MANATEE COUNTY MOSQUITO CONTROL DISTRICT REVIEW FINAL REPORT

September 2023

Prepared for

The Florida Legislature

Prepared by

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Executive Summary

The Manatee County Mosquito Control District (Manatee County MCD) is an independent special district that serves the entirety of Manatee County, Florida. Manatee County MCD totals 893 square miles, spanning the western urban coastal and eastern agricultural areas of the County. Manatee County MCD is one of the largest MCDs in the state, serving a population of just over 429,000 residents in Fiscal Year (FY) 2021-22. Manatee County has 27 miles of white sand beaches and barrier islands, including Anna Maria Island and Longboat Key, which support a high seasonal population of tourists and seasonal residents.

Eastern Manatee County is largely rural, but development is encroaching on previously undeveloped areas. Residential development is rapidly expanding in the Lakewood Ranch area, for example, likely contributing to the Florida Office of Economic and Demographic Research's (EDR) population project of 578,535 residents in Manatee County by 2050.

Manatee County boasts thousands of acres of federally and state-owned environmental protection areas that spawn mosquitoes prolifically and have associated restrictions on Manatee County MCD operations. About 210,600 households paid ad valorem taxes to support Manatee County MCD operations in FY 2022-23. The most recent budget year included about $49 billion in taxable value for real property, plus an additional $3.8 billion from about 27,300 tangible personal property accounts that are subject to Manatee County MCD millage.

SCOPE

Section 189.0695, *Florida Statutes,* requires the conduct of performance reviews of Independent Mosquito Control Districts. The Balmoral Group was selected by the Office of Program Policy Analysis and Government Accountability to perform the review, which evaluates the district's programs, activities, and functions, including

- evaluating the district board's primary function and governance;
- assessing service delivery and comparing similar services provided by municipal or county governments located within the district's boundaries;
- describing district purpose, goals, objectives, performance measures, and performance standards and evaluating the extent to which they are achieved;
- analyzing resources, revenues, and costs of programs and activities; and
- providing recommendations for statutory or budgetary changes to improve the special district's program operations, reduce costs, or reduce duplication.

Manatee County MCD was established in 1947 to be run by an elected board of three commissioners. The board is actively engaged in a review of operational success, financial stewardship, and efficiency. Due to geographic scale, coordination efforts with protected areas and tourist-heavy islands, and environmental sensitivity to limit impacts on non-target species, Manatee County MCD has committed to Integrated Mosquito Management methods, as detailed in Manatee County MCD's Strategic Management Plan. Operations largely focus on the prevention of mosquito infestation via surveillance, monitoring, larvicide, and targeted adulticide, along with operational research to improve the effectiveness and efficiency of Manatee County MCD activities.

The Balmoral Group worked in consultation with a mosquito control expert in the course of this review and found that Manatee County MCD follows industry standards for Integrated Pest Management and provides an array of mosquito control services consistent with the district's charter and statute. Other local government entities located wholly or partially within the district do not provide similar mosquito control services and, as such, consolidation with another local government entity is not possible. The district has demonstrated effective management of its resources and utilizes them in an efficient manner to achieve its goals and objectives; increasing revenues and expenditures mirror population growth in the county and district resources will need to continue to expand to meet growing service needs. The district has clearly defined, measurable goals and

objectives that adequately address its statutory purpose; the district has favorable performance for service call responses and keeping arbovirus counts low.

Based on its review, The Balmoral Group presents the following recommendations for the improvement of mosquito control services in the Manatee County MCD:

- Manatee County MCD could consider investing in additional facilities including a larger storage hanger; additional space to secure property; a larger storage facility; and additional lab and dedicated desk space for staff.
- The district could formalize additional performance measures and standards that would allow the district to monitor and track progress toward all its goals and objectives. Such performance information would facilitate the district in consistently monitoring its progress.
- The Legislature could consider amending s. 388.46*, Florida Statutes*, to direct the Florida Coordinating Council on Mosquito Control to form a subcommittee consisting of mosquito professionals and researchers from around the state to develop model goals, objectives, and performance measures and standards to assist MCDs with performance monitoring.

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1. Background

District Description

District Purpose

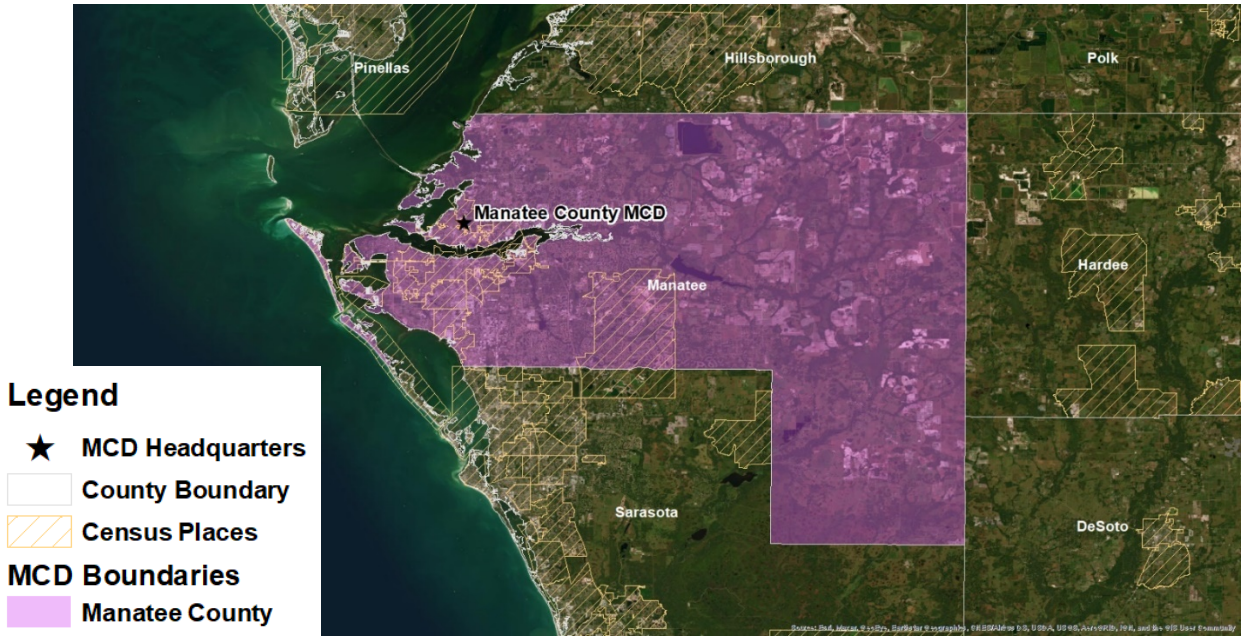
According to district representatives, the purpose of the Manatee County Mosquito Control District (Manatee County MCD) is to reduce the threat caused by both nuisance and disease-vectoring mosquitoes throughout all the incorporated and unincorporated areas of Manatee County, Florida. District representatives have reported that Manatee County MCD has worked since inception to provide a safe and fiscally responsible public health service to all residents of the district utilizing proven Integrated Pest Management methods that are efficient, effective, and environmentally sound in order to minimize the impact of both nuisance and disease-vectoring mosquitoes on the health and welfare of the community.

Service Area

Manatee County MCD serves the entirety of Manatee County, Florida, totaling 893 square miles. However, a large portion of non-residential and agricultural land in the eastern part of the county is not routinely treated.

Manatee County MCD's 4.2-acre headquarters, built in 1964, is located at 2317 2nd Avenue, West Palmetto, FL 34221. A new 30-acre facility is currently under construction to accommodate staff, equipment, and increased operations as Manatee County's population continues to expand. **Figure 1** shows a map of the Manatee County MCD boundary, with the county boundary and the MCD's current headquarters marked.

Figure 1. Manatee County MCD Map



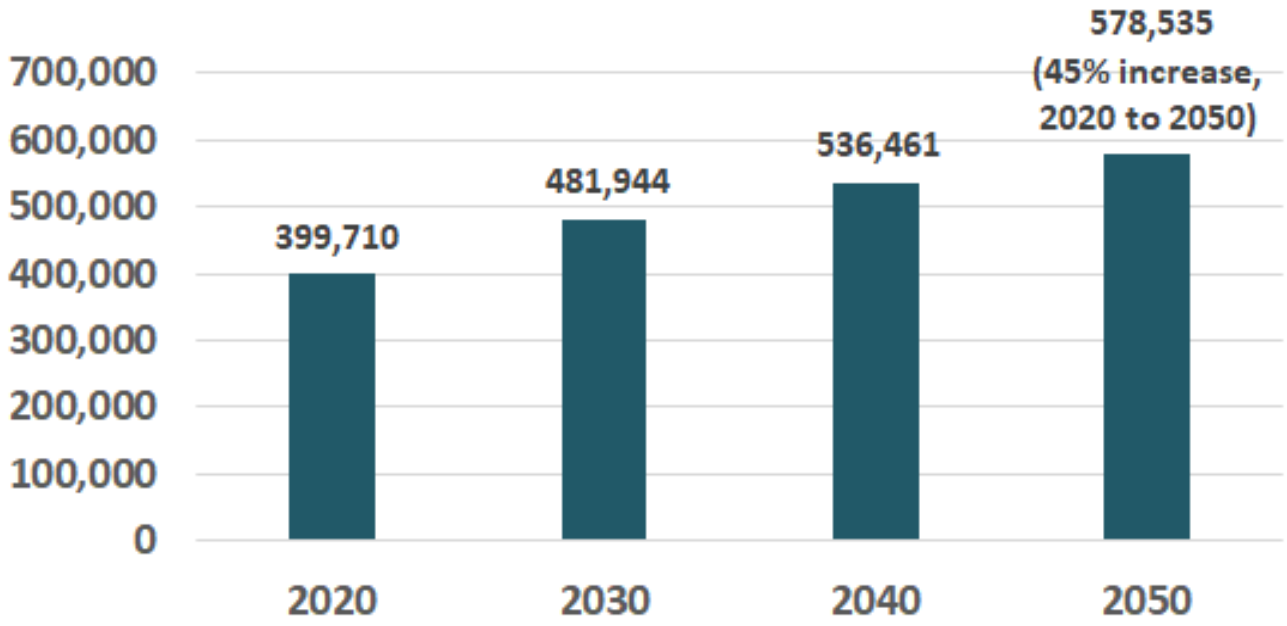
Source: TBG Work Product, ESRI, US Census, MCDs.

Population

Manatee County's population was estimated at 429,125 in 2022 according to the United States (U.S.) Census.[1] The Florida Legislature's Office of Economic and Demographic Research (EDR) projects Manatee County's population to increase by 45% through 2050 to 578,535 residents compared to a 2020 baseline. [2]

Figure 2 shows Manatee County's projected population estimates calculated by EDR.

Figure 2. Manatee County Population Projection



Source: TBG Work Product, EDR.

District Characteristics

Manatee County is on the west coast of Florida adjacent to the Gulf of Mexico. Bordering counties include Hillsborough, Polk, Hardee, DeSoto, and Sarasota Counties. In 2022, the average annual temperature was 75.1 degrees Fahrenheit, while precipitation totaled 62.76 inches. Meteorology is the primary driving force for producing mosquitoes with heavy rainfall events being the most important.

