

Northeast Florida Regional Council
Military Installation Readiness Review



Evaluating Potential Adaptation Solutions: **Quantitative and Qualitative** **Comparison of Alternative**

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1 Introduction

Northeast Florida's military installations, ports, transportation corridors, utilities, and surrounding communities are often exposed to chronic flooding, coastal storms, sea level rise, groundwater emergence, heat, infrastructure aging, and other compounding stressors that may affect long-term operational continuity and economic stability (National Academy of Engineering, 2019; Wilbanks et al., 2013). Military missions across the region depend heavily on civilian infrastructure systems located outside installation boundaries, including regional transportation networks, electrical substations, fuel distribution systems, communications networks, stormwater infrastructure, housing, and workforce access routes. As a result, disruptions occurring outside installation boundaries may affect mission continuity even when on-base assets remain protected. Research following major hurricanes has shown that infrastructure failures across transportation, power, communications, housing, and supply chain systems can significantly delay recovery and continuity of operations across entire regions (National Academies of Sciences, Engineering, and Medicine, 2020).

Recent adaptation planning efforts across Northeast Florida, including the Northeast Military Installation Resilience Review (MIRR), have successfully identified vulnerabilities and prioritized infrastructure projects using established technical, environmental, and feasibility criteria. However, many adaptation evaluations remain centered on individual assets or isolated hazards rather than broader system performance. For example, roadway elevation projects may maintain physical access during flood events while nearby substations, stormwater pump systems, or fuel distribution infrastructure remain vulnerable, limiting the operational value of the transportation investment itself. Similarly, hardened facilities with backup power systems may still experience operational disruptions if personnel cannot safely access installations or if regional communications and supply chain systems fail during extended events. These examples illustrate the growing importance of evaluating how infrastructure systems function together under changing environmental and operational conditions rather than evaluating adaptation measures independently.

This white paper presents a framework for evaluating adaptation solutions through both quantitative and qualitative lenses, with a focus on infrastructure systems supporting military resilience and regional continuity in Northeast Florida. Rather than duplicating previous project-level adaptation analyses, this effort examines broader approaches for assessing the effectiveness, flexibility, durability, and regional value of adaptation investments. The paper explores methods for comparing adaptation strategies such as protection, accommodation, avoidance, managed relocation, and collaborative regional resilience initiatives while considering mission continuity, infrastructure interdependencies, governance complexity, lifecycle performance, and community co-benefits. Lessons from military resilience programs, mission-critical infrastructure sectors, and international adaptation practices are also considered to help inform future resilience planning and investment strategies throughout the region.



1.1 Balancing Installation Resilience and Regional Dependencies

Historically, military resilience planning has emphasized protection of assets and operations within installation boundaries through measures such as hardened facilities, backup power systems, flood barriers, and redundant communications. At the same time, mission assurance assessments have increasingly highlighted the importance of transportation, utilities, housing, communications, wastewater systems, and other infrastructure operated outside installation boundaries. During Hurricane Michael in 2018, extensive damage to surrounding transportation, housing, utilities, and commercial infrastructure significantly affected recovery operations at Tyndall Air Force Base despite substantial federal investment in rebuilding and hardening installation facilities (Government Accountability Office, 2021). Similar challenges have been observed at coastal installations where recurrent flooding of surrounding roadways, utility corridors, or civilian support systems may disrupt installation access and operations even when primary facilities remain functional.

Rather than replacing installation-focused resilience investments, recent planning efforts have increasingly evaluated how military missions depend on transportation access, fuel distribution, electrical reliability, communications systems, ports, rail corridors, water and wastewater infrastructure, and workforce stability beyond installation boundaries. This perspective remains reflected in current Department of Defense programs that support both installation-focused investments and community infrastructure improvements where they contribute to mission assurance, readiness, and military value. The Office of Local Defense Community Cooperation (OLDCC) Installation Readiness Program continues to support studies and implementation efforts addressing transportation, utility services, housing, stormwater management, sewer, and communications systems that affect installation mission capability, while the Defense Community Infrastructure Program (DCIP) funds off-installation transportation, water, wastewater, utility, telecommunications, and emergency response infrastructure that supports military readiness and lethality (Office of Local Defense Community Cooperation [OLDCC], 2025a, 2025b). Recent OLDCC program guidance specifically identifies infrastructure dependencies and external threats to installation readiness as continuing areas of investment and coordination between installations and surrounding communities (OLDCC, 2025a).

The balance between installation-controlled infrastructure and regional partnerships depends on mission needs, asset type, and operational requirements. Some critical functions may shift under direct military control to improve reliability and flexibility, while others may be better addressed through regional coordination and shared infrastructure investments. Regardless of ownership, military missions still rely on interconnected transportation, utility, logistics, workforce, and emergency management systems beyond installation boundaries. OLDCC mission statements continue to emphasize cooperation between military installations and surrounding communities to support readiness and national defense, underscoring the need to evaluate both installation resilience and regional infrastructure dependencies in long-term mission assurance planning (OLDCC, 2025c; National Academy of Engineering, 2002).



