THESIS

CLEAN WATER ACT ENVIRONMENTAL COMPLIANCE PROGRAM REVIEW OF TEN AIR FORCE BASES AND WATER QUALITY SURVEY

Submitted by

Jacob Hoeffner

Department of Civil and Environmental Engineering

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Fall 2024

Master's Committee:

Advisor: Kenneth Carlson

Ellison Carter
John Didier

ABSTRACT

AIR FORCE CLEAN WATER ACT ENVIRONMENTAL COMPLIANCE PROGRAM REVIEW OF TEN AIR FORCE BASES AND WATER QUALITY SURVEY

This study includes two main components. First, environmental compliance program reviews (ECPRs) of ten AF bases investigated the permits, programs, and compliance records at an installation level. Due to the depth of the ECPRs, detailed performance metrics from EPA ECHO, EASIER, and OSD databases were integrated into the ECPRs findings. Second, a survey further investigated trends identified in the ECPRs across 25 participating installations. The relevant performance metrics were used to evaluate the effectiveness of water programs that participated in the survey. Systemic compliance risks in permit management, data management, and stormwater and wastewater infrastructure were identified.

ACKNOWLEDGEMENTS

Thank you to Ken for the opportunity to contribute to meaningful research; to Asma for your mentorship and patience; to Brady Spitulski for the company in classes, research meetings, and long car rides; and Amanda Innes, Julie Robinson, and Katie Lenny for their technical support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION AND METHODS

The Center for Environmental Management of Military Lands (CEMML) at Colorado State University (CSU) was tasked by the Air Force Civil Engineer Center (AFCEC) to provide expertise for Clean Water Act (CWA) compliance to support the United States Air Force (AF) installations identified in the Cooperative Agreement # W9126G-20-2-0030 and as directed by AFCEC, Environmental Directorate, Technical Division (AFCEC/CZTQ).

CEMML partnered with CSU's Center for Energy Water Sustainability (CEWS) team in the Department of Civil and Environmental Engineering (CEE) to leverage their combined expertise and institutional knowledge gained from work experience in the fields of stormwater and wastewater (processes, operations, and associated permitting and regulations). They worked with the AF CWA programs to provide expertise to assess and evaluate stormwater and wastewater programs, systems, and outcomes. This work involved providing technical expertise, strategic evaluation, and assistance to ensure that AF, federal, and state environmental regulations are met while minimizing the impact of AF activities on natural resources, including Waters of the United States (WOTUS) and overseas natural resources under control of the AF or governed by DoD-developed Final Governing Standards (FGS). This support included installation, regional, and enterprise-wide wastewater, stormwater and drinking water programs (when applicable), and initiatives focusing on the CWA and FGS (when applicable). Figure 1 highlights the key goals and objectives called out in the scope of work and the funded project proposal.

Figure 1. Key goals and objectives, as highlighted in the scope of work and proposal

To complete the tasks identified in the cooperative agreement and the above-mentioned goals and objectives, the CSU-CEMML team reviewed all pertinent regulatory documents and data for 10 installations, then conducted data analysis and assessments to synthesize technical observations and recommendations. The installations were McConnell Air Force Base (McAFB), Robins Air Force Base (RAFB), Beale Air Force Base (BAFB), Langley Air Force Base (LAFB), Charleston Air Force Base (JBC), Tinker Air Force Base (TAFB), Scott Air Force Base (SAFB), Malmstrom Air Force Base (MAFB), Pittsburgh Air Reserve Station (PARS), and Pittsburgh Air National Guard (PA ANG). Technical observations and recommendations were delivered in 10 environmental compliance program review (ECPR) reports, which are summarized in Chapter 4.0.

ECPR findings were studied for events indicating systematic CWA compliance issues throughout the AF enterprise. The CSU-CEMML team organized the program review findings into the following categories: base characteristics and operations, permit types and requirements, data trending and analysis, management methods, and violation data. Those categories structured the Year 3 effort to collect and analyze additional regulatory and compliance data.

To further investigate regulatory and compliance patterns revealed in the program reviews, CSU-CEMML used (1) a comprehensive survey of water quality program managers across all AF installations and (2) an analysis of critical compliance databases (EPA ECHO, EASIER, and OSD).

A survey was designed to collect water quality program information from Water Quality Managers at the installation level. The final survey had 7 categories and included questions about active permits, permit requirements, personnel responsibilities, management strategies, communication protocols, industrial activities, GIS data management, asset management, and inflow and infiltration (I&I) responses. Survey data were compared to trends identified in the ECPRs. The CSU-CEMML team had additional insights into the approach and effectiveness of AF water quality programs.

To expand on information collected through the ECPRs and the survey, enterprise-wide AF data were analyzed using 3 compliance databases: Office of Secretary of Defense (OSD) Metrics; Enforcement

Actions, Spills, and Inspections Environmental Reporting (EASIER); and the US Environmental Protection Agency's Enforcement and Compliance History Online (EPA ECHO).

2.0 LITERATURE REVIEW

2.1 Clean Water Act Background and Major Components

2.1.1 Clean Water Act Background

The Clean Water Act (CWA) is a law in the United States (US) that regulates the discharge of pollutants into navigable waters, which includes, rivers, streams, wetlands, lakes and coastlines. The current CWA was enacted in 1972 and was amended in 1977, 1981, and 1987 to include most of the major components today including National Pollutant Discharge Elimination System Permits, Best Management Practices, monitoring strategies, various grants and funding mechanisms, and enforcement actions. (Lewis and Kähler 2018)

In the first decade of the 20th century, an estimated 90% of total wastewater in the United States was discharged directly into rivers as untreated sewage. (Doyle 2018) Prior to the Water Pollution Control Act (FWPCA) of 1948 industrial and municipal pollution was unregulated and ubiquitous in urban environments. (Mehan 2022) As a result, detrimental environmental consequences were pervasive in American cities and their surrounding natural environments.

The FWPCA was the first comprehensive federal law addressing water pollution in the United States. The FWPCA focused on providing financial support to states for water pollution control projects. Several key factors influenced the development of the FWPCA including increased industrialization, public health concerns, environmental degradation, interstate pollution, and limited state resources. In 1965, the Water Quality Act, a revision of the FWPCA, introduced water quality standards and authorized grants to assist states in developing water pollution control programs.

Following the establishment of the EPA in 1970, the Federal Water Pollution Control Amendments of 1972, also called the Clean Water Act, marked a major milestone in establishing environmental stewardship. These amendments expanded federal water pollution control efforts and established a national goal of making all U.S. waters "fishable and swimmable." Water quality standards were set based on specific uses. (Kutz 2018)

The amendments also introduced the National Pollutant Discharge Elimination System (NPDES) program, requiring permits for entities discharging pollutants into navigable waters. These permits set limits on pollutants and established monitoring and reporting requirements. Amendments to the CWA in 1977 expanded the NPDES program, addressed toxic pollutant control, and provided funding for sewage treatment facilities.

The Water Quality Act of 1987 amended the Clean Water Act and focused on addressing nonpoint source pollution, such as agricultural runoff. It emphasized voluntary measures and state-led efforts. The 1987 amendments also included requirements for municipal separate storm sewer systems (MS4s) to reduce pollutants in stormwater discharges to the maximum extent possible (MEP). (Kutz 2018) In response to Exxon Valdez oil spill, the Clean Water Act of 1990 aimed to control industrial discharges and implement a phased reduction of toxic pollutants as well as strengthen pollution prevention measures and improve enforcement mechanisms. (Lewis and Kähler 2018)

Since 1990, there have been ongoing efforts to enforce and strengthen the Clean Water Act specifically aimed at managing stormwater runoff, concentrated animal feeding operations (CAFOs), and protecting wetlands. (Lewis and Kähler 2018)

*2.1.2 **Major Components of the Clean Water Act***

2.1.2.1 Water Quality Standards

National The Environmental Protection Agency (EPA) establishes national Water Quality Standards (WQS) and approves WQS established by individual states. WQS are defined in the Code of Federal Regulations Part 131 as

"…provisions of State or Federal law which consist of a designated use or uses for the waters of the United States and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act." (USEPA 2015)

Water quality standards are a set of legally defined criteria and guidelines established by the EPA and state environmental regulators to protect the quality of water bodies. These standards specify the maximum allowable levels of various pollutants or parameters in the water, ensuring it is safe for humans, aquatic life, and other designated uses. States are responsible for reviewing, establishing, and updating WQS that meet the EPA WQS.

The specific components of water quality standards can vary between states, but they generally cover the elements included in Table 1. Descriptions of each component include examples of parameters that can be measured and might be found in discharge permits.

Table 1: Description of WQS Components

WQS Components	**Description**
Physical Parameters	temperature, turbidity (clarity), color, odor, and total suspended solids (particles floating in the water).
Chemical Parameters	chemicals and substances such as nutrients (nitrogen and phosphorus), heavy metals (mercury, lead, etc.), pesticides, organic compounds, and toxins
Biological Parameters	bacteria (E. coli), viruses, and other microorganisms
Dissolved Oxygen	minimum concentration of dissolved oxygen necessary to support fish and other organisms
pH	acidity or alkalinity of water
Nutrients	Excessive amounts of nutrients such as nitrogen and phosphorus can lead to eutrophication where excessive plant growth depletes oxygen levels in water bodies.
Toxicity	specific toxic substances that pose significant risks to human health or the environment, such as heavy metals, pesticides, or industrial chemicals

2.1.2.2 Discharge Permits

A permit is a license for a facility to discharge a specified amount of a pollutant into a receiving water body. (USEPA 2023) Permits are administered by a regulatory agency and authorize discharges based on activity. The various types of NPDES permits are listed below.

1. Multi-Sector General Permits (MSGP)s are written by the state agency and authorize the discharge of industrial stormwater. MSGPs also contain requirements such as the implementation of stormwater pollution prevention plans (SWPPP). While MSGPs contain general requirements for all applicants, they also contain additional requirements specific to facility types and industrial activities. Not all industrial stormwater permits require the reporting of stormwater data to the state regulatory agency.
2. Individual NPDES permits (IP)s are generally issued when an installation discharges effluent from a wastewater treatment plant on the base; however, they can be issued as an alternative to an MSGP when there has been a history of compliance issues or when there were wastewater discharges covered by the permit in the past. They contain requirements specific to the permit applicant based on facility details.
3. Municipal Separate Storm Sewer System (MS4) Permit permits are required by municipalities, counties, and certain other governments with separate storm sewer systems that receive stormwater discharge from urban development (e.g., housing, roadways, etc.).
4. Construction Permits are administered to contractors responsible for CWA compliance through maintaining site-specific SWPPPs, typically on construction projects that exceed one acre of disturbed land.

2.1.2.3 Best Management Practices

Best management practices or BMPs are measures and strategies designed to prevent or reduce stormwater pollution from construction sites or industrial facilities. The specific BMP required in a

SWPPP can vary based on the type of activity, site characteristics, and regional regulations. Typical BMPs found in SWPPPs include:

1. Permanent Stormwater BMPs

Permanent stormwater management structures are intended to treat and reduce the impact of stormwater runoff. Examples of permanent stormwater BMPs include vegetated swales that slow and treat runoff, inlet protection devices that prevent debris and pollutants from entering the conveyance systems, and stormwater detention or retention basins that temporarily store and release stormwater to reduce peak flow rates and treat runoff. (ARC 2016)

2. Good Housekeeping Practices

Good housekeeping practices minimize the exposure of pollutant sources to stormwater. Examples include the proper storage of materials, waste management, equipment maintenance to prevent leaks and spills, and regular site inspections. (USEPA 2023)

3. Vegetation and Soil Stabilization

Typically completed after construction, vegetation and soil stabilization BMPs like planting vegetation and hydroseeding stabilizes soil and reduces erosion. (USEPA 2023)

4. Erosion and Sediment Control

Erosion and Sediment control BMPs are designed to reduce the amount of disturbed soil prevent soil from leaving a construction site. Examples of erosion and sediment control BMPs include silt fence along the perimeter of a site, sediment basins or ponds downstream of a site, and straw or hay bails to slow and filter runoff. (USEPA 2023)

5. Pollution Prevention

Spill response plans are typically required by stormwater permits and prepare environmental personnel to manage accidental spills. Hazardous material plans ensure that chemicals are properly stored, handled and disposed. (USEPA 2023)

6. Monitoring and Reporting

Monitoring requirements are included in stormwater permits and depend on industrial activity, pollutants, and receiving water parameters. Reporting monitoring data to a regulator is typically required. Monitoring and reporting frequency varies based on previous permit requirements and historical data.