Manatee County has 27 miles of white sand beaches and barrier islands, including Anna Maria Island and Longboat Key, which support a high seasonal population of tourists and seasonal residents. Densely populated areas include the Palmetto, Bradenton, and South Bradenton areas, along with recent developments in Lakewood Ranch. Much of the coastal areas, including the barrier islands, are rimmed with mangrove areas and natural preserves that house larval habitat, and controlling mosquito populations in these areas is critical to quality of life in both the coastal and inland portions of the county. Preserve areas require careful coordination with both state and federal regulators, as treatment is greatly restricted.

Eastern Manatee County is largely rural, but development is expanding previously undeveloped areas, like Lakewood Ranch. In general, new developments across the county are encroaching on historical mosquito

[1] Population Estimates, July 1, 2022 retrieved from U.S. Census Bureau QuickFacts: United States.
[2] Based on 2021 Estimates, Population: 1970-2050, County projections retrieved from Population and Demographic Data - Florida Products (state.fl.us).

habitats, increasing the resources needed to maintain public health and limit nuisance as the human population grows.

The eye of Hurricane Ian, a Category 4 storm and the third most costly in U.S. history, passed about 22 miles from Manatee County in September 2022. Most structural damage occurred in western Manatee County, where most of the population is centered. Older parts of the community and manufactured home parks saw the worst of the damage. In the eastern half of Manatee County, the agricultural industry saw heavy winds and the worst of the county's flooding.

Meteorology is the primary driving force for producing mosquitoes, with heavy rainfall events creating standing pools of water that serve as larval habitat for mosquito species capable of transmitting several arboviruses. Changing water levels through tidal events can also produce such pools. Humans contribute to the problem by allowing water to stand in waste containers, garden pots, tires, and other vessels. The characteristics of the natural areas of the district, combined with the growing population in urban areas of the district and the meteorological conditions described above, create an environment conducive to extensive mosquito habitats that require constant mosquito control. The services needed to control mosquitoes include routine surveillance of mosquito-producing habitats, source reduction through aerial and/or ground treatments using pesticides to treat areas with large mosquito populations, and regular testing for disease transmission in animals.

Real Property Data

Manatee County MCD receives ad valorem taxes to fund operations. The total taxable value of properties within Manatee County MCD was almost $53 billion in the most recent fiscal year under a millage rate of 0.1997 (**Table 1**). Real property parcels subject to Manatee County MCD millage grew from 191,221 parcels to 210,618 parcels over the last four fiscal years (**Table 2**). The taxable value of real property parcels increased 37% in FY 2022-23 compared to FY 2019-20, following changes in property values.

Table 1. Millage Rates and Total Taxable Value of Properties Subject to Manatee County MCD Millage

Manatee County MCD	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23
Millage Rate	0.1600	0.1600	0.1997	0.1997
Taxable Value of Parcels ($Mil.)	$35,839	$38,463	$41,669	$49,182
Taxable Value of Accounts ($Mil.)	$3,109	$3,249	$3,265	$3,775
Taxable Value of Centrally Assessed Property ($Mil.)[1]	$9	$11	$9	$9
Total Taxable Value ($Mil.)	**$38,956**	**$41,721**	**$44,942**	**$52,965**

Source: Florida Department of Revenue (FDOR).

[1] Centrally assessed property includes railroad and private carline company assessments as defined in Rule 12D-2.011, *F.A.C.*

Table 2. Real Property Parcels Subject to Manatee County MCD Millage

Manatee County MCD	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23
Just Value of Parcels ($Mil.)	$49,288	$52,000	$56,429	$78,160
Real Property Parcels Subject to Millage	191,221	196,980	202,556	210,618
Taxable Value of Parcels ($Mil.)	$35,839	$38,463	$41,669	$49,182

Source: FDOR.

Tangible Personal Property Data

In addition to real property, tangible personal property accounts subject to district millage totaled 27,304 accounts in FY 2022-23, down 1% since FY 2019-20 (**Table 3**). However, the taxable value of tangible personal property accounts also increased in FY 2022-23 by 21% compared to FY 2019-20 due to higher property values.

Table 3. Tangible Personal Property Accounts Subject to Manatee County MCD Millage

Manatee County MCD	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23
Just Value of Accounts ($Mil.)	$3,540	$3,687	$3,705	$4,235
Tangible Personal Property Accounts Subject to District Millage	27,638	27,120	27,304	27,304
Taxable Value of Accounts ($Mil.)	$3,109	$3,249	$3,265	$3,775

Source: FDOR.

History and Composition

Manatee County MCD was established in 1947 by an act of the Florida Legislature,[3] which was approved by the voters through a public referendum. The district currently operates pursuant to Chapter 2002-332, *Laws of Florida*, and is also subject to Chapter 189, *Florida Statutes*, given its status as an independent special district; Chapter 388, *Florida Statutes*, setting forth the requirements for creating and operating mosquito control districts in this state; and Chapter 5E-13, *Florida Administrative Code*, setting forth rules adopted by the Department of Agriculture and Consumer Services (DACS) for mosquito control program administration.

The Manatee County MCD Board of Commissioners is comprised of three elected members, each serving a four-year term. The positions currently include a chairperson, vice chairperson, and secretary/treasurer. As of the date of this report, there are no vacant positions.

Pursuant to Chapter 388, *Florida Statutes*, the powers and duties of the board of commissioners include:

- Performing all duties necessary for the control and elimination of mosquitoes and other arthropods of public health importance.
- Being authorized to provide for the construction of canals, ditches, drains, dikes, fills, and other necessary works, and to install and maintain pumps, excavators, and other machinery and equipment.
- Preparing and adopting a district budget.
- Being authorized to hold, control, and acquire by gift or purchase for district use any real or personal property.
- Having all the powers of a body corporate, including the power to contract and to employ a director, employees, and others.

Section 388.151, *Florida Statutes*, requires the board of commissioners to hold regular monthly meetings. The board met seven times during the seven months between October 1 and April 30, 2023. Manatee County MCD holds consistent monthly meetings, with minutes and agendas published online following each assembly. In

[3] Chapter 24667-1003, *Laws of Florida*.

addition to regular monthly meetings, special meetings may be called to discuss the draft and final budget for the upcoming FY, as well as special topics like district banking practices and aerial activities. **Table 4** summarizes the number of meetings that the board held during the review period.

Table 4. Manatee County MCD Commissioner Meeting Counts

Commissioner Meetings	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[1]
Monthly Meetings	12	12	12	7
Special Meetings	2	2	2	0

Source: TBG Work Product, MCD. 2023 YTD through April.
[1] 2023 YTD through April.

The board's meetings are open to the public and noticed and conducted in accordance with s. 189.015, *Florida Statutes*.

Intergovernmental Interactions

Manatee County MCD collaborates with national and state peers on research and mosquito control activities on a regular basis. Techniques developed by Manatee County MCD in 2014 were used by the Centers for Disease Control and Prevention in 2016 to help control the Zika outbreak in Miami-Dade County related to an influx of international travel. In addition, Manatee County MCD works with the University of Florida on non-target species impacts, including testing the effects of mosquito control chemicals on native bee populations.

Manatee County MCD works closely with local, county, and state institutions in several ways:

1. Manatee County MCD works with the Manatee County Department of Health and the Florida Department of Health (DOH) for arbovirus disease response by providing vector surveillance and efficient control methods.
2. Manatee County MCD works with the Florida Department of Environmental Protection (DEP), the Florida Fish and Wildlife Conservation Commission (FWCC), Southwest Florida Water Management District (SWFWMD), and the National Wildlife Refuge to assist with vector management on protected lands to promote public health and maintain the pristine environment.
3. Manatee County MCD also works with DEP concerning mosquito control in the Terra Ceia Aquatic Preserve, which is surrounded by residential areas and popular vacation spots. The Preserve is a significant mosquito habitat, but Manatee County MCD activities are sufficient to control and mitigate impacts on residents and visitors.
4. Manatee County MCD works with the DACS, providing detailed budgets tracking expected revenues and expenditures each fiscal year.

Manatee County MCD has not received any state grants or federal funding in FY 2021-22, or in the past three fiscal years.

Resources for Fiscal Year 2021-22

The published FY 2021-22 millage rate established by Manatee County MCD was 0.1997. The district received $8.62 million in revenues and spent $6.28 million in FY 2021-22. The district had 33 paid staff (30 full-time staff and three commissioners) and owned or leased 33 vehicles and one facility with 6 buildings in FY 2021-22 (**Table 5**); this does not include the facility that is under construction.

Table 5. Manatee County MCD Resources for FY 2021-22

Resource Item	FY 2021-22 Amount
Millage Rate	0.1997
FY 2021-22 Revenues	$8.62 million
FY 2021-22 Expenditures	$6.28 million
Number of Paid Staff	33
Vehicles	3 helicopters, 1 boat, 27 trucks and vans, 2 utility vehicles
Equipment	Field equipment: 120 Lab equipment: 20 Office equipment: 5 Surveillance Equipment: 59 traps, 66 sentinel chickens, 12 coops
Facilities	1 facility with 6 buildings

Source: TBG Work Product, MCD.

2. Findings

Service Delivery

Manatee County MCD follows industry standards for Integrated Pest Management and provides an array of mosquito control services consistent with the district's charter and statute; other local government entities located wholly or partially within Manatee County MCD do not provide similar mosquito control services.

To assess the delivery of services in the district, The Balmoral Group (TBG) requested information on the geographic characteristics of the district; other local governments to which the district provides services or with which it coordinates efforts; the services provided by the district; similar services provided by other entities; district studies or evaluations of alternative service delivery methods including consolidation of services with other government entities; unique contributions from the district relative to the county or municipalities; and local stakeholder perceptions of the relative value of the district's services. In addition, TBG requested information from representatives of the Board of County Commissioners, local health department, and local parks and recreation department on their perceptions of the district's service delivery and efficiency.

Overview of Services

Most mosquito control programs use an Integrated Pest Management (IPM) approach to control mosquito populations, which targets the different stages of a mosquito's life cycle with various prevention and control measures. IPM addresses eight areas. Surveillance of mosquito populations is an essential component of all IPM

programs with chemical treatments based on the surveillance findings. IPM can also include source reduction (e.g., container disposal, water/impoundment management), larviciding and adulticiding (using ground and/or aerial treatments), biological and alternative control, and disease surveillance. Research and education are also important components of IPM programs. See attachment titled, "Integrated Pest Management" for more information. Manatee MCD conducts activities in eight areas of IPM.

