



*Analysis of Florida's Defense
Incentives and Industry*

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EXECUTIVE SUMMARY

Background and Purpose

Legislation enacted in 2013 and revised in 2014 directs the Office of Economic and Demographic Research (EDR) and the Office of Program Policy Analysis and Government Accountability (OPPAGA) to analyze and evaluate state economic development incentive programs on a recurring three-year schedule.¹ EDR is required to evaluate the economic benefits of each program, using project data from the most recent three-year period, and to provide an explanation of the model used in its analysis and the model's key assumptions. Economic Benefit is defined as "the direct, indirect, and induced gains in state revenues as a percentage of the state's investment" – which includes "state grants, tax exemptions, tax refunds, tax credits, and other state incentives."² EDR's evaluation also requires identification of jobs created, the increase or decrease in personal income, and the impact on state Gross Domestic Product (GDP) for each program.

In this report, the following incentives are under review:

- The Defense Infrastructure and Reinvestment Grants under the auspices of the Department of Economic Opportunity's Military Base Protection Program;
- The Florida Defense Support Task Force Grants; and
- The Sales Tax Exemption for Manufacturing and Equipment Used in the Semiconductor, Defense, or Space Technology Production.

The review period covers Fiscal Years 2017-18, 2018-19, and 2019-20. This is EDR's third evaluation of these incentives.³

Explanation of Return-on-Investment

In this report, the term "Return on Investment" (ROI) is synonymous with economic benefit, and is used in lieu of the statutory term. This measure does not address issues of overall effectiveness or societal benefit; instead, it focuses on tangible financial gains or losses to state revenues, and is ultimately conditioned by the state's tax policy.

The ROI is developed by summing state revenues generated by a program less state expenditures invested in the program, and dividing that calculation by the state's investment. It is most often used when a project is to be evaluated strictly on a monetary basis, and externalities and social costs and benefits—to the extent they exist—are excluded from the evaluation. The basic formula is:

$$\frac{(\text{Increase in State Revenue} - \text{State Investment})}{\text{State Investment}}$$

¹ Section 288.0001, F.S. As of 2021, nineteen programs are specified.

² Section 288.005(1), F.S.

³ The previous reports can be found at EDR's website: <http://edr.state.fl.us/Content/returnoninvestment/> The Qualified Defense Contractor and Space Flight Business Tax Refund Program is also required to be reviewed. However, the program sunset in 2014.

Since EDR's Statewide Model⁴ is used to develop these computations and to model the induced and indirect effects, EDR is able to simultaneously generate State Revenue and State Investment from the model so all feedback effects mirror reality. The result (a net number) is used in the final ROI calculation.

As used by EDR for this analysis, the returns can be categorized as follows:

- **Greater Than One (>1.0)**...the program more than breaks even; the return to the state produces more revenues than the total cost of the investment.
- **Equal To One (=1.0)**...the program breaks even; the return to the state in additional revenues equals the total cost of the investment.
- **Less Than One, But Positive (+, <1)**...the program does not break even; however, the state generates enough revenues to recover a portion of its cost of the investment.
- **Less Than Zero (-, <0)**...the program does not recover any portion of the investment cost, and state revenues are less than they would have been in the absence of the program. This typically occurs because taxable activity is shifted to non-taxable activity.

The numerical ROI can be interpreted as return in tax revenues for each dollar spent by the state. For example, a ROI of 2.5 would mean that \$2.50 in tax revenues is received back from each dollar spent by the state.

The basic formula for ROI is always calculated in the same manner, but the inputs used in the calculation can differ depending on the needs of the investor. Florida law requires the return to be measured from the state's perspective as the investor, in the form of state tax revenues. In this regard, the ROI is ultimately shaped by the state's tax code.

Overall Results and Conclusions

Florida is home to 20 major military installations⁵ and some of the largest defense contractors in the country. In Federal Fiscal Year 2020, total federal spending on defense contracts and payroll amounted to over \$29.1 billion.⁶ Nationally, Florida is ranked 5th in the country in total defense spending.⁷

The analysis examines the economic impact of the defense industry in Florida, specifically the impact of Federal (DOD) contracts and grants on the state's economy. EDR found that those contracts and grants contributed over \$40 billion to Florida's GDP in the review period. Federal Defense spending was also responsible for an estimated 21,000 Florida jobs annually.

The analysis specifically reviewed the **Defense Infrastructure and Reinvestment Grants** under the Department of Economic Opportunity's Military Base Protection Program and the **Florida Defense Support Task Force grants**. These grants fund activities and strategies intended to preserve or expand the U.S. military base presence throughout the state. Notably, these grants are not typical incentives, but rather function to coordinate and fund investments designed to influence future decisions regarding federal military resource allocation in the state.

⁴ See the Methodology section for a description of the Statewide Model.

⁵ See map on page 5. [Florida's Military and Defense Strategies \(enterprise-florida.com\)](https://www.enterprise-florida.com/Florida-Military-and-Defense-Strategies) and [Floridas-Military-Installations-Map.pdf \(enterprise-florida.com\)](https://www.enterprise-florida.com/Florida-Military-Installations-Map.pdf)

⁶ <https://www.defense.gov/News/Releases/Release/Article/2819472/dod-releases-report-on-defense-spending-by-state-in-fiscal-year-2020/>

⁷ *Ibid.*

Florida's Major Military Installations



The Return-on-Investment for these grants is unknown because of the difficulty in measuring the effectiveness of these grant programs. The programs' main goal is to prevent any significant realignment or base closure from occurring in Florida. However, there has not been a Military Base Realignment and Closure (BRAC) process since 2005. Therefore, it is impossible to evaluate how well these programs have done to prevent a BRAC base contraction or closure in Florida.⁸ In addition, no evidence was found in the academic literature to suggest that state-funded advocacy programs are effective in preventing BRAC base closures, or that the negative repercussions of a base closure are persistent over the long term.⁹

A new appendix has been included that discusses the future impact of climate change and sea level rise on Florida's military installations. Conceivably, these issues could prove to be a greater factor in potential base contraction or closure discussions than the size of Florida's grant programs.

The analysis also reviewed the **Sales Tax Exemption for Machinery and Equipment Used in the Semiconductor, Defense, or Space Technology Production (SDST)**. This program exempts sales tax on the purchase of machinery and equipment used in the production processes of businesses engaged in the production of semiconductor, defense, or space technology products for sale or use, as well as building materials purchased for use in manufacturing or expanding clean rooms in semiconductor-manufacturing facilities.

The analysis does not include a return on investment for the SDST exemption, because the size of the incentive is deemed too small to be of material consequence to the affected industries in Florida. This incentive is eligible to any business in Florida that is engaged in the production of semiconductor, defense, or space technology products. There are no other requirements to obtain the exemption, and it is not contingent upon the "but for" criteria required in many of the state's economic development incentive programs. The SDST exemption cannot reasonably be deemed the primary or determining factor in the business' decision to purchase machinery and equipment. To remain competitive in the industry, these businesses need to maintain existing capacity or upgrade their machinery and equipment as technology changes or conditions otherwise warrant. Moreover, the majority of businesses who have applied for and been granted the exemption are federal contractors, and their machinery and equipment purchases are directly related to the federal contracts that they are awarded. The competitive advantage yielded by the amount of the forgone state taxes to any one business is unlikely to be a determining factor in the federal government's decision to award a procurement contract. Further, other state incentives exist that provide viable alternatives for at least some of the participants.

⁸ Even if there were a BRAC process within or following the review period, it is unlikely that the "but for" test would reasonably be met for any of the grant programs because the scope and size of the grants makes it unlikely that they are the primary or determining factor in the federal government's decisions. Without the attestation that "but for" the state's investment the outcome would be different, there is no way to calculate the state's return.

⁹ See EDR's conclusions in "Analysis of Florida's Defense Incentives, Including a Review of the Defense and Space Industries," Office of Economic and Demographic Research, 2018: 8-14, 19-20. [Analysis of Florida's Defense Incentives, Including a Review of the Defense and Space Industries \(state.fl.us\)](https://www.state.fl.us/economic-research/analysis-of-florida-s-defense-incentives-including-a-review-of-the-defense-and-space-industries)

OVERVIEW OF FLORIDA’S DEFENSE INCENTIVES

Florida’s defense incentives include those under the auspices of the Department of Economic Opportunity’s Military Base Protection Program; the Florida Defense Support Task Force grants; and the Sales Tax Exemption for Machinery and Equipment Used in the Semiconductor, Defense, or Space Technology Production.¹⁰ Each of these areas is described below.

