crew recovery, preservation of the Orion capsule for post flight analysis, open water data collection, validation of procedures through the Underway Recovery Test campaign, and capture of lessons learned. Department of Defense needs emphasize clear authority boundaries, adequate deployment lead time, and safety assurance for Navy personnel. Additional stakeholder needs

address preservation of spacecraft integrity and chain of custody for Orion hardware after splashdown. These requirements are carried forward into the project organization, technical planning, testing, and implementation structure. A matrix organization supports this work by defining both leadership authority and functional participation across the recovery effort.

Another important contribution of the report is the creation of a readiness centered management framework. The budget is organized by major project phases and places the largest share of nonrecurring resources in readiness activities such as dry runs, integrated rehearsals, post test assessment, mitigation development, and recovery strategy validation. Risk management is structured through Risk and Safety Expert Teams and Failure Mode and Effects Analysis. Quality is monitored through dedicated Quality Teams using rubrics tied to efficiency, safety, and conformance to plans. Testing is organized around small team trials and joint NASA and Navy exercises with formal readiness criteria and corrective action if performance is insufficient. Together, these elements ensure that planning products are not accepted on the basis of document completion alone. They are assessed against readiness evidence, operational coordination, and mission relevant performance.

The effort further establishes the controls needed to preserve consistency and traceability across a multiagency recovery system. Documentation is maintained through an access controlled repository and a Recovery Living Document that records current baselines, revision history, open issues, and readiness status. Change control is structured around formal review and approval across NASA and Navy organizations. Implementation is governed through phased execution, defined entry and exit conditions, milestone based reviews, and final integration into an operational recovery baseline. This control structure gives the effort a stable technical and administrative foundation while allowing the project to mature through review, coordination, and controlled update.

The overall impact of this work is the establishment of a disciplined recovery planning and readiness framework that improves technical traceability, strengthens multiagency coordination, and supports formal readiness assessment before mission execution. The report provides the basis for training, rehearsal, operational review, risk reduction, documentation control, financial control, and transition to a validated operational recovery baseline. In that sense, the work does more than define recovery activities. It establishes a managed recovery capability intended to support safe crew recovery, secure spacecraft handling, and coordinated post recovery transfer across the full recovery sequence.

The recommended path forward is defined in three parts. First, the final planning baseline should undergo stakeholder validation to confirm that the defined scope, requirements, and communications structure are both achievable and aligned with the larger Artemis II mission. This includes validation of scope and requirement definitions within the recovery chain of command and verification that communication systems, reporting paths, meeting structures, and record keeping practices are sufficient to support execution. Second, once the contained processes have been verified, mission execution should begin through formal distribution of plans to all relevant recovery personnel and decision makers. Broad visibility of the planning baseline is necessary so that each participant understands both assigned responsibilities and the upstream and downstream effects of recovery decisions. Third, mission progress should be

sustained and monitored through continuous upkeep of the living planning baseline and collection of relevant performance data. As implementation proceeds, updated documents, operational cost, testing results, and resource utilization should be monitored so that the recovery effort remains current, measurable, and responsive to changing mission needs.

2. INTRODUCTION

This report presents the management and systems engineering basis for the Artemis II recovery effort. It is written from the recovery planning perspective and is intended to define the organizational, technical, and operational framework required to support safe crew recovery, spacecraft securement, and post recovery transfer following splashdown. The report addresses the planning problem created by fixed splashdown timing, demanding crew safety requirements, spacecraft preservation needs, environmental uncertainty, and the coordination demands of a multiagency recovery operation.

The report is organized to move from project foundation to technical implementation. The Project Charter establishes the purpose, scope, stakeholders, technical objectives, delivery schedule, and major constraints that define the effort. The Concept of Operations then describes the recovery concept and the operational context in which the project must function. Together, these sections establish the basis for the management and technical planning that follows.

The Project Management Plan provides the administrative framework for the effort. It defines requirements, organizational responsibilities, work definition, schedules, budget, quality, risk, testing, change control, documentation, procurement, implementation, health and safety, communications, and financial control. The Systems Engineering Management Plan provides the technical framework for executing the effort through requirements development, common technical processes, additional systems engineering functions, technical integration, and compliance management. In this way, the report defines both how the recovery effort will be managed and how it will be engineered.

The report is further grounded in the recovery planning structure developed for Artemis II, which organizes the effort into scope and organization, team preparation, readiness programs, operations strategy, and post recovery planning. This structure provides the basis for work packages, milestone logic, readiness assessment, and final integration of the recovery baseline. As a result, the report treats recovery not as a single operational event, but as a controlled planning and readiness effort that must be developed, reviewed, and validated before mission support begins.

Taken together, the sections of this report provide the planning baseline for the Artemis II recovery effort. Its purpose is to establish a disciplined and technically grounded basis for coordination, readiness development, risk reduction, and operational support across the full recovery sequence.

3. PROJECT CHARTER

3.1 PURPOSE

The purpose of this project is to support the planning of the Artemis II Orion spacecraft recovery following splashdown by defining the major technical and operational considerations that shape recovery success. The project focuses on organizing the recovery problem in a structured manner so that the team can establish a clear technical basis for recovery planning, crew safety, and post splashdown decision-making.

3.2 SCOPE

The scope of this project applies to the planning of Artemis II Orion spacecraft recovery following splashdown. The work is limited to the recovery planning context and includes the development of a technical background review, identification of the major engineering factors affecting recovery performance, consideration of crew safety during post-splashdown operations, and formulation of a recovery decision-support and contingency framework. The project does not include real-time mission execution, hardware development, or operational command of recovery assets.

3.3 STAKEHOLDERS

The primary stakeholders for this project are:

- **U.S. Department of Defense:** Primary recovery partner; provides ship, divers, helicopters, and crew
- **National Aeronautics and Space Administration (NASA):** Project sponsor; Landing and Recovery Director has operational authority
- **Canadian Space Agency (CSA):** International partner; astronaut Jeremy Hansen is mission specialist
- **Lockheed Martin Space:** Orion prime contractor; capsule handling and post-flight analysis support

3.4 TECHNICAL OBJECTIVES

TO1: Develop a technical background review of Artemis II recovery, including splash down behavior, seakeeping, and uprighting

Description: This objective establishes the technical foundation for the project by reviewing the overall Artemis II recovery context and identifying the major stages, conditions, and considerations associated with Orion splashdown and recovery.

Outline of Actions:

• Review Artemis mission recovery information and prior recovery

concepts. • Examine Artemis splashdown and recovery operations at a

system level. • Define the major stages of the recovery process in a logical

sequence.

- Describe the role of the recovery team at each stage, including approach, stabilization, securing the vehicle, crew retrieval, and shipboard transfer.
- Organize these stages into a clear recovery process framework that can be communicated in the final deliverables.

TO2: Identify and explain the major engineering factors affecting recovery performance, such as parachute-supported touchdown conditions, water impact loads, and flotation stability

Description: This objective examines the principal technical conditions that influence recovery success and explains how those conditions affect the safe and effective retrieval of the crew and spacecraft.

Outline of Actions:

- Identify the principal technical conditions influencing recovery success, including capsule orientation, sea conditions, flotation stability, access to the crew module, and crew condition after landing.
- Assess how each condition affects the team's ability to safely approach, secure, upright, and retrieve the spacecraft and crew.
- Determine the operational implications of these conditions for timing, safety, coordination, and mission execution.
- Summarize the results in a technical assessment that supports recovery planning and aligns with the required project deliverables.

TO3: Develop a crew safety considerations framework for post-splashdown recovery operations

Description: This objective focuses on identifying the major safety considerations associated with crew recovery after splashdown and structuring them into a framework that supports safe recovery planning and execution.

Outline of Actions:

- Identify the principal hazards and safety concerns associated with post-splashdown crew recovery.
- Examine crew-related considerations such as medical condition, egress support, environmental exposure, and recovery timing.
- Define the major interfaces between crew safety needs, vehicle condition, and recovery team actions.
- Organize these considerations into a crew safety framework that can guide post-splashdown recovery planning.

TO4: Develop a recovery decision-support and contingency framework for nominal and off-nominal recovery conditions

Description: This objective establishes a structured basis for recovery planning under both expected and unexpected conditions by identifying the key decision points, operational disruptions, and contingency considerations that may arise during recovery.

Outline of Actions:

- Identify the major nominal and off-nominal recovery conditions that may affect mission success.
- Determine the critical decision points associated with approach, stabilization, uprighting, crew retrieval, and post-recovery handling.
- Define the contingency considerations needed to respond to environmental, vehicle, crew, or coordination-related disruptions.
- Organize these elements into a decision-support and contingency framework for use in recovery planning.

3.5 HIGH-LEVEL DELIVERY SCHEDULE

The recovery project is organized into five phases aligned with the IDEF0 CONOPS functions. Each phase produces defined milestones that serve as prerequisites for next phases

Phase	Timeframe	Key Milestones
1: Scope and Authorization (A1)	Months 1–6	Recovery project scope established: NASA-DoD MOA signed; Technical objectives approved
2: Team Preparation (A2)	Months 6–18	Recovery team recruited, Recovery team trained and qualified, Personnel support needs defined
3: Readiness Programs (A3)	Months 18–36	Dry-run testing procedures developed, Post-test assessment system approved, Mitigation procedures prepared, URT-12 certification complete, Recovery readiness program approved
4: Operations Strategy (A4)	Months 18–36	Landing zone selection plan approved, Naval positioning strategy approved, Crew disembarkation procedure approved, Recovery operations strategy baselined
5: Post-Recover Planning (A5)	Months 30–36	Post-recovery operations plan approved, Integrated recovery plan ready for execution
Execution	Splashdown week	USS Murtha positioned; Crew recovered, Capsule delivered to KSC

3.6 CONSTRAINTS OF NOTE

The project is constrained by mission safety requirements, the operational complexity of open water recovery, coordination demands across multiple teams and assets, and the need to maintain both crew safety and spacecraft integrity throughout recovery operations. Additional constraints include environmental uncertainty, limited time for post splashdown response, dependence on successful communication and coordination, and the requirement that all recovery actions be performed in a controlled and sequenced manner. The project must also remain aligned with schedule expectations, deliverable requirements, and the practical realities of executing spacecraft recovery in a dynamic operational environment.

3.7 CHARTER DISCUSSION

The charter was developed to scope and authorize the planning of a spacecraft ocean recovery which the united states has not conducted since apollo missions in 1975.

Four stakeholders were identified based on their direct operational role in recovery. The fout Technical objectives cover the recovery planning space without any overlap. TO1 establishes the process baseline, TO2 examines engineering constraints, TO3 focuses on crew safety, and TO4 addresses off nominal decision-making. We structured the schedule around the IDEFO functions because the planning activities has a chain that the model already captures which keeps the charter and CONOPS aligned. The constraints were identified through previous NASA recovery operations and reflect the factors that most directly shape how this project must be planned, particularly the fixed splashdown time, the one shot execution with no margin for error, and the hazardous materials protocols that constrain how and when personnel can approach the capsule.

4. CONCEPT OF OPERATIONS

4.1 CONOPS Discussion

The IDEF0 (Concept of Operations) was constructed to represent the managerial effort of how the project would be managed. The model breaks down the effort to develop the plans related to the Artemis II recovery operations. There is more emphasis on how the plans will be realized and less focus on the execution of the recovery options. The outputs of this model showcases the various plans related to the managerial effort of how the recovery operations will be run.

4.2 IDEF0 CONOPS Model

(See Attached IDEF0 Model.)

5. PROJECT MANAGEMENT PLAN

5.1 EXECUTIVE SUMMARY

Who: The recovery is a multi-agency effort managed by NASA Exploration Ground Systems at Kennedy Space Center, with the Landing and Recovery Director as operational authority. Partners include the U.S. Navy, U.S. Space Command, the Canadian Space Agency, and Lockheed Martin Space. The Artemis II crew consists of NASA astronauts Reid Wiseman, Victor Glover, Christina Koch, and CSA astronaut Jeremy Hansen.

What: The project encompasses recovery planning from atmospheric reentry through delivery of the crew to NASA JSC Houston and the Orion capsule to NASA KSC Florida. The effort addresses four technical objectives defined in the charter: (TO1) technical background review of the recovery process, (TO2) engineering factors affecting recovery, (TO3) crew safety framework, and (TO4) decision-support and contingency framework.

Why: Artemis II is NASA's first crewed lunar mission since 1975. The recovery carries unique risks: a fixed splashdown time driven by orbital mechanics, residual hypergolic propellants in the capsule, crew deconditioning after 10 days in microgravity, environmental uncertainty, and multi-agency coordination complexity. Failure to recover safely would jeopardize both the crew and the future of the Artemis program.