1.2 Emerging Federal and DoD Resilience Priorities

Recent federal and Department of Defense resilience initiatives have emphasized mission assurance, infrastructure interdependencies, energy resilience, and long-term operational adaptability under changing environmental conditions. Rather than focusing solely on static flood protection measures, current resilience programs prioritize redundancy, distributed systems, adaptive infrastructure, and continuity of operations during extended disruptions. The United States Department of Defense Climate Adaptation Plan identifies installation resilience, infrastructure dependencies, supply chain vulnerabilities, and climate-informed decision-making as key components of maintaining operational readiness (DoD, 2021). The Department of Defense has also identified recurrent flooding, storm damage, and infrastructure exposure at numerous military installations nationwide as growing operational risks requiring long-term resilience planning and adaptation investment (Department of Defense, 2019). Similar priorities are reflected in ongoing investments in microgrids, distributed energy systems, transportation resilience, and mission assurance planning across military installations nationwide.

Several recent projects illustrate this shift in approach. At Marine Corps Air Station Miramar (California), installation resilience initiatives have included microgrid and energy resilience investments intended to maintain critical operations during regional grid disruptions through partnerships with regional utilities and energy providers (U.S. Department of Energy, 2022). Along the Gulf Coast, resilience planning efforts associated with rebuilding Tyndall Air Force Base following Hurricane Michael incorporated elevated infrastructure, decentralized utility systems, and flexible facility planning intended to support long-term operational continuity under future hazard conditions (GAO, 2021).

Federal resilience initiatives have also incorporated nature-based solutions, regional watershed approaches, and partnerships with surrounding communities to reduce flood risk and improve infrastructure reliability beyond installation boundaries. Examples include the Norfolk Coastal Storm Risk Management Project (Virginia), which combines floodwalls, surge barriers, pump stations, and natural and nature-based features to reduce regional flood risk affecting military and civilian infrastructure alike (U.S. Army Corps of Engineers, 2024). In parallel, the United States Army Corps of Engineers Engineering With Nature initiative has expanded collaboration with Department of Defense installations to integrate natural and nature-based features such as wetlands, dunes, and living shorelines into resilience planning to provide flood risk reduction, ecosystem restoration, and infrastructure protection benefits simultaneously (Bridges et al., 2021). Collectively, these efforts demonstrate a broader transition from isolated asset protection toward integrated resilience strategies focused on sustaining operational capability across interconnected regional systems.



2 Considerations for Evaluating Adaptation Solutions

The following considerations are not intended to establish a prescriptive scoring methodology or replace existing adaptation planning processes. Rather, they are provided as example questions and evaluation factors that may help military planners, local governments, utilities, and infrastructure owners assess the long-term operational value, feasibility, and durability of future adaptation investments. Depending on project type, scale, available data, and planning objectives, some considerations may be more relevant than others. In many cases, professional judgment, stakeholder coordination, and understanding of local infrastructure dependencies may be equally important to quantitative analysis.

Traditional adaptation evaluations often focus on the direct performance of individual projects, such as estimated flood reduction, construction feasibility, or benefit-cost relationships. However, infrastructure systems supporting military operations and regional continuity are highly interconnected, and project performance may depend heavily on surrounding systems remaining operational. For example, an elevated roadway may reduce localized flood exposure while nearby electrical substations, pump stations, communications infrastructure, or fuel distribution systems remain vulnerable, limiting the operational benefit of the transportation investment itself. Similarly, backup generators may support critical facilities during outages but remain dependent on fuel delivery routes that are vulnerable to flooding or storm damage.

As a result, adaptation evaluations may benefit from broader consideration of operational continuity, infrastructure interdependencies, implementation complexity, and long-term adaptability under changing conditions. Particular attention should be given to whether projects remain functional as surrounding environmental, regulatory, economic, and infrastructure conditions evolve. Some adaptation measures may perform well initially but gradually lose effectiveness due to increased maintenance demands, changing flood conditions, groundwater emergence, adjacent infrastructure failures, or accelerated sea level rise. Other strategies may provide lower initial protection levels while offering greater flexibility, scalability, regional co-benefits, or long-term operational value.

The considerations presented in Figure 1 are intended to support future discussions regarding adaptation prioritization, regional coordination opportunities, phased implementation approaches, and long-term planning for mission-critical infrastructure systems throughout Northeast Florida.



3 Comparing Adaptation Strategy Types in Northeast Florida

Adaptation planning efforts commonly group resilience measures into four broad strategy types: protect, accommodate, avoidance and relocation, as well as local policy changes and regional collaboration.