The Military Base Protection Program Grants

The Military Base Protection Program consists of activities and strategies intended to preserve or expand the U.S. military base presence throughout the state, or to mitigate the impact to the local economy should bases be realigned or closed.¹¹ To accomplish these goals, the Department of Economic Opportunity (DEO) administered two grant programs during the review period.¹² Funding for the Defense Infrastructure (DIG) and Defense Reinvestment (DRG) grants remained consistent over the period, with \$2.45 million appropriated annually in FYs 2017-18, 2018-19 and 2019-20, for a total of \$7.35 million.¹³ In addition, the department coordinated the submission of recommendations regarding purchase of base buffering encroachment lands to the Board of Trustees of the Internal Improvement Trust Fund.¹⁴

The impetus of the program was the 1993 Base Realignment and Closure (BRAC) process that saw both the Orlando Naval Training Center and the Orlando Naval Hospital recommended for closure.¹⁵ In response, the Florida Legislature created several grant programs to support Florida’s military installations and to help shield them from the adverse effects of future federal base realignment and closure actions.

In 2004, the Legislature created the **Defense Infrastructure Grant Program (DIG)** in order to support local infrastructure projects deemed to have a positive impact on the military value of installations within the state. Eligible projects include, but are not limited to, those related to: encroachment, transportation and access, utilities, communications, housing, environment, and security. These grants are to be used for projects that benefit both the local community and the military installation. DEO accepts applications from economic development applicants serving in the official capacity of a governing board of a county, municipality, special district, or state agency that will maintain the project upon completion, and represents a community or county in which a military installation is located. In addition, the local authority must secure matching funds equal to 30% of the grant award.¹⁶

¹⁰ For the most recent Association of Defense Communities’ assessment of state-sponsored military support throughout the US, see “State of Support 2016: Highlights of State Support for Defense Installations”, July 2016. [State of Support 2016: Highlights of State Support for Defense Installations | Knowledge Online for Defense Communities \(knowledgeowl.com\)](https://www.knowledgeowl.com/state-support-2016-highlights-of-state-support-for-defense-installations/)

¹¹ Section 288.980, F.S.

¹² See [Military Community Programs - FloridaJobs.org](https://www.floridajobs.org/military-community-programs/)

¹³ \$150,000 annually appropriated specifically for “Military Base Protection” was not used to fund Defense Infrastructure or Reinvestment Grants. Therefore, these dollars are not included in the appropriated total.

¹⁴ Section 288.980(2)(b), F.S. DEO solicits recommendations from military installations of base buffering encroachment lands, and submits the list to the Florida Defense Support Task Force for ranking. The list is then submitted to the Board of Trustees of the Internal Improvement Trust Fund for acquisition, provided available funding. This program was last funded in 2014.

¹⁵ For an overview of the economic impact of military base closures across the US as well as Florida, see EDR’s 2018 “*Analysis of Florida’s Defense Incentives, Including a Review of the Defense and Space Industries*,” pp. 6-14. [Analysis of Florida’s Defense Incentives, Including a Review of the Defense and Space Industries \(state.fl.us\)](https://www.state.fl.us/edr/analysis-of-floridas-defense-incentives-including-a-review-of-the-defense-and-space-industries/).

¹⁶ See [Florida Defense Infrastructure Grant Program - FloridaJobs.org](https://www.floridajobs.org/florida-defense-infrastructure-grant-program/)

DEO reports that, in Fiscal Years 2017-18 through 2019-20, \$5,268,239 in state payments were made for 15 grants to 14 recipients. This amount is higher than the original appropriations of \$4,800,000 due to the fixed capital outlay nature of these grants. The funding for some grants was appropriated prior to the review period, but paid out during it.

In 2012, the **Defense Reinvestment Grant Program (DRG)** was established to replace some of the early defense-related grant programs. The DRG's purpose is to help defense-dependent communities develop and implement strategies that would help the community protect its existing military installations. The grant is also available to help transform the economy of a defense-dependent community to one that was more diversified. Eligible applicants include cities, counties, Chambers of Commerce, or an economic development entity where the military installation is located.

The Defense Reinvestment Grant provides support for community based activities that address one of three designated issues: protection of military installations, diversification of a defense dependent community; or the development of plans for the reuse of a closed or realigned military installation.¹⁷ A 30% match is required from grant recipients.

DEO reports that, in Fiscal Years 2017-18 through 2019-20, \$2,321,683 in state payments were made for 31 grants to 31 recipients from a total appropriation of \$2,550,000.

No returns-on-investment were calculated for the two grant programs. Instead, the Statewide Model was used to calculate the economic impact of the defense industry in Florida, specifically the impact of Federal (DOD) contracts and grants on the state. See the Program Findings section.

The Florida Defense Support Task Force Grants

In 2009, the Legislature created the Florida Council on Military Base and Mission Support. The council was charged with providing oversight and direction for initiatives and actions to protect Florida's military bases from budget cuts or closures, including identifying opportunities to expand the mission of the state's military installations. In 2012, the duties of the Florida Council on Military Base and Mission Support were transferred to the newly created Florida Defense Support Task Force.¹⁸ The Task Force was charged with making recommendations for preparing the state to effectively compete in any federal base realignment and closure action, for supporting the state's position in research and development related to or arising out of military missions and contracting, and for improving the state's military friendly environment for service members, military dependents, military retirees, and businesses that bring military and base-related jobs to the state.¹⁹

The Task Force is authorized to use appropriated funds to award grants for: economic and product research and development; joint planning with host communities to accommodate military missions and prevent base encroachment; advocacy on the state's behalf to federal civilian and military officials; assistance to school districts in providing a smooth transition for large numbers of additional military-

¹⁷ See [Florida Defense Reinvestment Grant Program - FloridaJobs.org](http://FloridaDefenseReinvestmentGrantProgram-FloridaJobs.org)

¹⁸ Section 38, ch. 2011-76, which created s. 288.987, F.S. Also see <https://www.enterpriseflorida.com/military-defense/florida-defense-support-task/>

¹⁹ Section 288.987(2), F.S.

related students; job training and placement for military spouses in communities with large shares of active duty military personnel; and promotion of the state to military and related contractors and employers. Grants administered by the Task Force do not require matching funds, and there are no imposed caps. Grant applications must be sponsored by a Task Force member, and the Task Force is responsible for deciding grant awards.

Funding of Florida Defense Support Task Force has remained consistent over the review period, with \$2 million appropriated annually in FYs 2017-18, 2018-19 and 2019-20, for a total of \$6 million.²⁰ Task Force staff report that, in Fiscal Years 2017-18 through 2019-20, EFI made payments of \$3,316,400 to thirteen entities for 15 grants. Of the remainder, funds were used for administrative expenditures,²¹ contractual obligations regarding federal advocacy for Florida installations (which ended in 2019), and contracts for research. By law, any unused funds revert to the state at the end of each fiscal year.

A return-on-investment was not calculated for this grant program. Instead, the Statewide Model was used to calculate the economic impact of the defense industry in Florida, specifically the impact of Federal (DOD) contracts and grants on the state. See the Program Findings section.

The Sales Tax Exemption for Semiconductor, Defense, or Space Technology

The Sales Tax Exemption for Machinery and Equipment Used in the Semiconductor, Defense, or Space Technology Production (SDST) was first created in 1997.²² When it was originally established, the exemption was limited to silicon technology production and research and development. In 2000, the law was amended to remove any reference to silicon technology, and to add semiconductor, defense, or space technology production and research and development to the exemption. In addition, certain building materials purchased for use in semiconductor-manufacturing facilities were exempted.²³ The exemption for research and development was transferred to a new subsection of the statute in 2006.²⁴

The current program exempts sales tax on the purchase of machinery and equipment used in the production processes of businesses engaged in the production of semiconductor, defense, or space technology products for sale or use, as well as building materials purchased for use in manufacturing or expanding clean rooms in semiconductor-manufacturing facilities. “Semiconductor technology products” includes:

“...raw semiconductor wafers or semiconductor thin films that are transformed into semiconductor memory or logic wafers, including wafers containing mixed memory and logic circuits; related assembly and test operations; active-matrix flat panel displays; semiconductor chips; semiconductor lasers; optoelectronic elements; and related semiconductor technology products as determined by DEO.”