Where: Splashdown is targeted for the Pacific Ocean approximately 50 miles southwest of San Diego. The crew will be transported via helicopter to USS Murtha, then by NASA aircraft to JSC Houston. The capsule will transit to Naval Base San Diego and then overland by truck to KSC Florida.

When: Splashdown is targeted for approximately 10 days after launch. Recovery timeline targets are: crew extraction within 2 hours, capsule in well deck within 5 hours, crew to JSC within 48 hours. USS Murtha will depart San Diego approximately 3 days before splashdown. Recovery readiness was validated through 12 URTs, with URT-12 completing certification in March 2025.

How: The effort is structured around the IDEF0 managerial CONOPS with five primary functions: establishing recovery project scope (A1), preparing recovery teams (A2), preparing recovery readiness programs (A3), strategizing recovery operations (A4), and planning post-recovery operations (A5). The PMP provides administrative governance; the SEMP will provide the complementary technical management plan.

5.2 REQUIREMENTS

5.2.1 NASA Artemis Program

- Safe recovery of all four Artemis II crew members and delivery to the ship's medical bay within two hours of splashdown
- Recovery of the Orion capsule in a condition that supports post-flight analysis, particularly the thermal protection system given findings from the Artemis I mission

- Opportunity to conduct open-water data collection on the capsule before it is brought aboard the ship
- Recovery procedures validated through the Underway Recovery Test campaign prior to mission execution
- Lessons learned documented to support future Artemis recovery planning

5.2.2 U.S. Department of Defense

- Formal agreement defining roles, responsibilities, and command authority boundaries between NASA and Navy
- Adequate lead time for ship deployment and positioning in the recovery zone
- Safety assurance for all Navy personnel operating near the capsule
- Defined certification standards for recovery personnel through the URT campaign

5.2.3 Canadian Space Agency

- Equal crew safety priority for CSA astronaut Jeremy Hansen
- Inclusion in recovery communications and post-flight data access

5.2.4 Lockheed Martin Space

- Capsule handling procedures that preserve spacecraft integrity for post flight engineering analysis
- Access to inspect the capsule aboard the ship prior to overland transport
- Chain of custody documentation for all Orion flight hardware from splashdown to KSC

5.2.5 Traceability to Technical Objectives

The recovery process and sequencing needs to be traced to TO1. Engineering and environmental factors trace to TO2. Crew safety and medical needs trace to TO3. Decision-making and contingency needs to be traced to TO4. Full traceability will be formalized in the final report.

5.3 PROJECT ORGANIZATION AND RESPONSIBILITY FOR TASKS

5.3.1 Organization structure

A matrixed structure will be utilized due to the multiple agencies being involved in the recovery operation. Team members are expected to report to project managers for project tasks/responsibilities and their functional managers for assignments.

5.3.2 Stakeholders

This section identifies the stakeholders involved in the recovery effort of the Orion capsule and crew:

- National Aeronautics and Space Administrations (NASA)
- United States of America Department of Defense

- **Canadian Space Agency (CSA)**

5.3.2 Head Project Roles and Responsibilities

This section identifies head project recovery roles and their responsibilities:

- **Landing and Recovery Director:** Responsible for the efforts related to the recovery or the Orion capsule and crew. Given priority mission authority from the mission Flight Director post splashdown.
- **Flight Director:** Has main authority over the entirety of the NASA Artemis mission and oversees Orion's status. Responsible for authority handover to the Landing and Recovery Director once criteria are met.
- **Master Diver (US Navy):** Coordinates the movement of recovery equipment and recovery divers.
- **Open Water Lead:** The lead design engineer and subject matter expert for recovery operations in open waters.

5.3.3 Working Groups

The working groups are different teams responsible for various aspects of the recovery operations. The identified working groups and their responsibilities are as follows:

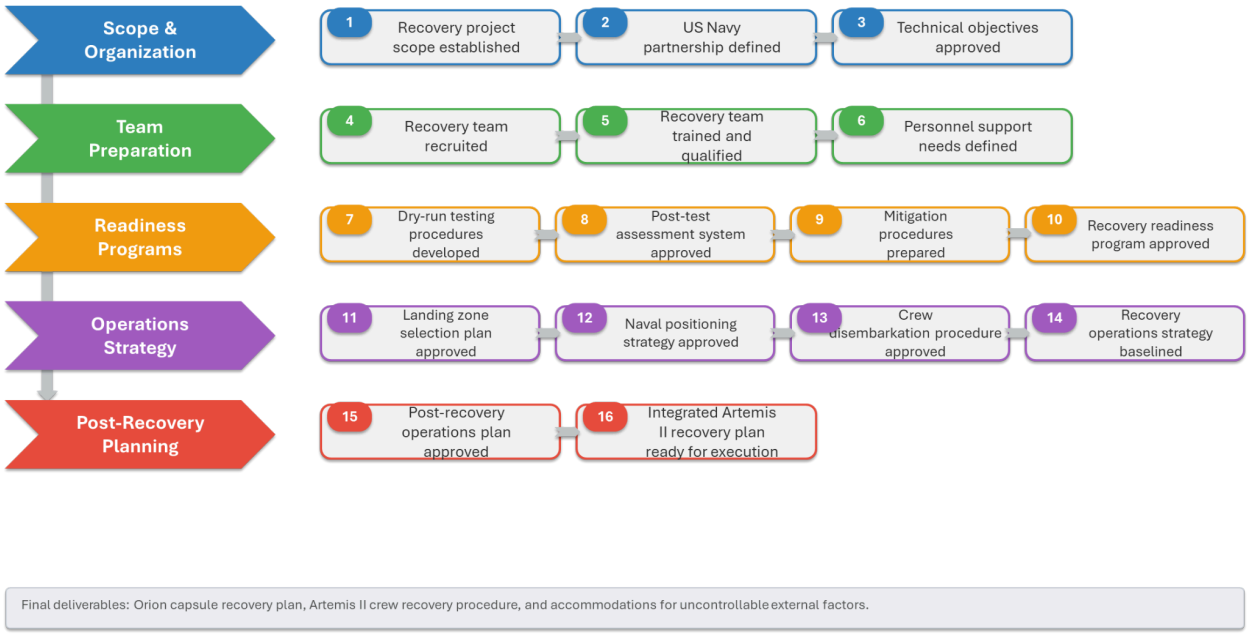
- **Recovery Engineering Team:** Responsible for the equipment to be used for recovery operations. Acts as subject matter experts for divers deploying equipment.
- **Medical Team:** Handles the medical evaluations of the Artemis crew post splash down.
- **Diving Team:** Responsible for the deployment of recovery equipment pertaining to the stabilization of the Orion capsule and egress point for the Artemis crew.
- **Mission Management Team:** Responsible for reviewing mission status and risk assessment for issues that may arise and provides support.

5.4 WORK DEFINITION

WBS	Work Package	Description	TO	IDEF0
1.0	Project Scope Definition			A1
1.1	Contract Navy for Recovery Ops	Establish NASA MOA defining roles, responsibilities, and command authority	TO1	A11
1.2	Identify Recovery Team Needs	Identify personnel, equipment, and qualification requirements for all recovery elements	TO1	A12
1.3	Define Technical Objectives	Refine charter TOs into actionable planning requirements with success criteria	TO1–TO4	A13
2.0	Team Preparation			A2

2.1	Recruit Team Members	Identify and assign qualified personnel across NASA, Navy, and contractor organizations	TO1	A21
2.2	Train Team Members	Conduct training for dive teams, helicopter crews, flight surgeons, and deck crew; validate recovery skills	TO1, TO3	A22
2.3	Define Team Members Needs	Define equipment, medical resources, communication systems, and logistical support for each team element	TO3	A23
3.0	Recovery Readiness Programs			A3
3.1	Develop Dry Run Testing Procedures	Plan the 12-URT campaign	TO1, TO4	A31
3.2	Develop Post-Test Assessment System	Develop evaluation criteria and performance metrics to assess URT results	TO2, TO4	A32
3.3	Prepare Mitigation Procedures	Develop contingency plans for off-nominal scenarios	TO4	A33
4.0	Recovery Operations Strategy			A4
4.1	Identify Landing Zone	Define splashdown zone criteria	TO2	A41
4.2	Identify Naval Positioning Strategies	Plan ship deployment timeline, helicopter staging, and approach sequencing	TO1, TO2	A42
4.3	Identify Crew Disembarkation Procedures	Define the crew extraction and transport sequence from capsule to ship medical bay	TO1, TO3	A43
5.0	Post-Recovery Operations			A5
5.1	Plan Route from Landing Zone	Plan USS Murtha transit to San Diego and capsule overland transport route to KSC	TO1	A51
5.2	Formulate Risk Mitigation Plans	Develop risk plans for post recovery phase	TO4	A52
5.3	Draft Crew Debrief Questionnaire	Develop post mission debrief covering recovery experience, crew condition etc.	TO3	A53

5.5 SCHEDULES WITH MILESTONES



Final deliverables: Orion capsule recovery plan, Artemis II crew recovery procedure, and accommodations for uncontrollable external factors.

5.6 PROJECT BUDGET

5.6.1. Budget Planning Basis

The budget for the Artemis II recovery project is organized by major project phases and aligned with the milestone-based planning and readiness approach. It separates nonrecurring planning and development costs from recurring sustainment costs and identifies training and upgrades as explicit resource elements. This structure provides the recovery management team with a clear view of the resources required to support safe crew recovery, spacecraft securement, and post-recovery transfer.

This estimate serves as the preliminary planning baseline for the recovery effort and supports internal formulation, coordination, and resource planning. It is scaled to the scope of Artemis II recovery planning, with emphasis on readiness, rehearsal, and sustainment to support time-critical crew retrieval, controlled ship and small-boat operations, and execution within operational constraints.

For planning purposes, the initial nonrecurring estimate is $14.8 million, with an annual recurring sustainment estimate of $3.3 million. The largest share of the nonrecurring budget is assigned to readiness activities, including dry runs, integrated rehearsals, post-test assessment, mitigation development, and recovery strategy validation. This allocation reflects the operational demands of coordinated NASA and Navy support, offshore recovery operations, and sustained readiness of personnel, equipment, and support systems.

5.6.2. Budget Summary by Milestone Phase

Everything mentioned in the tables are in the millions

Milestone Phase	Related Milestones	Nonrecurring Estimate	Recurring Annual Estimate	Primary Cost Drivers
Scope and Organization	1–3	2.1	0.2	project initiation, NASA–Navy coordination, scope definition, technical objective development
Team Preparation	4–6	3.0	1.1	recruitment support, training development, qualification activities, personnel support definition
Readiness Programs	7–10	4.8	0.9	dry runs, rehearsal support, assessment system development, mitigation procedure development
Operations Strategy	11–14	2.9	0.6	landing zone planning, naval positioning, crew disembarkation planning, operational baselining
Post-Recover y Planning	15–16	2.0	0.5	post-recovery operations planning, handoff procedures, crew debrief development, sustainment setup
Total		**14.8**	**3.3**	

5.6.3. Detailed Budget Breakdown by Cost Category

Cost Category	Scope and Organization	Team Preparation	Readiness Programs	Operations Strategy	Post-Recovery Planning	Total
Project management and integration	0.5	0.2	0.3	0.2	0.2	1.4
Systems engineering and planning	0.4	0.4	0.3	0.5	0.4	2.0
NASA–Navy and interagency coordination	0.4	0.2	0.1	0.1	0.1	0.9
Training development	0.1	0.5	0.1	0.1	0.1	0.9
Training execution and qualification	0.0	1.2	0.7	0.1	0.0	2.0
Dry runs, rehearsals, and test support	0.0	0.1	2.1	0.2	0.0	2.4
Operations analysis and recovery modeling	0.0	0.0	0.2	0.7	0.0	0.9
Medical, safety, and debrief planning	0.1	0.1	0.2	0.0	0.1	0.5
Communications, IT, documentation, and configuration control	0.2	0.1	0.2	0.1	0.1	0.7
Minor equipment and consumables support	0.1	0.1	0.3	0.0	0.0	0.5

Upgrade and refresh reserve	0.1	0.1	0.3	0.1	0.2	0.8
Contingency reserve	0.2	0.0	0.0	0.8	0.8	1.8
Total	**2.1**	**3.0**	**4.8**	**2.9**	**2.0**	**14.8**

5.6.4. Recurring Annual Operational Cost Estimate

Recurring Cost Element	Annual Estimate	Purpose
Refresher training and requalification	0.95	maintain team proficiency and qualification status
Annual integrated readiness exercise	0.85	preserve end-to-end recovery readiness
Weather, trajectory, and communications tool support	0.35	sustain operational planning and coordination capability
Procedure, documentation, and configuration maintenance	0.25	maintain the recovery plan and associated controlled documents
Equipment inspection and replacement	0.45	sustain readiness of support hardware and consumables
Medical and safety drill sustainment	0.20	preserve crew-handling and emergency-response capability
Upgrade and technology refresh reserve	0.25	support process improvement and capability refresh over time
Total Annual Recurring Cost	**3.30**	

5.6.5. Budget Management and Refinement

This budget shall be treated as the preliminary resource planning baseline for the draft Project Management Plan. It is expected to be refined during formal planning meetings, during development of the detailed work packages, and as responsibilities, interfaces, and readiness activities are matured. Subsequent updates should preserve the same phase-based structure so that budget growth or reallocation can be evaluated directly against milestone progress, operational need, and changes in recovery scope or risk posture.