7. Corrective Actions

Stormwater permits typically outline the steps and measures that must be taken when a facility or site covered by the permit is not in compliance with the stormwater management requirements and regulations. These actions are designed to address and rectify any violations, deficiencies, or issues related to stormwater management to prevent further environmental harm and maintain compliance with permit conditions. Depending on the frequency and severity of a violation, regulators can require additional monitoring, inspections, or a corrective action plan. (USEPA 2023)

8. Recordkeeping

Maintaining documentation of BMP implementation, inspections, and corrective actions is required by most stormwater permits.

2.2 Air Force Installation Overview

2.2.1 Air Force Industrial Functions and Facilities

Air Force installations are strategically located across the United States and support a variety of operations and deployments. Air Force industrial functions and facilities may vary depending on the installation's or unit's mission and capabilities. The most common functions and facilities that are relevant to water quality programs are listed below:

1. Flight operations

Airfields and flight facilities typically have large, paved surfaces, such as runways and parking areas. During rainfall or snowmelt, stormwater runoff can collect contaminants like oil, grease, heavy metals, deicing fluid and other pollutants from paved surfaces and transport them into storm drains, ultimately discharging into nearby water bodies.

2. Aircraft maintenance and repair

Maintenance activities on aircraft often involve the use of chemicals, solvents, and cleaning agents. Improper disposal or handling of these substances can lead to the release of pollutants into stormwater runoff, which can then flow into nearby streams, rivers, or groundwater.

3. Pretreated wastewater facilities

Wastewater from various sources on a base, such as office buildings, barracks, kitchens, industrial processes, and sanitary facilities, is collected through a network of sewer lines and conveyed to the pretreated wastewater facility. Pretreatment involves the initial treatment of wastewater to remove or reduce contaminants that could negatively impact the municipal wastewater treatment plant or the environment. Pretreatment processes can include screening, grit removal, and sometimes the separation of oil and grease. (Barry 2012) Oil water separators are a common pretreatment technology used

4. Wastewater treatment plants

Some installations with a wastewater treatment plant (WWTP) on site treat and discharge effluent directly to waterways. Most wastewater facilities that are permitted to discharge effluent incorporate nutrient removal processes to reduce the levels of nitrogen and phosphorus in the effluent. Depending on the industrial activity on the installation and nature of the wastewater, chemical treatment processes such as coagulation, flocculation, and disinfection may be employed to remove specific contaminants and pathogens. Common WWTP technologies include aerated lagoons, trickling filters, activated sludge, a variety of biological reactors, and sand filters. (Barry 2012)

5. Outfalls or discharge facilities

Most installations have stormwater discharge facilities or outfalls that discharge stormwater collected from a network of stormwater drains or conveyance systems, is released into natural water bodies such as rivers, streams, lakes, oceans, or other surface waters. Periodic outfall monitoring is a typical BMP required by stormwater permits.

2.2.2 AF Water Quality Management Personnel

Water Quality Managers are environmental personnel responsible for managing and ensuring the quality of water resources on Air Force bases and installations. Water quality program managers typically act as points of contact between regulators and the installation. Support staff and assistance to the water quality program manager varies between an installation's needs and resources. Environmental programs often contract specific permit tasks, e.g., sampling, reporting, work studies, and planning depending on personnel availability. Other Air Force personnel that protect water quality involve Operations and Maintenance (O&M) and facility supervisors. Unit Environmental Coordinators (UECs) serve as the Environmental Management strategy conduit between the installation environmental function and their unit. (AF/A4CA 2019)

2.3 Air Force Environmental Management Strategy

The Air Forces Environmental Management Strategy (EMS) is outlined in an Air Force Instruction 32-7001 (referred to as "the AFI"). The AFI provides an overview of the purpose, vision, and scope of the EMS in Chapter 1 and identifies the roles and responsibilities of AF personnel in Chapter 2. Chapters 3-8 detail the various components that comprise the EMS including: Leadership Commitment; Risk Management; Planning; Planning, Programming, Budgeting, and Execution (PPBE), Compliance, and Environmental Inspection Process (EIP). (AF/A4CA 2019)

*2.3.1 **AFI 32-7001 Organization and Summary***

In response to the Air Force Policy Directive (AFPD) 32-70 *Environmental Considerations in Air Force Programs and Activities* and AFPD 90-8, *Environment, Safety, and Occupational Health Management and Risk Management*, the United States Air Force implemented the Air Force Instruction (AFI) 32-7001. The current version supersedes AFI 32-7001 (April 2015) and AFI 32-7047 (January 2015).

The AFI establishes the framework for an organizational-level Environmental Management System (EMS) at Headquarters Air Force (HAF), the Air Force Civil Engineer Center (AFCEC), and Air Force (AF) installations. Additionally, the AFI establishes the AF organizational level EMS, consistent with the International Organization for Standardization (ISO) 14001:2015. (AF/A4CA 2019)

The purpose of the AFI instruction is to provide define the roles and provide the requirements of applicable organizations within the AF as they pertain to operating withing the EMS. Moreover, the AFI establishes environmental quality program compliance and budgeting for the three pillars of environmental management: compliance, conservation, and pollution prevention. Most importantly, the AFI provides installation environmental reporting requirements, including environmental incidents, spill reporting, and provides the guidance to integrate Department of Defense (DoD) environmental inspection requirements with the AF Inspection process.

Figure 1 shows the conceptual framework of the USAF EMS and the chapters of the AFI that are associated with it. Moreover, Figure 1 represents the AF's approach to environmental management and continual improvement stated below.

"Clearly defining environmental roles and responsibilities, planning requirements, budgeting, implementation and operation, and management review ensures process improvement." (AF/A4CA 2019)

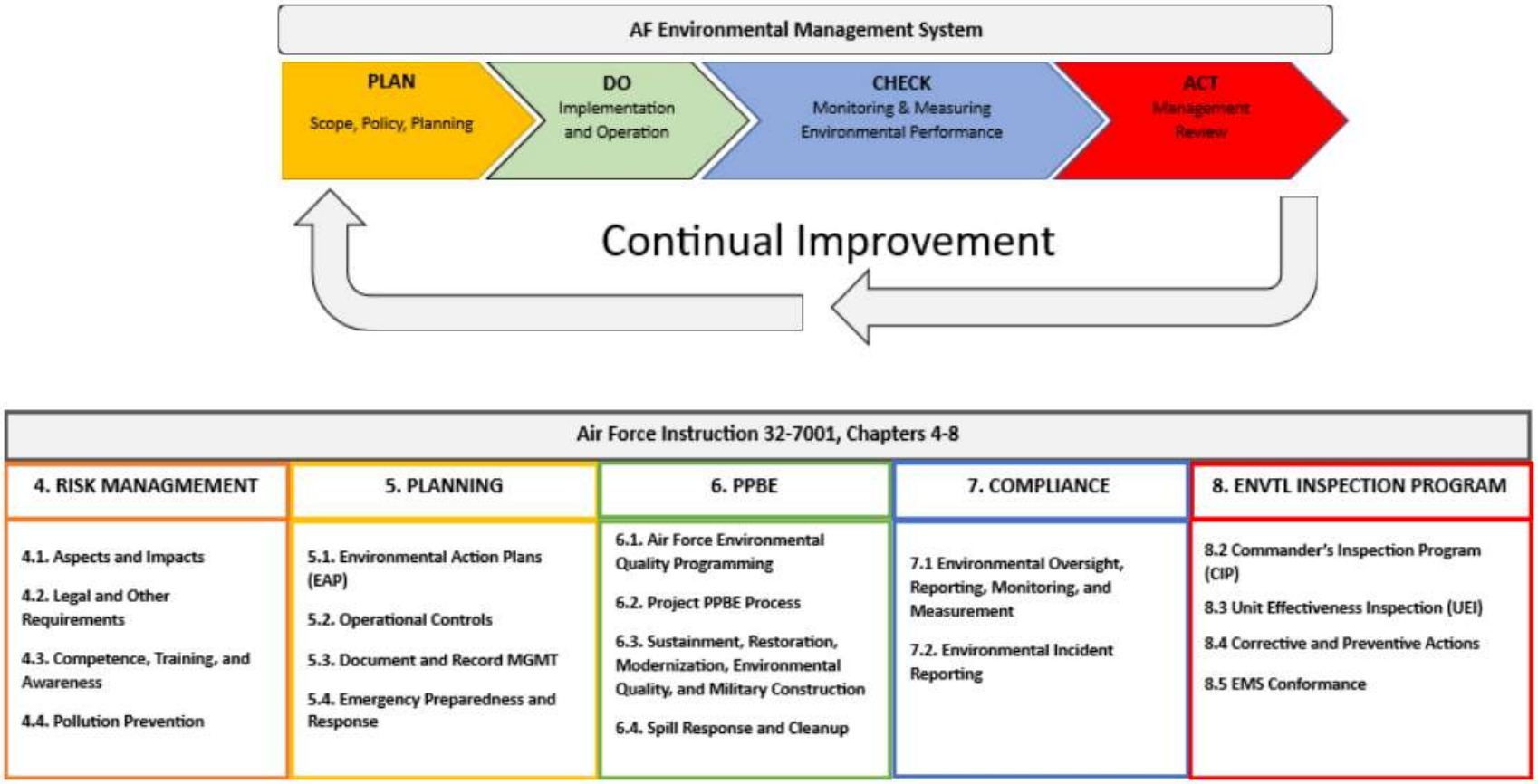


Figure 1: Air Force EMS Framework

The AFI provides a framework for continual program and process improvement applicable to commanders, supervisors and process owners with Air Force mission activities that impact the environment. An organizational-level EMS hierarchical approach is shown in Table 2. (AF/A4CA 2019)

Table 2: EMS Hierarchical Approach

Organizational-Level	**Requirements**
Headquarters (HAF)	- Environmental Policy (AFPDs) - Directive Guidance (AFIs, AFMANs) - Roles and Responsibilities (AFIs, AFMANs) - Operational Controls and Resources - Legal and Other Requirements (Regulations, DoD, AF, etc.) - EAPs and Performance Indicators (AF level objectives, targets, and metrics) - Communication (horizontal and vertical) - Document and Records Management - Competence, Training, and Awareness - Monitoring and Measurement (data collection and analysis; reporting to higher headquarters) - Management Review (ESOHCs, Steering Committees, Program Management Reviews)
Major Command (MAJCOM)	- Programs - Operational Controls and Resources - Supplemental Guidance (MAJCOM instructions) - Roles, and Responsibilities (MAJCOM instructions, policies, and guidance) - Communication (to higher and lower levels) - Monitoring and Measurement (data collection and analysis; reporting to higher headquarters) - EIP (self-inspection and external inspection oversight) - Corrective and Preventive Action - Management Review (ESOHCs, Steering Committees, Program Management Reviews)
Air Force Installation and Missions Support (AFIMSC)	- Programs - Operational Controls and Resources - Roles, and Responsibilities (AFIs, AFMANs, AFIMSC instructions, policies, and guidance) - Communication (to higher and lower levels) - Monitoring and Measurement (data collection and analysis; reporting to higher headquarters) - EIP (self-inspections) - Corrective and Preventive Action