²⁰ Enterprise Florida, Inc. (EFI) provides support to and administers the grants on behalf of the Task Force. EFI also houses the Florida Defense Alliance, which serves as an overall advisory body for defense-related activity of EFI. (Section 288.980(1)(b), F.S.)

²¹ Section 288.987(7), F.S. authorizes \$250,000 annually for staffing and administrative expenses of the task force.

²² Section 212.08(5)(j), F.S., s. 11, ch. 97-278, Laws of Florida.

²³ Section 10, ch. 2000-351, Laws of Florida.

²⁴ Section 2, ch. 2006-57, Laws of Florida.

“Defense technology products” includes:

“...products that have a military application, including, but not limited to, weapons, weapons systems, guidance systems, surveillance systems, communications or information systems, munitions, aircraft, vessels, or boats, or components thereof, which are intended for military use and manufactured in performance of a contract with the United States Department of Defense or the military branch of a recognized foreign government or a subcontract which relates to matters of national defense.”

“Space technology products” includes:

“...products that are specifically designed or manufactured for application in space activities, including, but not limited to, space launch vehicles, space flight vehicles, missiles, satellites or research payloads, avionics, and associated control systems and processing systems and component of any of the foregoing. The term does not include products that are designed or manufactured for general commercial aviation or other uses even though those products may also serve an incidental use in space applications.”

“Clean rooms” means manufacturing facilities enclosed in a manner that meets the clean manufacturing requirements necessary for high-technology semiconductor-manufacturing environments.²⁵

Initial applications for the SDST exemption are reviewed by EFI and certified by DEO. Exemption certifications are forwarded to DOR, who then issues the tax exemption certificate to the business. Businesses may request a renewal of the exemption every two years by submitting a letter to DEO, certifying under oath, that there has been no material change in the conditions or circumstances entitling the business to the original certification. A business certified to receive this exemption may elect to designate one or more state universities or community colleges as recipients of up to 100 percent of the amount of the exemption for which they qualify.

DEO reports that, during the review period, sixteen different companies used SDST exemptions. Out of 65 exemptions approved, 44 were in the defense industry, 7 were in the space industry and 14 were in the semi-conductor industry. The total value of the tax exemptions was estimated to be \$27 million.²⁶

Total Tax Exemption by Fiscal Year			
FY 2017-18	FY 2018-19	FY 2019-20	Total
\$ 9,423,555	\$ 10,241,490	\$ 7,376,750	\$ 27,041,795

Renewal applicants are required to submit the value of any tax exempt purchase, for which the exempt amount is calculated, for the two calendar years prior to requesting the renewal. Given that not all businesses are required to report every year and not all businesses renew every two years, there are years when a business may not report any purchases to DEO. This results in gaps in actual purchases, which can be seen when looking at the annual totals of taxes exempted.

²⁵ Section 212.08(5)(j)7. F.S.

²⁶ The reported value of tax exemptions is much higher than the projected values used in the 2021 Florida Tax Handbook, which contained estimates for FY 2022-23 of \$0.2 million for clean rooms and \$3.7 million for the machinery and equipment.

The primary beneficiaries of the SDST exemption are businesses involved in the production of defense technology products. Defense technology facilities accounted for \$16.9 million or 62 percent of all taxes exempted. Semiconductor facilities accounted for approximately \$2.3 million or 8 percent.

A return-on-investment was not calculated for this sales tax exemption, primarily because the exemption's size is not deemed to be material to the final purchasing decisions.

METHODOLOGY

Statewide Model

EDR used the Statewide Model to simulate the economic impact of federal contracts and grants to the defense industry in Florida. The Statewide Model is a dynamic computable general equilibrium (CGE) model that simulates Florida's economy and government finances.²⁷ The Statewide Model is enhanced and adjusted each year to reliably and accurately model Florida's economy. These enhancements include updating the base year the model uses, as well as adjustments to how the model estimates tax collections and distributions.²⁸

Among other things, the Statewide Model captures the indirect and induced economic activity associated with the defense industry in Florida. This is accomplished by using large amounts of data specific to the Florida economy and fiscal structure. Mathematical equations²⁹ are used to account for the relationships (linkages and interactions) between the various economic agents, as well as likely responses by businesses and households to changes in the economy.³⁰ The model also has the ability to estimate the impact of economic changes on state revenue collections and state expenditures in order to maintain a balanced budget by fiscal year.

When using the Statewide Model to evaluate the defense industry in Florida, the model is shocked³¹ using static analysis to develop the initial or direct effects attributable to defense contracts and grants. In this analysis, the annual direct effects (shocks) of defense contracts and grants took the form of:

- Removal of spending associated with Federal (DOD) Contracts and Grants at the Florida industry level; and
- Removal of spending associated with the military base procurement contracts and grants.

After the direct effects are developed and estimated, the model is then used to estimate the additional—indirect and induced—economic effects generated by the defense contracts and grants. This includes the supply-side responses to defense industry activity, where the supply-side responses are changes in investment and the demand for labor arising from that activity. Indirect effects are the changes in employment, income, and output by local supplier industries that provide goods and services to support the direct economic activity. Induced effects are the changes in spending by households whose income is affected by the direct and indirect activity.

All of these effects can be measured by changes (relative to the baseline) in the following outcomes:

- State government revenues and expenditures
- Jobs

²⁷ The statewide economic model was developed using GEMPACK software with the assistance of the Centre of Policy Studies (CoPS) at Monash University (Melbourne, Australia).

²⁸ Reports prior to January 1, 2017 have used 2009 as the base year. Reports as of January 1, 2017 have used 2011 as the base year.

²⁹ These equations represent the behavioral responses to economic stimuli – to changes in economic variables.

³⁰ The business reactions simulate the supply-side responses to the new activity (e.g., changes in investment and labor demand).

³¹ In economics, a shock typically refers to an unexpected or unpredictable event that affects the economy, either positively or negatively. In this regard, a shock refers to some action that affects the current equilibrium or baseline path of the economy. It can be something that affects demand, such as a shift in the export demand equation; or, it could be something that affects the price of a commodity or factor of production, such as a change in tax rates.

- Personal income
- Florida Gross Domestic Product
- Gross output
- Household consumption
- Investment
- Population

EDR's calculation of the financial value of contracts and grants to Florida's defense industry is used to model the impact on state revenues and expenditures. Other measures for this analysis include the number of jobs created, the increase or decrease in personal income, and the impact on gross domestic product, all of which are included in the model results.³²

³² For an overview of Issues that shape EDR's Analysis of Economic Development Incentive Programs and Calculation of Return on Investment, See Appendix One, "Economic Evaluation for Select State Economic Development Incentive Programs," Office of Economic & Demographic Research, November 2021.
http://edr.state.fl.us/Content/returnoninvestment/ROISELECTPROGRAMS2020final_Revised%2011-29-21.pdf

KEY ASSUMPTIONS

The following key assumptions are used in the Statewide Model to determine the impact of the defense industry in Florida. Some of the assumptions are used to resolve ambiguities in the literature, while others conform to the protocols and procedures adopted for the Statewide Model.

1. The analysis assumes the data used to estimate defense industry spending is accurate and a reasonable approximation when used to simulate related economic activity. The data comes from USASpending.gov, which is the official source for U.S. Government contracts. The data was not independently audited or verified by EDR.
2. The analysis assumes, given the time span under review, applying discount rates would not prove material to the outcome.
3. The analysis assumes the relevant geographic region is the whole state, not individual counties or regions. The model takes account of and makes adjustments for the fact that industries within the state cannot supply all of the goods, services, capital, and labor needed to produce the state's output.

KEY TERMS

Key terms used in the following table are described below:

Total Net State Revenues \$ (M) – Represents the amount of state revenue generated by the activity in each fiscal year.

Personal Income (Nominal \$(M)) – Reflects income received by persons from all sources. It includes income received from participation in production as well as from government and business transfer payments. It is the sum of compensation of employees (received), supplements to wages and salaries, proprietors' income with inventory valuation adjustment (IVA) and capital consumption adjustment (CCAdj), rental income of persons with CCAdj, personal income receipts on assets, and personal current transfer receipts, less contributions for government social insurance.

Real Disposable Personal Income (Fixed 2016-17 \$(M)) – Reflects total after-tax income received by persons; it is the income available to persons for spending or saving.