5.7 QUALITY PLAN

5.7.1. Formation of Quality Teams

Quality Teams (QTs) will be formed to define and enforce quality standards within project teams (PTs). QTs will consist of experts in the activity that the PT is performing, as well as internal auditors and a leader of the PT.

At a minimum, the quality of every PT will be evaluated based on its efficiency, safety, and conformance to plans. The QT for each PT may define up to four additional dimensions of quality that will be monitored. Each metric of quality must have an established rubric that will be used during evaluations. Below is the rubric for the three baseline dimensions:

	10	7	3	0
Efficiency	PT shows consistent regard for allotted time and resources	Occasional observations of wasted operational resources	Numerous examples of wasted resources or time	Blatant disregard for resources, time, goals, or quality of work
Safety	No outstanding team member safety hazards	1-3 safety hazards noted during quality evaluation	4-6 safety hazards noted during quality evaluation	7+ safety hazards noted during quality evaluation
Conformance to Plans	Actions of team members result in the team's full accomplishment of planned tasks / mission	Actions taken during observation period prevent accomplishment of ideal outcome	Large gap between product of team actions and established goal for team	Team is unable to perform duties required of them to successfully aid in recovery operation

5.7.2. Quality Monitoring

QTs will conduct quality evaluations (QEs) as PTs complete trainings and joint exercises. Other opportunities for QEs will differ based on PT needs, but QEs should be conducted as frequently as possible.

Each QT member should have their own rubric and complete it independently. QT members should evaluate and score each dimension and keep notes about observations. The scores and notes from the QE team should be recorded and presented to the team during meetings.

5.7.3. Quality Improvement

The QT and the PT leadership should meet to discuss the PT's worst quality metrics, and to formulate a plan to improve. Progress should be tracked, and the aggressiveness of improvement strategy should be adjusted based on level of improvement.

Individual team members resulting in low quality scores should be made aware of their incorrect behaviors and warned the first time, and demoted or replaced at the leader's discretion on subsequent infractions of quality standards.

5.8 RISK PLAN

5.8.1. Identify Risks

Risk and Safety Expert Teams (RSETs) will be assigned to identify risks posed to personnel and other assets associated with all recovery operations. The minimum composition of the Risk and Safety Expert Teams are as follows:

- The director of the activity being evaluated
- >2 Safety Engineers (at least one PE)
- Representative of the US Navy teams involved
- OSHA compliance officer

An RSET should be assigned to each of the following:

- Staging and Preparations
- Approach to Orion Spacecraft
- Stabilization of Orion Spacecraft
- Artemis II Crew Contact and Disembarkation
- Artemis II Crew Transportation to Vessel
- Orion Spacecraft Transportation to Vessel
- Artemis II Crew Return to Houston
- Orion Spacecraft Return to Houston

5.8.2. Conduct Failure Mode and Effects Analysis

Each RSET will conduct a Failure Mode and Effects Analysis (FMEA) on the risks identified. The FMEA framework should be provided to the RSET members to ensure mutual understanding of the procedure among team members. It is recommended that individual operators, documented lessons learned from Apollo missions, and outside experts be consulted to provide comprehensive insights into the elements of the FMEA.

5.8.2.1. Failure Likelihood

Each risk should be evaluated based on its likelihood of occurrence. Training records and operator interviews are likely to provide insights into the frequency of failure.

5.8.2.2. Failure Detectability

The ability of a team member or supervisor to recognize the occurence of failure must be evaluated. In undetectable failure modes, alert systems should be implemented. Increased training may also increase failure detectability.

5.8.2.3. Failure Severity

An understanding of the magnitude of a failure's effect on the project is crucial in prioritizing it amongst others. The severity of a failure may be determined by loss of ability to continue the operation, the monetary loss associated with the failure, or the time delay in completion of the operation.

5.8.3. Generate Recommendations for Risk Mitigation

Each RSET should use the results of the FMEA to order the list of risks associated with their activity. Using the information gained during the FMEA, as well as further consultations with operators and experts, recommendations should be provided to aid in the abatement of the risk.

5.8.4. Mitigate Risks

Using the ordered risk lists, mitigation recommendations, and information gained during the FMEA process, plans should be made within the groups described in 8.1 to mitigate the risks. Likely mitigation solutions should be the introduction of safety features, increased personnel training, or implementation / updating of inspection checklists.

5.9 TESTING PLAN

5.9.1 Development of Testing Procedures

Dry runs of the recovery mission should be conducted on a monthly basis starting 3 months before splashdown. The first two should be small-team trials, and the final one should be large-scale joint training between US Navy and NASA personnel.

The first two trials should be organized by the leaders of the individual teams. They may choose the scope, complication, and activities required within the trial. The leaders will also be responsible for creating and grading systems to be used to evaluate their group's performance during the trial.

The coordination of the joint training between NASA and the US Navy will be the responsibility of the leadership of each. The trial should provide a comprehensive simulation of the actual recovery operations to be performed. The leaders of the two organizations should form an agreement on the logistics, complexity, and grading system to be used for the trials.

5.9.2 Approval of Post-Test Assessment System

The small-team trial grading systems proposed by the individual leaders should be submitted to the leadership of their respective organizations for approval. Leadership of NASA and the US Navy should only approve grading systems that are appropriately thorough. Acceptable grading schemes should use defined rubrics, provide opportunity to receive actionable feedback, set reasonable benchmarks, and measure the accomplishment of mission-relevant objectives.

The proposed grading system to evaluate the joint training should have the unanimous approval of all Navy and NASA leadership. All mission objectives should be evaluated in the grading scheme, and each activity should receive feedback from the approved grading scheme.

5.9.3 Recovery Readiness Criteria

Individual teams may be declared Recovery Ready after accomplishing the goals established by their leadership in the small-team tests, and receiving passing scores from the joint trial. In the event that a team is not found to be recovery ready, corrective actions will be taken to promote their success. Corrective actions may include mandatory increased training, meetings, coordination with other teams, or other activities that their leadership sees fit. The individual team will be tested repeatedly until recovery readiness is achieved.

5.10 CHANGE CONTROL PLAN

5.10.1. Changes Requested by NASA

When the need for a change is identified within NASA, all affected NASA teams must approve the updated plan. After passing the internal threshold, NASA must alert the US Navy leadership of planned changes to the recovery procedures and provide all supporting documentation. The request for change must be made at least 45 days prior to splashdown.

Upon receipt of the request for change, the US Navy leadership will alert all groups affected by the change of the request. The groups may use informal communication techniques to coordinate the undertaking of the new procedures. If all teams determine that the new plans are executable, then the US Navy leadership will formally communicate the adoption of the new plans to NASA. An official memorandum will be distributed to the affected personnel of both organizations

If the proposed plans are unable to be implemented, the teams may formally submit a revised version of the change request to NASA, which would be handled as a Change Requested by the US Navy.

5.10.2. Changes Requested by US Navy

When a US Navy recovery team requires a change, it should first be discussed by all affected US Navy teams. If the change is able to be implemented by all US Navy personnel, the request for change should be formally submitted to NASA for approval no later than 30 days prior to launch.

After receiving the request, NASA must gain approval of all affected NASA teams. If each NASA group is able to support the proposed plans, NASA will formally communicate this to the US Navy. An official memorandum will be released to the relevant teams in both organizations synopsizing the changes being made.

If NASA is unable to support the changes requested by the US Navy, NASA teams may draft and submit a revised version of the Navy’s change request. This revised change request will be treated as a Change Requested by NASA.

5.11 DOCUMENTATION PLAN

5.11.1 Central Repository

The Recovery Living Document is stored in a centralized, access-controlled configuration management repository accessible to all authorized Artemis II recovery stakeholders (NASA recovery office, U.S. Navy partners, medical teams, flight operations).

This includes the current approved baseline version of the recovery plan and procedures, the full revision history and prior baselines, all open risks and issues specific to splashdown, open-water extraction, and shipboard operations

5.11.2 Continuous Status Update

The document is updated on both a periodic and event-driven basis to keep recovery status aligned with the evolving Artemis II mission configuration and timeline.

Updates are driven by recurring recovery status and management reviews, major milestone reviews where recovery is baselined and polled “go/no-go,” changes to Orion, ground systems, recovery procedures, and the results of integrated recovery tests. This keeps the Recovery Living Document synchronized with readiness.

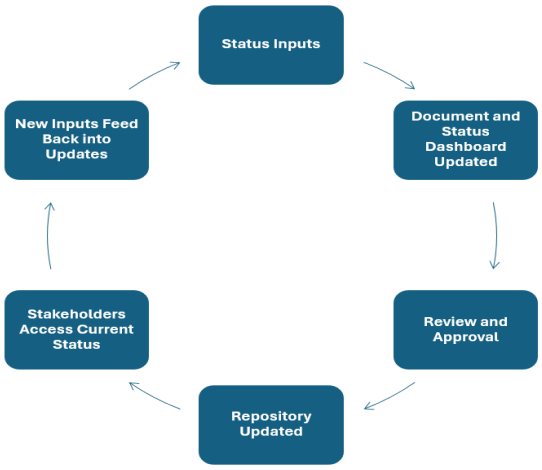
5.11.3 Version Control

All changes to the Recovery Living Document are managed under formal configuration control consistent with NASA systems engineering and human-rating standards. The control process includes (a) Unique revision identifiers and version numbering for each release.(b) A maintained change log capturing drivers, rationale, and impacted sections for each update. (c) Review and approval by the appropriate Configuration Control Board prior to baseline changes.

This ensures that the recovery teams carry out the same procedures that are documented and helps prevent anyone from using outdated instructions during splashdown and crew extraction.

5.11.4 Status Reporting Visibility

The Recovery Living Document contains embedded status reporting so stakeholders can quickly assess recovery readiness without external dashboards or deep dive in the documentation. visual indicators (such as green, yellow, and red) within the Recovery Living Document to show the current status of each area at a glance. These indicators are a defined criteria, “green” means requirements and tests are complete and no critical actions are open, while “yellow” indicates that some work or risk remains but operations can still proceed with monitoring. Each indicator is backed by underlying data in the document (e.g., completed exercises, open actions, or open risks), so stakeholders can prioritize from the high level color to the detailed status text. This approach lets us quickly understand overall readiness while still having traceability to the evidence behind each status.



Documentation Workflow

5.12 PROCUREMENT PLAN

5.12.1 External assets

Recovery Operation relies on assets from external organizations. The agreement between NASA and the US Navy provides maritime and aerial assets crucial for the recovery of the Orion capsule and crew.

- **Maritime Support:** Coordination with the US Navy to utilize San Antonio-class amphibious transport dock ships to deploy recovery assets and transportation of the Orion capsule post recovery.
- **Aerial support:** Coordinate with the US Navy to procure MH-60s Seahawk helicopters for astronaut transportation to US Navy ships and aerial video visuals.
- **Personnel Support:** Coordinate with the US Navy to supply certified recovery divers for Artemis crew extraction and Orion capsule securement.

5.12.2 Recovery Hardware

Item	Function	Procurement Source
Pneumatic Wench	Towing of the Orion capsule	US Navy
Front Porch	Deployable raft for Artemis crew exit and pickup	NASA
Capsule Stabilization Collar	Deployable raft for the securement of the Orion capsule	NASA
CMUS Bags	Keeps Orion capsule upright post splash down	NASA
Broadcasting Equipments	High quality video imagery of recovery efforts	NASA

5.12.3 Post recovery inspection/check-in

After recovery, equipment personnel will conduct inspections on recovery hardware. Equipment/assets should be checked back in and accounted for in the inventory logs.