TBG reviewed documentation, interviewed staff and management, and inspected field facilities to assess delivery of services. District services include conducting ground and aerial surveillance to determine areas within the district that warrant treatment due to larvae and mosquito populations exceeding established thresholds. Surveillance methods include the following activities:

- Utilizing aerial operations to measure mosquito populations.
- Conducting daily landing counts at 29 sites across the district. If the number of mosquitoes meets a certain threshold, treatment in the area is initiated.
- Conducting both daily and weekly mosquito trap collection and analysis. If the number of mosquitoes in the trap meets a certain threshold, treatment is initiated in the area. Daily collection is observed at 16 sites and weekly trap collection is conducted at 59 sites.
- Obtaining blood samples on a weekly basis from sentinel chickens (disease surveillance) that are placed throughout the district. The samples are sent to the state laboratory in Tampa and tested for antibodies of arboviruses. If antibodies are observed, the district knows that virus is circulating in the mosquito population and treatment is initiated. The district coordinates with the local and state health departments.
- Completing follow-up and investigations relating to citizen complaints. The district's representatives conduct field visits to the areas of concern to assess treatments needed.

Mosquito control treatments implemented by the district include the following activities:

- Source reduction activities include emptying containers with standing water when responding to resident service requests; this can include collection of waste tires. In addition, the district breeds mosquito-eating fish in a pond at their facility and distributes the fish to the public as a method of source control.
- Treating the distinct habitats of Manatee County are a challenge, but the MCD has different management approaches depending on whether treatment is needed for saltmarsh, urban, or freshwater areas.
- Daytime mosquito breeding site inspection and larvicide treatment. Larviciding is done by hand-held sprayer for areas under half an acre, by truck for ditches and 1 to 2-acre sites, or by helicopter for 1 to 200-acre sites. On average, about 10,000 to 30,000 acres are larvicided by helicopter per year.
- Nighttime adulticide when adult mosquitoes are most active, most residents are inside, and non-target species are least active. Adulticiding is done with hand-held sprayer for backyards by resident request in the daytime, by truck in urban and semi-urban areas with good street networks (averaging 150,000 acres per year), or by helicopter in all areas of the county (ranging from 500,000 – 1,500,000 acres per year, or 850,000 acres on average).

- Operational research to improve the science of mosquito control in areas such as (1) Resistance management, (2) Non-target impact studies, (3) Meteorology and spray cloud dynamics, (4) Novel approaches to controlling *Ae. Aegypti*, (5) Evaluation of new, non-chemical control methods (In2Care Trap), and (6) New product evaluations required by the U.S. Environmental Protection Agency for commercial use.

A summary of the eight areas of IPM in which Manatee County MCD conducts activities is set forth in **Table 6**.

Table 6. Manatee County MCD Services Overview

Integrated Pest Management Service	Manatee County MCD Services Provided
Mosquito Surveillance	Weekly ground and aerial surveillance using trap collection and analysis
Source Reduction	Emptying containers when responding to resident service requests
Larviciding	Application of larvicides in using helicopters
Adulticiding	Delivery of ultra-low volume (ULV) insecticide in helicopters and nighttime aerial ULV adulticiding using helicopters
Disease Surveillance	Regular blood sample collection from sentinel chickens and submittal of samples to state laboratory in Tampa
Biological Control	Mosquito-eating fish hatchery (Gambusia)
Mosquito Control Research	Ongoing research efforts to identify new methods and technologies to improve treatment efficiency
Outreach and Education	Numerous education programs and outreach efforts coordinated with the County; ongoing employee training

Source: TBG Work Product, Manatee County MCD.

Analysis of Delivery of Services

Manatee County MCD delivers services that are within the scope of its charter and purposes outlined in applicable laws and regulations. Manatee County MCD provides services in seven areas of IPM, as described above, and all services are directed toward the abatement and control of mosquitoes. No services were noted that fall outside the district's charter or applicable laws and regulations. As described above, the district covers an area that is largely rural, but development is expanding into previously undeveloped areas and encroaching on historical mosquito habitats, increasing the resources needed to maintain public health and limit nuisance as the human population grows. TBG requested information from representatives of the Board of County Commissioners, local health department, and local parks and recreation department on their perceptions of the district's service delivery and efficiency, but stakeholders did not provide substantive responses after multiple contacts. The mosquito control expert retained by TBG for this review did not identify any alternative methods for providing the district's services that would reduce the district's costs or improve the district's performance.

Comparison to Other Services

Other local government entities located wholly or partially within Manatee County MCD do not provide similar mosquito control services. TBG interviewed staff and reviewed documents available online to establish if services could be or are redundant to or overlapping with county and municipal government services. Services similar to those provided by Manatee County MCD are not provided by county and municipal governments located within the district. The district's operations are fairly sophisticated, and the local government is likely not equipped to

deliver the services that the district oversees and administers. In addition, local pest control contractors are not approved to use the same level of chemicals that Manatee County MCD is.

Considerations for Consolidations

Consolidation of operations in not recommended for Manatee County MCD based on the findings of this review. Manatee County MCD operates throughout the entirety of Manatee County and no similar service has been identified for consolidation.

Resource Management

The Manatee County MCD has demonstrated effective management of its resources and utilizes them in an efficient manner to achieve its goals and objectives; increasing revenues and expenditures mirror population growth in the county and district resources will need to continue to expand to meet growing service needs.

To assess the district's resource management, TBG analyzed information on revenue sources, revenue and expenditure trends and their possible causes; analyzed staffing trends and their possible causes; requested data on services delivered by district staff vs third-party contractors for the last three fiscal years; analyzed equipment inventory and capital investment trends; reviewed the activities the district conducts to manage costs and plan personnel; requested information on resident feedback survey data related to finances and spending by the district; reviewed performance reviews and audits; and interviewed district staff and board members.

Current and Historic Revenues and Expenditures

Manatee County MCD's revenues and expenditures have been steadily increasing; revenues have exceeded expenditures in the current and past three fiscal years. To review current and historic revenues and expenditures of the Manatee County MCD, TBG requested and received financial information from Manatee County MCD from FY 2019-20 through FY 2022-23. Funding is primarily comprised of ad valorem taxes. The Manatee County Property Appraiser, with approval from the Florida Department of Revenue, certifies the county's tax roll each year and provides the information to the Manatee County Tax Collector, which in turn collects monies authorized under the Manatee County MCD's taxing authority. Millage rates are set each year by the Manatee County MCD's board of commissioners. The Manatee County Mosquito Control District's fiscal year begins October 1st and ends September 30th.

In addition, TBG interviewed Manatee County MCD staff and reviewed documentation both online and as provided by Manatee County MCD's accounting and operation systems. Revenues have steadily increased over time, going from $6.02 million in FY 2019-20 to $10.15 million through May of FY 2022-23, the majority of which came from ad valorem taxes and a small amount from other sources (**Table 7**). The recent, substantial increase in revenues for FYs 2021-22 and 2022-23 reflects an increase in the millage rate by the district's board of commissioners (i.e., the rate was increased from 0.1600 in FY 2020-21 to 0.1997 for FYs 2021-22 and 2022-23) for purposes of constructing a new facility. Expenditures increased from $4.64 million in FY 2019-20 to $6.28 million in FY 2021-22. Other expenditures include debt service, which increased by almost $1 million from FY 2019-20 through FY 2021-22. Expenditures for FY 2022-23 as of May 2023 were $4.51 million.

Table 7. Revenues and Expenditures

Revenues and Expenditures (in $Mil.)	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[2]
Revenues	**$6.02**	**$6.41**	**$8.62**	**$10.15**
Ad Valorem	$5.93	$6.35	$8.53	$9.90
Other Sources	$0.09	$0.06	$0.09	$0.25
Expenditures[1]	**$4.64**	**$5.70**	**$6.28**	**$4.51**
Administrative Costs	$0.60	$1.72	$1.21	$0.57
Direct Program and Activity Costs	$3.51	$3.10	$3.62	$3.19
Other Expenditures	$0.52	$0.88	$1.45	$0.75

Source: TBG Work Product, Manatee County MCD.
[1] Categorization of costs was completed by Manatee County MCD based on an outline provided by TBG to ensure consistency across reports.
[2] 2023 YTD through May.

General trends for Manatee County MCD's historical revenues and expenditures show revenues routinely exceed expenses by more than $1 million, indicating that the district has been carefully managing operating costs and reserves. Revenues collected by Manatee County MCD increased during the last two fiscal years given rising property values and increased millage rates. Revenue and expenditure trends show the rise in development with the gain of millage revenue, and the rise in expenses associated with expansion of services for these new developments, indicating that revenues to support the district's operations should be sufficient in the coming years.

Administrative Costs

Expenditures on administrative staff and other costs increased significantly in FY 2020-21 and FY 2021-22 with the construction of the new facility. Manatee County MCD provided a breakdown of total expenditures by administrative and other program costs. **Table 8** summarizes the detailed administrative cost data provided by the district. Land and buildings increased the most, while operating expenses and supplies and materials decreased year-over-year. Administrative expenditures in FY 2020-21 were significantly higher than the other years due to the construction of a new facility, and that increase is also seen in the rise of debt service cost in FY 2021-22. Total administrative and other costs for FY 2022-23 through May were $572,198.

Table 8. Administrative Cost Data

Expenditure Category[1]	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[2]
Personal Services	$206,987	$234,535	$252,743	$184,912
Personal Service Benefits	$126,308	$131,121	$147,964	$108,668
Operating Expenses	$104,011	$96,924	$76,003	$76,514
Travel, Utilities, Repair, & Maintenance	$95,644	$67,184	$75,370	$61,037
Supplies and Materials	$20,972	$4,374	$6,119	$1,913
Land and Buildings	$50,000	$1,182,661	$648,961	$139,154
Total	**$603,922**	**$1,716,798**	**$1,207,159**	**$572,198**

Source: TBG Work Product, Manatee County MCD.
[1] Categorization of administrative and other costs was completed by Manatee County MCD based on an outline provided by TBG to ensure consistency across reports.
[2] 2023 YTD through May.

Direct Program Costs

Expenditures on direct program costs were stable from FY 2019-20 through FY 2021-22, ranging between $3.1 to $3.6 million. They accounted for about 65% of total expenditures on average. Manatee County MCD provided a breakdown of total expenditures by direct program costs, which are summarized in **Table 9**. Direct personal services costs have remained fairly stable, decreasing 4% from FY 2019-20 to FY 20-21 but rising back up 2% by FY 2021-22. The supplies and materials category are where costs have increased the most. In FY 2021-22, supplies and material costs were 27% higher than in FY 2019-20. Items such as direct operating expenses and travel, utilities, repair, and maintenance saw significant decreases from FY 2019-20 to FY 2021-22, though for FY 2022-23 the travel, utilities, repair, and maintenance costs are already higher than in FY 2021-22. However, total direct costs in FY 2021-22 were similar to those in FY 2019-20 due to higher supplies and materials expenditures.

Table 9. Direct Program Cost Data

Expenditure Category[1]	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[2]
Personal Services	$1,423,067	$1,370,442	$1,403,018	$1,024,038
Personal Service Benefits	$605,913	$629,002	$709,797	$521,293
Operating Expenses	$35,798	$24,708	$11,226	$14,622
Travel, Utilities, Repair, & Maintenance	$554,432	$346,197	$371,056	$401,519
Supplies and Materials	$753,047	$666,851	$953,553	$1,000,962
Capital Outlay	$141,563	$57,960	$174,804	$223,523
Total	**$3,513,819**	**$3,095,160**	**$3,623,455**	**$3,185,956**

Source: TBG Work Product, Manatee County MCD.
[1] Categorization of direct program costs was completed by Manatee MCD based on an outline provided by TBG to ensure consistency across reports.
[2] 2023 YTD through May.