Real Gross Domestic Product (Fixed 2016-17 \$(M)) – Measures the state's output; it is the sum of value added from all industries in the state. GDP by state is the state counterpart to the Nation's gross domestic product.

Consumption by Households and Government (Fixed 2016-17 \$(M)) – Reflects the goods and services purchased by persons plus expenditures by governments consisting of compensation of general government employees, consumption of fixed capital (CFC), and intermediate purchases of goods and services less sales to other sectors and own-account production of structures and software. It excludes current transactions of government enterprises, interest paid or received by government, and subsidies.

Real Output (Fixed 2016-17 \$(M)) – Consists of sales, or receipts, and other operating income, plus commodity taxes and changes in inventories.

Total Employment (Jobs) – Provides estimates of the number of jobs, full time plus part time, by place of work. Full time and part time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included.

Population (Persons) – Reflects first of year estimates of people, including survivors from the previous year, births, special populations, and three types of migrants (economic, international, and retired).

PROGRAM FINDINGS

Florida is home to 20 military installations and some of the largest defense contractors in the country. In Federal Fiscal Year 2020, total defense spending on contract obligations and payroll spending amounted to over \$29.1 billion.³³ Nationally, Florida is ranked 5th in the country in total defense spending.³⁴

The analysis examines the economic impact of the defense industry in Florida, specifically the impact of Federal (DOD) contracts and grants with industries in the state.

Statewide Economic Model Impact Projections of the Removal of Defense Spending

		FY2017	FY2018	FY2019	Total		Average per Year
Personal Income	Nominal \$ (M)	9,868.06	10,368.38	15,105.00	35,341.44		11,780.48
Real Disposable Personal Income	Fixed 2016-17 \$ (M)	8,795.31	9,001.29	12,875.81	30,672.42		10,224.14
Real Gross Domestic Product	Fixed 2016-17 \$ (M)	16,146.08	14,915.03	20,558.80	51,619.91		17,206.64
Consumption by Households and Government	Fixed 2016-17 \$ (M)	19,859.70	18,723.16	25,696.70	64,279.56		21,426.52
Real Output	Fixed 2016-17 \$ (M)	21,934.86	20,596.56	28,467.61	70,999.04		23,666.35
Total Net State Revenues	Nominal \$ (M)	270.55	265.51	389.08	925.15		308.38

		FY2017	FY2018	FY2019	Minimum	Maximum	Average per Year
Total Employment	Jobs	39,864	27,014	35,894	27,014	39,864	34,257.33
Population	Persons	0	11,514	23,306	0	23,306	11,606.67

The Department of Defense contracts annually contributed, on average, nearly \$17.2 billion to Florida's Real Gross Domestic Product, \$10.2 billion in real Disposable Personal Income, and \$308.38 million in state revenue. These contracts amounted to about 1.2 percent of Florida's total GDP and 1.3 percent of Florida's total real Disposable Personal Income. Additionally, Florida defense spending on contracts was responsible for an estimated 34,000 jobs annually.

The defense contracts benefitted Florida primarily through the volume of contracts and the total annual amount awarded to Florida-based companies. Within the review period, this amounted to over \$39.8 billion worth of contracts. This contracted level is significantly higher than the amount analyzed in the 2018 report for the prior period (\$39.8 billion versus \$30.0 billion).

Additionally, Florida's economy benefitted by the concentration of defense contracts in aerospace manufacturing. Aerospace manufacturing firms have larger economic multipliers than the average Florida company. Larger economic multipliers means more indirect and induced economic impacts in Florida from every dollar spent on aerospace manufacturing contracts.

³³ <https://www.defense.gov/News/Releases/Release/Article/2819472/dod-releases-report-on-defense-spending-by-state-in-fiscal-year-2020/>

³⁴ *Ibid.*

APPENDIX – Climate Change, Sea Level Rise and Florida’s Military Installations

Introduction

Climate largely determines where we can live and thrive.³⁵ Because of this, a significant change in climate is highly disruptive and challenging. Among other issues, new ways of adapting to the altered circumstances must be found. If unchecked and unmitigated, climate change will pose a significant threat to our water resources, food supply, infrastructure, human health, and the environment.³⁶

In April, 2021, U.S. Defense Secretary Lloyd Austin called climate change an existential threat to U.S. national security: “Today, no nation can find lasting security without addressing the climate crisis. We face all kinds of threats in our line of work, but few of them truly deserve to be called existential. The climate crisis does...”³⁷ The U.S. Department of Defense (DoD) has significant assets throughout the world, both property and personnel. The global climate change will have wide-ranging near and long-term impacts on these assets, the operating environment and the nation’s ability to respond to emerging security challenges.

The U.S. Government and several Non-Governmental Organizations (NGOs) have funded a growing body of research to determine the effect of climate change on DoD missions and national security. This Appendix briefly discusses climate change, its consequences and recent reports that assess the risks to U.S. military installations, including Florida facilities.

Climate Change

Climate change may be defined as:

“...detectable changes in one or more climate system components over multiple decades, including changes in the average temperature of the atmosphere or ocean; changes in regional precipitation, winds, and cloudiness; and changes in the severity or duration of extreme weather, including droughts, floods, and storms.”³⁸

Climate change results from many factors, and rigorous research regarding anthropogenic (originating from human activity) climate change is relatively recent.³⁹ This research field links the buildup of carbon dioxide in the atmosphere from the burning of fossil fuels and emission of other gases (methane and nitrous oxides) to the “greenhouse effect” on the global climate and its likely practical effects.⁴⁰

³⁵ Climate is generally defined as the average course of weather conditions over many years, including temperature, precipitation, and wind that characteristically prevail in a particular region.

³⁶ [Climate change impacts | National Oceanic and Atmospheric Administration \(noaa.gov\)](#)

³⁷ “Pentagon chief: Climate crisis 'existential' threat to US national security,” *The Hill*, April 22, 2021. [Pentagon chief: Climate crisis 'existential' threat to US national security | TheHill](#)

Also see National Intelligence Estimate, “Climate Change and International Responses Increasing Challenges to US National Security Through 2040,” October 21, 2021. NIC-NIE-2021-10030-A [NIE Climate Change and National Security.pdf \(dni.gov\)](#)

³⁸ [Presidential Memorandum -- Climate Change and National Security | whitehouse.gov \(archives.gov\)](#) September 21, 2016

³⁹ Although in the late 19th and early 20th centuries, Svante Arrhenius researched and published his findings regarding the “hot-house theory” of the atmosphere. See [Svante Arrhenius \(nasa.gov\)](#)

At least by the 1980s, there was an emerging consensus that the global warming trend was caused by pollutants in the atmosphere. See Shabecoff, Philip. “Global Warming Has Begun, Expert Tells Senate,” *NY Times*, June 24, 1988. [Global Warming Has Begun, Expert Tells Senate - The New York Times \(nytimes.com\)](#)

⁴⁰ [What is the greenhouse effect? – Climate Change: Vital Signs of the Planet \(nasa.gov\)](#)

The increasing accumulation of carbon dioxide in the atmosphere results in higher global temperatures, which has a compounding and potentially cascading effect on the earth's climate.⁴¹ Higher temperatures cause the global retreat of glaciers; a decrease in the Arctic sea ice area; surface melting of the Greenland Ice sheet; and a decline in snow cover – all of which decrease the reflection of the sun's rays. As the permafrost thaws, it further releases methane into atmosphere. These events accelerate temperature increases in the atmosphere, land and upper-ocean. The increase in sea water temperature causes thermal expansion of the water, which coupled with the ice loss on land, causes sea level to rise and disruption of global ocean currents.⁴²

These changes disrupt weather patterns, and increase the incidence, severity and duration of extreme weather.⁴³ While there is a projected overall increase in precipitation, it is likely to become "... more variable over most land regions within seasons from year to year."⁴⁴ The warmer atmosphere holds more moisture, which increases rainfall intensity and flooding. Both warmer air and ocean temperatures increase the intensity of hurricanes. With sea level rise, there is also added risk of coastal flooding from storm surge. In addition, the warmer atmosphere amplifies evaporation of moisture from the soil and

⁴¹ In 2021, the World Economic Forum warned that "climate change is not incremental...it is episodic...There are parts of our planet's carbon cycle, the ways that the earth and the biosphere store and release carbon, that could trigger suddenly in response to gradual warming. These are tipping points that once passed could fundamentally disrupt the planet and produce abrupt, non-linear change in the climate." [Climate change will be sudden and cataclysmic. We need to act fast | World Economic Forum \(weforum.org\)](https://www.weforum.org)

Also see Zscheischler, J., S. Westra, B. J. J.M. van den Hurk, S.I. Seneviratne, P. J. Ward, A. Pitman, A. AghaKouchak, D. N. Bresch, M. Leonard, T. Wahl and X. Zhang. (2018). "Future Climate Risk from Compound Events." *Nature Climate Change*, 8(6), pp. 469–477. <https://doi.org/10.1038/s41558-018-0156-3>.