5.13 IMPLEMENTATION PLAN

5.13.1 Implementation Plan

The Artemis II recovery project shall be implemented through a phased, milestone-driven approach aligned with the approved work packages and schedule baseline. Implementation will proceed sequentially through scope and organizational establishment, team preparation, readiness program development, recovery operations strategy development, post-recovery planning, and final plan integration.

Implementation is focused on planning, readiness development, and recovery integration rather than mission execution. Each phase will be governed by defined entry and exit criteria, supported by assigned work packages, and closed through formal milestone completion.

Project implementation will be managed through the approved schedule and milestone structure. Downstream activities will proceed only after required predecessor products have been completed, reviewed, and accepted.

5.13.2 Implementation Structure

Work Package Group	Implementation Purpose	Principal Planning Outputs
Work Package 1 – Scope and Organization	Establish the project foundation, organizational structure, interagency coordination basis, and technical objectives	defined scope, team roles and responsibilities, Navy coordination basis, technical objectives
Work Package 2 – Team Preparation	Prepare, assign, qualify, and support personnel required for recovery planning and operations readiness	recruited personnel, trained and qualified teams, documented personnel support needs
Work Package 3 – Readiness Programs	Develop the readiness framework required to verify recovery preparedness before operations	dry-run procedures, assessment system, mitigation procedures, readiness program baseline
Work Package 4 – Operations Strategy	Establish the operational basis for splashdown recovery, ship	landing zone planning basis, naval positioning strategy, crew

	positioning, and crew extraction planning	disembarkation procedure, recovery operations strategy
Work Package 5 – Post-Recovery Planning	Define the post-recovery transportation, handoff, contingency, and debrief framework	transportation route, contingency planning basis, handoff procedure, crew debrief plan
Work Package 6 – Final Integration	Consolidate all approved planning products into the integrated recovery planning baseline	integrated Orion capsule recovery plan, crew recovery procedure, accommodations for external factors

5.13.3 Implementation Sequence

Implementation Phase	Primary Activities	Exit Milestone
Phase 1 – Scope and Organization	establish project scope, define organizational responsibilities, confirm Navy support basis, approve technical objectives	Scope baseline approved
Phase 2 – Team Preparation	recruit personnel, conduct training, qualify recovery support teams, identify personnel support requirements	Recovery team trained and qualified
Phase 3 – Readiness Programs	develop dry-run procedures, establish assessment process, prepare mitigation procedures, baseline readiness program	Readiness program approved
Phase 4 – Operations Strategy	establish landing zone planning basis, define naval positioning strategy, approve crew disembarkation procedure, baseline operations strategy	Recovery operations strategy baselined
Phase 5 – Post-Recovery Planning	define post-recovery transportation, establish contingency and mitigation framework, complete crew debrief planning	Post-recovery operations plan approved
Phase 6 – Final Integration	integrate approved planning products, validate internal consistency, confirm readiness for execution support	Integrated Artemis II recovery plan ready for execution

5.13.4 Milestone Driven Execution

The principal implementation milestones are as follows:

1. Recovery project scope established
2. US Navy partnership defined
3. Technical objectives approved
4. Recovery team recruited
5. Recovery team trained and qualified
6. Personnel support needs defined
7. Dry-run testing procedures developed
8. Post-test assessment system approved
9. Mitigation procedures prepared
10. Recovery readiness program approved
11. Landing zone selection plan approved
12. Naval positioning strategy approved
13. Crew disembarkation procedure approved
14. Recovery operations strategy baselined
15. Post-recovery operations plan approved
16. Integrated Artemis II recovery plan ready for execution

5.13.5 Relationship to Schedule Baseline

The implementation plan is directly coupled to the schedule baseline. The schedule shall identify the start and finish windows for each major work package group, the review and approval points associated with milestone closure, and the dependencies that govern progression from one implementation phase to the next. Milestone dates shall be used to assess whether the project remains on track to deliver an integrated recovery planning solution in time to support readiness activities and operational planning needs.

5.13.6 Implementation Reviews and Decision Gates

- A scope and organization review following completion of initial planning products,
- A team readiness review following training and qualification activities,
- A readiness program review following completion of procedures, assessments, and mitigation planning,
- An operations strategy review following definition of landing zone, naval positioning, and crew disembarkation planning,
- A post-recovery planning review following completion of transportation, contingency, and debrief planning, and
- A final integration review prior to approval of the integrated recovery planning baseline.

5.13.7 Transition to Operational Readiness

The implementation effort concludes when approved planning products have been integrated into the operational recovery baseline that supports readiness activities. This end state establishes the framework for training, rehearsals, coordination, and final recovery preparation. Transition to operational readiness requires completion and control of the integrated recovery

plan, crew recovery procedure, contingency planning basis, and post-recovery handoff logic. At that point, implementation is considered complete.

5.13.8 Implementation Management Responsibility

Overall implementation responsibility rests with the recovery project manager, supported by recovery planning leads and participating functional organizations. Work package leads are responsible for executing assigned activities, coordinating contributors, delivering required planning products, and reporting schedule and milestone status.Implementation performance will be monitored through periodic status reviews, milestone assessments, and schedule updates to ensure continued alignment among work packages, schedule execution, and milestone completion.

5.14 HEALTH, SAFETY, ENVIRONMENT PLAN

5.14.1 Personnel Safety

Recovery personnel will conduct hazard assessments to ensure the safety of the recovery teams. The following are identified the safety protocols:

- **Hazardous Gas Check:** Navy recovery divers will use devices to assess the air and water surrounding the capsule to identify if hazardous gases are present.
- **Debris Assessment:** Aerial assets and maritime assets will monitor debris that may become hazardous during recovery operations.
- **Personal Protective Equipment:** In the event there are hazards present, all recovery personnel in the open waters must use the necessary PPE per situation.

5.14.2 Astronaut Health and Safety

This section covers the checks on ensuring the astronauts health and safety post splashdown. The checks are as follows:

- **Rapid Extraction:** The Artemis 2 crew extraction should take less than 2 hours following splashdown.
- **Medical Assessment:** Astronauts will have an initial medical assessment following hatch opening. They will then receive a more in-depth medical evaluation once inside the ship's medical bay.
- **Disorientation Following Prolonged Zero Gravity Exposure:** The astronauts are to be assisted by US Navy divers and medical personnel as they exit the Orion capsule and are airlifted to the US Navy ship.

5.14.3 Orion Spacecraft Safety

Once Orion splashes down, the capsule must remain upright and afloat to keep the Artemis crew safe and the Orion capsule from sinking. Airbags will be used to maintain the capsule in the upright position on the open water and the stabilization collar will aid in keeping the capsule afloat.

5.15 COMMUNICATION PLAN

5.15.1 Recovery Operations Communication Primary Points

Outlined are the primary points of contact per recovery activity:

Task	Primary Point of Contact
Open Waters Recovery Operations	Open Waters Lead/Master Diver
Artemis Crew Extraction	Landing and Recovery Director
Orion Capsule Securement	Landing and Recovery Director
Public Media Communication	Head of NASA Office of Communications
Maritime Operations	United States Navy Liaison
Artemis II Mission Operations	Mission Flight Director

5.15.2 Public Relations/Communications

The NASA Office of Communications will be responsible for public broadcasting and the sharing of public information. Media inquiries will be directed to the Office of Communications.

5.15.3 Emergency Communications

In the event of an emergency, special communication lines are to be established. This section outlines identified contingency situations and identifies the primary point of contact:

Contingency Situation	Primary Point of Contact
Hazardous Gas Detection	Master Diver
Medical Emergency	Lead Medical Officer
Communication Blackout	Mission Flight Director
Abnormal Reentry/Splashdown	Landing and Recovery Director

5.16 FINANCIAL PLAN

5.16.1 Funding Authorization

For planning purposes, the Artemis II recovery effort is authorized against an initial internal funding baseline of $14.8 million for nonrecurring project implementation and an annual

recurring sustainment baseline of $3.3 million to maintain recovery readiness after initial implementation is complete.

The initial funding baseline supports the phased implementation of the recovery project, including project formulation, team preparation, readiness program development, recovery operations strategy development, post-recovery planning, and final integration. The recurring sustainment baseline supports continued qualification, periodic readiness exercises, procedure maintenance, equipment support, and incremental capability refresh necessary to preserve operational readiness.

Accordingly, the funding authorization for this effort is established as follows:

- Initial implementation authorization: $14.8 million
- Annual recurring sustainment authorization: $3.3 million per year

This authorization shall be treated as the internal planning baseline for the recovery effort and shall remain subject to refinement as work packages are matured, schedules are updated, and resource allocations are confirmed through project and program planning processes.

5.16.2 Source of Funds

Funding for this effort is to be provided from Agency resources made available through congressional appropriations and distributed through NASA's Planning, Programming, Budgeting, and Execution process to the responsible programmatic organizations. Under this approach, the Artemis II recovery effort is funded as a mission-supporting activity within the broader ground and recovery capability required to prepare for and support Orion splashdown recovery. The financial basis for the effort resides in the organizational and operational resources necessary to develop, maintain, and execute the recovery planning framework, including management integration, systems engineering support, readiness development, operational coordination, and sustainment activities. Funding is assumed to be phased through established program and project channels in accordance with approved work scope, implementation priorities, and milestone requirements.

5.16.3 Funding Profile

Funding shall be phased in accordance with the major implementation groupings defined in the work package structure and milestone sequence. This approach ensures that financial authorization remains aligned with the actual progression of the project and provides management with a clear basis for monitoring financial execution against milestone completion.

Table 5-16-1. Initial Funding Authorization by Implementation Phase

All values in millions of dollars.

Implementation Phase	Funding Authorization
Scope and Organization	2.1
Team Preparation	3.0

Readiness Programs	4.8
Operations Strategy	2.9
Post-Recovery Planning and Final Integration	2.0
Total Initial Authorization	14.8

This funding profile reflects the phased nature of the recovery project and supports disciplined release of resources as the project advances from foundational planning through final plan integration. The largest share of initial funding is assigned to readiness programs because those activities drive procedure development, assessment planning, mitigation preparation, rehearsal support, and readiness validation.

5.16.4 Financial Control

Financial control of the Artemis II recovery effort shall be maintained through phased allocation, work package accountability, milestone based review, and periodic status reporting. Funds shall be controlled at the project level in a manner that preserves traceability between authorized resources and approved work products.

Financial control for the effort shall include the following:

- Allocation of funds by implementation phase and major work package,
- Tracking of commitments, obligations, and expenditures against the approved funding profile,
- Comparison of actual financial execution against schedule and milestone status,
- Management review of material variances,
- Approval authority for use of contingency and upgrade reserve,
- Documentation of funding adjustments through established project control processes.

This control structure is intended to ensure that financial performance remains directly linked to the approved implementation approach and that resources are applied in a controlled manner as planning maturity increases.

5.16.5 Release of Funds

Funds should be released in alignment with approved work initiation and milestone progression. Major downstream activities should not receive full resource commitment before predecessor planning products have been completed and accepted. This is particularly important where readiness development, operations strategy formulation, and post recovery integration depend on the satisfactory completion of earlier organizational and planning work.

The phased release of funds supports disciplined project execution and reduces the likelihood of committing significant resources before foundational planning decisions have been completed. It also provides a practical basis for management review at each major implementation transition.

5.16.6 Reserve and Funding Flexibility

The project financial baseline includes contingency and upgrade reserve as part of the overall internal funding structure. These reserves are intended to support mission relevant adjustments that may arise during implementation, including additional readiness activities, revised coordination needs, updates to procedures, support-tool refresh, and other actions necessary to preserve recovery planning effectiveness and operational supportability.

Reserve use shall not be treated as routine execution funding. Application of reserve should require project level approval and should be documented through the project change control process so that financial impacts remain visible, justified, and traceable to approved project needs.

5.16.7 Recurring Sustainment Funding

Following completion of the initial implementation effort, the project shall transition to an annual sustainment funding posture in order to preserve the operational value of the recovery planning baseline. The recurring sustainment authorization of $3.3 million per year is intended to support the continuing functions required to maintain readiness.

These recurring functions include:

- Refresher training and requalification,
- Integrated readiness exercises,
- Maintenance of weather, trajectory, and communications support capability,
- Controlled updates to procedures and planning documentation,
- Equipment inspection and replacement,
- Medical and safety drill sustainment,
- Technology refresh and incremental upgrades.

The recurring sustainment posture recognizes that the Artemis II recovery capability is not preserved solely through document completion. Continued readiness depends on trained personnel, maintained tools and procedures, periodic validation activities, and ongoing support to operational integration.