- Protective strategies reduce direct exposure to flooding, erosion, or shoreline change through measures such as shoreline stabilization, roadway elevation, utility hardening, or floodproofing.
- Accommodation strategies allow flooding or changing conditions to occur while modifying infrastructure, operations, or land use to reduce disruption.
- Avoidance and relocation strategies reduce long-term dependence on vulnerable areas by redirecting future development, relocating critical systems, or creating alternative infrastructure networks.
- Local policy changes modernize municipal laws to consider future conditions.
- Regional collaboration strategies focus on coordinated investments across jurisdictions and infrastructure sectors to improve broader system performance and continuity.

The following sections compare adaptation strategy types in the context of interconnected regional resilience issues affecting military installations and surrounding communities in Northeast Florida. Quantitative screening values are assigned on a relative scale from one to five for operational value, implementation feasibility, and long-term durability. Scores were developed based on APTIM's experience supporting military resilience, infrastructure planning, and regional adaptation efforts, informed by findings from the Northeast Florida MIRR process, related regional resilience planning efforts, published literature, infrastructure dependency considerations, and the anticipated ability of each strategy to support long-term mission continuity under changing environmental and operational conditions. Operational value reflects the potential to reduce mission disruption and improve continuity of critical regional systems; implementation feasibility considers relative complexity, cost, governance, and implementation barriers; and long-term durability reflects the expected ability of a strategy to remain effective as conditions evolve over time. Scores represent relative performance within each topic area and are intended as screening-level indicators to facilitate comparison of adaptation approaches rather than establish formal project rankings, funding priorities, or benefit-cost results. No weighting was applied among evaluation criteria because operational value, implementation feasibility, and long-term durability may be prioritized differently by installations, infrastructure owners, and implementation partners. As a result, scores may vary between subsections as strategy effectiveness changes based on the specific regional resilience issue being evaluated. The analysis reflects recurring issues identified through the Northeast Florida MIRR process and related resilience planning efforts, including transportation dependency, utility vulnerabilities, compound flooding, shoreline change, port and logistics continuity, housing pressures, and increasing infrastructure interdependencies (Northeast Florida Regional Council, 2025).



Figure 3-1. Considerations for Evaluating Adaptation Solutions in Broader Context

1 OPERATIONAL CONSIDERATIONS		EXAMPLE QUESTIONS TO CONSIDER
	Operational Continuity	- Does the project maintain installation access, emergency response, or mission-critical functions during disruptive events? - How does the project affect the ability to evacuate or move supplies and personnel?
	Dependency Reduction	- Does the project reduce reliance on vulnerable external infrastructure (power, fuel, communications, transportation)? - Does it diversify or decentralize critical system dependencies?
	Recovery Improvement	- Could the project reduce downtime or speed restoration of services after storms or other disruptions? - Does it support faster return to baseline operations?
	Redundancy	- Are alternative routes, systems, or backup capabilities available if primary assets fail? - Does the project create or strengthen redundancy in the network?
	Cascading Failure Reduction	- Could the project reduce the likelihood or severity of secondary failures across interconnected systems? - Does it protect key enablers that support other critical infrastructure?
2 IMPLEMENTATION CONSIDERATIONS		EXAMPLE QUESTIONS TO CONSIDER
	Governance Complexity	- How many agencies, jurisdictions, or stakeholders are involved? - What level of coordination and agreement will be required?
	Permitting Feasibility	- Are regulatory, environmental, or cultural resource constraints likely to be significant? - What is the anticipated permitting timeline?
	Maintenance Burden	- What are the long-term operations and maintenance requirements? - Does the project require specialized equipment, skills, or frequent inspection?
	Scalability & Phasing	- Can the project be implemented in phases or expanded in the future? - Can the design adapt to changing conditions or new information?
	Regional Co-benefits	- Does the project provide benefits to surrounding communities, infrastructure, or ecosystems? - Does it support broader regional resilience or economic objectives?
3 LONG-TERM DURABILITY CONSIDERATIONS		EXAMPLE QUESTIONS TO CONSIDER
	Future Condition Sensitivity	- How might the project perform under higher sea level rise, storm intensity, or rainfall conditions? - What is the expected range of future conditions over the project life?
	Adaptation Performance Decay	- Could the project become less effective over time as surrounding conditions or systems change? - What maintenance or upgrades would be needed to sustain performance?
	Flexibility	- Can the solution be modified, expanded, or repurposed over time? - Does it allow for learning and adjustment as conditions evolve?
	Dependency Vulnerability	- Does the project rely on other infrastructure or services remaining operational? - How vulnerable are those dependencies?
	Lifecycle Cost and Sustainment	- What are the anticipated long-term operations, maintenance, and replacement costs? - Could maintenance demands increase significantly under future conditions? - How does long-term sustainment compare to alternative approaches?
	Stranded Investment Risk	- Could the project become economically or operationally unsustainable? - Is there a risk the project will need early replacement or abandonment?