⁴² Boers, N. "Observation-based early-warning signals for a collapse of the Atlantic Meridional Overturning Circulation." *Nature Climate Change*. 11, 680–688 (2021). <https://doi.org/10.1038/s41558-021-01097-4>

Kaplan, Sarah, "A critical ocean system may be heading for collapse due to climate change, study finds," *Washington Post*, August 5, 2021. [Climate change almost completely destabilizes Atlantic Meridional Overturning Circulation, study finds - The Washington Post](https://www.washingtonpost.com/climate-environment/2021/08/05/atlantic-meridional-overturning-circulation-collapse-study-finds/)

[Climate change almost completely destabilizes Atlantic Meridional Overturning Circulation, study finds - The Washington Post](https://www.washingtonpost.com/climate-environment/2021/08/05/atlantic-meridional-overturning-circulation-collapse-study-finds/)
"Atlantic 'conveyor belt' has slowed by 15% since mid-20th century," *CarbonBrief*, April 11, 2018. [Atlantic 'conveyor belt' has slowed by 15% since mid-20th century | Carbon Brief](https://www.carbonbrief.org/atlantic-conveyor-belt-has-slowed-by-15-percent-since-mid-20th-century)

Intergovernmental Panel on Climate Change (IPCC), "Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate." 2019: (A.2.7.) [Summary for Policymakers — Special Report on the Ocean and Cryosphere in a Changing Climate \(ipcc.ch\)](https://www.ipcc.ch/report/srocc/)

⁴³ IPCC, "Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Cambridge University Press. 2021: SPM 19-27. [IPCC AR6 WGI Full Report.pdf](https://www.ipcc.ch/report/ar6/wg1/)
The Panel includes 195 member countries. The report represents years of research on the topic, was authored by more than 200 scientists from over 60 countries and cites more than 14,000 individual studies.

For two recent views on the IPCC report, see Steven E. Koonin, "Climate Change Brings a Flood of Hyperbole," *WSJ* August 10, 2021, [Climate Change Brings a Flood of Hyperbole - WSJ](https://www.wsj.com/articles/climate-change-brings-a-flood-of-hyperbole-2021-8-10) and Ben Santer, "How IPCC went from 'not proven' that we cause climate change in 1990 to 'we are guilty' in 2021." *The Hill*, August 8, 2021. [How IPCC went from 'not proven' that we cause climate change in 1990 to 'we are guilty' in 2021 | TheHill](https://thehill.com/policy/energy-environment/958441-how-ipcc-went-from-not-proven-that-we-cause-climate-change-in-1990-to-we-are-guilty-in-2021/)

Also see Irfan, Umair, "Climate change worsens extreme weather. A revolution in attribution science proved it," *Vox*, August 12, 2021. [IPCC report: How UN climate scientists revolutionized extreme weather attribution - Vox](https://www.vox.com/2021/8/12/23054444/ipcc-report-how-un-climate-scientists-revolutionized-extreme-weather-attribution)

⁴⁴ IPCC, 2021:SPM 23 (B.3.1.)

water bodies, decreasing rain events in arid regions while increasing rainfall intensity when they do happen.⁴⁵ Some regions will get drier, which intensifies drought and wildfires.⁴⁶

Other consequences of climate change include the dislocation of human populations and disruption of habitats of wildlife, plants and pests.⁴⁷ Glacier melting and saltwater intrusion in inland aquifers will impact the availability of water for human consumption, agriculture, energy generation and other uses.⁴⁸ Flooding, storm surge and sea level rise may affect soil conditions, which would impact the integrity of ground underpinning infrastructure.⁴⁹ Rising ocean temperatures and increasing accumulation of carbon dioxide in the atmosphere also increases ocean acidification.⁵⁰

These changes are likely to have lasting effects. In 2021, the IPCC concluded that “Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level.”⁵¹

Sea Level Rise

The primary consequences of sea level rise include permanent loss of coastal and riverine land, increased threats of flooding from storm surge, and saltwater intrusion in inland aquifers.⁵² The level of

⁴⁵ “A warmer atmosphere acts like a bigger sponge, drawing more moisture from the soil and plants at a higher rate via evapotranspiration while at the same time being able to hold more water before reaching saturation and starting to rain. In arid regions, the net result is that as temperatures warm it becomes increasingly rare for there to be enough moisture in the atmosphere to produce rain: “Rain events become much rarer, but when rain comes it is very intense. Aridity and multi-year droughts increase along with wildfire risk. Surface water supplies decline. Vegetation cover becomes sparser and the land surface more easily degraded through human activity and during rain events.” Pinson, A.O., K.D. White, E.E. Ritchie, H.M. Conners, and J.R. Arnold, “DoD Installation Exposure to Climate Change at Home and Abroad.” U.S. Army Corps of Engineers: Washington, DC, 2021:52 [DOD Installation Climate Exposure at Home and Abroad \(defense.gov\)](#)

⁴⁶ National Geographic reports that “Between 1983 and 2001, according to [statistics from the National Interagency Fire Center](#), an average of 3.24 million acres a year burned in the U.S. Between 2002 and 2020, that figure more than doubled, to 7.21 million acres a year.” “River’s Decline Cuts Water supply to U.S. West,” August 17, 2021.

⁴⁷ The expanded range of certain species of mosquitoes is projected to result in an increase in transmission of infectious tropical diseases to warming areas of the globe. See Jordan, Rob, “How does climate change affect disease?” Stanford Woods Institute for the Environment, March 15, 2019. [How does climate change affect disease? \(stanford.edu\)](#)

⁴⁸ Shidore, Sarang, Alexandra Naegele, Natalie Baillargeon, Rachel Fleishman, Madeleine Holland, Christopher Schwalm. “Melting Mountains, Mounting Tensions, Climate Change and the India-China Rivalry” Woodwell Climate Research Center, the Converging Risks Lab and Council on Strategic Risks, May 2021. [Melting-Mountains-Mounting-Tensions Climate-Change-and-the-India-China-Rivalry 2021_05_13.pdf \(climateandsecurity.org\)](#)

⁴⁹ “The ground underfoot: Impact of climate change on U.S. military bases,” University of Delaware, February 3, 2021. [The ground underfoot: Impact of climate change on U.S. military bases \(newswise.com\)](#)

⁵⁰ The increase in carbon dioxide in the atmosphere contributes to ocean acidification, which disrupts the ocean food web and ecosystem. NOAA reports that “Ocean acidification refers to a reduction in the pH of the ocean over an extended period of time, caused primarily by uptake of carbon dioxide (CO₂) from the atmosphere....The ocean absorbs about 30 percent of the CO₂ that is released in the atmosphere, and as levels of atmospheric CO₂ increase, so do the levels in the ocean.” [What is Ocean Acidification? \(noaa.gov\)](#) Also see [Ocean Acidification | Smithsonian Ocean \(si.edu\)](#)

Also, other human activity degrades natural carbon sinks (such as soil, inland forests, kelp and mangrove forests) that offset carbon emissions. See Kaplin, Sarah, “Humanity’s greatest ally against climate change is Earth itself,” *Washington Post*, April 22, 2021. [Protect biodiversity to fight climate change - The Washington Post](#)

⁵¹ IPCC, 2021:SPM 27 (B.5.) The IPCC suggest that if the increase in global temperature is limited to 1.5 degrees Celsius (2.7 Fahrenheit) above pre-industrial levels (1850-1900), it could stabilize the progression in climate change. However, the estimated increase to date has already exceeded 1 degree Celsius, and it is estimated that in ten years of current global carbon dioxide emissions will cause us to reach the 1.5 degree threshold. Given the efforts necessary to significantly reduce future carbon dioxide emissions, the IPCC concludes it is unlikely the goal can be reached.