5.16.8 Financial Reporting

Financial status shall be reviewed as part of routine project management activities. At a minimum, financial reporting should identify:

- Authorized funding to date,
- Obligations and expenditures to date,
- Remaining available funding,
- Forecasted funding needs by remaining implementation phase,
- Reserve status,
- Significant variances or anticipated reallocations.

This reporting approach is intended to provide management with timely visibility into whether the recovery effort remains financially aligned with the approved project baseline and whether corrective action is required to preserve scope, schedule, or readiness objectives.

5.16.9 Financial Plan Statement

The Artemis II recovery effort is planned against an initial internal funding baseline of $14.8 million, followed by an annual recurring sustainment baseline of $3.3 million. Funding is phased by the implementation group, controlled through work package and milestone logic, and managed to support the full recovery planning sequence from project formulation through integrated readiness support. This financial plan establishes the internal funding basis for the effort.

5.17 REFERENCES

https://www.jonessite.net/upload/LRD/Recovery/Apollo%20Recovery%20Ops%20Manual.pdf

https://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7120_005F_&page_name=AppendixH

https://ntrs.nasa.gov/citations/20220009501

6. SYSTEMS ENGINEERING MANAGEMENT PLAN

6.1 PURPOSE AND SCOPE

6.1.1 Purpose of the SEMP

The Systems Engineering Management Plan (SEMP) serves as a living document that identifies and specifies how the technical efforts involved in the recovery of the Artemis II Orion spacecraft will be communicated and implemented.

6.1.2 Scope of the SEMP

The scope of the recovery spans from the training of personnel before splashdown to the return of the Artemis II crew to land.

The scope of the SEMP will be the content of the engineering work required to successfully execute the recovery. The SEMP is to be used by the Engineering Managers (EMs) to provide direction and information to the engineers working on the project.

6.1.3 Content Within SEMP

The SEMP is organized as follows:

1. PURPOSE AND SCOPE
    - An Identification of the purpose, scope, and content of the SEMP
2. APPLICABLE DOCUMENTS
    - A list of the documents applicable to the project and implementation of the SEMP
3. TECHNICAL SUMMARY
    - An executive summary describing the problem to be solved and products to be developed and integrated with other systems
4. RESPONSIBILITY AND AUTHORITY
    - A summary of the organizing structure for the technical teams assigned to the effort
5. COMMON TECHNICAL PROCESSES
    - A plan for performing each of the 17 common technical processes
6. TECHNOLOGY INSERTION
    - A description of the approach and methods for identifying the risks and use cases for technology
7. ADDITIONAL SE FUNCTIONS AND ACTIVITIES
    - A description of items essential to the technical effort that haven’t been detailed in previous sections of the SEMP
8. INTEGRATION WITH PROJECT PLAN AND RESOURCE ALLOCATION
    - A description of how the technical effort will integrate with project management
9. COMPLIANCE MATRICES
    - A confirmation that the project is in compliance with standards

6.2 APPLICABLE DOCUMENTS

1. Artemis II Orion Spacecraft Recovery Project Charter
2. Artemis II Orion Spacecraft Recovery IDEF0 Model
3. Artemis II Orion Spacecraft Recovery Project Management Plan
4. NASA SEMP Outline
5. NASA Organization Charts
6. Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards

6.3 TECHNICAL SUMMARY

6.3.1 System Description

This SEMP is establishing the framework of an engineering effort to safely recover the Artemis II crew and Orion spacecraft from their splashdown location and transport the assets back to land.

6.3.1.1 Product Layers

The product layers are defined as follows:

1. Scope and Organization
    - Purpose: Identify the specific tasks included within project, identify the nature of NASA - US Navy Relationship, and to define the technical objectives to be achieved
2. Team Preparation
    - Purpose: To prepare all personnel involved in the recovery operation for the execution of the plan and fulfillment of the technical objectives.
3. Readiness Programs
    - Purpose: To verify the readiness of the teams, and identify areas/teams needing improvement. Team preparation measures should prepare personnel for achieving readiness benchmarks.
4. Operations Strategy
    - Purpose: To strategize and plan out the achievement of the recovery operation, assuming all personnel have been certified as ready.
5. Post-Recovery Planning
    - Purpose: To identify the procedures for returning the astronauts and spacecraft to shore, based on the level of success in executing the Operations Strategy.

6.3.1.2 SEMP Customers

The customers of the SEMP are those who are served through the execution of the plans created within it. These include:

- The Artemis II crew and all who depend on their safety
- The American taxpayers
- Future Artemis and other Manned Space Mission Recovery teams.

6.3.1.3 SEMP Users

The expected users of this Systems Engineering Management Plan include

- NASA Systems Engineers
- NASA Leadership
- US Navy Leadership (Master Diver and Open Water Lead)
- Small Team Leaders

6.3.1.4 SEMP Priorities

The priorities of the SEMP are the same as the Technical Objectives established in the Project Management Plan:

1. Develop a technical background review of Artemis II recovery, including splash down behavior, seakeeping, and uprighting
2. Identify and explain the major engineering factors affecting recovery performance, such as parachute-supported touchdown conditions, water impact loads, and flotation stability
3. Develop a crew safety considerations framework for post-splashdown recovery operations

6.3.1.5 SEMP Critical Questions

Questions that ought to be answered through the SEMP include:

- Where does the responsibility lie for each portion of the effort?
- How will the plans resulting from the SEMP be Validated and Verified?
- How will technology be effectively leveraged to accomplish the project?
- How will the safety of the system be ensured?
- How will lessons and tools gained from previous recoveries be used in the present mission?
- What are the expectations regarding bookkeeping and creating paper trails?

6.3.2 System Structure

Project Layers	Technical Portion	Plans for Development
Scope and Organization	Definition of Project Scope	The project scope established in the project charter will be used throughout the completion of the program, and may be amended if necessary. Individual aspects pertaining to the project's scope may be determined by NASA System Engineers.
	Establishment of US Navy Partnership	Leaders of the Department of Defense and NASA will meet to discuss terms of partnership and expectations of both parties
	Definition of Technical Objectives	Technical Objectives laid out in Project Charter will be iterated upon so that the full needs of the project are met.
Team Preparation	Recovery Team Recruitment	Leadership of NASA and the US Navy will define the personnel needed to carry out the mission. NASA and Navy recruiters will use typical operating procedures to fill the needed positions.

	Recovery Team Training	The specification of training will fall to the flight director for NASA personnel and Master Diver for the US Navy. These leaders will coordinate training activities that directly prepare personnel for the achievement of the Technical Objectives
	Identification of Personnel Needs	All personnel within head roles will identify the supply needs of their personnel. Supplies will be purchased by NASA and US Navy's procurement teams.
Readiness Programs	Dry Run Testing	Will be conducted under the direction and supervision of the Landing and Recovery Director, Flight Director, Master Diver, and Open Water Lead, each for their respective teams.
	Development of Assessment System	The assessment system for each team will be set forth by NASA and DoD in order to ensure that the teams can fulfill the technical objectives
	Development of Risk Mitigation Procedures	To be done by individual team leaders, based on team performance during testing
Operations Strategy	Selection of Landing Zone Criteria	To be determined by Flight Director based on planned re-entry location, and approved by Master Diver on the basis of recovery feasibility at location
	Establishment of Naval Positioning Strategy	To be developed by Master Diver and Open Water lead based on landing zone location
	Creation of Crew Disembarkation Procedures	To be created by NASA Flight Director's team in order to ensure safety and no compromise of mission-relevant information.
Post-Recovery Planning	Post-Recovery operations plan approved	To be organized by Flight Director based on testing and data-collection needs of NASA
	Certification of Recovery Plan	Recovery Plan to be agreed upon and signed-off by all leadership personnel of US Navy and NASA

6.3.3 Product Integration

6.3.3.1 Definition of Integration Procedures

The recovery mission requires the cooperation of NASA, with primary directors being Flight Director and Landing and Recovery Director, and the Department of Defense (DoD), led by the Master Diver and Open Water Lead. Correspondence between the two entities should be

conducted using the guidelines established by NPR 1450.10C. Any requests to change the plans should follow the rules set forth in the Project Management Plan (PMP).

Responsibilities of the DoD and NASA (and the subteams within) should be established and recorded during the Scope and Organization stage of work.

The development of plans within NASA will occur in the Kennedy Space Center in the office of the Landing and Recovery Director. Communications will be made between the Kennedy Space Center and the Pentagon, which serves as the DoD headquarters.

6.3.3.2 Integration of Products

The products created by independent NASA teams will be integrated and tested during in-house NASA training as described in PMP-9.1. NASA and Navy products will be integrated and tested during the Joint Trainings, also described in PMP-9.1. Frequent and substantial correspondence between the agencies prior to the joint training is expected, in order to ensure well-founded expectations are formed of each other's capabilities. The frequency, style, and content of this communication will be decided upon during the initiation of the partnership between the two agencies.

Correspondence should be held regardless of the current status of a product. All products being developed by one of the agencies should be disclosed, in an effort to uphold transparency. A product will be deemed "Ready to Integrate" when the team working on it finalizes it, and tests it in the small team tests.

In the context of the Artemis II Recovery operation, "products" may include plans, strategies, personnel choices, equipment selections, or other decisions made by an agency that has an effect on the operation.

6.3.4 Planning Context

In order to ensure safety and viability, the adherence to the following regulations is mandatory:

- All parts of the project should adhere to the guidelines established in NPR 7120.148.
- All gear and personnel must be in compliance with regulations found in OSHA Regulations (Standards - 29 CFR)
- All correspondence pertaining to the operation should be done in accordance with NPR 1450.10C

6.3.5 Boundary of Technical Effort

6.3.5.1 Boundary Definition

The recovery project is responsible for the successful extraction of the astronauts from the capsule, and their following safe return to shore.

6.3.5.2 Internal Controls

- Capsule Approach
- Stabilization and Opening of Orion Capsule
- Disembarkation of Artemis II Crew

- Transportation of Artemis II Crew to ship
- Transportation of Orion Capsule to ship
- Transportation of Artemis II Crew and Orion Capsule back to US mainland

6.3.5.3 External Influences

- Orion Capsule's successful re-entry into Earth's Atmosphere
- Orion Capsule's successful navigation to landing zone
- Weather around landing zone at time of recovery
- Artemis II Crew adherence to recovery team instructions
- NASA Artemis II data-collection needs
- NASA Artemis II crew health/safety requirements
- US Navy Asset demands

6.3.6 Cross References

6.3.6.1 Project Management Plan

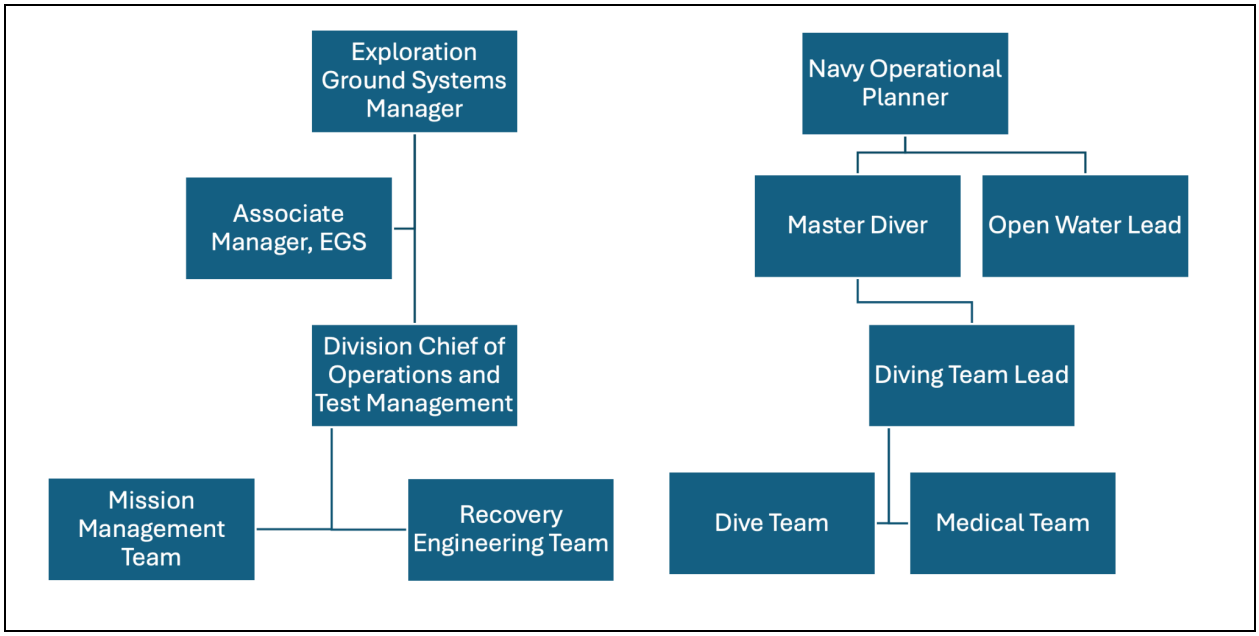
The PMP and its subplans will be fulfilled throughout the Artemis II planning process. Each of the plans will be drafted, finalized, approved, and then carried out by the appropriate leadership. The instructions laid out in the subplans will be followed in order to ensure adherence to both their letter and intent.