Source: Developed for NE MIRR by Aptim

3.1 Single-Point Access and Transportation Dependency

Low-lying transportation corridors, limited redundancy, tidal flooding, shoreline erosion, and increasing congestion create operational risks for military installations across Northeast Florida, particularly near Naval Station Mayport and Marine Corps Support Facility Blount Island where regional access routes support military logistics, workforce movement, fuel delivery, and emergency response. Northeast Florida MIRR materials and regional transportation discussions have repeatedly identified portions of A1A, bridge approaches, evacuation corridors, and port access routes as vulnerable to flooding and disruption during coastal storms and compound rainfall events (NEFRC, 2025).

For Naval Station Mayport, protective and regional collaborative strategies appear to provide the greatest operational value because installation access depends heavily on vulnerable coastal transportation corridors with limited redundancy (Figure 2). Elevating critical roadway segments and stabilizing vulnerable shoreline areas may reduce near-term access disruptions; however, continuity likely depends on broader regional transportation redundancy, utility continuity, and coordinated evacuation planning beyond installation boundaries. Alternative higher-elevation access corridors score strongly for durability but face major implementation barriers due to cost, right-of-way constraints, and regional development patterns.

For Marine Corps Support Facility Blount Island, transportation resilience is closely tied to freight movement, port operations, and industrial logistics systems rather than shoreline access. As a result, regional collaboration strategies involving transportation agencies, utilities, port operators, and emergency management organizations appear likely to provide greater benefits than isolated roadway protection projects. Several resilience discussions across Northeast Florida continue to focus heavily on shoreline stabilization while transportation redundancy and evacuation reliability remain comparatively underdeveloped despite their importance to both civilian and military continuity. Across Duval County overall, transportation adaptation strategies that improve both civilian evacuation and military access provide the greatest regional value because they reduce dependence on single transportation corridors while supporting emergency response, workforce continuity, and freight movement simultaneously.



Figure 3-2. Transportation Strategy Evaluation

3.1 TRANSPORTATION ACCESS AND REGIONAL DEPENDENCY			
STRATEGY COMPARISON (1–5 SCALE)			
STRATEGY	OPERATIONAL VALUE	IMPLEMENTATION FEASIBILITY	LONG-TERM DURABILITY
 PROTECT	5	2	4
 ACCOMMODATE	3	5	2
 AVOIDANCE / RELOCATION	5	1	5
 REGIONAL COLLABORATION	5	3	4
 STRONGEST NEAR-TERM STRATEGY Protect + Regional Collaboration  HIGHEST LONG-TERM DURABILITY Avoidance / Relocation  PRIMARY BENEFICIARY Mayport, Blount Island, Duval County			

3.2 Utility, Fuel, and Infrastructure Interdependency

Military installations throughout Northeast Florida depend heavily on external electric supply systems, substations, fuel distribution systems, communications infrastructure, wastewater systems, and transportation networks. Regional utility hardening discussions and Florida Public Service Commission storm protection planning efforts have focused on grid resilience, undergrounding, substation protection, outage reduction, and restoration time improvement throughout Northeast Florida (Florida Public Service Commission, 2024). The Northeast Florida MIRR process has similarly identified electric supply systems, wastewater infrastructure, fuel access, and utility interdependencies as significant mission-supporting vulnerabilities (NEFRC, 2025).

Utility and fuel resilience strategies consistently provide some of the highest operational value across all Northeast Florida installations because failures in these systems often create cascading disruptions affecting transportation, communications, wastewater, emergency response, and installation operations simultaneously. Floodproofing substations, pump stations, communications systems, and fuel infrastructure may provide greater mission continuity benefits than some large-scale shoreline protection projects because these systems support many dependent functions. Port and logistics resilience strategies may similarly provide high operational value where military continuity depends on freight movement, fuel delivery, utility restoration, and transportation access across interconnected civilian infrastructure systems. For Marine Corps Support Facility Blount Island in particular, regional logistics continuity, freight mobility, and fuel redundancy may provide greater near- to mid-term operational value than standalone facility protection measures because military operations depend heavily on externally owned transportation, utility, and supply chain networks extending beyond installation



boundaries. Protective strategies therefore score particularly high for all installations where utility and fuel systems represent operational enabling infrastructure (Figure 3). These findings are consistent with recent defense planning that emphasizes supply chain resilience, logistics continuity, and industrial base capacity as important components of military readiness (Department of Defense, 2024).