AFCEC (Air Force Civil Engineering Center)	- Scope (AF List of EMS Appropriate Facilities) - Programs - Operational Controls and Resources - Roles, and Responsibilities (AFIs, AFMANs, AFIMSC instructions, Playbooks, eDASH) - Aspects and Impacts (AF Standardized List of Aspects and Impacts) - Federal and Higher Headquarters Legal and Other Requirements - EAPs and Performance Indicators (objectives, targets, and metrics) - Communication (horizontal and vertical) - Document and Records Management - Emergency Preparedness and Response Procedures - Competence, Training, and Awareness - Monitoring and Measurement (data collection and analysis; reporting to higher headquarters) - EIP (self-inspections; installation-level self-inspection and external inspection oversight) - Corrective and Preventive Action - Management Review (Program Management Review)
Air National Guard Reserve Command (ANGRC)	- EMS Administration - EMS Scope (ANG List of EMS Appropriate Facilities) - Environmental Policy (Communicate AFPD 90-8, AFIs, AFMANs) - Environmental Aspects & Impacts - Legal and Other Requirements (Regulations, DoD, AF, ANG, etc.) - Objectives, Targets, and Programs (Action Plans) - Resources, Roles, Responsibility, and Authority - Training, Competence, and Awareness - Communication - Documentation and Document Control - Operational Controls - Emergency Preparedness and Response - Monitoring and Measurement (Environmental Reporting) - Environmental Inspection Process (Evaluation of Compliance; Nonconformity, Corrective Action, and Preventive Action: Internal Audit) - Control of Records - Management Review (Cross-Functional Team and Environment, Safety, and Occupational Health Council)
AF/AFR Units/Bases	- Scope (included organizations and units) - Commitment Statement - Aspects and Impacts - Legal and Other Requirements (includes state and local) - EAPs and Performance - Indicators - Resources, Roles, and Responsibilities - Communication - Document and Records Management - Emergency Preparedness and Response - Competence, Training, and Awareness - Operational Controls (Environmental Management Plans) - EIP (Inspector General databases, eDASH) - Monitoring and Measurement (data collection and analysis; reporting to higher headquarters)

	- Corrective and Preventive Action - Management Review (CFT and ESOHC)
ANG Installations	- EMS Administration - EMS Scope (included organizations and units) - Environmental Policy (Communicate AFPD 90-8) - Environmental Aspects & Impacts - Legal and Other Requirements (state and local) - Objectives, Targets, and Programs (Action Plans) - Resources, Roles, Responsibility, and Authority - Training, Competence, and Awareness - Communication - Documentation and Document Control - Operational Controls (Environmental Management Plans) - Emergency Preparedness and Response - Monitoring and Measurement (data collection and analysis; reporting to higher headquarters) - Evaluation of Compliance (Inspector General databases, Environmental Data Assessment Reporting Tool) - Nonconformity, Corrective Action, and Preventive Action (Inspector General databases, Environmental Data Assessment Reporting Tool) - Internal Audit (Inspector General databases, Environmental Data Assessment Reporting Tool) - Control of Records - Management Review (CFT and ESOHC)

*2.3.2 **AFI 32-7001 Chapters 4-8***

Figure 2 through Figure 6 detail the chapters of the AFI. Each chapter's subsections are included on the left side of the figure. The arrows in Figure 2 through Figure 6 relate the chapter sections with eDASH tools and documents listed on the right of the figures. eDASH is an online Microsoft SharePoint tool and serves as the central repository and information sharing for AF enterprise-wide environmental programs supporting installations. Primary one-stop source for environmental procedures, non-directive guidance, and best practices. It provides the Air Force Civil Engineer Center (AFCEC) the ability to establish standard procedures and performance standards for more efficient and effective information management and exchange, communication, and program reviews for environmental and sustainability programs at all levels of the AF. Pages and tools contained within eDASH function as an electronic EMS manual and performance tracker to ensure conformance and mission effectiveness. Finally, eDASH provides AF subject matter experts the ability to provide online technical support to the installations and use standard

tools for carrying out data collection and reporting from the installations to reduce the burden of manual data collection tasks on the installations. (AF/A4CA 2019) Most organizational levels that execute the EMS action items have defined roles in each chapter. Key players in each chapter are mentioned above each figure.

Figure 2 shows the subsections within the Risk Management chapter of AFI and the eDASH tools and documents associated with risk management. Key players include AFCEC/CZ (environmental management directorate), MAJCOM commander, and installation commanders.

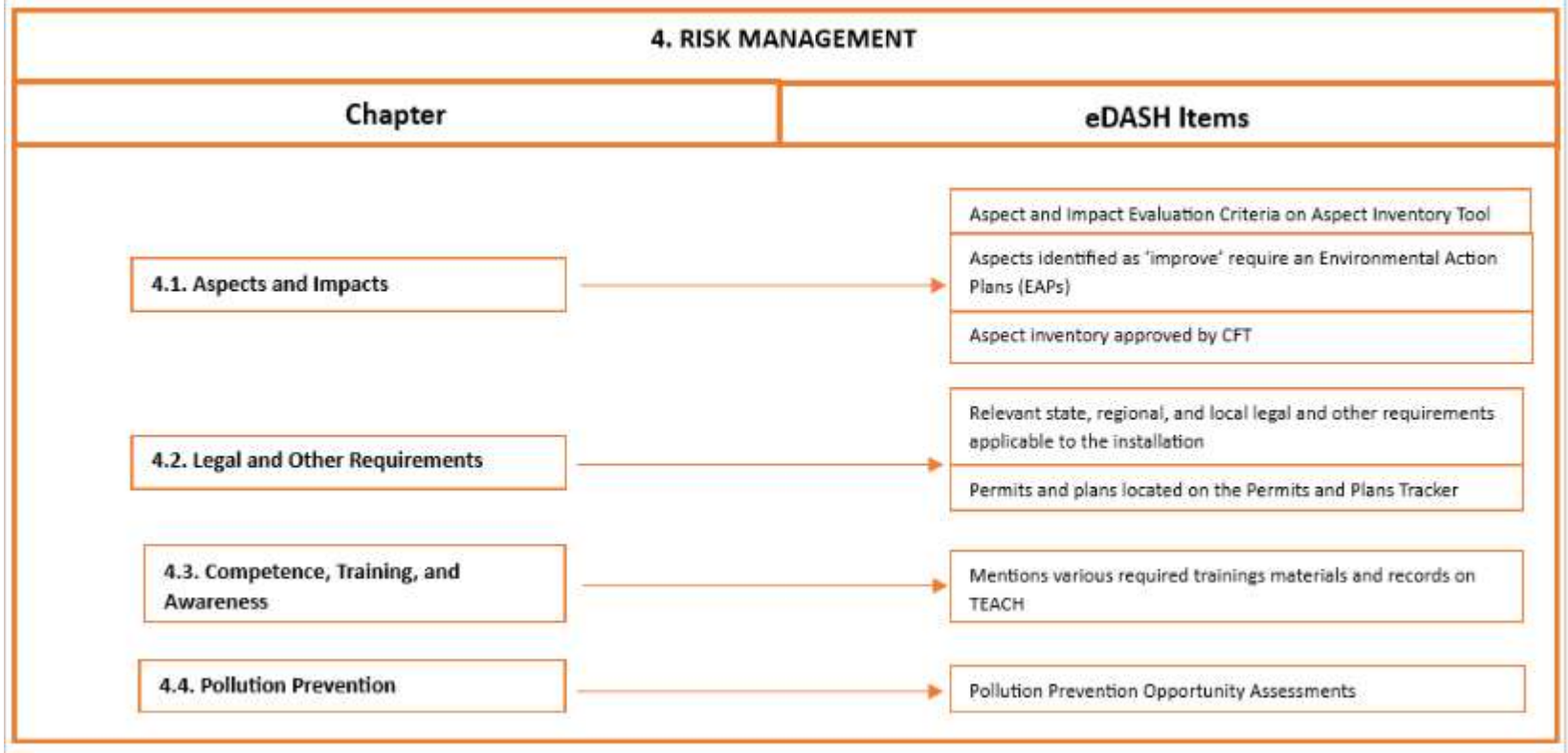


Figure 2: Chapter 4—Risk Management

Figure 3 shows the subsections within the Planning chapter of AFI and the eDASH tools and documents associated with planning. Key players involved in planning include AFCEC/CO (operations), AFCEC/CP (planning and integration), and the installations' cross-functional team (CFT),

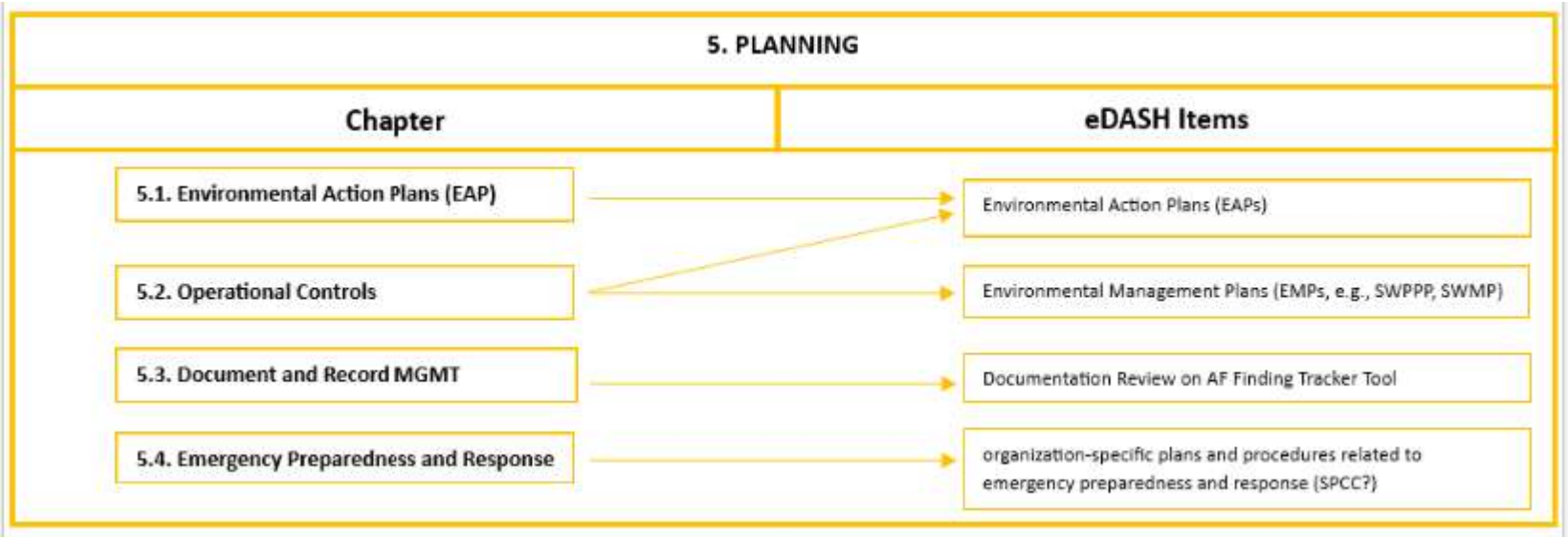


Figure 3: Chapter 5—Planning

Figure 4 shows the subsections within the PPBE chapter of AFI and the eDASH tools and documents associated with PPBE. Key players involved in the PPBE phase include the AFCEC/CZ and installation CFT.