⁵² For a recent assessment of community vulnerability to flooding in the US over the next 30 years, see “The 3rd National Risk Assessment: Infrastructure on the Brink.” First Street Foundation, October 2021. [The 3rd National Risk Assessment: Infrastructure on the Brink | PreventionWeb](#)

sea rise over time depends on the rate of future carbon dioxide emissions and the rate of glacier and ice sheet melting.⁵³ In 2021, the IPCC concluded the rate of sea level rise is escalating. The Panel found that global mean sea level increased by 20 centimeters between 1901 and 2018, and the annual average rate of sea level rise between 1901 and 1971 was .13 centimeters, increasing to .19 centimeters between 1971 and 2006, and further increasing to .37 centimeters between 2006 and 2018.⁵⁴

In 2018 the U.S. Global Change Research Program (USGRP) indicated that relative to the year 2000, the global average sea level is very likely to rise by 0.3–0.6 feet (9–18 cm) by 2030, 0.5–1.2 feet (15–38 cm) by 2050, and 1–4 feet (30–130 cm) by 2100.⁵⁵ They noted that:

“These ranges do not, however, capture the full range of physically plausible global average sea level rise over the 21st century. Several avenues of research, including emerging science on physical feedbacks in the Antarctic ice sheet suggest that global average sea level rise exceeding 8 feet (2.5 m) by 2100 is physically plausible, although its probability cannot currently be assessed.”⁵⁶

NOAA projects “global sea level is very likely to rise at least 12 inches (0.3 meters) above 2000 levels by 2100 even on a low-emissions pathway.” If future emissions increase significantly, “sea level rise could be as high as 8.2 feet (2.5 meters) above 2000 levels by 2100.”⁵⁷

Sea level rise will vary by region, according to coastal and sea floor topography, the presence of currents, and whether or not the land surface itself is rising or falling.⁵⁸

Drought and Wildfires

Climate change will also impact the incidence of drought and wildfires.⁵⁹ The U.S. Global Change Research Program (USGCRP) finds that “variable precipitation and rising temperature” already intensifies droughts and disrupts water cycles, with far-reaching implications:

⁵³ The IPCC reports that “Continued ice loss over the 21st century is virtually certain for the Greenland Ice Sheet and likely for the Antarctic Ice Sheet” and “It is virtually certain that global mean sea level will continue to rise over the 21st century.” IPCC, 2021:SPM-28. (B.5.2.)

A recent NASA study finds that flooding at high tide along the Atlantic coast will be exacerbated by the natural cyclical nodal cycle modulations of tidal amplitude, or “moon wobble,” over the coming decades. See [Rapid increases and extreme months in projections of United States high-tide flooding | Nature Climate Change](#) and

[Moon ‘wobble’ and climate change could mean ‘double whammy’ of flooding in 2030s, NASA warns - The Washington Post](#)

⁵⁴ IPCC, 2021:SPM 6 (A.1.7.) The Panel concluded that “Human influence was very likely the main driver of these increases since at least 1971.”

⁵⁵ USGCRP, “Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II,” 2018: Chapter 2, Key Message 4. [Fourth National Climate Assessment \(globalchange.gov\)](#)

⁵⁶ *Ibid.*

⁵⁷ National Oceanic and Atmospheric Administration (NOAA) [Climate Change: Global Sea Level | NOAA Climate.gov](#)

This assessment is echoed by The Union of Concerned Scientists USA, who reports that while estimates vary, “...if emissions increase we could experience up to eight feet of sea level rise by the end of the century.” [Climate Impacts | Union of Concerned Scientists \(ucsusa.org\)](#)

⁵⁸ Strategic Environmental Research and Development Program (SERDP), “Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications.” US Department of Defense. 2013: ES-1. [Assessing Impacts of Climate Change on Coastal Military Installations: \(climateandsecurity.org\)](#)

⁵⁹ Recent research reports that “... the period from 2000 to 2018 was the driest 19-year span since the late 1500s and the second driest since 800 CE. This appears to be just the beginning of a more extreme trend toward megadrought as global warming continues.” Williams, A. Park, Edwards R. Cook, Jason E. Smerdon, Benjamin I. Cook, John T. Abatzoglou, Kasey Bolles, Seung H. Baek, Andres M. Badger, Ben Livneh. “Large contribution from anthropogenic warming to an emerging North American

Increasing air temperatures have substantially reduced the fraction of winter precipitation falling as snow, particularly over the western United States. Warming has resulted in a shift in the timing of snowmelt runoff to earlier in the year. Glaciers continue to melt in Alaska and the western United States. Shifts in the hydrological regime due to glacier melting will alter stream water volume, water temperature, runoff timing, and aquatic ecosystems in these regions. As temperatures continue to rise, there is a risk of decreased and highly variable water supplies for human use and ecosystem maintenance.⁶⁰

In 2021, the IPCC concluded that “concurrent heatwaves and droughts are likely to become more frequent.”⁶¹

Droughts increase the risk, frequency, duration, extent and intensity of wildfires.⁶² For example, during the on-going drought in California, six of the state’s seven largest wildfires have occurred in the 2020 and 2021 fire seasons.⁶³ Drought results in drier air, soil, and vegetation – the stockpile of fuel for wildfires – and the loss of surface water through evaporation. The USGCRP reports that “... by the middle of this century, the annual area burned in the western United States could increase 2–6 times from the present, depending on the geographic area, ecosystem, and local climate.”⁶⁴

Assessments of Risk to Military Installations

The U.S. Government and several Non-Governmental Organizations have funded a growing body of research to determine the effect of climate change on DoD missions and national security.⁶⁵ Recent reports assess the risks to vulnerable U.S. military installations, including Florida facilities.

megadrought.” *Science*, Vol. 368, Issue 6488, pp. 314-318. [Large contribution from anthropogenic warming to an emerging North American megadrought \(science.org\)](https://www.science.org)

⁶⁰ USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Ch.3, [Water - Fourth National Climate Assessment \(globalchange.gov\)](https://www.globalchange.gov)

⁶¹ IPCC, 2021:SPM 23 (C.2.7. Also see A.3.5; B2.; & B.3.)

⁶² U.S. Environmental Protection Agency, “Climate Change Indicators: Wildfires.” [Climate Change Indicators: Wildfires | US EPA](https://www.epa.gov/climate-change-indicators/wildfires)
Mansoor, Sheikh, Iqra Farooq, M. Mubashir Kachroo, Alaa El Din Mahmoud, Manal Fawzy, Simona Mariana Popescu, N.N. Alyemeni, Christain Sonne, Jorg Rinklebe and Parvaiz Ahmad. “Elevation in wildfire frequencies with respect to the climate change,” *Journal of Environmental Management*. Volume 301, 1 January 2022. [Elevation in wildfire frequencies with respect to the climate change - ScienceDirect](https://www.sciencedirect.com)

⁶³ Philip Bump, “Six of California’s seven largest wildfires have erupted in the past year.” Washington Post, August 6, 2021.

⁶⁴ *Ibid.* Ch. 4. [Six of California’s seven largest wildfires have erupted in the past year - The Washington Post](https://www.washingtonpost.com)

Also see “The changing risk and burden of wildfire in the United States.” Marshall Burke, Anne Driscoll, Sam Heft-Neal, Jiani Xue, Jennifer Burney, Michael Wara. Proceedings of the National Academy of Sciences Jan 2021, 118 (2) [The changing risk and burden of wildfire in the United States | PNAS](https://www.pnas.org)

⁶⁵ Principal Government agencies include:

The Strategic Environmental Research and Development Program (SERDP), DoD’s environmental science and technology program, executed in partnership with the Department of Energy (DOE) and the Environmental Protection Agency (EPA). One of the three areas of their research addresses climate resiliency. See [RC Fact Sheet.pdf](https://www.serdp-estcp.org) and [About SERDP \(serdp-estcp.org\)](https://www.serdp-estcp.org) (search “Climate Change Reports” for catalog of research.)