6.3.6.2 NASA Correspondence Management (NPR 1450.10C)

The guidelines provided by NASA in NPR 1450.10C ought to be followed in all communications within NASA and from NASA to the DoD. This is to ensure a uniform standard and provide consistent paper trails regarding communications.

6.4 RESPONSIBILITY AND AUTHORITY

The organization chart for the recovery operation is as follows:



6.4.1 NASA

6.4.1.1 Explorations Ground Systems Manager

Responsibilities: Develop Systems and Infrastructure to be used for all ground operations (including recovery operations)

6.4.1.2 Explorations Ground Systems Associate Manager

Responsibilities: Assist program manager to lead government teams in preparing systems, facilities, processes, and infrastructure in preparing the ground systems for use

6.4.1.3 Division Chief of Operations and Test Management

Responsibilities: Staffing, resourcing, facilitating teams involved in flight hardware processing and Artemis mission launch and recovery operations.

6.4.1.4 Mission Management Team

Responsibilities: Reviewing and supporting mission status and risk assessment for issues that arise

6.4.1.5 Recovery Engineering Team

Responsibilities: Design, implementation, and maintenance of equipment used during the recovery process. May need to act as subject matter experts for the Navy Dive team as the recovery equipment is used.

6.4.2 US Navy

6.4.2.1 Navy Operational Planner

Responsibilities: Advise how to allocate multiple ships to multiple missions in order to accomplish those missions to a prescribed level of completion. link

6.4.2.2 Master Diver

Responsibilities: Master Divers are experts in all operational and emergency procedures involving diving and salvage. They will coordinate the movement of recovery equipment and divers. link

6.4.2.3 Open Water Lead

Responsibilities: Advise Master Diver and Diving Team Lead about complications specific to Splashdown zone, weather conditions, or other external circumstances.

6.4.2.4 Diving Team Lead

Responsibilities: Act as a liaison between Master Diver and Dive Team. Provide direction and leadership with the team in the water.

6.4.2.5 Dive Team

Responsibilities: The deployment of recovery equipment pertaining to the stabilization of the Orion Capsule and egress point for the Artemis II crew.

6.4.2.6 Medical Team

Oversee the medical medical evaluation of the Artemis II crew post-splashdown.

6.5 COMMON TECHNICAL PROCESSES

6.5.1 Stakeholder Expectations Definition

6.5.1.1 Purpose

This process establishes the stakeholder expectations that drive recovery planning, readiness development, and operational support. The primary stakeholder groups are NASA, the U.S. Department of Defense, the Canadian Space Agency, and Lockheed Martin Space.

6.5.1.2 Approach and Methods

Stakeholder expectations will be identified through charter review, requirement capture, coordination meetings, and lessons learned review. Expectations will be organized around crew safety, spacecraft securement, open water recovery, post flight engineering needs, and post recovery transfer.

6.5.1.3 Responsibility and Resources

The recovery project manager and systems engineering lead are responsible for this process, with support from the Landing and Recovery Director, Navy representatives, medical representatives, and other affected organizations. Supporting resources include coordination meetings, existing recovery documentation, and lessons learned from prior recovery missions.

6.5.1.4 Controls, Reviews, and Outputs

Stakeholder expectations will be reviewed for completeness and traceability to TO1 through TO4 and then placed under configuration control. The primary outputs are the stakeholder expectations set and the initial traceability basis for downstream requirements development.

6.5.2 Technical Requirements Definition

6.5.2.1 Purpose

This process converts stakeholder expectations into measurable and traceable recovery planning requirements. The resulting requirements define what the recovery products and supporting activities must achieve.

6.5.2.2 Approach and Methods

Requirements will be derived through requirement analysis, decomposition, and traceability mapping. Particular emphasis will be placed on crew extraction timing, capsule recovery condition, open water data collection, validation through recovery testing, and documentation of lessons learned.

6.5.2.3 Responsibility and Resources

Systems engineering leads this process with review support from recovery leadership and affected working groups. Resources include stakeholder expectations, technical objectives, prior mission data, and approved planning guidance.

6.5.2.4 Controls, Reviews, and Outputs

Requirements will be reviewed for completeness, clarity, verifiability, and traceability before baseline release. Outputs include the technical requirements baseline, traceability records, and requirement based acceptance criteria for planning products.

6.5.3 Logical Decomposition

6.5.3.1 Purpose

This process decomposes the recovery effort into manageable functional elements that can be assigned, planned, and integrated. It provides the functional basis for the work structure and technical effort.

6.5.3.2 Approach and Methods

Logical decomposition will follow the A1 through A5 recovery planning structure and the approved work definition. Functional elements will be mapped to scope and organization, team preparation, readiness programs, operations strategy, and post recovery planning.

6.5.3.3 Responsibility and Resources

Systems engineering and project planning leads are responsible for this process, with support from recovery subject matter experts and work package leads. Resources include the IDEF0 model, work package structure, and technical objectives.

6.5.3.4 Controls, Reviews, and Outputs

The decomposition will be reviewed for complete coverage of recovery functions and alignment to the work structure. Outputs include the functional architecture, process decomposition, and mapping of functions to work packages and milestone products.

6.5.4 Design Solution Definition

6.5.4.1 Purpose

This process defines the technical planning solution that satisfies the approved recovery requirements. The solution consists of procedures, planning products, decision logic, and readiness artifacts rather than flight hardware design.

6.5.4.2 Approach and Methods

The design solution will be developed through procedure definition, recovery concept refinement, interface planning, and integration of medical, safety, logistics, and post recovery needs. This process will define the structure and content of the integrated recovery plan and associated supporting products.

6.5.4.3 Responsibility and Resources

Recovery planning leads are responsible for this process, supported by the Recovery Engineering Team, Medical Team, Diving Team, and Mission Management Team. Resources include technical requirements, work package outputs, and prior recovery knowledge.

6.5.4.4 Controls, Reviews, and Outputs

Design solution products will be reviewed for internal consistency, requirement satisfaction, and interface compatibility before release. Outputs include the integrated recovery plan, crew recovery procedure, mitigation procedures, and post recovery planning products.

6.5.5 Product Implementation

6.5.5.1 Purpose

This process develops the approved recovery planning products in controlled form. It translates defined solutions into usable technical work products.

6.5.5.2 Approach and Methods

Implementation will be carried out through controlled document development, procedure drafting, readiness product generation, and release through the approved repository and baseline process. Work will proceed in the same phased sequence used by the implementation plan.

6.5.5.3 Responsibility and Resources

Assigned work package leads are responsible for implementation, supported by recovery planners, operations specialists, documentation personnel, and functional contributors. Resources include repository tools, templates, and controlled document workflows.

6.5.5.4 Controls, Reviews, and Outputs

Implemented products will be reviewed for completeness and conformance to approved baselines before release. Outputs include completed draft and baseline planning products for each work package.

6.5.6 Product Integration

6.5.6.1 Purpose

This process combines the individual recovery planning products into a single operationally consistent baseline. It ensures that independently developed products function together as one recovery system.

6.5.6.2 Approach and Methods

Integration will be performed through cross document checks, interface review, schedule alignment, and formal integration review. Integration will focus on consistency among readiness procedures, operations strategy, contingency planning, and post recovery actions.

6.5.6.3 Responsibility and Resources

The recovery project manager and systems engineering lead are responsible for product integration, supported by work package leads and interface owners. Resources include approved baseline products, schedule logic, and interface records.

6.5.6.4 Controls, Reviews, and Outputs

The integrated baseline will be reviewed at formal integration and decision gate reviews before approval. Outputs include the integrated Artemis II recovery plan and aligned subordinate procedures.

6.5.7 Product Verification

6.5.7.1 Purpose

This process confirms that each recovery planning product has been developed correctly and meets its defined requirements. Verification addresses technical correctness rather than operational suitability.

6.5.7.2 Approach and Methods

Verification will use document reviews, requirement trace checks, interface checks, and completeness reviews. Verification criteria will be established from the technical requirements baseline and work product expectations.

6.5.7.3 Responsibility and Resources

Systems engineering leads verification with participation from designated reviewers in affected organizations. Resources include requirement baselines, traceability products, and review records.

6.5.7.4 Controls, Reviews, and Outputs

Verification results will be documented, noncompliances will be corrected, and only acceptable products will proceed forward. Outputs include verification records, review comments, and corrected baseline products.

6.5.8 Product Validation

6.5.8.1 Purpose

This process confirms that the integrated recovery baseline is suitable for operational use. Validation demonstrates that the planning solution supports the intended recovery mission needs.

6.5.8.2 Approach and Methods

Validation will be conducted through small team trials, joint NASA–Navy exercises, dry runs, post test assessment, and readiness review. Validation methods will use defined rubrics, mission relevant objectives, and approved grading systems.

6.5.8.3 Responsibility and Resources

Recovery leadership and team leads are responsible for validation, with participation from evaluation personnel and operational teams. Resources include training events, exercise plans, grading systems, and readiness criteria.

6.5.8.4 Controls, Reviews, and Outputs

Validation results will be reviewed at readiness and management reviews, and corrective actions will be tracked until closure. Outputs include validation results, readiness findings, and recovery ready determinations.

6.5.9 Product Transition

6.5.9.1 Purpose

This process places approved recovery planning products into operational use. Transition ensures that current, controlled products are available to the organizations that must use them.

6.5.9.2 Approach and Methods

Transition will be performed through controlled release, repository update, stakeholder notification, and turnover to readiness and operations personnel. Transition also includes confirmation that only the current baseline is in use.

6.5.9.3 Responsibility and Resources

Project leadership and designated document custodians are responsible for transition, supported by work package leads and configuration personnel. Resources include the central repository, release records, and communication channels.

6.5.9.4 Controls, Reviews, and Outputs

Transition will be reviewed through baseline release checks and stakeholder access confirmation. Outputs include released planning products, current baseline records, and confirmed user access to approved procedures.

6.5.10 Technical Planning

6.5.10.1 Purpose

This process defines the technical work, resources, sequence, and success criteria required to complete the recovery effort. It provides the planning basis for execution and control.

6.5.10.2 Approach and Methods

Technical planning will use work package planning, milestone logic, implementation phasing, schedule development, and budget phasing. Planning will remain aligned with the approved implementation sequence and milestone roadmap.

6.5.10.3 Responsibility and Resources

The recovery project manager and planning leads are responsible for technical planning, supported by work package owners and systems engineering. Resources include the work definition, schedule baseline, budget basis, and milestone structure.

6.5.10.4 Controls, Reviews, and Outputs

Technical planning products will be reviewed at status reviews, decision gates, and milestone assessments. Outputs include tasking logic, schedule inputs, milestone relationships, and resource planning products.

6.5.11 Requirements Management

6.5.11.1 Purpose

This process maintains the integrity, traceability, and controlled evolution of the recovery requirements baseline. It ensures that approved changes are evaluated and incorporated in a disciplined manner.

6.5.11.2 Approach and Methods

Requirements will be managed through traceability maintenance, change impact assessment, coordinated review, and controlled update of affected products. Requirement changes will be evaluated for impacts to readiness, procedures, interfaces, and downstream work.

6.5.11.3 Responsibility and Resources

Systems engineering is responsible for requirements management, with review by the appropriate project and organizational authorities. Resources include requirement records, traceability products, and change control records.

6.5.11.4 Controls, Reviews, and Outputs

Approved requirement updates will be configuration controlled and traceability will be maintained to technical objectives and downstream products. Outputs include current requirement records, change evaluations, and updated traceability matrices.

6.5.12 Interface Management

6.5.12.1 Purpose

This process defines and controls the technical and operational interfaces among the participating organizations and recovery activities. It is essential to coordinate multi agency execution.