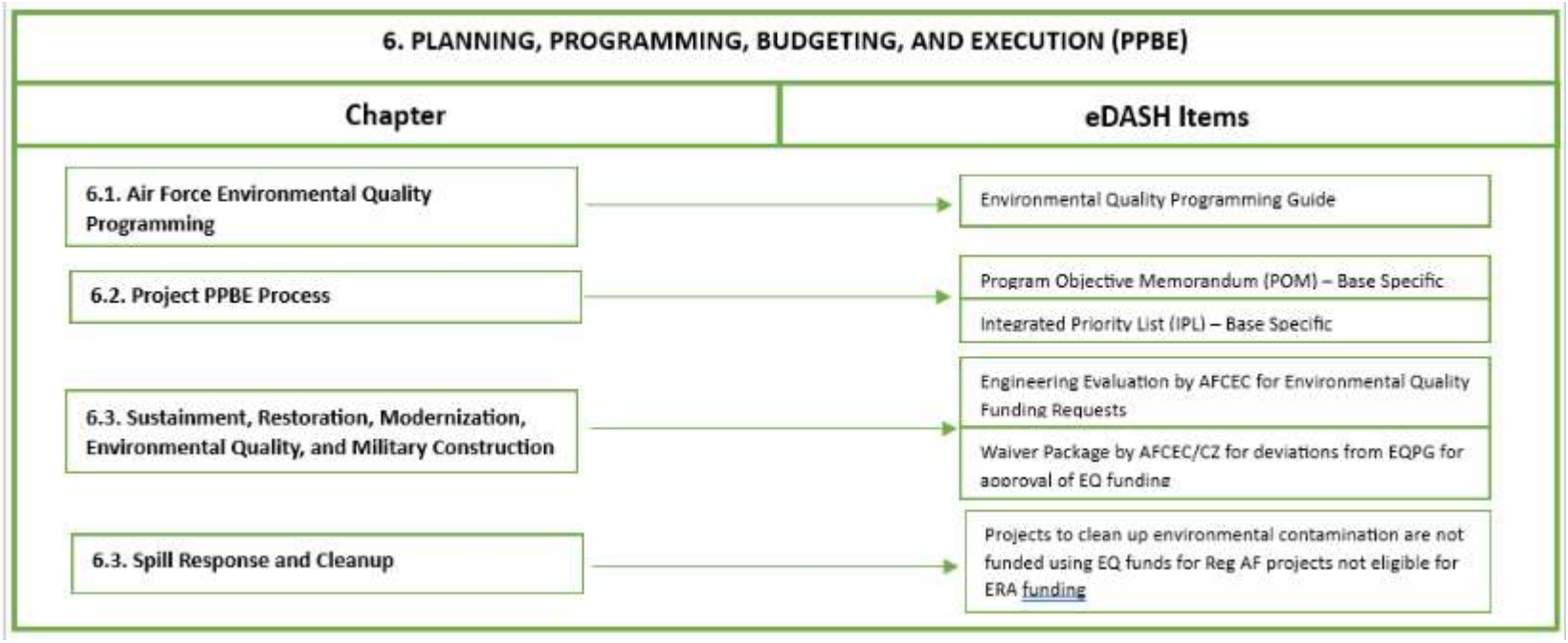


Figure 4: Chapter 6—Planning, Programming, Budgeting, and Execution

Figure 5 shows the subsections within the Compliance chapter of AFI and the eDASH tools and documents associated with compliance. Key players in compliance include AFCEC/CZ, AFCEC Intermediate Environmental Function (IEF), AFCEC/CO (operations), Installation CFT, squadron commanders, Unit Environmental Coordinators.

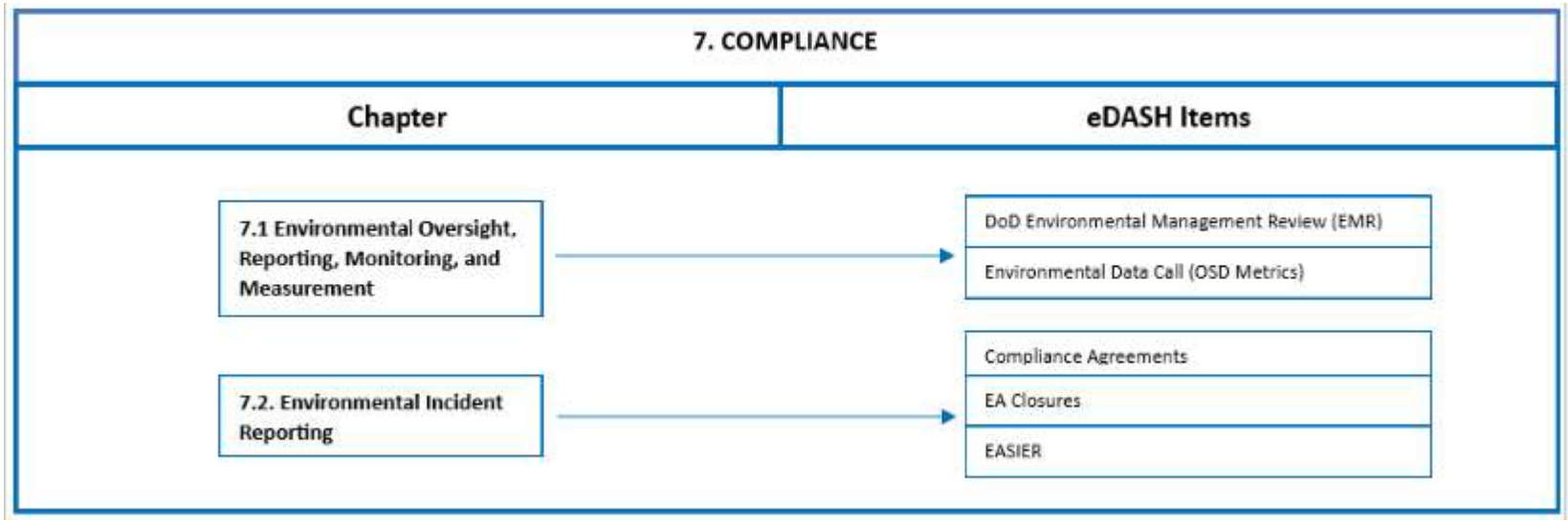


Figure 5: Chapter 7—Compliance

Figure 6 shows the subsections within the Environmental Inspection Program chapter of AFI and the eDASH tools and action items associate with the environmental inspection program. Key players in the environmental inspection program include the AFCEC Environmental Management Directorate (AFCEC/CZ), AFCEC Intermediate Environmental Function (IEF), Installation Commanders, Installation EMS Coordinator, and Unit Environmental Coordinators (UECs).

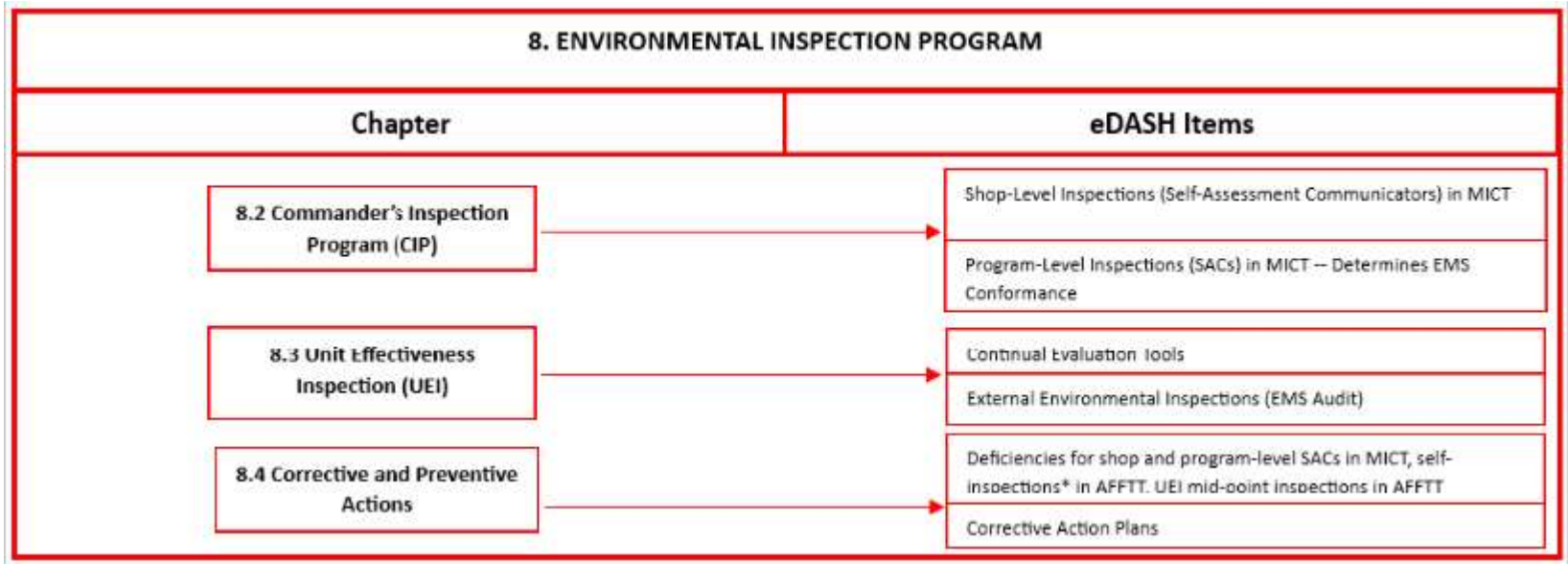


Figure 6: Chapter 8—Environmental Inspection Program

3.0 DEFICIENCIES AND RESEARCH OBJECTIVES

3.1 Deficiencies or Gaps

A comprehensive review of multiple CWA programs to discover compliance risks and deficiencies across the USAF enterprise is needed. Specific gaps include updated CWA compliance information related to source contaminants, infrastructure needs, permit management strategies, and data management that threaten water quality across the USAF enterprise. Identifying the mechanisms that elevate and mitigate compliance issues in the AF environmental management system (via eDASH) is also needed based on literature reviews.

3.2 Research Objectives

1. Identify and analyze Clean Water Act compliance risks at AF installations including Air Bases, Air National Guard, and Air Reserve Bases.
2. Identify process improvements to improve water quality and regulatory compliance.
    a. Conduct compliance review of overall wastewater management
        i. Identify sources of contaminants, methods to improve compliance, and optimize operational and management efficiencies.
        ii. Identify any stormwater infrastructure (conveyance, wastewater treatment plants, and other stormwater and wastewater facilities) that might pose a compliance risk across the Air Force enterprise.
        iii. Determine stormwater system deficiencies.
    b. Conduct compliance review of overall wastewater management
        i. Assess wastewater compliance for Federally Owned Treatment Works (FOTWs) effluent or discharges to Publicly Owned Treatment Works (POTWs).
        ii. Identify source of discharge exceedances to include operational deficiencies and contaminants introduced to the wastewater system.
        iii. Review of O&M procedures and documentation/manuals

iv. Review and provide recommendations for infrastructure planning and programming using results of recent inflow/infiltration studies, and analysis of system for sustainability and growth.

4.0 ENVIRONMENTAL COMPLIANCE PROGRAM REVIEWS

Sections 4.1 through 4.10 are overviews of the Environmental Compliance Program Reviews that occurred between June 2021 and March 2023. The components of each overview include:

1. Water Quality Program Review and Permit Overview
2. Facility Overview
3. Compliance Summary
4. GIS Review (if applicable)

4.1 McConnell Air Force Base

4.1.1 Water Quality Program and Permit Overview

Industrial Stormwater Permit

McConnell AFB's industrial stormwater permit is an individual NPDES permit (Federal Permit No. KS0086452) issued by the Kansas Department of Health and Environment (KDHE). In addition to monitoring requirements and effluent limitations for 5 of 21 listed outfalls (011, 015, 017, 019, and 032), the permit contains supplemental conditions surrounding MAFB's use of deicing fluid. These include maintenance, monitoring, cleanup procedures, and requirements for underground storage tanks that store spent deicing fluid. BOD is required to be monitored at outfalls 011 and 019 quarterly; however, BOD effluent limitations only apply during periods of deicing. The permit also includes requirements and guidelines for completing a SWPPP.

MS4 Permit

MAFB operates under a general MS4 NPDES permit issued by KDHE (Federal Permit No. KSR410018). This permit contains requirements for monitoring impaired streams and implementing BMPs and TMDL BMPs. A point system is used to indicate the fulfillment of BMP requirements, which requires meeting a minimum number of points within 6 BMP categories in addition to TMDL BMPs. Sampling is only required in the event of an illicit discharge from MS4-area outfalls. Although MS4-area outfalls do not

discharge to impaired stream Gypsum Creek, several other outfalls around the installation do; consequently, surface water monitoring of Gypsum Creek for bacteria, nutrients, and sediment is required under this permit. MAFB is required to implement a wet weather program to assess the installation's impact on Gypsum Creek, utilizing 2 monitoring locations: one upstream and another downstream of the installation's discharge into the stream.