Figure 3-3. Infrastructure Adaptation Strategy Evaluation

3.2 UTILITY, FUEL, AND INFRASTRUCTURE INTERDEPENDENCY			
STRATEGY COMPARISON (1–5 SCALE)			
STRATEGY	OPERATIONAL VALUE	IMPLEMENTATION FEASIBILITY	LONG-TERM DURABILITY
 PROTECT	5	4	4
 ACCOMMODATE	4	5	3
 AVOIDANCE / RELOCATION	5	2	5
 REGIONAL COLLABORATION	5	4	5
 STRONGEST NEAR-TERM STRATEGY Protect + Regional Collaboration  HIGHEST LONG-TERM DURABILITY Regional Collaboration  PRIMARY BENEFICIARY All Installations / Duval County			

Resilience depends on potable water reliability and groundwater conditions as sea level rise, increasing regional demand, saltwater intrusion, and changing groundwater elevations place additional pressure on water supply systems, underground infrastructure, and drainage performance throughout coastal Northeast Florida. In low-lying industrial and military-supporting areas, groundwater emergence affects underground utilities, contaminated soils and groundwater, stormwater systems, and long-term infrastructure durability (Befus et al., 2020; U.S. Geological Survey [USGS], 2023).

For Marine Corps Support Facility Blount Island and Naval Station Mayport, regional utility coordination and fuel redundancy strategies appear especially important because military logistics and operations depend heavily on externally owned infrastructure systems. Relocation of selected utility nodes or critical fuel systems may provide the strongest long-term durability where repetitive flooding, shoreline exposure, and utility vulnerabilities are expected to increase. Increasing electrical demand associated with regional growth, electrification, industrial expansion, port activity, and emerging data center development places additional pressure on utility infrastructure throughout Northeast Florida. Across Duval County overall, regional collaboration strategies score highest because utility restoration capability, redundancy, and mutual aid systems function regionally rather than at the installation scale. As such, long-term mission continuity will likely depend more on coordinated regional infrastructure performance than protection of isolated facilities. In practice, utility restoration timelines and



fuel delivery continuity may ultimately affect operational recovery more than flood depth at individual facilities.

3.3 Compound Flooding, Drainage Limitations, and Shoreline Change

Northeast Florida's flat topography, tidal influence, aging drainage systems, groundwater emergence, and continued coastal development create conditions where rainfall flooding, tidal flooding, storm surge, and shoreline change interact. Similar compound flooding interactions involving rainfall and coastal water levels have been identified as increasing risks for many U.S. coastal regions, particularly where drainage systems are tidally constrained (Wahl et al., 2015). Regional adaptation planning efforts and Resilient Florida projects have repeatedly identified compound flooding and drainage limitations as major long-term concerns throughout Duval, Nassau, Clay, and St. Johns Counties (Florida Department of Environmental Protection, 2025). These conditions may reduce the effectiveness of traditional gravity drainage systems while increasing dependence on pumps, storage, operational flexibility, and regional watershed coordination.

Compound flooding conditions increase the risk of contaminant mobilization, reduced stormwater storage capacity, underground utility corrosion, and failure of gravity drainage systems in low-lying coastal and industrial areas. These interactions are recognized in coastal resilience planning because surface flood protection measures alone may not address groundwater rise, tidal influence, or subsurface infrastructure vulnerabilities over time (Befus et al., 2020; National Academies of Sciences, Engineering, and Medicine, 2022).

Accommodation and regional collaboration strategies generally perform strongest under compound flooding conditions because they recognize flooding as a regional systems issue rather than an isolated shoreline problem (**Error! Reference source not found.**). At Naval Air Station Jacksonville, accommodation strategies such as allowing controlled flooding of low-criticality open space, increasing retention capacity, improving drainage flexibility, and adapting operations around predictable flood conditions appear more feasible and durable than attempting to fully exclude water from all low-lying areas. Protective shoreline measures may still provide important localized benefits, particularly for utilities, transportation corridors, and critical operational areas, but their effectiveness may decline if surrounding drainage systems, groundwater conditions, and tidal interactions continue to worsen.

For Duval County overall, regional watershed coordination and living shoreline implementation appear likely to provide the strongest long-term value because flood conditions cross jurisdictional boundaries and involve interconnected drainage, shoreline, transportation, and utility systems. Nature-based and watershed-scale approaches also score strongly for durability because they can adapt incrementally while supporting multiple co-benefits, including erosion reduction, habitat improvement, water quality enhancement, and flood storage. Thus, long-term resilience in Northeast Florida may depend less on isolated shoreline hardening and more on coordinated management of interconnected drainage, shoreline, groundwater, and utility systems. Many existing drainage systems throughout Northeast Florida were designed around historical rainfall and tidal assumptions that may no longer reflect current conditions. In some areas, groundwater rise and subsurface infrastructure vulnerability may reduce the long-term effectiveness of surface-only protection approaches.