Contracts for Services

Manatee County MCD contracts for only a small portion of its operations, equating to $26,746, or 0.4% of total expenditures in FY 2021-22. TBG reviewed documentation provided by Manatee County MCD to determine what services were contracted rather than conducted in-house. Contracted expenses include copier and printer leases and maintenance payments, annual fire extinguisher inspections, accounting software fees (Abila), accounting and auditing services, water cooler rentals, alarm monitoring, disposal/environmental fees, annual post office box rental, drum pick-up, cylinder leases, and service contracts. A significant decrease in contracted services was observed between FY 2019-20 and FY 2021-22, primarily due to fees the district had to pay for environmental assessments and other costs associated with the planning and construction of the district's new facility. **Table 10** summarizes contracted services from the district's income statements.

Table 10. Summary of Contracted Services

Expenditure Category	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[1]
Professional Services	-	-	-	-
Legal & Engineering Services	$45,197	$34,741	$4,475	$3,775
Accounting & Auditing	$11,900	$13,800	$11,950	$12,000
Other Contractual Services	$33,798	$24,131	$10,321	$13,943
Total	**$90,895**	**$72,672**	**$26,746**	**$29,718**

Source: TBG Work Product, Manatee County MCD.
[1] 2023 YTD through May.

Staff

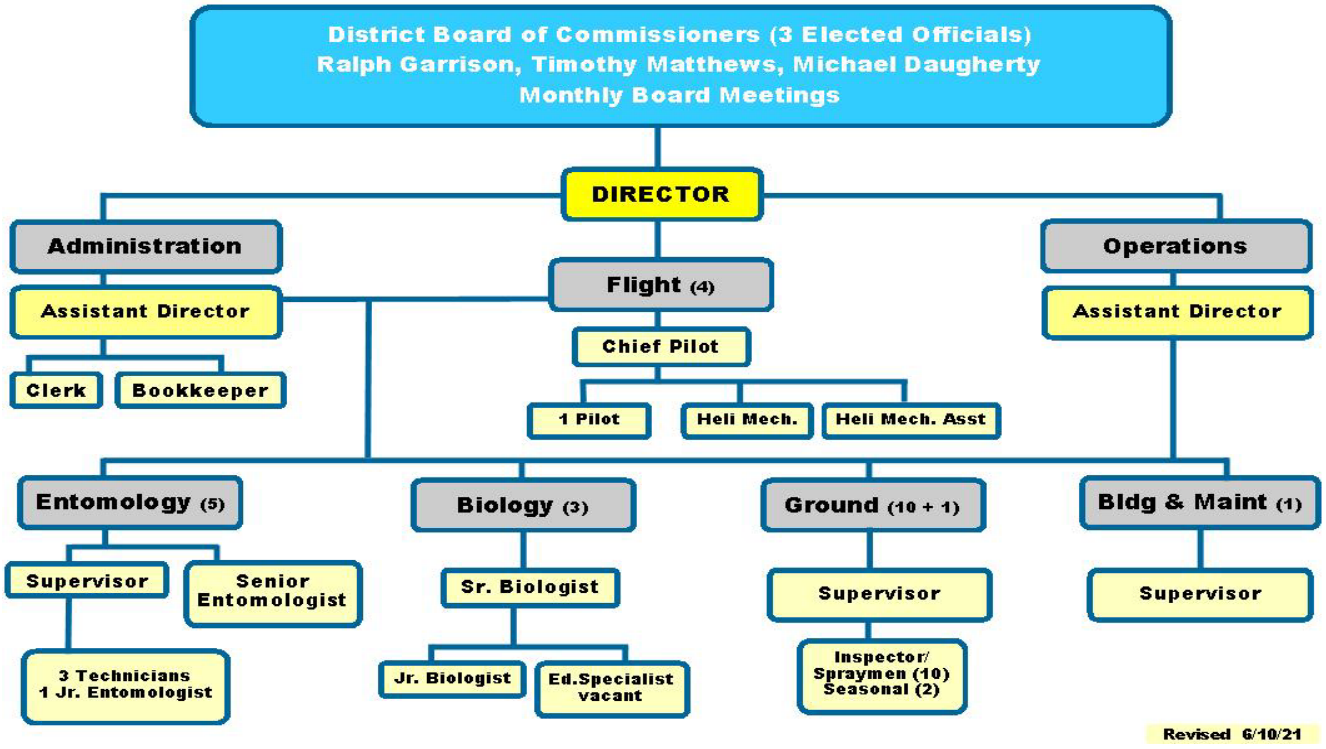
Manatee County MCD employed 33 in-house staff members in FY 2021-22 with a range of responsibilities and expertise. The district had 33 paid staff members in FY 2021-22 across several types of positions (including the commissioners) representing a wide range of responsibilities and expertise, including management, scientific, and technical roles. The district had no volunteers, but does run a seasonal staffing program in the summer to recruit new talent. Paid positions are listed in **Table 11**, and an organizational chart is presented in **Figure 3**. The table reflects the five vacancies that existed in FY 2021-22.

Table 11. Manatee County MCD Staff Positions

• 3 Commissioners • Director • Assistant Director of Administration • Assistant Director of Science and Technology (vacant) • Bookkeeper • Clerk	• Chief Pilot • Pilot • Helicopter Mechanic • Plane & Grounds Manager • Entomologist Manager • Senior Entomologist • Entomology Tech III • Entomology Tech II	• Junior Entomologist (vacant) • Inspector Supervisor • Inspector Sprayman • Senior Biologist • Junior Biologist • Biologist Tech (vacant) • Laborers

Source: Manatee County MCD.

Figure 3. Manatee County MCD Organizational Chart



Source: Manatee County MCD.

Analysis of Program Staffing Levels

Manatee County MCD staffing levels have been relatively stable in the current and past three fiscal years, but some vacancies still exist; upcoming retirements in highly specialized positions will require the district to address staffing needs over the next five years. District staff report that they routinely evaluate program staffing levels and have been successful in recruiting qualified staff and achieving high levels of retention at most positions. There are two vacant positions that are budgeted but not yet filled as of FY 2022-23 (**Table 12**). Space at the current facility has led to hiring limitations, and staffing needs may be revisited once the new facility is built. In addition, district staff reported that upcoming retirements over the next five years of staff in highly specialized, technical positions will create challenges due to the highly competitive workforce climate. The district is preparing for these retirements and planning to hire potential replacements at least one year prior to retirement dates for all management and leadership positions to ensure a smooth transition, knowledge transfer, and uninterrupted public service.

Table 12. Manatee County MCD Staff Counts

Employee Counts	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[1]
Commissioners	3	3	3	3
Full Time	30	31	30	29
Part Time	0	0	0	2
Contracted	6	6	6	4
Volunteers	0	0	0	0
Vacancies	3	4	5	2
Total	**42**	**44**	**44**	**40**

Source: TBG Work Product, MCD. 2023 YTD through April.

[1] 2023 YTD through April.

Equipment and Facilities

Equipment and vehicles owned by Manatee County MCD are currently sufficient for operations and are being serviced regularly to maintain and maximize efficiency in operational capabilities. Operations have outgrown current facilities; a new campus is currently under construction to address increased service operations and support staff needs. To review the equipment and facility trends of Manatee County MCD, TBG analyzed documentation provided by the district, interviewed district staff and visited the facility housing equipment and vehicles.

Manatee County MCD has made a few large purchases over the last few years. In FY 2017-18, two Bell-407 helicopters were purchased from Lee County MCD for $1.7 million each or $3.4 million total, replacing two smaller, 1978 Hughes-500D helicopters that were becoming increasingly more difficult to maintain. One Hughes-500D helicopter from 1980 is still in service. Recent vehicle purchases include a 2022 GMC Sierra 2500HD ($40,107) and a 2022 GMC Sierra 1500 ($37,737). In total, the district owns 27 trucks and 2 utility vehicles.

Equipment purchases in FY 2021-22 included a Toyota forklift ($36,016), Leica microscope and microsystems computer and camera package ($24,935), reciprocating air compressor ($3,289), and a new computer ($1,350).

Manatee County MCD owns two facility sites, one built in 1964 in Palmetto, Florida and a replacement campus currently being constructed in Ellenton, Florida. Manatee County MCD staff and operations have outgrown the

4.2-acre 1964 facility, which is expected to be sold once operations are moved to the new location. Construction of the new 30-acre facility began in September 2022, with an estimated completion date of October 2023. The land was purchased in January 2021 for $1 million. The total cost to finance the acquisition, construction, and installation of the new administrative and operational facility is $14.3 million, as stated in the district's FY 2021-22 Independent Auditors' Report.

Table 13 summarizes equipment and facilities counts by fiscal year.

Table 13. District Vehicles, Equipment, and Facilities

	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[1]
Vehicles	**31**	**31**	**33**	**33**
Helicopters	3	3	3	3
Boats	1	1	1	1
Trucks and Vans	25	25	27	27
ATVs and Utility Vehicles	2	2	2	2
Equipment	**147**	**149**	**153**	**153**
Field Equipment	125	126	128	128
Lab Equipment	19	19	20	20
Office Equipment	3	4	5	5
Facilities	**1**	**1**	**2[2]**	**2[2]**
Buildings	6	6	6	6

Source: TBG Work Product, Manatee County MCD.
[1] 2023 YTD through April.
[2] Second facility site under construction.

Manatee County MCD also has several different types of surveillance equipment, including mosquito traps, sentinel chicken coops, and chicken counts. The district has 12 sentinel chicken stations placed strategically throughout the county. The supplies of this equipment have remained constant during the current and past three fiscal years (**Table 14**).

Table 14. Surveillance Equipment

Equipment	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23[1]
Mosquito Traps	59	59	59	59
Sentinel Chicken Coops	12	12	12	12
Chicken Counts	66	66	66	66

Source: TBG Work Product, MCD. 2023 YTD through April.
[1] 2023 YTD through April.

Strategic or Other Formal Plans for the District's Future

Manatee County MCD has created a strategic plan outlining its goals for the five-year span of 2020-2025, with measures to account for the expansion of district operations and services. The district's 5-Year Strategic Plan includes a detailed list of projects, protocols, and considerations to expand and improve mosquito control operations in Manatee County, including: (1) Constructing a new 30-acre campus, to replace the current 4.2-acre 1964 facility and improve the effectiveness of MCD operations and keep pace with the growing county and service area; and (2) Hiring new staff to fill key positions well ahead of known employee retirement dates to ensure a

seamless operation. In addition, the district is working on new ways to encourage employee retention and plans to re-evaluate wages compared to current economic conditions in Manatee County.

Additional future plans include: (3) Adopting new and modern software systems to increase operational efficiency, (4) Establishing cooperative agreements with Public Land Managers to facilitate Manatee County MCD operations, (5) Inspecting existing capital ahead of the move to the new facility, (6) Regularly monitoring chemical resistance in mosquito populations to maintain effectiveness of larvicide and adulticide protocols, (7) Educating residents on mosquito control safety and best practices, and (8) Creating a response plan against extreme weather conditions.