Wastewater Permit

MAFB does not operate a WWTP but holds a permit with the City of Wichita for the discharge of its wastewater (City of Wichita Permit No. 2182). Monitoring, with effluent limitations, is required for several metals, oil and grease, BOD, TSS, pH, flow, and other parameters.

4.1.2 ***Facility Overview***

Figure 7 shows the drainage areas, storm lines, and discharge points for McConnell AFB. The installation's MS4 area is located in the northeast. Several of the drainage areas in the northwest discharge to Gypsum Creek. Of note, fuel storage tanks are primarily contained in drainage area 1-15, a 175,600-gallon OWS is contained in drainage area 1-1, and a groundwater treatment unit that discharges at Outfall 032 is contained in drainage area 1-22. Additionally, 2 deicing pads are contained in drainage area 1-19.

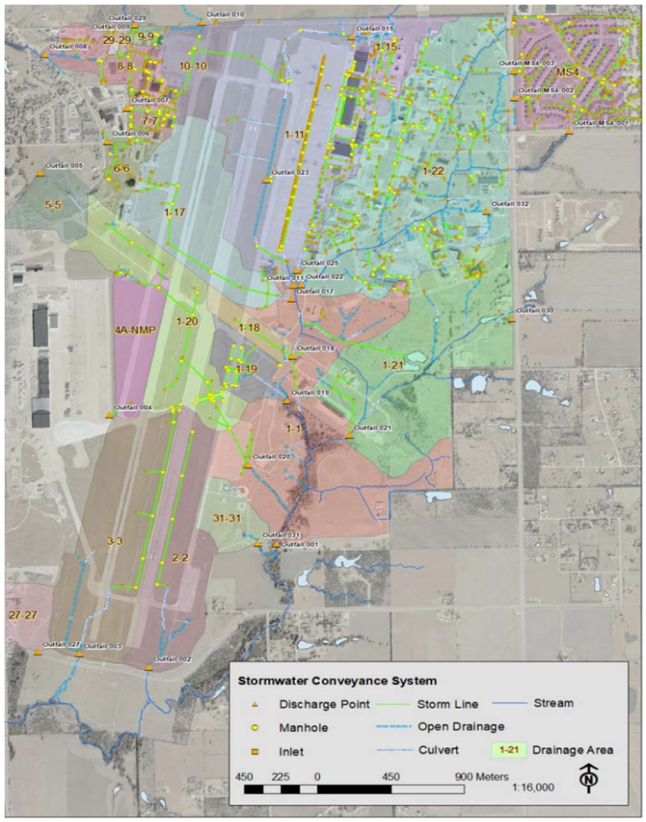


Figure 7: McConnell AFB drainage areas, storm lines, and discharge points

*4.1.3 **McConnell AFB Compliance Summary***

Monitoring data for McConnell AFB were downloaded from EPA ECHO from 2006 to the time of review (early 2021). McConnell AFB's monitoring requirements have changed drastically since 2006, including reductions in both the number of outfalls and number of parameters required to be monitored. Therefore, data were analyzed only for the current permit cycle, beginning in 2016. Of the 4 parameters of focus for the analysis (benzene, BOD, oil and grease, and pH), BOD has been of primary concern and a recurring issue.

Figure 8 shows the drainage areas relevant to BOD. According to the data analysis, 3 recent BOD exceedances occurred at Outfall 011 (Feb 2018, Feb 2019, and Dec 2019). These exceedances are

consistent with violations reported in OSD metrics. The OSD metrics lists “Operating Procedure” as a root cause for these exceedances, with 2 of them explicitly linked to “aircraft deicing.” Additionally, of 43 reported BOD measurements at Outfall 019, 20 exceeded effluent limitations. These exceedances were not identified as exceedances in the EPA ECHO database. The most recent BOD exceedance listed in EPA ECHO occurred in 2008.

In response to BOD issues, McConnell AFB has implemented new procedures and infrastructure several times, particularly in drainage area 1-19. 50-80% of planes undergo light deicing on the parking apron in drainage area 1-11 for more rapid deployment, reducing the amount of deicing that occurs in drainage area 1-19. The spent deicing fluid is hauled to drainage area 1-19. Two 50,000-gallon underground storage tanks collect spent deicing fluid from the deicing pads (and the fluid hauled from drainage area 1-11), from where it is eventually discharged through the sanitary sewer system. During periods of no deicing, stormwater from the deicing pads is discharged to Outfall 019. A drain-plug is used to prevent leakage to the outfall during periods of deicing. The SWPPP states that personnel began flushing the deicing containment system at the end of deicing periods to reduce the potential for BOD issues at the outfall; however, personnel stated that this is not always conducted. In June 2021, during the CSU-CEMML team’s site visit, a small discharge occurred at Outfall 019 in addition to signs of BOD (an onion smell and an orange coloration of the water). Personnel stated that BOD measurements were high (this would not be considered an exceedance as June is not included in the period of deicing; therefore, only monitoring of BOD is required with no effluent limitation applied). The discharge indicated signs of groundwater infiltration, as no precipitation event had occurred recently. The CSU-CEMML team recommended investigating BOD at this outfall further, as it appeared residual BOD was present in the storm line and infiltration was carrying it to the outfall.

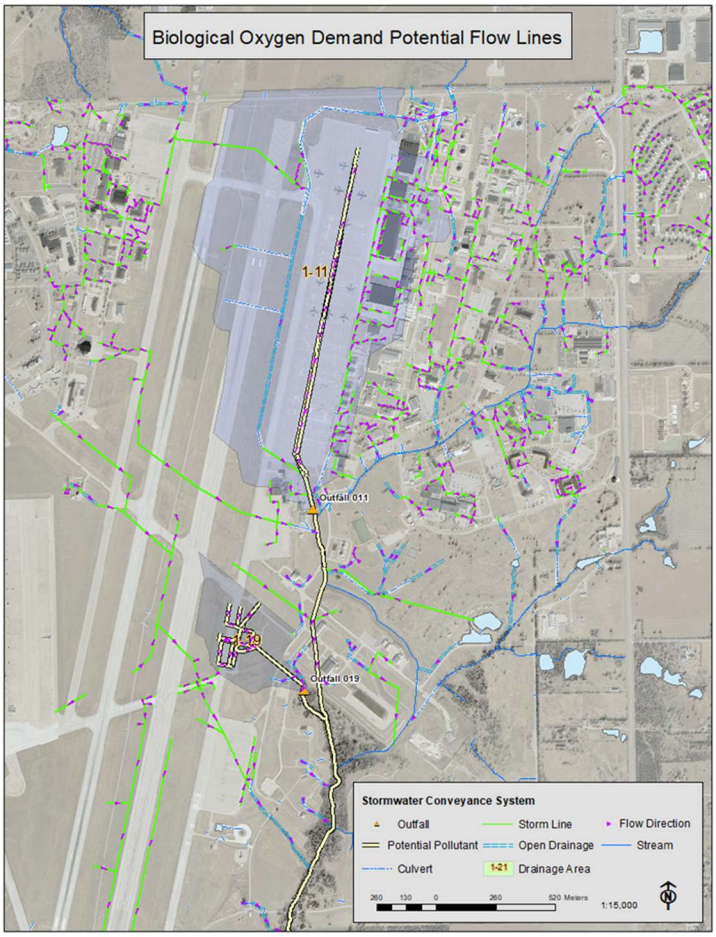


Figure 8: McConnell BOD drainage areas

*4.1.4 **McConnell GIS Review***

GIS data were reviewed for spatial consistency and valid attribution. GIS data showed issues with overcollection of culverts and stream lines and no collection of open drainage lines. Stormwater lines have been collected as culverts and some of the open drainage lines have been collected as stream lines. Connectivity between features is poor throughout the system. Additionally, there are missing attributes, including inlet type and invert elevation for inlet features, for all the 1,194 inlet features.

4.2 Robins Air Force Base

4.2.1 Water Quality Program and Permit Overview

Robins AFB follows 3 NPDES permits under the Georgia Water Quality Control Act, the Federal Water Pollution Control Act, and the Federal Clean Water Act.

The industrial wastewater permit (IWP), GA0002852, is an individual NPDES permit that covers both wastewater and stormwater discharges. Discharges from wastewater treatment facilities are monitored at Outfalls 008, 009, 010, and 011. Flows from 008010 commingle at Outfall 011, a river lift station, before leaving the base and entering the Ocmulgee River. Stormwater discharges covered under the IWP are monitored at Outfalls 001-006 (Figure 9). Outfalls 001-006 and Outfall 011 are referred to as "external outfalls" by the IWP because they discharge directly to receiving waters. Outfalls 008010 are referred to as "internal outfalls" by the IWP because they do not discharge directly to receiving waters. The current wastewater permit cycle began in July 2018 and expired in June 2023.

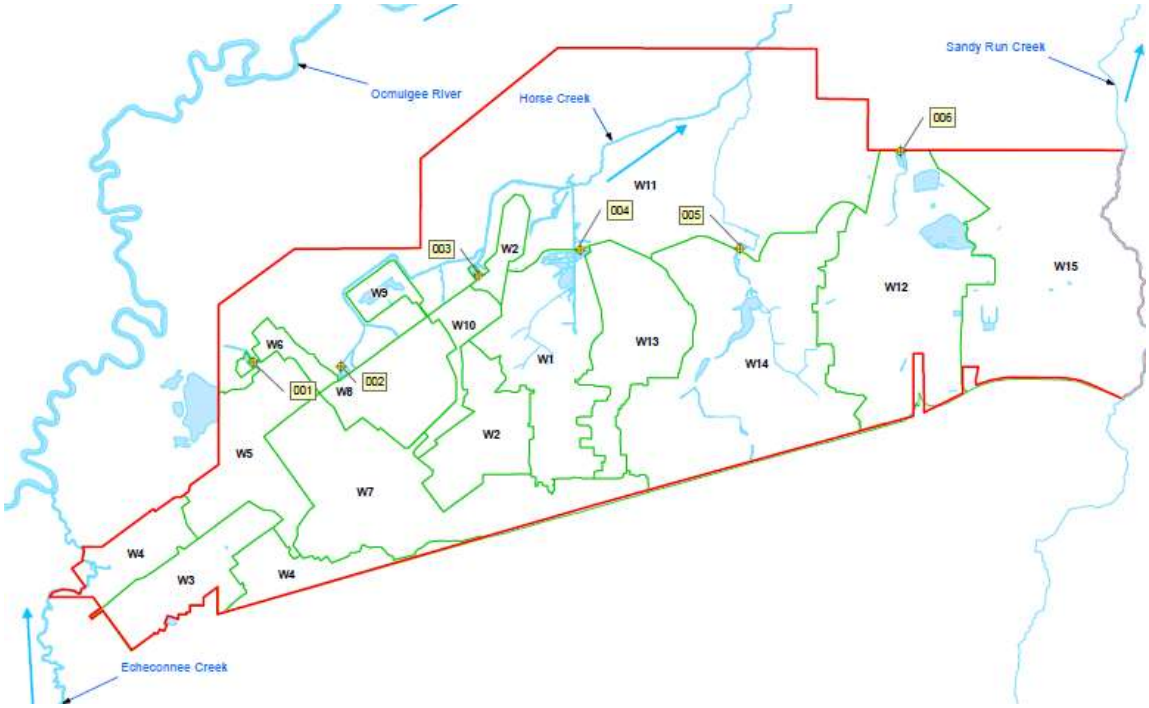


Figure 9: Summary of outfall locations under GA0002852 and drainage watersheds at Robins AFB.