Figure 3-4. Water Management Strategy Evaluation

3.3 COMPOUND FLOODING, DRAINAGE, AND SHORELINE CHANGE			
STRATEGY COMPARISON (1–5 SCALE)			
STRATEGY	OPERATIONAL VALUE	IMPLEMENTATION FEASIBILITY	LONG-TERM DURABILITY
 PROTECT	4	3	3
 ACCOMMODATE	4	5	4
 AVOIDANCE / RELOCATION	4	2	5
 REGIONAL COLLABORATION	5	3	5
 STRONGEST NEAR-TERM STRATEGY Accommodate + Regional Collaboration  HIGHEST LONG-TERM DURABILITY Avoidance / Relocation & Regional Collaboration  PRIMARY BENEFICIARY NAS Jacksonville, Duval County, Regional Systems			

3.4 Workforce Stability, Housing, and Community Continuity

Military installations across Northeast Florida depend heavily on civilian workforce access, freight movement, healthcare systems, emergency response, housing availability, and other supporting infrastructure located outside installation boundaries. Regional planning discussions and the NE MIRR materials have identified housing affordability, transportation access, logistics continuity, insurance pressures, and post-disaster recovery capacity as emerging resilience concerns affecting long-term workforce stability and regional continuity (NEFRC, 2025). These issues may become more important as flooding impacts, infrastructure costs, insurance rates, and development pressures continue to influence redevelopment patterns and the long-term viability of workforce housing, logistics facilities, and supporting services in vulnerable coastal areas (Federal Emergency Management Agency, 2023).

Regional collaboration strategies consistently score highest for workforce continuity, logistics resilience, and long-term regional stability because these systems operate across jurisdictions and depend on civilian infrastructure networks extending well beyond installation boundaries (Figure 5). For Marine Corps Support Facility Blount Island and regional port systems, logistics continuity and freight movement appear especially dependent on coordinated investments involving port operators, transportation agencies, utilities, emergency management organizations, and local governments. Port resilience investments therefore provide both military and civilian economic continuity benefits simultaneously. Federal port resilience guidance has similarly emphasized the importance of maintaining freight mobility, fuel delivery, intermodal access, and supply chain continuity during disruptive events (U.S. Department of Transportation, 2022).



Figure 3-5. Continuity Strategy Evaluation

3.4 WORKFORCE, HOUSING, LOGISTICS, AND REGIONAL CONTINUITY			
STRATEGY COMPARISON (1–5 SCALE)			
STRATEGY	OPERATIONAL VALUE	IMPLEMENTATION FEASIBILITY	LONG-TERM DURABILITY
 PROTECT	5	3	4
 ACCOMMODATE	4	5	3
 AVOIDANCE / RELOCATION	4	2	5
 REGIONAL COLLABORATION	5	4	5
 STRONGEST NEAR-TERM STRATEGY Regional Collaboration  HIGHEST LONG-TERM DURABILITY Avoidance / Relocation & Regional Collaboration  PRIMARY BENEFICIARY Duval County, All Installations, Regional Economy			

For Duval County overall, housing resilience and workforce continuity appear likely to become more important resilience issues such as infrastructure costs, insurance pressures, and flood exposure influence regional development patterns. Avoidance and relocation strategies score strongly for long-term durability because they reduce future dependence on highly vulnerable areas; however, implementation feasibility remains limited by land availability, affordability, infrastructure capacity, and governance complexity. Across all installations, regional resilience strategies providing shared transportation, housing, utility, logistics, and emergency management benefits may ultimately provide greater long-term mission continuity than isolated installation-focused protection projects. Workforce continuity may become increasingly difficult to separate from regional housing affordability, insurance pressures, and transportation reliability as growth continues across Northeast Florida.



4 Lessons from Other Mission-Critical Sectors and International Examples

Other military organizations evaluate resilience as a regional operational continuity issue rather than solely an installation protection issue. The Dutch Ministry of Defence has integrated military readiness into the Netherlands' broader Delta Programme approach, recognizing that transportation, energy, flood protection, ports, and water systems must continue functioning together during extreme events (Ministry of Infrastructure and Water Management, 2023). This approach is relevant to Northeast Florida because military operations at Naval Station Mayport, Marine Corps Support Facility Blount Island, and Naval Air Station Jacksonville depend heavily on regional infrastructure systems outside installation boundaries. Dutch resilience planning also emphasizes adaptive pathways and long-term flood management horizons extending beyond typical capital planning cycles, which may be important for shoreline resilience planning in Northeast Florida. This adaptive pathway approach has increasingly been used to support decision-making under deep uncertainty by identifying actions, thresholds, and future transition points rather than relying on a single permanent solution (Haasnoot et al., 2013).