6.5.12.2 Approach and Methods

Interface management will be carried out through interface definition, role clarification, coordination meetings, agreement tracking, and interface change review. Key interfaces include NASA and Navy coordination, medical support, communications support, maritime operations, and post recovery handoff.

6.5.12.3 Responsibility and Resources

Project leadership and designated interface owners are responsible for this process, with support from participating organizations and working groups. Resources include interface records, communication plans, and formal coordination products.

6.5.12.4 Controls, Reviews, and Outputs

Project leadership and designated interface owners are responsible for this process, with support from participating organizations and working groups. Resources include interface records, communication plans, and formal coordination products.

6.5.13 Technical Risk Management

6.5.13.1 Purpose

Technical risk management will use Risk and Safety Expert Teams, Failure Mode and Effects Analysis, operator input, lessons learned, and mitigation planning. Risks will be evaluated for likelihood, detectability, and severity and then dispositioned through mitigation or contingency action.

6.5.13.2 Approach and Methods

Technical risk management will use Risk and Safety Expert Teams, Failure Mode and Effects Analysis, operator input, lessons learned, and mitigation planning. Risks will be evaluated for likelihood, detectability, and severity and then dispositioned through mitigation or contingency action.

6.5.13.3 Responsibility and Resources

Responsible activity directors, safety engineers, Navy representatives, and project leadership support this process. Resources include FMEA frameworks, risk tracking products, safety expertise, and assessment results

6.5.13.4 Controls, Reviews, and Outputs

Risk status will be reviewed during periodic status meetings, milestone assessments, and readiness reviews. Outputs include risk lists, FMEA results, mitigation recommendations, contingency actions, and maintained risk records.

6.5.14 Configuration Management

6.5.14.1 Purpose

This process maintains control of the approved recovery planning baseline and its associated work products. It ensures that all users operate from the same current configuration.

6.5.14.2 Approach and Methods

Configuration management will use revision identifiers, version numbering, maintained change logs, controlled repository release, and formal approval prior to baseline change. The process will be applied to designated recovery planning products and supporting technical records.

6.5.14.3 Responsibility and Resources

The designated configuration authority and document owners are responsible for configuration control, with support from work package leads. Resources include the central repository, version records, and formal approval paths.

6.5.14.4 Controls, Reviews, and Outputs

Baseline status and changes will be reviewed through the approved change and release process. Outputs include controlled baselines, revision history, approved change records, and prevention of outdated procedure use.

6.5.15 Technical Data Management

6.5.15.1 Purpose

This process controls the creation, storage, update, access, and retention of technical information produced by the recovery effort. It ensures that technical data remain current, accessible, and traceable.

6.5.15.2 Approach and Methods

Technical data management will be performed through use of the central repository, access control, periodic and event driven updates, and embedded status reporting. Data products include planning documents, risk data, readiness data, review records, and technical support records.

6.5.15.3 Responsibility and Resources

Document custodians, configuration personnel, and work package leads are responsible for this process. Resources include the access controlled repository, status inputs, and update workflows.

6.5.15.4 Controls, Reviews, and Outputs

Technical data will be reviewed for currency, completeness, and availability during project reviews and document updates. Outputs include controlled technical records, updated status information, and retained review evidence.

6.5.16 Technical Assessment

6.5.16.1 Purpose

This process provides visibility into product maturity, technical progress, readiness status, and issue resolution. It supports corrective action and management awareness across the recovery effort.

6.5.16.2 Approach and Methods

Technical assessment will use quality evaluations, milestone assessments, readiness reviews, status reviews, and action tracking. Assessment will consider efficiency, safety, conformance to plans, and other quality dimensions defined by the responsible teams.

6.5.16.3 Responsibility and Resources

Project leadership, Quality Teams, and technical review participants are responsible for assessment activities. Resources include evaluation rubrics, review records, team observations, and status metrics.

6.5.16.4 Controls, Reviews, and Outputs

Assessment results will be reviewed with team leadership and project management, and corrective actions will be tracked. Outputs include review findings, quality scores, improvement plans, and management assessment records.

6.5.17 Decision Analysis

6.5.17.1 Purpose

This process supports structured comparison and selection of alternatives affecting recovery planning and readiness. It is used when recovery decisions must be supported by defined criteria and documented rationale.

6.5.17.2 Approach and Methods

Decision analysis will use trade studies, mission driven evaluation criteria, assessment results, and risk informed comparison of alternatives. It will be applied to landing zone planning, naval positioning, crew disembarkation, contingency actions, and post recovery routing.

6.5.17.3 Responsibility and Resources

Project leadership and the relevant technical and operational subject matter experts are responsible for this process. Resources include test results, risk information, interface data, and decision documentation formats.

6.5.17.4 Controls, Reviews, and Outputs

Major decisions will be reviewed through the established management and technical review structure before baseline incorporation. Outputs include documented decisions, evaluation rationale, and approved decision products that support the recovery baseline.

6.6 TECHNOLOGY INSERTION

6.6.1 Technology Identification and Insertion

The identified technologies used in the Artemis II recovery operations plan are to meet the criteria that satisfy requirements and the challenges associated. All critical recovery hardware, such as the inflatable front porch and stabilization collar, will be assessed against identified risk. The special technologies will be implemented during the system validation phase if they meet criteria. If an identified technology fails to meet criteria, alternative methods will be used to ensure the safety of the crew and preservation of the Orion capsule.

6.6.2 Relationship to Research and Development

The operation will use technologies developed from research and development of various organizations partnered with NASA. These R&D efforts were focused on capsule stability, communication methods, and crew safety. The recovery hardware to be used during the operation are the result of the research and development efforts. The results of these efforts will support various stages of the recovery operation. The data from the Artemis I mission will also be implemented during the development of the recovery procedure.

6.6.3 Insertion and Certification of External Elements

Formal agreements between NASA and external organizations define responsibilities and primary authority pertaining to the use of external elements. External assets are certified for adequacy through NASA’s Underway Recovery Tests (URT).

6.6.4 Required Facilities

The insertion of technology depends on the use of special facilities. The Neutral Buoyancy Lab at NASA Johnson Space Center will be the primary facility for crew extraction training. The USS John P. Murtha will serve as the primary maritime facility for Orion capsule securement and

transportation. The US Navy ship will also function as the primary medical facility for the Artemis II crew postsplashdown medical evaluation.

6.6.5 Configuration Transition

Technologies are transitioned to be part of the mission configuration after verification through training and technical verification. Validated elements/hardware are integrated through documents related to recovery operations and are then considered a part of the configuration. The documentation will ensure recovery operations teams use the most recently validated procedures in compliance with the configuration documents.

6.7 ADDITIONAL SE FUNCTIONS AND ACTIVITIES

6.7.1 System Safety

System safety for the Artemis II recovery effort addresses risk to recovery personnel, flight crew, the Orion spacecraft, the maritime environment, and the public during splashdown recovery and post recovery transfer. Safety analysis will be performed throughout planning, readiness development, testing, and final integration, with emphasis on open water operations, hazardous conditions around the capsule, crew extraction, shipboard handling, and transportation interfaces. The system safety approach is aligned with the existing project risk structure, which assigns Risk and Safety Expert Teams to major recovery activities and uses Failure Mode and Effects Analysis to evaluate risk likelihood, detectability, and severity.

Safety methods will include hazard assessments, Failure Mode and Effects Analysis, lessons learned review, operator input, readiness reviews, and mitigation planning. Safety controls will include hazardous gas checks, debris assessment, personal protective equipment requirements, rapid extraction targets, medical evaluation protocols, and spacecraft flotation and stabilization provisions. Safety findings will be documented, tracked, and reviewed during readiness assessments and milestone reviews. The primary safety outputs are hazard controls, risk mitigation actions, safety constraints for recovery procedures, and go/no go inputs for readiness decisions.

System safety responsibility rests with recovery leadership, safety representatives, and the responsible activity directors, with support from Navy representatives, medical personnel, and operations planners. Safety related work products and approved mitigations will be maintained under configuration control through the same controlled document and change processes used for the recovery baseline. Success will be measured by closure of identified safety actions, acceptable residual risk posture, successful readiness evaluations, and the ability to execute recovery procedures without unresolved critical safety noncompliances.

6.7.2 Engineering Methods and Tools

The engineering methods and tools for the Artemis II recovery effort support planning, coordination, assessment, risk analysis, schedule management, documentation control, and readiness evaluation across the full recovery planning baseline. The development environment for this effort is centered on controlled planning documents, schedule products, risk and readiness records, interface agreements, and configuration controlled technical data rather than on software or flight hardware development. The project will use standard document templates,

planning workflows, trade study formats, risk evaluation tools, schedule products, and repository controls to maintain consistency across the multi agency effort.

Key tools and methods include the IDEF0 planning structure, work package and milestone tracking, document based traceability, Failure Mode and Effects Analysis, readiness grading rubrics, status indicators embedded in the Recovery Living Document, and simulation and rehearsal environments used during dry runs and joint exercises. Supporting technical tools also include weather forecasting tools, trajectory prediction resources, communication systems, navigation planning resources, and the centralized access controlled repository used to store and manage current baselines, revision history, open risks, and readiness status.

Tool standardization will be achieved through common document formats, common status reporting conventions, common evaluation rubrics, and shared repository access for authorized stakeholders. Training will be provided for repository use, document control, grading systems, risk evaluation methods, and any specialized planning tools required for weather, trajectory, or operational coordination support. Tool ownership rests with the responsible work package leads and document custodians, while technical method oversight rests with systems engineering and recovery planning leadership. Success will be measured by consistent use of approved methods, current and accessible baseline data, and effective support to readiness, decision making, and configuration control.

6.7.3 Specialty Engineering

Specialty engineering for the Artemis II recovery effort includes safety, human factors, medical support, logistics, quality, maintainability of the recovery baseline, operability, and supportability. These functions apply across the work package structure and are treated as enabling disciplines that support the technical success of the recovery effort rather than as stand alone products. The specialty areas most critical to this project are system safety, human performance and crew handling, recovery logistics, quality monitoring, communications support, and operational supportability.

Safety planning is supported through the project’s hazard assessments, Risk and Safety Expert Teams, mitigation planning, and emergency communications structure. Human factors and medical support are addressed through crew disembarkation planning, medical assessment procedures, rapid extraction requirements, and post recovery debrief planning. Logistics and supportability are addressed through ship positioning, helicopter staging, route planning, hardware check in and inspection, and coordination for maritime, aerial, and diver support assets. Quality is addressed through Quality Teams, independent rubrics, and improvement actions following training and joint exercises. Operability is addressed through integrated rehearsals, readiness criteria, and periodic status visibility within the Recovery Living Document.

Staffing for specialty engineering is drawn from the existing matrix organization and working groups. The Recovery Engineering Team, Medical Team, Diving Team, Mission Management Team, Quality Teams, and Risk and Safety Expert Teams provide the core specialty discipline support for the project. Additional subject matter expertise is drawn from Navy representatives, safety engineers, operations planners, and document custodians as needed. Specialty engineering outputs include safety controls, medical and crew handling procedures, logistics

support definitions, quality metrics, supportability requirements, and readiness constraints incorporated into the recovery baseline.

6.7.4 Technical Performance Measures

Technical performance measures for the Artemis II recovery effort are tailored to the fact that this project is a recovery planning and readiness effort rather than a new spacecraft design effort. Hardware specific TPMs such as mass margin and power margin are not primary measures for this project because the principal products are planning baselines, readiness products, procedures, and coordination frameworks. Where support hardware condition or capability affects readiness, those items will be tracked through equipment inspection, qualification status, and supportability reviews rather than through new design margin tracking. Review action closure, readiness trends, requirement stability, interface closure, verification and validation completion, schedule performance, and staffing support are the primary measures used to assess technical progress on this effort.

The following TPMs will be used to measure technical progress:

- Milestone completion against the approved recovery roadmap;
- Closure rate of review actions, deficiencies, and corrective actions from dry runs, joint exercises, and readiness reviews;
- Requirement maturity, including reduction of unresolved requirements and closure of TBD/TBR items where applicable;
- Interface maturity, including approval status of NASA–Navy coordination products and closure of open interface issues;
- Validation progress, including completion of small team trials, joint exercises, readiness assessments, and recovery ready determinations;
- Risk trend status, including number of high priority risks open, mitigated, or accepted;
- Document baseline maturity, including controlled release of required procedures and planning products;
- Schedule trend status, including performance against critical milestone dates and readiness review dates;
- Staffing and qualification status, including trained and qualified team members versus plan.