Source: Permit Application (2015)

There are a total of 10 permitted outfalls under the IWP. Six outfalls discharge stormwater runoff along the northern boundary of the base. Historical precedent and selective monitoring have kept Outfalls 001-006 under the IWG as opposed to the industrial stormwater permit. Outfall 011 discharges outflow from all wastewater treatment facilities on the base. Outfalls 001-006 and 011 are categorized as external outfalls per IWP. The remaining outfalls (e.g., 008, 009, 010) are classified as internal outfalls and are the most immediate permitting locations after treatment. The permitted limitations and monitoring constituents per outfall are summarized in Table 3 in addition to inflow source.

Table 3: GA0002852 outfall summary

Outfall Type	ID	Wastewater Source	Limitations[1]
External	**001**	Stormwater runoff from DA5, non-contact cooling water/cooling tower blowdown, and oil/water separator. DA5 activities include: - refueling and maintenance of aircraft; - and industrial activities associated with the JSTARS (i.e., Sector S type activities) - aircraft flight operations	*pH 6.0-8.5* *BOD_5* *Oil & grease* *Fecal coliform* *Total phosphorus* *Various metals* *Temperature* *Quarterly flow measurements*
	002	Stormwater runoff from DA7, non-contact cooling water/cooling tower blowdown, and oil/water separator. DA7 activities include: - aircraft paint and depainting facilities; - general aircraft and engine maintenance; - aircraft fuel pits; the aircraft purge station; - aircraft flight operations; - aircraft fueling and defueling systems; - aircraft mechanical flight testing; and - EHWAS Nos. 4, 19, and 23.	*pH 6.0-8.5* *BOD_5* *Oil & grease* *Fecal coliform* *Total phosphorus* *Various metals* *Temperature* *Quarterly flow measurements*
	003	Stormwater runoff from DA2, non-contact cooling water/cooling tower blowdown, and oil/water separator. DA2 activities include: - aircraft maintenance; - air freight; - industrial wastewater treatment; - EHWAS Nos. 1 and 22; fuel dispensing; defueling; - fuel tank purging; - pre-flight operational testing; and - metal finishing and plating	*pH 6.0-8.5* *BOD_5* *Oil & grease* *Fecal coliform* *Total phosphorus* *Various metals* *Temperature* *Quarterly flow measurements*
	004	Stormwater runoff from DA1, non-contact cooling water/cooling tower blowdown, and oil/water separator. DA1 activities include: - domestic and industrial wastewater treatment at STP - groundwater treatment at GTP - staging, storage, and classification of drummed chemical waste; - hazardous waste storage, including the Treatment, Storage, and Disposal Facility (TSDF) at Building 352; - EHWAS No. 7; - vehicle maintenance; - application and removal of industrial coatings; - bulk storage and dispensing of fuel; - metal fabrication; and - steam generation	*pH 6.0-8.5* *BOD_5* *Oil & grease* *Fecal coliform* *Total phosphorus* *Various metals* *Temperature* *Quarterly flow measurements*

Outfall Type	ID	Wastewater Source	Limitations[1]
	005	Stormwater runoff from DA1, non-contact cooling water/cooling tower blowdown, and oil/water separator. DA1 activities include: - aircraft maintenance; - hazardous material storage including the TSDF at Building 359; - chemical receiving; - avionics fabrication; - painting and repair; - steam generation; - EHWAS No. 18; and - Inflow from the City of Warner Robins (non-industrial)	*pH 6.0-8.5* *BOD_5* *Oil & grease* *Fecal coliform* *Total phosphorus* *Various metals* *Temperature* *Quarterly flow measurements*
	006	Stormwater runoff from DA12, non-contact cooling water/cooling tower blowdown, and oil-water separator. DA12 activities include: - aircraft parts testing; vehicle fueling and maintenance; - insecticide/herbicide storage; - chemical storage and dispensing; - avionics fabrication; - metal recycling; and - EHWAS Nos. 16, 17, and 20 - SL-11A discharges SW runoff to 006	
	011[3]	Commingled wastewater from Outfalls 008, 009, and 010	*pH 6.0-9.0* *BOD_5* *Oil & grease* Total phosphorus Dissolved oxygen Total residual chlorine[2] Chronic whole effluent toxicity
Internal	**008**	Industrial Waste Treatment Plant #2 and #3 (Electroplating/Metal Finishing Wastewater)	*pH 6.0-9.0* *COD* *TSS* *Oil & grease* *Various metals* *Total toxic organics*
	009	Industrial Waste Treatment Plant #1, Sewage Treatment Plant, Aqueous Film-Forming discharge, and Discharge from Groundwater Treatment Plant (Outfall 010)	*pH 6.0-9.0* *COD* *TSS* *Oil & grease* *Various metals* *Total toxic organics*
	010	Wastewater/Groundwater from restoration site, decontamination pad, and investigation-derived wastewater	*pH 6.0-9.0* *COD* *TSS* *Total phenols* *Trichloroethylene* Various solvents Various metals

The stormwater infrastructure on Robins AFB includes storm drainpipes, culverts, ditches, channels, swales, and detention basins. The conveyance system transports stormwater runoff generated from the Base and runoff from the City of Warner Robins. Most of the stormwater runoff from Warner Robins enters the base at 3 influent locations located along GA-247. Runoff generally flows from west to east

across Robins AFB and discharges to Echeconnee Creek on the north, Horse Creek and the wetlands of the Ocmulgee River floodplain on the east, and Sandy Run Creek on the south.

The 2 other CWA permits are in effect at Robins AFB including an general industrial stormwater permit and an MS4 permit.

The general stormwater permit, GAR050000, covers discharges from drainage areas containing industrial activity (SL-14A, SL-13, SL-16, SL-17, SL-9, SL-12). The industrial stormwater permit cycle began in 06/2017 and expired in 05/2022. These outfalls and their corresponding drainage areas can be found in Figure 10 below.

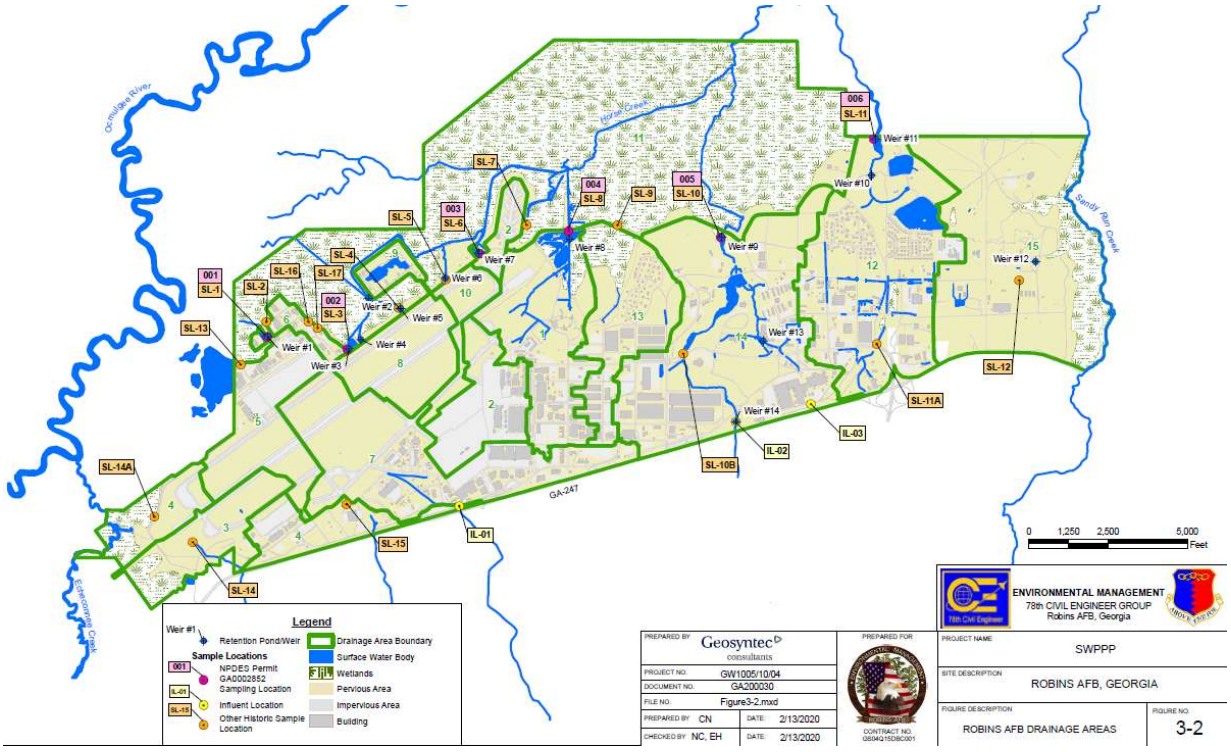


Figure 10: Robins AFB general stormwater permit outfalls and drainage areas

The MS4 permit, GAG480000, covers stormwater management program requirements.

4.2.2 ***Facility Overview***

Beyond stormwater inflow locations and outfalls, Robins AFB operates multiple wastewater treatment plants on the base. Water treatment facilities on the base include industrial wastewater treatment plant (IWTP 1) that receives bulk industrial wastewater, a sanitary treatment facility (STP), an abandoned industrial wastewater treatment plant that received metal plating rinse water (, and a groundwater treatment facility. All water treatment facilities flow into the same monitoring outfall (Outfall 011) and ultimately discharge to the Ocmulgee River. The flow and connectivity of the wastewater treatment system are illustrated in Figure 11, which also identifies the direction of flow between monitoring outfalls and the internal wastewater treatment system. General descriptions of the wastewater treatment facilities are in Table 4.

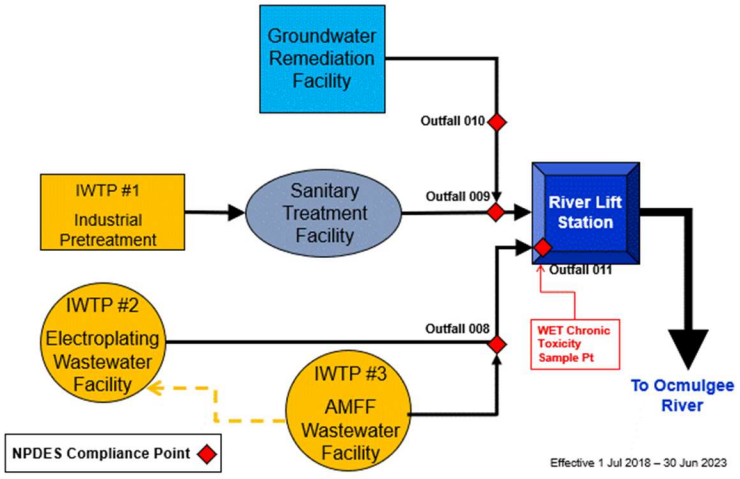


Figure 11: Robins AFB wastewater facility flow map

Table 4: General descriptions of wastewater treatment facilities

Outfall	Operation Description	Treatment Description
001-006 (External)	Stormwater runoff, non-contact cooling water/cooling tower blowoff, and oil/water separator discharge.	Holding basin followed by discharge to surface waters

Outfall		Operation Description	Treatment Description
011 (External)	008 (Internal)	Discharge from Industrial Wastewater Treatment Plants #2 and #3, includes process wastewater from electroplating/metal finishing operations. Process wastewater flows include: 1. Acid/Alkali rinses 2. Chromium-bearing Waste Stream 3. Cyanide-bearing Waste Stream	Chrome reduction, cyanide destruction/oxidation, neutralization/sedimentation, chemical precipitation, flocculation/mixing, sludge dewatering by pressure filtration, mixed flows treatment, microfiltration, equalizer tank, settling tank, thickening
	009 (Internal)	Discharge from Sanitary Wastewater Treatment Plant, Discharge from Groundwater Treatment Plant (Outfall 010), Aqueous Film-Forming Foam, and Discharge from Industrial Wastewater Treatment Plant # 1, which includes process water as follows: 1. Metal Finishing 2. Circuit Board Manufacturing 3. Painting/Depainting 4. Miscellaneous Process Wastewater and Utility Wastewater 5. Oil/Water Separator Discharge 6. Building 359 Decontamination Pad	Screening, chrome reduction, neutralization, chemical precipitation, flocculation/mixing, sedimentation, sludge dewatering by centrifugation, trickling filtration, activated sludge/nitrification-denitrification, multimedia filtration/disinfection, discharge to surface waters
	010 (Internal)	Wastewater/Groundwater from restoration site, decontamination pad, and investigation-derived wastewater.	Mixing, chemical oxidation, carbon adsorption, neutralization, and discharge to surface waters.