The U.S. Global Change Research Program (USGCRP), a federal program mandated by Congress to coordinate federal research and investments in understanding the forces shaping the global environment, both human and natural, and their impacts on society. USGCRP facilitates collaboration and cooperation across its 13 federal member agencies, including the USDoD, to advance understanding of the changing Earth system and maximize efficiencies in federal global change research. [About USGCRP | GlobalChange.gov](https://www.usgcrp.gov) and [Highlights | GlobalChange.gov](https://www.usgcrp.gov) For the latest report, see National Climate Assessment, 2021. [Fourth National Climate Assessment \(globalchange.gov\)](https://www.globalchange.gov)

The DoD's Strategic Environmental Research and Development Program (SERDP) initiated climate change-related research in 2009.⁶⁶ In the 2010 Quadrennial Defense Review (QDR), the DoD committed to assess the impact of climate change on the Department's operating environment, missions and facilities.⁶⁷ In 2013 the DoD's SERDP released its first report summarizing federal agency initiatives to address the impact of climate change on federal assets. SERDP also reported on four "research projects that are developing and testing the information, models, and tools needed to examine climate change impacts on coastal installations." From these projects, SERDP developed the policy context and technical considerations for "... the planning, design, and operations of military facilities, as well as into the strategic infrastructure decisions facing the Military Services and DoD as a whole."⁶⁸

In 2016, SERDP released a report providing regional sea level and Extreme Water Level (EWL) scenarios for future time horizons (2035, 2065, and 2100) for DoD coastal sites worldwide. This information was intended to be used as a "... starting point for siting decisions for infrastructure investments within an installation or at a new location, engineering design considerations associated with infrastructure planning, or a response to a vulnerability at an existing site."⁶⁹

Also in 2016, the U.S. Union of Concerned Scientists (USC) performed an analysis of the potential impact of sea level rise on eighteen military installations of significance along the East and Gulf coasts. The installations include, by state:

- Maine: Portsmouth Naval Shipyard
- New Jersey: US Coast Guard Station Sandy Hook
- Maryland: US Naval Academy
- Washington, DC: Joint Base Anacostia-Bolling and Washington Navy Yard
- Virginia: Joint Base Langley-Eustis | Naval Air Station Oceana Dam Neck Annex | Naval Station Norfolk⁷⁰
- North Carolina: Marine Corps Base Camp Lejeune

The U.S. Army Corps of Engineers, Responses to Climate Change Program [U.S. Army Corps of Engineers Headquarters > corpsclimate](#)

For additional reports, see Additional Research References, "Department of Defense Climate Adaptation Plan." Department of Defense, Office of the Undersecretary of Defense (Acquisition and Sustainment). 1 September 2021. [Department of Defense 2021 Climate Adaptation Plan \(sustainability.gov\)](#)

⁶⁶ Hall, John A. 2015. "Assessing the Impacts of Climate Change on Coastal Military Installation: A Short History from the R&D Perspective." *Natural Selections Newsletter*, Fall 2015: 10-11. <https://denix.osd.mil/nr/resources/newsletter/2015/fall-2015-natural-selections-newsletter/>

⁶⁷ Quadrennial Defense Review Report, U.S. Department of Defense, February 2010: 84-88. [Microsoft Word - QDR as of 29JAN10 1600.docx \(defense.gov\)](#)

⁶⁸ Strategic Environmental Research and Development Program, "Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications." US Department of Defense. 2013: ES-1. The four installations include Eglin AFB in FL, Norfolk NS in VA, Camp Lejeune MCB in SC, NB Coronado and MCB Camp Pendleton in CA.

[Assessing Impacts of Climate Change on Coastal Military Installations: \(climateandsecurity.org\)](#)

⁶⁹ The report stresses that the primary considerations in such decisions should include "complexity, risk consequences, and potential costs." Hall, J.A., S. Gill, J. Obeysekera, W. Sweet, K. Knuuti, and J. Marburger, "Regional Sea-Level Scenarios for Coastal Risk Management: Managing the Uncertainty of Future Sea-Level Change and Extreme Water Levels for Department of Defense Coastal Sites Worldwide." U.S. DoD, Strategic Environmental Research and Development Program. 2016: ES2.

<https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Resiliency/Infrastructure-Resiliency/Regional-Sea-Level-Scenarios-for-Coastal-Risk-Management>.

⁷⁰ See Dave Lindorff, "The US Navy Has a Water Problem," *The Nation*. September 19, 2019. [The US Navy Has a Water Problem | The Nation](#)

- South Carolina: Marine Corps Recruit Depot Parris Island⁷¹ and Marine Corps Air Station Beaufort
- Georgia: Hunter Army Airfield | Naval Submarine Base Kings Bay
- Florida: Naval Air Station Key West | Naval Station Mayport | Eglin Air Force Base

The analysis found that “... these sites are at risk for more frequent and extensive tidal flooding; land loss as some installation areas are permanently inundated and others flood with daily high tides; and deeper and more extensive flooding due to storm surge.”⁷² Further, sixteen of the 18 installations:

“...could have tidal flooding 100 times each year by midcentury with a moderate rate of sea level rise. By the end of this century, nine installations could lose one-quarter or more of their land area, including currently utilized areas, with a moderate rate of increase and half of their land or more with a faster rate. In that faster-rate scenario, four military installations would lose between 75 and 95 percent of their land area this century.”⁷³

These four installations include NAS Key West, Joint Base Langley-Eustis, NAS Oceana Dam Neck Annex, and Marine Corps Recruit Depot Parris Island. In both the moderate and faster-rate scenarios, NAS Key West ranked the most at risk for land loss due to daily flooding, NS Mayport ranked toward the middle, and Eglin AFB ranked at the bottom.

In response to the Fiscal Year 2018 National Defense Authorization Act, the DoD issued an “...assessment of the significant vulnerabilities from climate-related events in order to identify high risks to mission effectiveness on installations and to operations.”⁷⁴ The Department characterized its review as “a high-level assessment” of the threats to seventy-nine installations.

The assessment determined that each installation could be subject to multiple climate-related threats. Of the thirty-six Air Force installations reviewed, 20 were vulnerable to recurrent flooding, 20 to drought, 4 to desertification and 32 to wildfires. Of the 21 Army installations, 15 were vulnerable to recurrent flooding, 5 to drought, 2 to desertification, 4 to wildfires and 1 to thawing permafrost. Of the 18 Navy installations, 16 were vulnerable to recurrent flooding and 18 to drought.⁷⁵ The report noted that additional bases may be vulnerable to these threats 20 years in the future, and “... vulnerability analyses to mid- and late-century would likely reveal an uptick in vulnerabilities (if adaptation strategies are not implemented).”⁷⁶

As for installations in Florida, the U.S. Southern Command Headquarters-Miami was vulnerable to recurrent flooding and wildfires, as were the Cape Canaveral and MacDill AFBs. Eglin and Patrick AFBs were vulnerable to recurrent flooding, drought and wildfires, while NAS Key West was vulnerable to recurrent flooding and drought.⁷⁷

⁷¹ See Froeba, Kristine, “Parris Island in Peril: Rising Sea Levels Threaten Historic Marine Base,” *Marine Corp Times*, February 3, 2021. [Parris Island in peril: Rising sea levels threaten historic Marine base \(marinecorpstimes.com\)](https://www.marinecorpstimes.com/story/news/2021/02/03/parris-island-in-peril-rising-sea-levels-threaten-historic-marine-base/7041170002/)

⁷² Spanger-Siegfried, Erika, Kristina Dahl, Astrid Caldas, and Shana Udvardy, “The US Military on the Front Lines of Rising Seas: Growing Exposure to Coastal Flooding at East and Gulf Coast Military Bases. Union of Concerned Scientists. 2016:2.

⁷³ *Ibid.*

⁷⁴ Department of Defense, “Report on Effects of a Changing Climate to the Department of Defense.” 2019:2. [CLIMATE-CHANGE-REPORT-2019.PDF \(defense.gov\)](https://www.defense.gov/Portals/0/Documents/2019/02/CLIMATE-CHANGE-REPORT-2019.PDF)

⁷⁵ *Ibid.*, 5.

⁷⁶ *Ibid.*, 17.

⁷⁷ *Ibid.*, Appendix. Also see Gunn, Lee, “MacDill Air Force Base’s security is threatened by climate change,” Guest Column, *Tampa Bay Times*, May 16, 2021. [MacDill Air Force Base’s security is threatened by climate change | Column \(tampabay.com\)](https://www.tampabay.com/story/news/2021/05/16/macdill-air-force-base-security-threatened-climate-change-column/7041170002/)

In June 2019, the DoD released a list of the installations most threatened by climate change.⁷⁸ Six Florida bases ranked in the 10 most vulnerable Air Force Bases: Eglin AFB, Hurlburt Field, Patrick AFB, Homestead AFB, MacDill AFB, and Tyndall AFB. NAS Key West was included in the 16 most vulnerable Navy bases (unranked).