The United Kingdom's Ministry of Defence and the Thames Estuary 2100 program provide another useful example of phased adaptation planning under uncertainty. Rather than relying on a single permanent solution, the program uses monitoring, thresholds, and staged decision-making to determine when additional flood risk measures are needed (Environment Agency, 2020; Ranger et al., 2013). This approach is especially relevant for Northeast Florida because shoreline conditions, drainage limitations, groundwater emergence, utility demand, and development patterns are expected to continue changing. For example, shoreline protection near A1A, utility hardening, tide gates, living shorelines, evacuation improvements, and drainage upgrades may each provide value under current conditions but require future modification if flood frequency, groundwater levels, or infrastructure dependency patterns worsen. This phased approach may be particularly important in Northeast Florida, where uncertainty regarding future shoreline conditions, development patterns, and infrastructure demand remains high.

International military resilience planning has also increasingly emphasized energy security and operational redundancy. NATO climate security assessments and military energy resilience initiatives have highlighted the vulnerability of centralized energy systems, fuel supply chains, transportation corridors, and communications systems during compound disruptions (NATO, 2023). In Northeast Florida, military continuity is dependent on regional fuel delivery systems, external electric supply, port operations, freight movement, and transportation access. For Marine Corps Support Facility Blount Island in particular, regional logistics continuity, utility reliability, freight mobility, and fuel redundancy may provide greater near- to mid-term operational value than standalone facility protection measures because military operations depend heavily on interconnected civilian transportation, port, utility, and supply chain systems extending beyond installation boundaries and near term shoreline exposure risk is comparatively low.

Lessons from international port and waterfront cities also reinforce the importance of combining engineered and nature-based approaches rather than relying exclusively on hard protection. Singapore's long-term coastal adaptation planning integrates shoreline protection, drainage



improvement, phased adaptation, land use planning, and infrastructure elevation to address both current and future flood risks (Government of Singapore, 2023). Similarly, the U.S. Army Corps of Engineers Engineering With Nature® program promotes combining natural and engineered systems to improve resilience, habitat, and long-term adaptability (U.S. Army Engineer Research and Development Center, n.d.). For Northeast Florida, these examples support a blended regional strategy in which living shorelines, marsh restoration, retention areas, and adaptive drainage systems complement targeted hard protection for critical transportation, utility, port, and operational infrastructure.



5 Monitoring and Evaluating Adaptation Performance

Adaptation performance should be monitored because a project that works under current conditions may lose effectiveness such as sea level rise, rainfall intensity, groundwater levels, land use, utility demand, and maintenance needs change. This is especially important in Northeast Florida, where transportation access, drainage, shorelines, utilities, ports, and workforce systems are connected. A raised roadway may remain dry while adjacent utilities fail; a tide gate may reduce tidal backflow while worsening rainfall drainage if pump or storage capacity is insufficient; and a living shoreline may perform well in moderate-energy areas but underperform if erosion or wake energy increases.

5.1 Resilience Performance Tracking

After the MIRR, performance should be tracked using measures tied to mission continuity and regional function. Suggested measures include annual hours of roadway closure near installations, number of high-tide or storm-related access disruptions, duration of power or communications outages, fuel delivery interruptions, wastewater or pump station failures, shoreline retreat rates, beach nourishment losses, emergency response delay, evacuation route reliability, and post-event recovery time. For workforce and regional continuity, useful indicators include housing availability in resilient areas, insurance affordability trends, commute reliability after storms, and port/logistics downtime.

Performance tracking should be assigned to the likely data owner. Transportation agencies can track road closures and evacuation performance. Utilities can track outage duration, restoration time, and hardened assets. Local governments can track drainage complaints, flood claims, repetitive-loss areas, and capital project delivery. Installation representatives can track mission disruption, access reliability, and critical dependency failures. This approach would allow future MIRR updates to compare whether adaptation investments are reducing disruption in practice, not just whether projects were completed.

5.2 “Trigger-Based Adaptation”

Trigger-based adaptation uses observed conditions to decide when the next action is needed. This approach is well suited to shoreline resilience because future conditions are uncertain, but the consequences of waiting too long can be high. A trigger could be a measurable threshold such as SR A1A flooding more than a set number of times per year, a critical access route closing during routine high tides, a pump station exceeding design capacity, a shoreline retreating beyond a defined distance, groundwater reaching the elevation of buried utilities, or utility restoration exceeding an acceptable mission downtime threshold.

For Northeast Florida, trigger-based adaptation could be applied by strategy type.

- Protective measures may be triggered by overtopping, erosion, repeated roadway closures, or nourishment losses.



- Accommodation measures may be triggered by recurring nuisance flooding, pump capacity limits, or predictable high-tide operating constraints.
- Avoidance or relocation may be triggered when lifecycle costs exceed replacement value, when repeated repairs no longer restore reliable service, or when new critical infrastructure would create long-term dependency in a high-risk area.
- Local policy updates can be reactive or triggered by lessons learned post event, but can also be proactive through strategic planning efforts and scenario based planning.
- Regional collaboration may be triggered when disruptions affect multiple systems at once, such as flooding that interrupts access, power, fuel delivery, and emergency response in the same corridor. Several adaptation measures currently being considered in coastal Florida may perform differently than expected once exposed to repeated compound flooding, changing groundwater conditions, and long-duration nuisance flooding.