4.2.2.1 Industrial Wastewater Treatment Plant 1

IWTP 1 receives the "bulk wastewater" from all industrial activity on base. IWTP 1 is primarily used for the removal of metals. IWTP 1 discharges to STP (Figure 12) and is released to a wetland upgradient to Horse Creek.

The inflow to IWTP 1 varies, depending on the industrial activity that sourced the wastewater. Common industrial wastewater-generating activities on Robins AFB include depainting, painting, metal fabrication, general maintenance, non-contact cooling water, and cooling tower blowdown. Wastewater from such activities might include oil and grease, fuels, organic solvents from cleaning operation, painting wastes, and aqueous film-forming foam (AFFF). (The base is in the process of phasing out AFFF with high expansion foam (HEF) to lessen environmental impact.) Treatment activities that occur within IWTP 1

include chrome reduction, coagulation, and clarification. Preliminary grinders, a screening system, and an oil waste tank are currently bypassed. The average and peak design flows rate for IWTP 1 are 0.29 MGD and 0.65 MGD, respectively. The average and peak design flows rate for IWTP 1 are 0.29 MGD and 0.65 MGD, respectively.

4.2.2.2 Industrial Wastewater Treatment Plant 2

Within the last 10 years, the advanced metal finishing facility (AMFF) replaced an older plating facility that was located adjacent to IWTP 2. The previous metal finishing site required operators to work near plating chemical baths. AMFF consists of metal finishing processes such as plating, anodizing, etching, etc. and was designed to improve efficiency and safety of metal plating processes on base.

IWTP 2 receives all process wastewater from electroplating/metal finishing operations at AMFF. Waste streams include acid/alkali rinses, chromium, and cyanide. Treatments include chrome reduction, cyanide destruction/oxidation, neutralization/sedimentation, chemical precipitation, flocculation/mixing, sludge dewatering by pressure filtration, mixed flows treatment, microfiltration, equalizer tank, settling tank, and thickening. Base personnel stated that wastewater that does not meet discharge water quality criteria can be returned to IWTP 2 headworks for additional treatment, if necessary, although the process flow diagram does not clarify return routing. The design flow rate for IWTP 2 is 0.46 MGD. IWTP 2 effluent is discharged through Outfall 008, which commingles with the rest of the treated wastewater at Outfall 011.

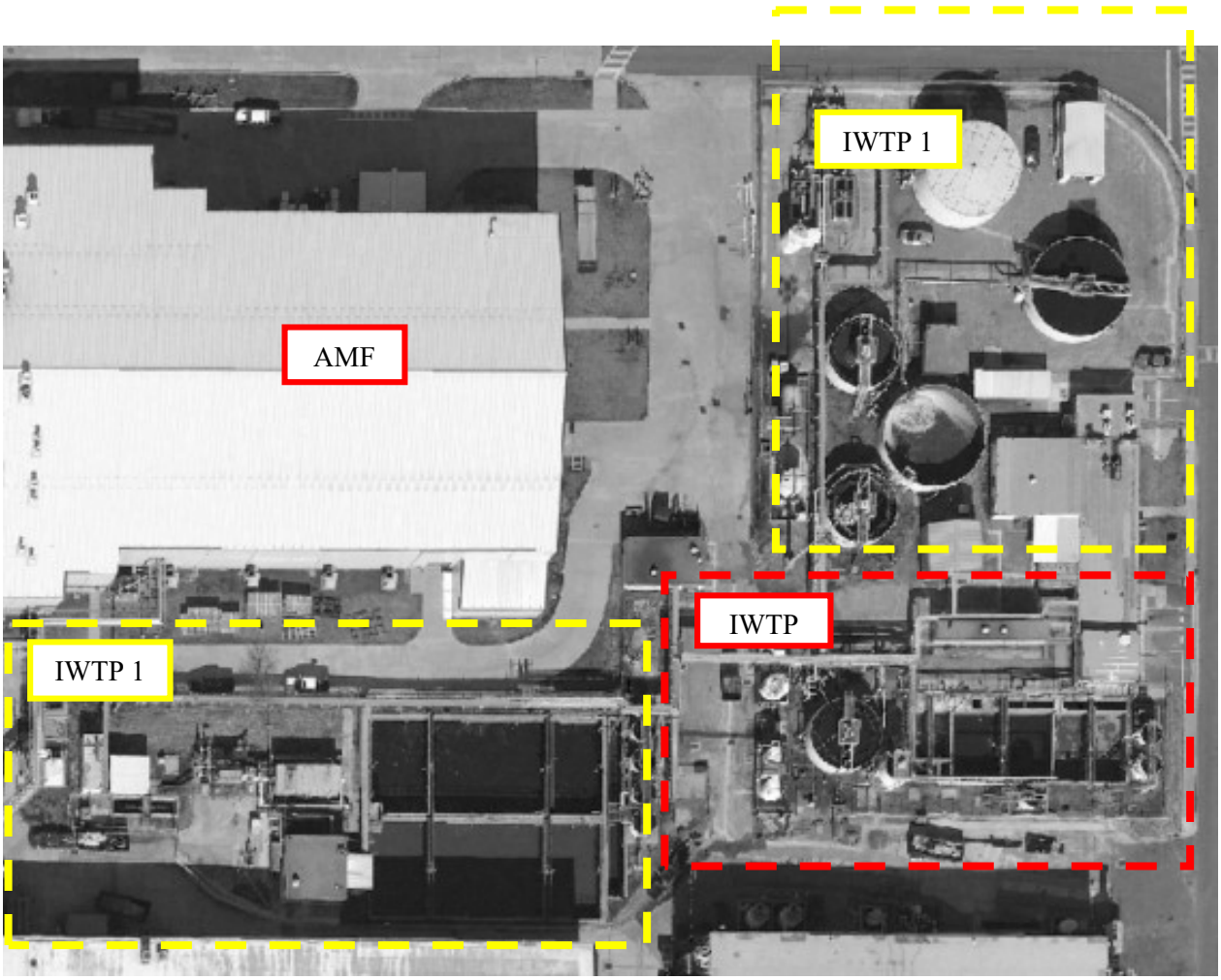


Figure 12: Industrial wastewater treatment plant 1 and 2

4.2.2.3 Sanitary Treatment Plant

The wastewater from IWTP 1 is pumped to the Sanitary Treatment Plant (STP), where it is comingled with sanitary wastewater from throughout the Base for additional treatment. The STP uses a combination of physical, biological, and chemical treatment processes to remove particulate and dissolved constituents in the wastewater. The STP treatment train includes initial screening for solids, primary sedimentation, trickling filters, nitrification, secondary clarification, activated sludge removal, tertiary filters, and disinfection with liquid CO2. The Base is in the process of implementing automated chlorine reduction equipment before discharge. Activated sludge is returned and removed as needed. Removed sludge is

pressed and disposed of as hazardous waste. Effluent from STP is discharged through Outfall 009, which commingles with the rest of the treated wastewater at Outfall 011.

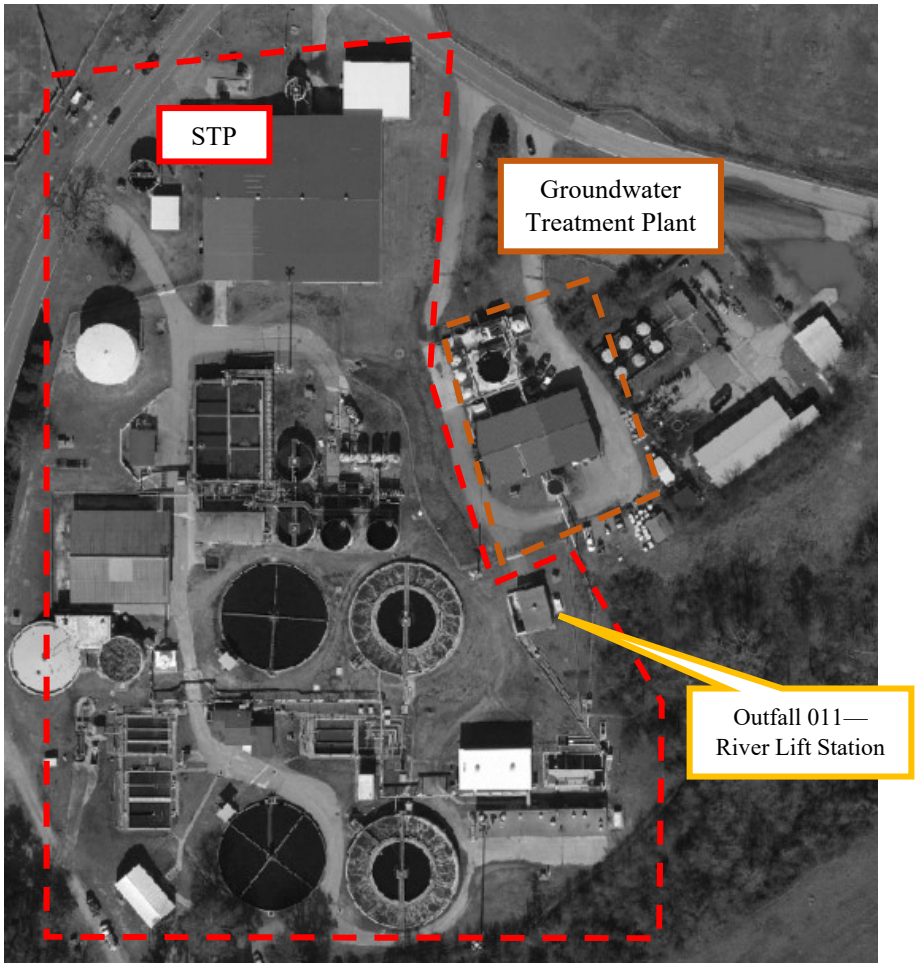


Figure 13: Sanitary treatment plant and groundwater treatment plant

4.2.2.4 Groundwater Treatment Plant

During the mid-1990s, a multisite (base-wide) pump and treat system (P&T) was installed to supplement corrective actions around localized environmental issues. The P&T system includes groundwater recovery and extraction wells located at various restoration sites; a network of conveyance piping; and a groundwater treatment plant. There are 6 restoration sites with P&T systems. The groundwater recovery systems at each of these sites, aside from Landfill 003, were shut down with regulatory approval (GPD

and EPA) to remediate the sites under an alternative remediation approach. As a result, the Groundwater Treatment Plant (GWTP) exclusively receives and treats the groundwater extracted from Landfill 003. GWTP treatment process includes 2 processes: ozone/hydrogen peroxide treatment and granular activated carbon filters. Filters are backwashed daily, and wastewater is sent to STP for treatment. Ozone treatment replaced an ultraviolet treatment system in 2015. The UV system remains in place as a backup system. The effluent from GWTP is discharged through Outfall 010.

4.2.3 ***Robins AFB Inflow and Infiltration***

Significant inflow and infiltration (I&I) at the headworks of IWTP 1 result in high flows through IWTP 1 and STP. 3E Consultant's 2016 rehabilitation plan identified the industrial sewer system surcharged piping and manhole rehabilitation as the highest priority I&I-related issues at the base. 3E recommended that the initial project inspection was not necessary and that the base should pursue direct rehabilitation. Operations personnel mentioned that the full scope of this project is in the planning phase. No documentation was received. Replacing the industrial surcharged collection system piping is highly recommended.