Also in June 2019, the General Accounting Office (GAO) released its report assessing "... DoD's progress in developing a means to account for potentially damaging weather in its facilities project designs." GAO reviewed the master plans and planning documents of 23 installations associated with climate vulnerabilities. The GAO found that 15 of the 23 installations "... had considered some extreme weather and climate change effects in their plans as required by DOD guidance, but 8 had not." Additionally, "...most of the installations had not used climate projections, because they lack guidance on how to incorporate projections into their master plans."⁷⁹

In response to Executive Order 14008 (January 27, 2021), in April 2021, the DoD published "DoD Installations Exposure to Climate Change at Home and Abroad," a report developed for the DoD to describe the climate vulnerabilities of its assets.⁸⁰ The report notes that:

"Although many definitions exist for climate vulnerability, three common factors that contribute to vulnerability are the exposure of the asset or activity to one or more climate hazards, the sensitivity of the asset or activity to the hazards, and the degree of adaptive capacity to reduce this exposure and sensitivity."⁸¹

The report assesses the exposure of military installations to eight hazards: coastal flooding, riverine flooding, heat, drought, energy demand, land degradation, wildfire, and historical extreme weather events.⁸² The report finds that:

Exposure to climate hazards is broadly similar across the Departments within CONUS (Continental U.S.), Alaska (AK), and Hawaii (HI). The Air Force installations are often located in areas where long-term aridity or recurring short-term drought are anticipated to increase, driving more wildfire risk. Army installations have a similar pattern of exposure but are more frequently located in areas where exposure to heat, drought, and riverine flooding increase with

⁷⁸ Watson, Ben and Patrick Tucker, "These Are the US Military Bases Most Threatened by Climate Change," *Defense One*, June 12, 2019. [These Are the US Military Bases Most Threatened by Climate Change - Defense One](#)

⁷⁹ Government Accountability Office (GAO), "CLIMATE RESILIENCE: DoD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs," GAO-19-453, June 2019, Highlights. <https://www.gao.gov/assets/gao-19-453.pdf>

Also see GAO-14-446, "Climate Change Adaptation: DoD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts." <https://www.gao.gov/products/GAO-14-446>.

⁸⁰ Pinson, A.O., K.D. White, E.E. Ritchie, H.M. Conners, and J.R. Arnold. (2021). "DoD Installation Exposure to Climate Change at Home and Abroad." U.S. Army Corps of Engineers: Washington, DC [DoD Installation Climate Exposure at Home and Abroad \(defense.gov\)](#)

Executive Order (EO) 14008 ("Tackling the Climate Crisis at Home and Abroad, Sec/ 211), required the DoD and other federal agencies to submit a draft action plan to the National Climate Task Force and the Federal Chief Sustainability Officer within 120 days that describes steps the agency can take with regard to its facilities and operations to bolster adaptation and increase resilience to the impacts of climate change.

⁸¹ *Ibid*, 3. The report did not address the sensitivity of assets or activities to the hazards, or the degree of adaptive capacity to reduce this exposure and sensitivity.

⁸² *Ibid*, i. This report assesses exposure to climate change hazards to 1055 installations in CONUS, AK, and HI, as well as 336 DoD installations around the world.

time. The Navy has a significant exposure to coastal and riverine flooding, but there is great variability: some installations are highly exposed, and some are not. Like other Departments, the Navy's drought exposure increases stepwise based on the time and scenario.⁸³

While the report did not identify the individual installations most exposed to climate hazards, maps in the report show that the Atlantic and Gulf coasts were more vulnerable across all hazards than other regions of the U.S. – and South Florida appears the most vulnerable.

Conclusion

As the climate changes, the DoD will have to adapt to the emerging weather patterns and sea level rise.⁸⁴ This will require designing and building the infrastructure necessary to carry out its missions, and evaluating the suitability and utility of existing military installations.

Florida is home to twenty installations, many of which are of military significance, most of which are on or near the coast. Consequently, they are vulnerable to sea level rise as well as other risks related to climate change. Recent weather events have exposed these vulnerabilities. In 2020, Pensacola Naval Air Station incurred extensive damage from Hurricane Sally, requiring repair and rebuilding of some facilities.⁸⁵ In October 2018, Tyndall AFB was decimated by Hurricane Michael, the first Category 5 hurricane on record to make landfall in Northwest Florida. It is estimated to cost \$4.9 billion to rebuild and replace the lost assets. The DoD reports the rebuild will be a prototype for "... Installations of the Future – an initiative that paves the way for more resilient, energy efficient and eco-friendly facilities."⁸⁶

Monroe County, home of NAS Key West, is attempting to plan for a 17-inch rise in sea level by 2040.⁸⁷ It is unlikely that the base would, in the long term, remain strategically and economically viable in this

⁸³ *Ibid*, ii. The report states that "... rising temperatures will increase exposure to a wide range of hazards (especially heat-related hazards) that can directly impact military readiness. Climate change is anticipated to increase heat-related health problems, with even small climate changes resulting in increases in illness and death." (p. 50)

Increases in temperature are also discussed, with a emphasis on the impact that rising temperature has on military readiness

⁸⁴ On September 1, 2021 the DoD outlined its climate adaptation strategic framework in the "Department of Defense Climate Adaptation Plan." 1 September 2021. [Department of Defense 2021 Climate Adaptation Plan \(sustainability.gov\)](https://www.sustainability.gov/department-of-defense-2021-climate-adaptation-plan)

The report also noted that:

"In October 2020, the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) launched the DOD Regional Sea Level (DRSL) tool enabling DOD planners and managers to understand and assess a range of site-specific scenarios of future sea level rise and extreme water level conditions for three time horizons: 2035, 2065, and 2100. The scenarios can be adjusted for local conditions of future sea level change and storm surge. The DRSL database contains a graphical user interface that provides users access to the scenario information for DOD coastal and tidally influenced military sites worldwide." (p. 8)

⁸⁵ In 2004, the station sustained serious damage from Hurricane Ivan, resulting in its closure for nearly a year.

⁸⁶ See "Tyndall updates community on state of base rebuild," By 325th Fighter Wing Public Affairs, April 26, 2021. [Tyndall updates community on state of base rebuild > Tyndall Air Force Base > Article Display \(af.mil\)](https://www.af.mil/Newsroom/ArticleDisplay.aspx?cid=244444)

The DoD's 2021 Climate Adaptation Plan also noted that:

"The Department of the Air Force exceeded Unified Facilities Criteria minimum design requirements in rebuilding Tyndall AFB following Hurricane Michael. The design wind speed used for rebuild is based on the Florida Building Code for High Velocity Hurricane Zone (165 mph), because maximum wind during Hurricane Michael was 161 mph. Other High Velocity Hurricane Zone requirements were adopted, such as roof framing to foundation connections. Design flood elevation merged Federal Emergency Management Agency base flood levels and the highest DOD regionalized sea level rise scenario for year 2100." (p. 11)

⁸⁷ See Milman, Oliver, "The Water is Coming: Florida Keys faces stark reality as Seas Rise." *The Guardian*, June 23, 2021.

[The water is coming': Florida Keys faces stark reality as seas rise | Florida | The Guardian](https://www.theguardian.com/us-news/2021/jun/23/florida-keys-sea-level-rise)

The rise in sea level is based on NOAA and IPCC projections, respectively, relative to mean sea level in 2000, as reported in "Unified Sea Level Rise Projection Southeast Florida," prepared by the Southeast Florida Regional Climate Change Compact's Sea

projected scenario. Notably, the CNA's Military Advisory Board in 2014 recommended that "... future basing decisions, as well as future Base Realignment and Closure (BRAC) rounds, will have to make climate change a crucial consideration." ⁸⁸

While the DoD's 2021 report assessed the exposure of military installations to climate hazards, it did not address the "... sensitivity of assets or activities to the hazards, or the degree of adaptive capacity to reduce this exposure and sensitivity..." These issues will ultimately be important to the "... simple to complex assessments of vulnerability at multiple scales as needed by DoD..."⁸⁹ It is likely that these factors will also be necessary to guide federal policy decisions regarding the future of many military installations.

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⁸⁸ CNA Military Advisory Board, National Security and the Accelerating Risks of Climate Change," Alexandria, VA: CNA Corporation, 2014:24 [MAB 5-8-14.pdf \(cna.org\)](#)

⁸⁹ Pinson, *et. al.*, 3.

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