Previous Performance Reviews, Financial Audits, and Resident Feedback Surveys

Manatee County MCD had no identified issues with financial audits. Manatee County MCD audits report no material findings nor weakness in internal controls. No performance reviews were identified and resident surveys have not been conducted. Analysis of the district's financial audits was conducted by reviewing financial audits provided by Manatee County MCD. Review of the Independent Auditors' Reports from the last three fiscal years (FY 2019-20 through FY 2021-22) showed no findings or issues. Statements and materials provided to auditors fairly represent Manatee County MCD's financial position. The district's revenues routinely cover costs and the district does not expect any interruption in tax collections due to Hurricane Ian.

Manatee County MCD staff routinely present to community groups/civic associations and run school-based education programs to teach about mosquito control. While this practice has lapsed since 2020, the Manatee County MCD has also staffed booths at County and State Fairs for many years. Residents have several direct ways to contact the Manatee County MCD, including by phone, email, and monthly commissioner meetings. District staff reported that customer service is an important goal of the district but they do not use public comment to commissioners or resident complaints as a performance metric because there is not a direct correspondence between number of customer complaints and number of mosquitoes trapped by the district.

Manatee County MCD has not implemented resident surveys at this time.

Analysis of Management Reports/Data and Performance Information

The review of Manatee County MCD reports suggest the district's board of commissioners conducts regular performance monitoring. To assess management reporting and performance information, TBG reviewed documentation provided by Manatee County MCD, including the 5-Year Strategic Management Plan and monthly board meeting agendas. Board meeting agendas indicate routine discussion of mosquito control activities by the district, identification of issues related to district activities and needs, and discussion of various opportunities for the district and its staff. For example, board meetings included discussions of purchases of vacant land; property and equipment to be liquidated; upcoming conferences and training opportunities for staff; updates on current construction projects; and relevant legislative issues.

Evaluation of Cost, Timing, and Quality of Current Program Efforts

Manatee County MCD conducts activities to improve the effectiveness and efficiency of programs and manage program costs. To assess cost, timing, and quality of program efforts, TBG reviewed documentation provided by Manatee County MCD, publicly available data and reports, interviewed district staff, and visited the district's facility. In addition, representatives of other MCD's interviewed by TBG commented (without prompting) on Manatee County MCD's effectiveness in mosquito control. Current program efforts include continuous monitoring

of programs for effectiveness, such as monitoring for insect resistance to specific chemicals, monitoring the impacts of treatments on non-target species, and customizing vehicles to improve the efficiency of operations. An example of the latter includes using a truck to refuel helicopters in the field to avoid backtracking and improve treatment efficiency.

In addition, Manatee County MCD's achievement of general goals set forth in the 2020-2025 strategic plan shows favorable performance. For example, the district has completed the purchase of 30 acres of land to expand operations and provide additional services and capacity to maintain mosquito control in Manatee County into the future. Construction on the new facility has begun, and is expected to be complete by October 2023. In addition, as of this writing, there have been no arbovirus-related deaths in Manatee County in the last several years.

On a day-to-day basis, Manatee County MCD uses a myriad of approaches to monitor and measure its effectiveness. Manatee County MCD monitors on a real-time basis the completion rate of missions, the area treated by truck, manually, or by aerial and other parameters. Computers in their operation center, as well as hard copy reports, are constantly updated to reflect current operational performance. A few examples include the ongoing monitoring of percentage completion of surveillance areas for the month, or percentage complete of service requests. Quantum Geographic Information System (QGIS) applications have improved visual identification of mosquito clusters from trap data and resident complaints over the last few years, allowing for the creation of heat maps to identify where resources should be allocated.

Surveillance is conducted through numerous traps spread throughout the county, as well as resident service requests. Sentinel chicken flocks are maintained for surveillance as well; lab technicians test their blood for any diseases that may arise in order to prevent the spread of it to humans and livestock. The district's capability for in-house testing produces faster test results than can be received from the Tampa DOH lab, thereby enabling district missions to address mosquito populations and potential disease outbreaks to be carried out more quickly. With mosquitoes able to multiply rapidly, and in a highly populated and tourism-dependent area, the ability to rapidly react is very valuable and effective. The district also submits sentinel chicken blood samples to the Tampa DOH for testing for its mosquito-borne disease surveillance program.

Goals, Objectives, and Performance Measures and Standards

Manatee County MCD has clearly defined, measurable goals and objectives that adequately address its statutory purpose; the district has favorable performance for service call responses and keeping arbovirus counts low.

To assess the district's goals, objectives, performance standards, and performance measures, TBG requested and reviewed the district's charter; requested and reviewed the district's strategic plan and requested the last three years of annual reports; requested information on performance measures and standards and records of the current and previous three fiscal years' measures, standards; requested records of success or failure to meet the standards; and evaluated the district's actual performance in meeting its goals and objectives. TBG requested previous performance reviews and requested and reviewed audits. In addition, TBG interviewed district staff and relevant local government entities about district performance and requested any available results of district-generated resident feedback surveys conducted during the current and previous three fiscal years.

Goals

Manatee County MCD has a set of goals specified in its Strategic Management Plan.

Table 15 provides the district's specific goals across the priority focus areas.[4]

Table 15. Manatee County MCD Goals

Priority Area	Goals
Disease/vector mosquitoes	Make every effort to eliminate all active vector populations and monitor efficacy of these efforts throughout the treatment period.
Nuisance Mosquito Control Practices	Good nuisance control is good disease control. Manatee County MCD will make every effort possible utilizing all aspects of Integrated Mosquito Management to control nuisance mosquito populations to ensure a high human quality of life. By extension, ensuring low populations of nuisance mosquito species often has the combined effect of also reducing populations of vector mosquito species.
Research	Actively engage in research including operational evaluations to optimize the district's ability to carry out its mission.
Public Awareness of Mosquito Control Practices	Ensure that county residents and visitors are educated on mosquito control practices, the services the district provides, and are satisfied with the service provided.
Economics and Accountability	Utilize public funds as fiscally responsible as possible while maintaining premier level of mosquito control services. Conduct all aspects of district business in a transparent and accountable manner. Ensure that district finances are adequately managed to provide for long-term financial stability and sustainability.
Relationships	Cultivate strong, mutually beneficial relationships with local, state, county, and federal agencies.
Employee Retention	Ensure management makes every effort to maintain a highly motivated, educated and productive staff that is aware of, and has access to, the latest materials, technologies, and techniques in vector control.
Political Responsibility	Ensure that the district commissioners operate in an ethical manner, making sound decisions based on current and complete information.
Accountability	Conduct all aspects of district business in a transparent and accountable manner.
Finances	Ensure that district finances are adequately managed to provide for long-term financial stability and sustainability.

Source: TBG Work Product, Manatee County MCD.

Objectives

Manatee County MCD activities include ground and aerial surveillance, larvicide (using products to kill mosquito larvae), adulticide (using products to kill adult mosquitoes), and research into new and novel approaches to mosquito control as part of its responsibility to curb mosquito populations that may become a nuisance or a threat to public health in Manatee County.

The Manatee County MCD's 5-Year Strategic Plan objectives include:

[4]Manatee County Mosquito Control District Strategic Management Plan: Calendar Year 2020-2025; MSSMP.pdf (manateemosquito.com)

1. Infrastructure:

    a. Facilities/Campus: Manatee County MCD currently operates from a facility initially built in 1964 with multiple physical additions over the past 55 years. The facility, while well maintained, has become too small for effective district operations with a growing county and service area. The District plans to purchase land and begin construction on a new facility/campus in the coming 5-year period. (Update: Campus construction began in September 2022 with an estimated completion date of October 2023).

    b. Helicopter: Manatee County MCD currently owns 2 Bell 407 and 1 MD500 helicopters for mosquito control services throughout the county to include activities such as applying mosquito larvicides and adulticides and conducting saltmarsh inspections. The Bell 407s were purchased in October 2018 to replace 2 (aging) MD 500s in order to provide greater lifting capacity and greater flight range to serve an expanding population. The 407s were purchased used for $3.4m and required an additional $100k each in FAA-required maintenance/updates but still represented a 50-60% savings over a new purchase. Two of the three MD500s were sold via broker for $1.1m. Future needs: Other than annual maintenance and inspections, no additional updates are planned for any of the 3 aircraft. Management must always be aware that a mechanical failure can occur at any time and repair can sometimes approach $1m depending upon severity even when repairs can be performed in-house. Reserve budgets must plan for this potential.

2. Employee Retention/Employee Retirement:

    a. Retirements: Manatee County MCD's largest and most valuable asset are the district's highly trained and dedicated employees. Of paramount importance to district management is employee morale and retention. Despite efforts to retain employees, retirement is inevitable and in the coming 5 years, the district anticipates the loss of the Chief Pilot, Lead Aircraft Mechanic, Manager of the Grounds Department, and several technicians in various departments. All positions will be difficult to replace due to the highly specialized nature of each position's respective work tasks and, increasingly, due to the highly competitive worker/economic climate. In preparation for these retirements, Manatee County MCD management needs to hire potential replacements at least 1 year prior to retirement dates for all management/leadership positions to ensure smooth transition, knowledge transfer and uninterrupted public service. Update: As of January 2023, the Chief Pilot retired in June 2022 and a replacement Chief Pilot had been hired and trained a year earlier. Retirement of the Aircraft Mechanic is anticipated May 2023 and a replacement A/V Mechanic was hired in October 2022. Retirement of the Grounds Department Manager is anticipated July 31, 2026.

    b. Salary Evaluations and Cost of Living Adjustments: Manatee County MCD adopted a formal salary structure for each position based upon a salary survey performed by the Indian River Mosquito Control District in 2018. The salary of each position should be re-assessed every 2-3 years with adjustments made based upon market demands. Similarly, Manatee County MCD management wants to ensure that employee salary, and more significantly, "dollar buying power" remains consistent or increasing each year relative to the US Bureau of Labor Statistics - Consumer Price

Index for the Tampa-St. Petersburg-Clearwater area. Annual salary adjustments should reference the CPI ensuring fair employee compensation.