The following metrics will be used to identify process improvement opportunities:

- Quality Team scores for efficiency, safety, and conformance to plans;
- Trend in recurring findings from exercises, reviews, and risk assessments;
- Repeated corrective actions against the same team or function;
- Delays in document update, review, or approval cycles;
- Repeated interface coordination issues;
- Recurring schedule slips within the same work package or milestone group;
- Training rework or repeated failure to achieve recovery ready status.

Progress against plans and schedules will be measured through milestone completion, implementation phase exit criteria, schedule status against start and finish windows, closure of predecessor products, and readiness review outcomes. Progress reporting will be supported by the schedule baseline, milestone assessments, technical review outputs, quality evaluations,

readiness status indicators in the Recovery Living Document, and financial/status review products.

Progress will be reported at recurring project status reviews and major milestone or readiness reviews. Work package leads will report status to the recovery project manager and recovery planning leads. Quality Teams, Risk and Safety Expert Teams, and other designated review participants will report process findings and technical issues to the responsible team leadership and project leadership. Readiness status, document status, and critical open actions will be visible to authorized stakeholders through the controlled Recovery Living Document and associated review meetings.

6.7.5 Heritage

The Artemis II recovery effort will make deliberate use of heritage products, legacy operational knowledge, and proven recovery methods from prior human spaceflight and Orion recovery activities. The primary heritage sources for this effort are Artemis I lessons learned, the Underway Recovery Test campaign, prior NASA recovery procedures, and established Navy support concepts for maritime recovery operations. These heritage inputs are already embedded in the project IDEF0 structure as major inputs and controls to scope definition, team preparation, readiness program development, operations strategy development, and mitigation planning.

Heritage will be used in four main ways. First, prior recovery lessons will inform stakeholder expectations, technical requirements, and risk identification. Second, validated recovery practices and hardware handling methods will inform procedure development and training. Third, the URT campaign and associated assessment results will support validation of readiness methods and criteria. Fourth, prior post flight handling expectations for Orion will support planning for capsule transportation, inspection, and handoff.

Heritage use will not be accepted without evaluation. Legacy procedures, assumptions, and methods will be reviewed for applicability to Artemis II crewed recovery conditions, mission timeline, crew medical needs, environmental constraints, and current organizational interfaces. Where differences from prior missions are identified, heritage products will be adapted, supplemented by new analysis or testing, or rejected. The primary outputs of this section are the set of approved heritage inputs, rationale for use, and identified validation or adaptation actions needed before incorporation into the controlled recovery baseline.

6.7.6 Other

The Artemis II recovery effort includes several project specific systems engineering activities that cut across the standard process structure. These include integrated readiness orchestration across NASA and Navy organizations, use of the Recovery Living Document as both a controlled baseline and a status visibility tool, embedding of readiness status indicators directly within controlled technical data, and the use of milestone driven implementation logic tied to the A1 through A5 recovery planning framework. These activities are central to this project because the principal system of interest is an operational recovery capability composed of people, procedures, interfaces, assets, and decision logic rather than a new hardware design.

This section also includes the project's emphasis on transition from planning products to an operational recovery baseline that supports training, rehearsals, coordination, and final recovery preparation. That transition is governed by phased implementation, formal decision gates, controlled document release, and readiness validation. The principal outputs are an integrated recovery baseline, visible readiness status, and an operationally supportable planning framework that remains current through configuration control, continuous update, and milestone based review.

6.8 INTEGRATION WITH PROJECT PLAN AND RESOURCE ALLOCATION

6.8.1 Risk Assessment and Mitigation Integration

Risk identification begins during scoping (IDEF0 A1) and continues through readiness testing (A3), operational strategizing (A4), and post-recovery (A5). The risk register will be maintained by the Recovery Director as a living document, subject to periodic recalibration, just as a measurement instrument must be calibrated against a known standard before each use, the risk register must be re-scored against current conditions at defined checkpoints (post-URT, quarterly planning review, pre-splashdown readiness review at L–3 days) rather than left static.

Risks are evaluated on a 5×5 likelihood by consequence matrix with the following escalation thresholds:

Level	Score	Trigger	Decision Authority
Low	1–4	Monitor; log in register	Technical Lead (work-package level)
Medium	5–12	Develop mitigation plan; brief Recovery Director	Recovery Director with SE team concurrence
High	15–20	Activate contingency; halt related activities	Recovery Director + NASA EGS Program Manager
Critical	25	Invoke abort / safe-haven protocol	Mission Management Team (NASA HQ authority)

Front-line empowerment is built into this framework to prevent delays in time-critical safety decisions. The dive team lead and the embarked flight surgeon each hold delegated authority to halt or modify operations in real time when crew safety is at immediate risk, without requiring upward escalation. This is not a general waiver of the chain of command, it is a narrowly scoped, pre-authorized decision right that applies only where delay would create unacceptable risk to the crew. All such decisions are logged and reconciled in the post-operation review. Key technical risks identified during the planning phase include residual hypergolic propellant exposure, heat shield uncertainty from Artemis I findings, adverse sea-state conditions, and communication-relay failures.

Risk Assessment Checklist (applied at each calibration checkpoint):

☐	Risk statement is specific, testable, and not compound
☐	Likelihood and consequence scores updated against current data (not just initial estimates)
☐	Named owner assigned with defined mitigation trigger and timeline
☐	URT results reflected where applicable
☐	Traceable to WBS work package and IDEF0 sub-activity
☐	Residual risk (post-mitigation) scored and documented

6.8.2 Communication Plan

Systems are weakest at their points of interface, and every organizational boundary in this multi-agency operation is a communication interface. The communication architecture provides both low-frequency corrective loops e.g. planning phase reviews and high-frequency loops e.g. real-time ops net.

Type	Frequency	Participants	Medium
Technical Status Review	Bi-weekly (planning)	TO leads, Recovery Director, Navy liaison	Virtual; minutes within 24 hrs
URT After-Action Briefing	After each URT	EODESU-1, HSC-23, NASA EGS, ship CO	In-person aboard vessel; report within 5 days
Pre-Splashdown Readiness	L–3 days	Full multi-agency team	Aboard USS Murtha; Go/No-Go format
Real-Time Ops Loop	Continuous (recovery)	Recovery Dir., dive lead, flight surgeon, bridge	UHF/VHF radio; Mission Control relay
External Stakeholder Update	Monthly; daily (final wk)	CSA, Lockheed Martin, NASA HQ	Encrypted email; video conf (final week)
Post-Recovery Debrief	R+7 and R+30	All agencies; crew medical	In-person KSC / JSC; formal report

External media communication is managed exclusively through NASA Public Affairs. CSA data-sharing follows the bilateral Artemis Accords protocol, ensuring equal access to Canadian crew member recovery telemetry.

6.8.3 Decision Recording

All significant technical decisions and those affecting crew safety timelines, modifying URT-validated procedures, reallocating resources, or deviating from the baseline Recovery Operations Plan will be recorded in a formal Decision Log within NASA's document management system.

Each entry captures the decision statement, alternatives considered, rationale, authorizing official, affected IDEF0/WBS references, and follow on actions with owners. During real time operations, a designated person will use a voice log to text protocol; entries are reconciled into formal records within 48 hours. The Decision Log is cross-referenced with the risk register so that any decision triggered by a risk escalation is traceable to the originating risk item. This log serves as corporate memory so without it, the reasoning behind decisions is lost when personnel rotate, forcing future Artemis teams to rediscover the same logic.

6.8.4 Incorporation of Lessons Learned

The Artemis II recovery project will incorporate lessons learned from three primary sources prior to mission execution. The most significant input comes from the Artemis I uncrewed recovery in December 2022, where unexpected heat shield erosion was observed during reentry. This finding drove the programmatic decision to switch from a skip entry trajectory to a direct entry profile for Artemis II, which directly affects the splashdown footprint precision, the duration of capsule exposure to sea-state conditions, and the thermal condition of the capsule exterior at the time of first contact by EODESU-1 divers. Updated thermal models and post-splashdown surface temperature profiles have been incorporated into the diver approach procedures accordingly.

The second source is the 12-URT campaign conducted between 2023 and March 2025, culminating in the URT-12 certification exercise aboard USS Somerset. Key findings that resulted in procedure changes include the need for redundant communication paths between the dive team and the recovery ship, the requirement to pre-stage hypergolic vapor detection equipment before hatch opening, and the confirmation that crew extraction can meet the 2-hour target under nominal conditions. Each URT finding that triggered a procedure change has been logged in the URT Lessons Learned Database and traced to the specific Recovery Operations Plan section it modified.

The third source is historical NASA crew recovery operations, particularly the Apollo program. Best practices for open ocean retrieval which include swimmer deployment sequencing, capsule uprighting procedures, and flight surgeon proximity.

During the planning phase, each TO lead will review the Lessons Learned Database for items relevant to their technical area and document how those items are addressed in current procedures. Any item that is only partially addressed will be entered into the risk register. After the Artemis II recovery is complete, a formal lessons-learned capture session will be conducted at R+30 days, and findings will be archived in the NASA Lessons Learned Information System (LLIS) for use by Artemis III and subsequent recovery planning teams

Budget tracking follows Earned Value Management (EVM) as specified in the PMP, with technical performance metrics from SEMP Section 7.0 feeding directly into cost/schedule

variance reporting to ensure technical and programmatic assessments remain aligned. When a technical finding drives the need for resource reallocation then such as an additional URT or a procedure redesign.The request is raised at the bi-weekly Technical Status Review, evaluated against cost and schedule impact, and approved or escalated by the Recovery Director before any change to the project baseline is executed.

6.9 COMPLIANCE MATRICES

Req ID	Requirement Statement	Center Implementation Intent	
		Existing Center Document(s)/Section	Compliance
1	Develop a technical background review of Artemis II recovery, including splashdown behavior, seakeeping, and uprighting	SEMP Section 6.3	Full
2	Identify and explain the major engineering factors affecting recovery performance, such as parachute supported touchdown conditions, water impact loads, and flotation stability	SEMP Section 6.5 SEMP Section 6.7.4	Full
3	Develop a crew safety considerations framework for post splashdown recovery operations	SEMP Section 6.7.1	Full
4	Develop a recovery decision-support and contingency framework for nominal and off-nominal recovery conditions	SEMP Section 6.8.1 SEMP Section 6.8.3	Full

7. NEXT STEPS AND RECOMMENDATIONS

7.1 OBTAIN FINAL STAKEHOLDER VALIDATION

The final version of this document should be presented to stakeholders in order to confirm that this project is achievable, and that achieving it will actually produce the desired outcome.

7.1.1 Validate Scope and Requirement Definitions

Verify that the scope and requirements fulfilled within the project are congruent with the larger Artemis II mission. This should be done through coordination between the leader of the Artemis II recovery mission and the Artemis II program director and Artemis II Re-entry mission leader. The scope and requirements established in the document should be verified by leaders within the recovery mission chain of command to be achievable and reasonable.

7.1.2 Validate Communications Systems

Verify the communication systems included in the plans contained in this document are functional and able to be used to the extent specified in the document. If lines of communication specified in the document do not exist, they should be established.

Communications Systems include meeting schedules, chains of command, record keeping practices, and all other ways that communications will be conducted and logged during the completion of the project as planned.

7.2 INITIATE MISSION EXECUTION

With all contained processes having been verified, the execution of the project may commence.

7.2.1 Distribute Plans

Every individual in the recovery team should receive any documentation pertinent to them. This should include all members of the chain of command who will be responsible for decision making.

Documentation should be provided to a level such that the decision makers have sufficient information about the context in which their decision is being made. They should be cognizant of the upstream and downstream effects of the decisions they are assigned to make according to the document. The IDEF0 model should be made widely available, as it effectively captures this relationship.

7.2.2 Prioritize Conformance to Plans

All team members should be made aware of the importance of their conformance to the plans. Decision makers should be held accountable for the fulfillment of their duties as established in the document. Deviation from the plans is allowable, only after official change requests are made. Otherwise, plans should be followed in word and spirit in order to maximize operational uniformity.

7.3 SUSTAIN AND MONITOR MISSION PROGRESS

7.3.1 Upkeep Living Documents

The components compiled in this document- the Project Management Plan and Systems Engineering Management Plan- are designed to be continuously updated to reflect changing needs, resources, or product scope. As changes occur, the Director of the Recovery Mission should update the document.

The team should be alerted to major changes in the document, and the most recent version of the document should be kept available for all permitted personnel.

7.3.2 Collect Necessary Data

As the plans established in the document are carried out, relevant Perfomance Indicators should be identified and monitored. Examples of useful performance indicators are Operational Cost, Average Testing Results, and Resource Utilization percentage.