6 Recommendations for Future MIRR Adaptation Evaluation

Future NE MIRR adaptation evaluation should compare solutions based on regional system performance, not only individual project feasibility. The most important finding from the screening analysis is that regional collaboration repeatedly scores highest for long-term durability because many mission-critical systems are externally owned and regionally operated. For Mayport, the strongest emphasis should be transportation access, SR A1A resilience, shoreline protection where necessary, and regional evacuation/access redundancy (Figure 6). For Blount Island, the strongest emphasis should be port resilience, fuel redundancy, utility hardening, and logistics continuity. For NAS Jacksonville, the strongest emphasis should be accommodation, drainage, controlled flooding of noncritical areas, utility protection, and groundwater/contamination awareness. For Camp Blanding, the emphasis should be water supply, heat, wildfire, utility reliability, and avoiding new critical dependencies in exposed or service-limited areas.

Figure 6-1. Overall Strategy Evaluation

B. HIGHEST LEVERAGE INVESTMENTS RANKING <i>Investments with Greatest Potential to Improve Mission Continuity Across Systems</i>			
RANK (1 = Highest)	INVESTMENT CATEGORY	WHY IT DRIVES HIGH SYSTEM VALUE	IMPACT SCORE (1–5)
1	 Transportation Access Redundancy & Resilience	• Maintains access for personnel, fuel, supplies, and emergency response • Supports evacuation and disaster recovery	5
2	 Utility Hardening & Redundancy (Power, Water, Wastewater, Communications)	• Enables mission-critical functions during disruptions • Reduces outage duration and recovery time	5
3	 Port & Logistics Resilience (Blount Island & Mayport)	• Protects supply chain, fuel delivery, and freight mobility • Supports regional economic stability	4
4	 Drainage & Flood Management (Regional Systems)	• Reduces compound flooding and recurrent disruptions • Improves reliability of transportation and utilities	4
5	 Workforce & Housing Resilience	• Ensures workforce availability and retention • Supports long-term regional continuity	3
6	 Shoreline & Coastal Protection (Strategic Areas)	• Protects critical waterfront assets and infrastructure • Reduces erosion and storm surge impacts	3
7	 Emergency Response & Regional Coordination	• Improves situational awareness and response time • Enhances coordination across jurisdictions	3
Impact Score: Combination of Operational Value, Feasibility, and Long-Term Durability (1 = Lowest, 5 = Highest)			

Future evaluations should use a two-step screen. First, identify the regional system problem: access, utilities, fuel, drainage, shoreline erosion, port logistics, housing/workforce continuity, water supply, or contamination risk. Some of the most significant long-term risks to military



continuity in Northeast Florida may emerge from interactions between systems rather than failure of individual assets. Since these dependencies frequently cross installation, municipal, county, utility, and transportation boundaries, continued regional coordination will remain essential to identifying vulnerabilities, evaluating adaptation opportunities, and aligning investments. The Northeast Florida MIRR process demonstrates the value of regional planning organizations in bringing together diverse stakeholders to address infrastructure challenges that no single jurisdiction or installation can resolve independently. Future evaluations should also consider how adaptation investments support broader regional logistics, supply chain continuity, and infrastructure reliability objectives that contribute to both military readiness and regional economic stability (Department of Defense, 2024; OLDCC, 2025b).

Second, compare protect, accommodate, avoidance/relocation, and regional collaboration strategies using the one to five scoring categories already developed: operational value, implementation feasibility, and long-term durability. Scores were assigned by APTIM's multidisciplinary team based on professional judgment informed by findings from the Northeast Florida MIRR process, stakeholder discussions, regional planning studies, published literature, and experience supporting military resilience, infrastructure, and adaptation planning efforts. The framework is intended to facilitate comparison of adaptation approaches rather than establish formal project rankings or benefit-cost results. This keeps the analysis quantitative enough to support comparison while avoiding false precision.

The MIRR should also identify “watch conditions” for each major strategy.

- For shoreline and access projects, track flooding frequency, erosion rate, road closures, and maintenance costs.
- For utility and fuel systems, track outage duration, restoration time, backup duration, and single points of failure.
- For drainage and groundwater systems, track high-tide flooding, pump performance, groundwater elevations, and contaminated-site exposure.
- For workforce and housing resilience, track commute reliability, housing affordability, insurance stress, and post-disaster workforce availability.

These indicators should be reviewed periodically with local governments, utilities, transportation agencies, port operators, and installation representatives so the region can adjust investments as conditions change.



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