3. Data Management Software: For the past 25-30 years, Manatee County MCD has managed all data (daily/weekly mosquito populations, public service requests, chemical applications, flight records, rainfall, mosquito-borne disease activity) with a Disk Operating System (DOS)-based, in-house generated program that is cumbersome and lacks a friendly user-interface. The district established an objective to adopt a more modern, custom-built data management software program, and in May 2021, fully integrated all data into MapVision (Leading Edge Associates).
4. Existing Capital Infrastructure: Manatee County MCD needs to remain vigilant on condition of existing capital infrastructure to ensure reliable delivery of public services.
    a. Vehicles: Due to the unique, rough, off-road environments where district vehicles are used, Manatee County MCD has found that a 5-year, 100k mile rotation is economically and mechanically justified. Efforts should be made to ensure this rotation is maintained.
    b. Truck-based Spray Systems: Many of the truck Ultra Low Volume (ULV) adulticide spray systems are now 15-20 years old and getting somewhat unreliable (electrically and mechanically). Efforts should be made to start replacing the 3-4 spray systems that are routinely used.
    c. Helicopter Spray Tanks: Chemicals used to spray for adult mosquitoes are known to be somewhat corrosive/damaging to fiberglass, metal, and rubber seals over long periods of exposure and in concentrated formulation. Efforts need to be made for annual inspections of these spray tanks and repairs to be made when needed. Management should budget for replacement when required. Some spray tanks are $100k or more.
5. Establishing Cooperative Agreements with Public Land Managers: One of the most significant producers of adult mosquitoes in the county are lands managed by the FWCC, DEP, SWFWMD, and other entities. For many years, some public land managers have been tentative towards local mosquito control efforts on public lands. Effort needs to be made by Manatee County MCD in the next five years to improve communications and efforts with these public agencies to work cooperatively towards common goals.
6. Lack of New Chemistries Available for Adult Mosquito Control/Chemical Resistance Management: For the past 40 years, there has been only two major classes of chemicals available for adult mosquito control which, without proper management could easily result in population-level chemical resistance. Efforts need to be made to regularly measure chemical resistance in mosquito populations throughout the county, regularly rotate chemistries applied to control adult mosquitoes, continue to place a heavy emphasis on larvicide management, and encourage/support manufacturers to develop new chemistries that can be U.S. Environmental Protection Agency (EPA)-approved/EPA-registered for public health mosquito control.
7. Public Opposition: As the county has grown in population, many new residents come from areas outside of Florida and are often unfamiliar with public-health mosquito control practices. This lack of knowledge sometimes leads to both fear and opposition to any type of mosquito control activity. Continual efforts

must be made to educate new residents on the proven safety and need for mosquito control using integrated mosquito management techniques.

8. Hurricane/Disaster Readiness: South Florida is a target for hurricane activity. Long-term and short-term efforts must be continually made to ensure Manatee County MCD is hardened for these potentially devastating impacts and can quickly re-establish a base of operations soon after weather conditions improve. Mosquito populations often spike after hurricane activity which hinders recovery efforts by first-responders and exposes residents to a public health threat when electrical infrastructure has often failed for weeks at a time. The district must be prepared to quickly mobilize helicopter, truck and personnel assets in response.

The district's goals and objectives address several problems. Manatee County MCD was founded to combat nuisance and disease-carrying mosquitoes within the county boundary. As human development disturbed mosquito breeding grounds and the county built a reputation for coastal tourism, Manatee County MCD has been called upon to reduce the threat caused by mosquito populations. Over the years, concern over balancing mosquito control with prevention of adverse effects to beneficial species like bees has been addressed by Manatee County MCD as well. In an attempt to assess the use of harsher treatment chemicals, the district ran 12 nighttime helicopter missions to test the effect of aerial adulticides on native bee populations and mosquitoes. The experiment found no difference in bee abundance in response to the aerial adulticides. On the other hand, mosquito populations were reduced significantly in response to the aerial adulticides. In addition, chemicals used by Manatee County MCD do not pose unreasonable risks to human health, according to the EPA. This has been a source of concern for residents. With increasingly dense development occurring in the county, additional operational capacity is needed. To address this need, Manatee County MCD has purchased land and begun development on a new facility and campus to better serve the growing community. To maintain services, Manatee County MCD has replaced several vital staff positions over the last few years in a timely manner as retirements would have left them vacant. Hiring new staff to take over pilot, mechanic, and other jobs one year in advance of employee retirements allowed for a seamless transition.

Expected benefits of these goals and objectives include reducing mosquito populations to help prevent disease, including serious mosquito-borne illnesses Zika virus, West Nile virus, Chikungunya virus, Dengue, and Malaria. At one time, Dengue had been eradicated in the United States. However, increased international travel has brought new diseases into Florida. Of the approximately 47 mosquito species found in Manatee County, about 10 to 15 of them require special attention. While most may be described as pest or nuisance control, three species are likely to become disease vectors if left unchecked: *Culex nigripalpus*, *Culex quinquefasciatus*, and *Aedes aegypti*. Manatee County MCD staff have identified these species through operational research, narrowing down efforts and improving efficiency. Mosquito species that carry arboviruses have historically been very difficult to control, so surveillance, larviciding, and adulticiding are vital to the process of mosquito control. To put it concisely, good nuisance control equates to good disease control in Manatee County. As a result, limiting the growth of adult mosquito populations helps avoid major nuisance and health hazards for residents.

Performance Measures and Standards

Manatee County MCD has not established formal performance standards and measures tied to each district goal and objective but does maintain and track performance over time for responses to service calls and prevalence of arbovirus in the district. TBG reviewed documents prepared by Manatee County MCD, including

its 5-year strategic plan, inspected operations and documents during a field visit, and reviewed records provided by Manatee County MCD and available online or through DACS. The district reports that it tracks mosquito-borne diseases and responses to service requests. While the district has defined several goals and objectives in its strategic plan, it does not currently have formally defined performance measures and standards with which to measure progress towards meeting its goals and objectives.

The following is a summary of the district's current performance measures and standards:

1. **Standard:** Zero human cases or deaths related to arboviruses acquired in Florida and detected in Manatee County.
   Measure: Manatee County MCD conducts weekly and daily arbovirus surveillance, and analyzes weekly Florida DOH reports to measure the success of their disease prevention efforts.

2. **Standard:** Address citizen requests for mosquito control efforts in a timely manner and improve response times over time.
   Measure: Number of service requests received and addressed with improved average response times. Further, Manatee County MCD uses a data mapping program called QGIS to visually plot resident complaints and identify where clusters may be occurring to help make informed decisions about the level of response needed. However, it should be noted that Manatee County MCD does not consider resident complaints or public comments to commissioners to be a metric for mosquito control in and of itself, as the average complaints received versus the average mosquitoes trapped do not correspond.

Analysis of Goals, Objectives, and Performance Measures

Manatee MCD shows favorable performance with respect to responses to service calls during the current and past three fiscal years and has maintained zero incidence of human arbovirus cases for the current and two of the past three full calendar years. Disease tracking is provided through the county health department to monitor for mosquito-borne diseases. This helps determine where surveillance should be conducted and where further cases may arise. It also assists in identifying the types of mosquitoes to treat. The district has successfully responded to all services calls in the current and each of the three past fiscal years and has kept arbovirus case counts low.

Table 16 illustrates performance measures that were able to be quantified by Manatee County MCD for the current and past three calendar years or current and past three fiscal years, as applicable. A summary of Manatee County MCD's performance measures and a brief assessment of whether standards were met is provided in **Table 17**.

Table 16. Performance Measures for Manatee County MCD

Performance Measure	CY 2020[1]	CY 2021[1]	CY 2022[1]	CY 2023[1]
Arbovirus Cases (Florida)	1	0	0	0
Arbovirus Cases (Travel)	0	0	2	0
Arbovirus Deaths	0	0	0	0
	FY 2019-20	**FY 2020-21**	**FY 2021-22**	**FY 2022-23[1]**
Service Calls	1720	1794	1756	856
Service Responses	1720	1794	1754	856

Source: TBG Work Product, MCD, DOH. 2023 YTD through April.
[1] Florida DOH data is provided by calendar year (CY).
[2] 2023 YTD through April.

Table 17. Assessment of Performance Measures and Standards for Manatee County MCD

Performance Measure	Performance Standard	Assessment
Number of service requests received and addressed with improved average response times	Address citizen requests for mosquito control efforts in a timely manner and improve response times over time	Standard met for responses to all service requests; assessment of the timeliness of responses to service requests is indeterminate due to lack of data.
Counts of arboviruses disease cases in humans as reported by DOH	Zero human cases or deaths from arboviruses acquired in Florida and detected in Manatee County	Standard met in the current and two of the past three calendar years; one case was identified in calendar year 2019-20.

Source: TBG Work Product, based on review of information provided by Manatee County MCD.

Perceptions of the District's Performance by Local Government Stakeholders, Residents and Other Relevant Local Stakeholders

Data on the perceptions of the Manatee County MCD's performance by residents and other stakeholders is limited. Manatee County MCD has not conducted resident surveys, but has received positive feedback in emails, public events, and through commissioner meetings. The district did not provide information on the specific feedback it has received from residents.

The district's current strategic plan states that as the county has grown in population, many new residents have come from areas outside of Florida and are often unfamiliar with mosquito control practices; this lack of knowledge sometimes creates fear and opposition among the public to mosquito control practices. The district has an established goal of making continual efforts to educate new residents on mosquito control techniques.

TBG requested information from representatives of the Board of County Commissioners, local health department, and local parks and recreation department on their perceptions of the district's service delivery and efficiency but did not receive responses after multiple contacts.

3. Recommendations

Discussion and Analysis

TBG analyzed findings by fiscal year to determine if revisions to district organization or administration can improve the efficiency, effectiveness, and/or economical operation of the district and presents several recommendations. TBG presents recommendations to invest in additional infrastructure and equipment to support more efficient operations and develop performance standards and measures with which to track achievement of its stated goals and objectives.

Infrastructure and equipment investments: The district needs additional storage and workspace that would improve its operations. During the field visit, several limitations of the current facility were discussed, and while the new facility should resolve many of these issues, several additional changes could be made to increase equipment and storage space and increase lab space. The current helicopter hangers are too small to easily store Manatee County MCD's two Bell-407 helicopters. It takes multiple staff to store them with very little room for error. A larger storage hanger is needed to protect these costly assets. Although only petty thefts have been reported, security is a consideration. The district currently has a gate and fence around the property, with storage facilities for most equipment and vehicles. Additional space to secure the district's property would better protect operational integrity. Some chemical labels now require cold storage. While Manatee County MCD has improvised with a small refrigerated storage room, the size is barely sufficient to hold biannual bulk chemical purchases. A larger facility would allow for better storage and management. Staffing levels appear sufficient, but there are several vacant positions being budgeted for that would improve district operations. Limited workspace has led these jobs continuing to be unfilled at this time. Additional lab and dedicated desk space would allow for more efficient analysis.

Performance Standards and Measures: Manatee MCD has developed a formal strategic plan with clear goals and objectives, but has not developed formal performance measures and standards tied to each district goal and objective. The district could establish clearly defined performance measures and standards with which to assess its progress towards achieving its goals and objectives.

Florida Coordinating Council on Mosquito Control: During TBG's review of the 15 independent MCDs, TBG found that most districts have not developed sufficient goals, objectives, or performance measures and standards. The Florida Coordinating Council on Mosquito Control was established by the Legislature to foster maximum efficient use of existing resources and to assist entities involved in mosquito control with best management practices. Membership on the council includes the agency heads for the DACS, DEP, and FWCC, the State Surgeon General, as well as representatives of federal agencies, the University of Florida's Florida Medical Entomology Laboratory, Florida MCDs, and others. The Legislature could direct the council to form a subcommittee consisting of mosquito professionals and researchers from around the state to develop model MCD goals, objectives, and performance measures and standards to assist MCDs with performance monitoring.[5]

Recommendations

Table 18 summarizes recommendations and associated considerations.

[5] Section 388.46, *F.S.*

Table 18. Recommendations with Associated Considerations

Recommendation	Considerations
Manatee County MCD could consider investing in: **(1) A larger storage hanger;** **(2) Additional space to secure property;** **(3) A larger storage facility; and** **(4) Additional lab and dedicated desk space for staff.**	• This recommendation could have a significant fiscal impact to the district.
The district could formalize additional performance measures and standards that would allow the district to monitor and track progress toward all its goals and objectives. Such performance information would facilitate the district in consistently monitoring its progress.	• This recommendation would require additional staff time and may result in additional administrative costs to the district.
The Legislature could consider amending s. 388.46, *Florida Statutes*, to direct the Florida Coordinating Council on Mosquito Control to form a subcommittee consisting of mosquito professionals and researchers from around the state to develop model goals, objectives, and performance measures and standards to assist MCDs with performance monitoring.	• This recommendation would require a statutory change. • This recommendation would impose additional workload on council members and staff. • The council's membership could assemble a committee with a broad range of expertise that could be ideal for the development of such model performance information. • While this guidance will assist all MCDs, it will be of particular benefit to MCDs that lack staff resources for the development of such performance information.

Source: TBG Work Product, based on review of information provided by Manatee County MCD.

4. District Response

Each independent MCD under concurrent review by TBG was provided the option of submitting a formal response letter for inclusion in the final published report. Manatee County MCD did not provide TBG with a response letter for inclusion in the final report.

Attachment 1

GLOSSARY OF TERMS
MOSQUITO CONTROL DISTRICT REVIEWS

September 2023

Prepared for

The Florida Legislature

Prepared by

The Balmoral Group

165 Lincoln Avenue

Winter Park, FL 32789

Attachment 1

Term	Definition
Adulticide	A chemical that kills adult insects, which is usually applied as a spray; depending on the circumstances, adulticide applications can be made from the ground (most commonly with ultra-low volume spray trucks) or from the air (with either fixed- or rotary-wing aircraft or helicopters)
***Aedes aegypti* mosquitoes**	The primary type of mosquitoes (commonly referred to as yellow fever mosquitoes) that spread Zika, dengue, chikungunya, and other viruses; because these mosquitoes live near and prefer to feed on humans, they are more likely to spread these viruses to humans than other types of mosquitoes
***Aedes albopictus* mosquitoes**	Although competent vectors of dengue, eastern equine encephalitis, and other viruses that affect humans, these mosquitoes (commonly referred to as Asian tiger mosquitoes) feed on animals as well as humans and are, thus, less likely to spread viruses to humans than *Aedes aegypti* mosquitoes
Altosid	The trade name for a mosquito larvicide that contains a synthetic version of the juvenile hormone insect growth regulator methoprene as the active ingredient
American Mosquito Control Association (AMCA)	A professional association that includes individuals working for mosquito control programs, academics conducting research on mosquitoes and other disease vectors, and industry representatives who support mosquito control efforts around the world; the AMCA is active in member training and educating the public on the health importance of mosquito control in the U.S. and beyond; the association is international in scope and has approximately 1,500 members
***Anopheles* mosquitoes**	A genus of mosquitoes with more than 400 species; female mosquitoes in approximately 40 of these species transmit malaria; this is the only genus of mosquitoes that can transmit malaria
Arbovirus	Arthropod-borne viruses that are transmitted to humans primarily through the bites of infected mosquitoes, ticks, sand flies, or midges; includes West Nile virus, eastern equine encephalitis virus, St. Louis encephalitis virus, dengue, chikungunya, Zika, California encephalitis group viruses, and malaria
Arthropod	As defined in Ch. 388, *Florida Statutes*, titled "Mosquito Control," "arthropods" are insects of public health or nuisance importance, including all mosquitoes, midges, sand flies, dog flies, yellow flies, and house flies

Attachment 1

Term	Definition
Barrier island	Land that separates the ocean from the mainland; frequently an estuary or a lagoon will be located between the barrier island and mainland
Biogents	A company that produces mosquito traps with the goal of reducing mosquito populations that are produced in container-type habitats
***Bacillus thuringiensis israelensis* (*Bti*)**	A naturally occurring bacteria commonly used as a mosquito larvicide since the 1980s
Chikungunya	A mosquito-transmitted disease caused by a virus that originated in Africa and is transmitted by *Aedes* mosquitoes; symptoms include fever, joint pain, and rash; the name chikungunya comes from the African Makonde language and means "to bend over in pain," which is the stance that many who contract this disease exhibit
***Culex* mosquitoes**	A genus of mosquitoes, several species of which serve as vectors of one or more important diseases of birds, humans, and other animals; the diseases they vector include West Nile virus, Japanese encephalitis, and St. Louis encephalitis.
***Culiseta melanura* mosquitoes**	A species of mosquitoes (commonly referred to as the black-tailed mosquito) that is significant due to its role in the transmission cycle of eastern equine encephalitis virus and potentially West Nile virus; these mosquitoes primarily feed on birds but can spread arboviruses to mammals as well
Dengue	A mosquito-transmitted virus that causes sudden fever and acute joint pain; occasionally occurs in Florida where the mosquito vector is *Aedes aegypti* or *Aedes albopictus*
Dibrom	The trade name for an organophosphate insecticide with the active ingredient naled; used in mosquito control as an adulticide and is typically applied with aircraft
Dipper	An approximately 300 ml container attached to an extension pole that is used to sample for the presence of mosquito larvae in aquatic habitats
Eastern equine encephalitis virus (EEEV)	A mosquito-transmitted virus that is rare but very dangerous when contracted by a horse, human, or other mammal; an average of 13 cases per year were reported in the United States from 2018-2022; approximately 30% of people with EEEV die and many survivors have ongoing neurologic

Term	Definition
	problems; in Florida, the freshwater swamp inhabiting mosquito *Culiseta melanura* is the primary vector of this disease
Fixed-wing aircraft	Commonly referred to as an airplane, these aircraft include stationary wings that provide lift for the aircraft; in mosquito control, these aircraft are commonly used for larvicide and adulticide applications
Florida Coordinating Council on Mosquito Control	An interagency council created in Ch. 388, *Florida Statutes,* in 1986, primarily to address issues concerning mosquito control applications, possible environmental impacts of control actions, and mosquito control management on State of Florida-owned lands
Florida Department of Agriculture and Consumer Services	The state agency that oversees and regulates mosquito control programs in Florida
Florida Department of Environmental Protection	The state agency responsible for coordinating efforts for intensified mosquito control on protected public lands when needed
Florida Department of Health (DOH)	The state agency responsible for implementing the Florida Sentinel Chicken Surveillance Program, reporting weekly data on the prevalence of arboviruses in this state, issuing public health arbovirus advisories and alerts, conducting or participating in arbovirus epidemiologic investigations, distributing weekly arbovirus epidemiology summary reports for mosquito control agencies, healthcare agencies, researchers, and others, and reporting human and animal arbovirus cases to the national arbovirus surveillance database
Florida Fish and Wildlife Conservation Commission	The state agency responsible for maintaining a database that enables the surveillance of bird mortality from arboviruses and for providing assistance and information on arboviruses in wildlife
Florida Medical Entomology Laboratory	A University of Florida laboratory (within the Institute of Food & Agricultural Sciences) that conducts research primarily on the control of mosquitoes; for the past 70 years, research at this lab has been instrumental in assisting mosquito control programs in Florida and elsewhere
Florida Mosquito Control Association (FMCA)	Created in the 1920s, the FMCA is Florida's professional association that includes individuals working for mosquito control programs, academic personnel conducting research on mosquitoes and other disease vectors,

Term	Definition
	and industry, which supports mosquito control efforts in Florida; the FMCA is active in the training of members and educating the public on the public health importance of mosquito control
Florida Sentinel Chicken Arboviral Surveillance Program	A program of the DOH that provides laboratory assistance to local agencies to monitor for the transmission of mosquito-transmitted viruses; sentinel chickens are stationed at locations throughout the state; when the chicken is bit by an arbovirus-transmitting mosquito, the chicken develops antibodies to the virus (the chicken does not become sick and cannot spread the virus to other mosquitoes); blood samples obtained from the sentinel chickens are submitted to DOH's lab in Tampa to be examined for the presence of antibodies; when present, the results indicate that arbovirus-transmitting mosquitoes are circulating in the location, enabling the increase of mosquito control efforts to reduce the risk of humans and animals from becoming ill
Genetically modified mosquitoes	*Ae. aegypti* mosquitoes that have been genetically modified to carry two genes: 1) a self-limiting gene that prevents female mosquito offspring from surviving to adulthood; and 2) a fluorescent marker gene that glows under a special red light, thereby allowing researchers to identify the genetically modified mosquitoes in the wild; because the female offspring die before becoming adults, the population of *Ae. aegypti* mosquitoes decreases
Geographic Information System (GIS)	Integrated computer hardware and software that stores, manages, analyzes, and visualizes geographic information
Good Laboratory Practices Program (GLP)	The goal of GLP is to ensure the quality and integrity of test data related to non-clinical safety studies
Granular application	Granular applications of chemicals differ from liquid applications by having a solid particle carrying the insecticide, which can better penetrate vegetation; this application is primarily used for larvicides to deliver mosquito toxin to the water where mosquito larvae are developing
Impoundment	Impoundments along Florida's central-east coast were created in the 1950s and 1960s by building earthen dikes around salt marshes known to produce mosquitoes; this allows the mosquito control program to manage the water level within the impoundment to prevent saltmarsh mosquitoes from laying

Term	Definition
	their eggs in these areas, thus effectively reducing their populations with a minimum need for pesticides; approximately 40,000 acres of impoundments were constructed from Volusia County south to Martin County; the impoundments remain a source reduction control method in the region
Landing rates	A surveillance method to determine the extent of a mosquito problem, where a person stands in a specific location and counts the number of mosquitoes that land on them within a designated period (such as 60 seconds)
Larvicide	A chemical that kills insects in their larval stages; for mosquitoes, larvicide must be introduced into the water where the larvae are developing; depending on the circumstances, larvicide applications can be made from the ground or from the air with either fixed- or rotary-wing aircraft or drones
Light Detection and Ranging (LiDAR)	A remote sensing technology used to precisely detect objects, such as mosquitoes, in real space
Malaria	A life-threatening illness transmitted primarily in tropical locations by female mosquitoes in the genus *Anopheles* primarily in tropical locations; symptoms include fever, headache, and chills and usually occur within 10-15 days after a bite
Methoprene	A synthetic juvenile hormone, which is an insect growth regulator, that has been used as a larvicide since the mid-1970s
Millage	A tax rate on property expressed as the number of dollars assessed for each $1000 of property value; for example, the property owner of a house valued at $250,000, which is assessed at a millage rate of 1.0, would be charged $250
Mosquito Control District	A local government entity enabled through a voter-approved local or state legislative act to provide mosquito control services in a geographically defined area
Mosquito counts	Surveillance of mosquito populations using a variety of techniques (*e.g.*, traps or landing rates); this term is usually used in reference to adult mosquitoes rather than immature ones
Natular	The trade name for a larvicide that includes the bacteria spinosid as its active ingredient

Term	Definition
Nuisance mosquito	A term used to designate a mosquito that typically does not transmit a pathogen such as a virus; these mosquitoes are in contrast to disease-transmitting mosquitoes that are readily capable of transmitting a pathogen
Pest resistance	The situation in which mosquitoes are no longer killed by the standard dose of an insecticide or manage to avoid coming into contact with the insecticide
Pyrethrum	A biochemical derived from a chrysanthemum plant that contains insecticidal properties; typically used in mosquito control as an adulticide
Rotary-wing aircraft	Aircraft that use a rotary blade rather than wings; a helicopter is the most common example
Rotational impoundment management	A management technique common in saltmarsh impoundments along Florida's Indian River Lagoon where the impoundment is artificially flooded during part of the spring and summer to prevent mosquitoes from laying their eggs in the marsh and is opened for the remainder of the year through culvert pipes to provide a hydrological connection between the impounded marsh and adjacent estuary or lagoon
Saint Louis encephalitis virus	A virus most commonly transmitted by *Culex* mosquitoes that can affect the central nervous system when a human is infected
Source reduction	Refers to the elimination of habitats that can produce mosquitoes; ranges from the proper disposal of waste containers to the complicated management of impoundments
Spinosid	A naturally occurring bacteria that contains insecticidal properties; is commonly applied as a larvicide; Natular is a commercial product that uses spinosid as its active ingredient
Sterile Insect Technique	A method whereby male insects are sterilized by radiation or other means; when the sterilized male mates with the female insect, viable offspring are not produced
Subcommittee on Managed Marshes	An interagency committee created in 1986 by the Florida Legislature in Ch. 388, *Florida Statutes,* to promote the wise management of Florida's wetlands for the mutual benefit of mosquito control and environmental enhancement
Ultra-low volume	A technique to dispense extremely small droplets of insecticide; while historically used for adulticiding, in some instances the technique is now used for larviciding

Term	Definition
United States Department of Agriculture (USDA)	Through its national Agricultural Research Service, the USDA participates in Florida mosquito control efforts largely with the Center for Medical, Agricultural and Veterinary Entomology, a laboratory in Gainesville, Florida, that conducts research on the biology and control of mosquitoes and other insects
United States Environmental Protection Agency	The federal agency that regulates mosquito control in Florida primarily through their approval and enforcement of chemical labels for insecticides
Unmanned Aerial System (UAS)	Aerial vehicles and associated equipment that do not carry a human operator and are remotely piloted or fly autonomously; drones are an example of a UAS
Vector	A living organism that transmits a pathogen (*e.g.*, virus, plasmodium, nematode) from an infected animal to a human or another animal; mosquitoes are an example of a vector
Vector surveillance	Monitoring for vectors that can be accomplished in several ways (e.g., various types of traps or landing rates)
Waste tires	Vehicle tires that are no longer of value and that have been improperly disposed in a manner that allows water to collect in the tires; some species of mosquitoes (e.g., *Aedes aeypti* or *Aedes albopictus*) lay their eggs in the standing water where the immature mosquitoes will develop to adulthood
Water management	In mosquito control, this term refers to a source reduction technique to minimize the production of mosquitoes in a particular aquatic habitat; the management of saltmarsh impoundments and some ditches are examples of water management projects
West Nile virus (WNV)	Introduced into the United States in New York around 2000, the virus is carried by birds and primarily transmitted by *Culex* mosquitoes; humans who contract the virus can develop a fever and other symptoms including headache, body aches, joint pains, and rash; most recover completely but symptoms can linger for weeks to months
Yellow fly trap	A sticky-type trap used to entangle yellow flies, a type of biting fly that occurs regularly in the Florida Panhandle, to reduce their population without insecticides

Term	Definition
Zika virus	A virus that originated in the Zika region of Africa and is transmitted by the mosquitoes *Aedes aegypti* and *Aedes albopictus;* humans who contract the virus can have symptoms similar to dengue such as fever, rash, headache, and joint pain; Zika passed from a pregnant woman to her fetus can result in birth defects including microcephaly and other brain abnormalities

Source: TBG work product.

Attachment 2

INTEGRATED PEST MANAGEMENT SUMMARY

September 2023

Prepared for

The Florida Legislature

Prepared by

The Balmoral Group

165 Lincoln Avenue

Winter Park, FL 32789

Attachment 2

Term	Summary
Integrated Pest Management	Most mosquito control programs use an Integrated Pest Management (IPM) approach to control mosquito populations, which targets the different stages of a mosquito's life cycle with various prevention and control measures. IPM addresses eight areas. Surveillance of mosquito populations is an essential component of all IPM programs with chemical treatments based on the surveillance findings. IPM can also include source reduction (e.g., container disposal and water/impoundment management), larviciding and adulticiding (using ground and/or aerial treatments), biological and alternative controls, and disease surveillance. Research and education are also important components of IPM programs.
Mosquito Surveillance	The general approach to surveillance is to define area-specific problems with mosquitoes through the establishment of a mosquito surveillance program. The program assists in determining the types of mosquito control efforts needed in each area so that pesticide applications are used only when necessary. Service requests made to mosquito control programs serve as one means of surveillance. Other means for adult mosquito surveillance include monitoring the landing rates and counts of mosquitoes in traps to determine when and where they are most prevalent and observing the effects of adulticide, larvicide, and source reduction efforts. Immature mosquito surveillance is conducted by collecting eggs, larvae, and pupae. Surveillance may also include inventorying and mapping data and using emerging technologies such as geo-referenced maps, geographic information systems (GIS), smart traps (e.g., a trap with an electronic device that differentiates mosquitoes from other insects, counts them, and wirelessly transmits the results), and unmanned aerial vehicles.
Source Reduction	Source reduction, also known as physical or permanent control, is considered the most effective mosquito control technique and is accomplished by eliminating larval habitats in salt marshes, freshwater habitats, temporarily flooded locations, and containers. Current saltmarsh source reduction techniques in Florida include • construction of shallow ditches that enhance drainage and thus eliminate mosquito-producing sites and create connectivity among water bodies to allow larvivorous fish (fish that feed upon insect larvae) access to mosquito habitats; and • management of impoundments by maintaining a sheet of water across a saltmarsh to prevent mosquitoes from laying eggs on the soil; this achieves saltmarsh mosquito control with minimum insecticide use.

Term	Summary
	Source reduction is also conducted in freshwater habitats and is based on the principle that manipulating water levels in low-lying areas will eliminate or reduce the need for insecticide use. The primary strategy used is reducing the amount of standing water or reducing the length of time that water can stand in low areas following significant rainfall. Another important area of source reduction is through aquatic plant management, which can be accomplished using chemical, biological, or mechanical control methods. Waste tire management is also a significant activity for many mosquito control districts because the proliferation and accumulation of discarded tires throughout the state continues to create habitats highly favored by mosquitoes, and these tires can be costly and labor-intensive to remove. Removing any receptacles that can contain water is beneficial in controlling mosquitoes.
Larvicides and Larviciding	Larvicides are insecticides used to kill insects in the larval stage. Most mosquitoes spend three to five days of their life cycle in the larval stage when they are highly susceptible to predation and control efforts; therefore, well-planned and timed larviciding is important for efficient operations to save labor costs and reduce chemical use. This also requires understanding the local mosquito ecology and patterns of arbovirus transmission to select the appropriate control techniques. Equipment used for ground application of larvicide can include trucks with sprayers mounted on the front bumper, all-terrain vehicles (ATVs), boats, and various hand-held and backpack sprayers. Aerial application uses various devices such as nozzles and metered systems that are attached to fixed-wing or rotary-wing aircraft (i.e., helicopters).
Adulticides and Adulticiding	Adulticides are insecticides used to kill adult mosquitoes. The majority of adulticiding in Florida is conducted using ultra-low volume (ULV) spraying during which an aerosol spray is released by specialized spray equipment mounted in aircraft, on the back of trucks or ATVs, or carried by hand or in a backpack. The spray drifts through the air and is effective only while it remains airborne; thus, having a short-term effect only. Where a longer-term effect is needed, residual sprays are applied to barriers or surfaces such as a stadium, park, or resident's yard and are often applied with a modified vehicle-mounted hydraulic sprayer. The mosquito must land on the surface where the residual insecticide has been deposited for it to be effective. Equipment operators must be properly trained in equipment maintenance and adulticide application because timing, targets, and thresholds for the application are based on numerous factors and can be challenging to establish.

Term	Summary
Biological and Alternative Control	Biological control agents include microbial control agents (e.g., bacteria, such as *Bacillus thuringiensis* or *Bt*, that can be sprayed over waterbodies to kill developing mosquito larvae), invertebrate arthropod mosquito predators (e.g., small aquatic crustaceans, such as copepods, that eat insect larvae), and vertebrate mosquito predators (e.g., larvivorous fish and birds). It is common for mosquito control districts in Florida to provide larvivorous fish as a service to the public. For example, Collier Mosquito Control District provides Gambusia mosquitofish to Collier County residents to release in standing water on their property to manage mosquito larvae. Alternative control methods include the sterile insect technique, trapping, repellents, and bug zappers.
Disease surveillance	Because of its geographic location and proximity to the Caribbean, Florida is vulnerable to the introduction of new vector-borne pathogens as occurred with the introduction of Zika virus in 2016 in South Florida. Disease surveillance includes monitoring for human cases of mosquito-borne arboviral diseases including dengue, chikungunya, West Nile virus, St. Louis encephalitis, and others. In addition, many mosquito control programs conduct regular blood testing of sentinel chickens. The state established the Florida Sentinel Chicken Arboviral Surveillance Program (FSCASP) in 1977 to provide laboratory services to local agencies to monitor the transmission of certain vector-borne diseases. The services are primarily used by mosquito control programs around the state. The programs submit sentinel chicken blood samples to the Florida Department of Health's Bureau of Laboratories in Tampa, where an antibody test is performed to identify if the chicken has been exposed to one of several viruses. Results are provided to participating agencies on a weekly basis.
Mosquito Control Research	Mosquito control programs must base their activities on sound and up-to-date scientific research in order to provide safe, effective, and efficient mosquito control services. Research that is either conducted or reviewed by mosquito control programs is essential to developing and implementing new and innovative methods and technologies. Numerous federal, state, and other entities conduct mosquito control research, as do several mosquito control districts in this state.
Outreach and Education	Increasing the public's understanding of the work of the mosquito control districts is an important component of overall mosquito control efforts. Public education helps people understand what is involved in mosquito control, the biology of mosquitoes, ecological issues, arboviral disease transmission, and actions that can be taken to prevent mosquito bites and reduce mosquitoes in yards and

Term	Summary
	neighborhoods. When adequately informed, the public is in a better position to protect themselves and support mosquito control efforts. This state's mosquito control programs and other entities, such as the Florida Department of Agriculture and Consumer Services, Florida Mosquito Control Association, and the University of Florida's, Institute of Food and Agricultural Sciences-Florida Medical Entomology Laboratory, dedicate significant efforts toward education.

Source: TBG work product.