3E Consultant's 2016 rehabilitation plan identified the surcharged collection system piping near the sanitary treatment plant headworks as one of the 3 highest-priority I&I-related issues. 3E consultants recommended an engineering study to evaluate the hydraulic profile and develop system modification alternatives. Replacing surcharged collection system piping near STP collection system is highly recommended.

4.2.5 ***Robins AFB Compliance Summary***

4.2.5.1 Wastewater Compliance Review

Figure 14 relates wastewater infrastructure and compliance issues to the 3 outfalls that discharge effluent at Robins AFB. Compliance issues related to wastewater treatment are due to 2 factors:

- significant inflow and infiltration (I&I) at the headworks of IWTP 1 result in high flows through IWTP 1 and STP; and
- highly variable waste streams from AMFF into IWTP 2 cause dramatic differences in treatment operations at IWTP 2.

An overview of the treatment train, specific permit exceedances, and flow data through the effluent of IWTP1 and STP (Outfall 009) are represented in Figure 14. Other compliance observations including I&I issues are also included.

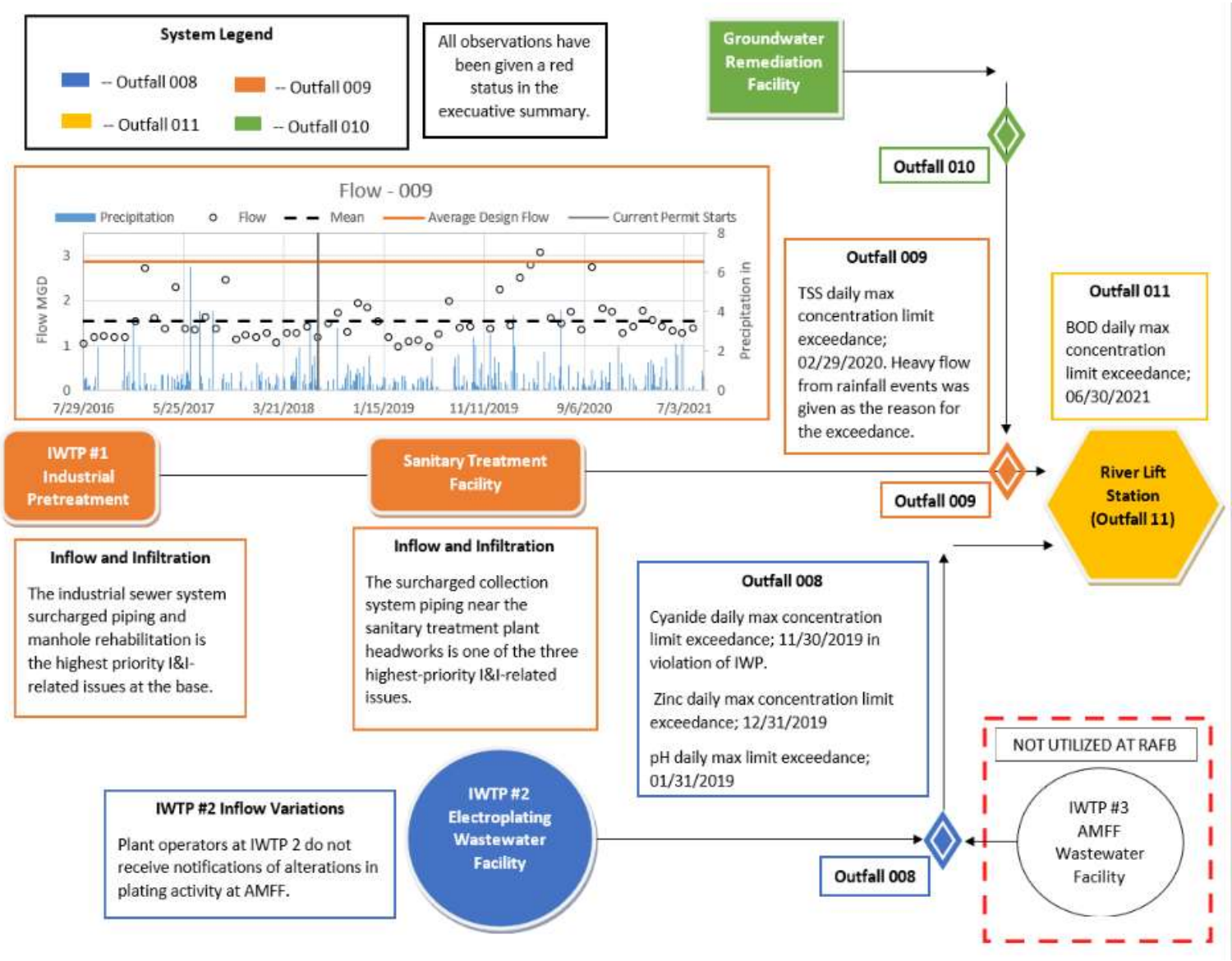


Figure 14: Robins AFB wastewater observations

4.2.5.2 Robins Stormwater Compliance Review

Outfall 003 registered a BOD permit exceedance in June of 2021. Drivers behind variance in BOD concentrations are currently unknown. Root causes driving inconsistencies in BOD concentrations should be further investigated.

As seen in Figure 15, 5 “external” or stormwater outfalls under individual permit, GA0002852, registered concentrations of at least one monitored parameter above the GA EPD water quality standard (WQS) threshold between January 2016 and June 2021.

Continual monitoring at Outfalls 001, 002, 004, and 006 for sources of fecal coliform was recommended by the CSU-CEMML team. Fecal coliform monitoring data show a significant variation in daily max concentration. More significant, however, is that the mean concentration at these Outfalls greatly exceeded the GA EPD the threshold for fecal coliform. The cause of high fecal coliform concentrations at Outfall 006 might involve stormwater runoff through horse stables upstream of the outfall. Other elevated levels are likely due to outdated sanitary sewer infrastructure.

Additionally, the mean concentration of metals (including cadmium, lead, and copper) at Outfalls 001, 002, 003, 004, and 006 significantly exceeded the GA EPD WQC thresholds. A potential source of metals is stormwater runoff containing brake dust from the JSTARS aircraft apron. Uncovered metal recycling bins might also be contributing to spikes in metal concentrations, especially around Drainage Area 12, which contains metal recycling and storage.

Figure 15: Robins AFB stormwater observations

*4.2.6 **Robins GIS Review***

The reviewed geodatabase that contains the stormwater utilities feature dataset for Robins AFB is dated 07/14/2021 and was provided by AFCEC GeoBase personnel. These GIS data were reviewed for spatial consistency and valid attribution.

The stormwater GIS data lacks connectivity of features. Point features need to be snapped to line features. Open drainage lines need to accompany culvert lines. New construction areas need to be incorporated into the stormwater GIS feature classes. Invert elevation data need to be added from as-built drawings and/or CAD. Removed infrastructure needs to be designated as removed.

4.3 Beale Air Force Base

*4.3.1 **Water Quality Program and Permit Overview***

Industrial Stormwater Permit

Beale AFB's industrial stormwater permit is a general NPDES permit (Permit No. CAS000001) issued by the California State Water Resources Control Board. The permit requires monitoring of pH, TSS, and oil and grease. These parameters do not contain standard effluent limits, but rather Numeric Action Levels (NALs). Exceedances of NALs are not considered violations. If an NAL is exceeded, depending on the frequency and consistency of exceedances of the parameter, the permittee cycles between 3 Exceedance Response Action (ERA) levels: baseline, ERA Level 1, and ERA Level 2. Each of these ERA levels contains different amounts of requirements, such as reviewing and revising the SWPPP and implementing response actions, with ERA Level 2 being the strictest. A violation occurs if the permittee does not follow these requirements.

Beale AFB does not operate under an MS4 permit.

Construction Permit

Beale AFB operates under a general NPDES permit for construction and land disturbance activities (Permit No. CAS000002). The permit requires the permittee to ensure proper qualifications of parties

responsible for writing a SWPPP and implementing BMPs. NALs for pH and turbidity are only applicable if the risk level of the project is deemed high enough by the permittee.

Wastewater Permit

Beale AFB operates a WWTP and discharges under an individual permit issued by the California Regional Water Quality Control Board, Central Valley Region (Order No. R5-2019-0086). The permit contains requirements for influent and effluent, wastewater ponds, groundwater, land application areas, water recycling, and sludge management. The monitoring requirements, including limitations, are summarized in Table 5. In addition to the monitoring requirements and limitations directly listed in the permit, many requirements reference Title 22 of the California Code of Regulations and the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins. A condensed list of these additional monitoring requirements, which are currently or have historically been monitored by Beale AFB personnel, is in Table 6 and Table 7.

Table 5. Monitoring requirements and limitations of Order No. R5-2019-0086

Location	Parameter	Limit value (type)	Monitoring Frequency
Influent (Headworks) [M1]	Flow (mgd)	0.75 (average daily)	Daily
	BOD (mg/L)		Weekly
M2	Flow (gpd)		Daily
M3	Flow (gpd)		Daily
	Flow (MG)	300 (total max. annual)	Daily
M4	Flow (gpd)		Daily
M5	Flow (gpd)		Daily
Effluent (Chlorine basin) [S4]	pH		Monthly
	Electric conductivity		Monthly
	Total coliform (MPN/100 mL)	23 (7-day median)	Twice weekly
		240 (monthly maximum)[1]	
Pond 4	BOD (mg/L)	90 (monthly average)	Monthly
	Sodium		Monthly
	Chloride		Monthly
	Nitrate as Nitrogen		Monthly
	TKN		Monthly
	Total Nitrogen		Monthly
	Standard minerals[2]		Annually
Wastewater ponds (Effluent Pond, A-Street Pond, Pond 2, Pond 3, and Pond 4)	Dissolved oxygen (mg/L)	1.0 (three consecutive)	Weekly
	Freeboard (ft)	2	Weekly
	Odors	Shall not create a nuisance beyond WWTP property	Weekly
	pH		Weekly
	Berm condition[3]		Monthly
Land application areas	Precipitation		Daily
	Temperature		Daily
	Wind direction		Daily
	Humidity		Daily
	Other relevant field conditions		Daily
	Observation		Daily
	Hydraulic loading rate		Daily
Groundwater[4]	Depth to groundwater		Semi-annually
	Groundwater elevation		Semi-annually
	Gradient		Semi-annually
	Gradient direction		Semi-annually
	Electric conductivity	See Error! Reference source not found.	Semi-annually
	Total dissolved solids	1000 mg/L (See Error! Reference source not found.)[5]	Semi-annually
	Nitrate as Nitrogen	10 mg/L	Semi-annually
	TKN		Semi-annually
	pH		Semi-annually

Location	Parameter	Limit value (type)	Monitoring Frequency
	Chloride	See Error! Reference source not found.	Semi-annually
	Sodium		Semi-annually
	Total coliform	2.2 MPN/100mL	Semi-annually
	Standard minerals[2]		Annually
Sludge in wastewater ponds	Thickness		Annually
	Cadmium		Upon removal
	Copper		Upon removal
	Nickel		Upon removal
	Chromium		Upon removal
	Lead		Upon removal
	Zinc		Upon removal

[1] *No more than one result shall exceed this value in a 30-day period.*

[2] *From the WDR: "Standard minerals shall include, at a minimum, the following: arsenic, boron, calcium, magnesium, potassium, sulfate, dissolved iron, dissolved manganese, total alkalinity (including alkalinity series), and hardness."*

[3] *From the WDR: Berm condition assessment shall include (1) presence of weeds in the water or along the berm, (2) accumulation of dead algae, vegetation, scum, or debris on pond surface, (3) animal burrows in the berm, and (4) flies or mosquitoes in the water or at the surface.*

[4] *Groundwater monitoring applies to "compliance" wells: P4C004MW, P4C005MW, P4C006MW, P4C008MW, P4C009MW, PA01, PA02, PA03, and PA04. Groundwater monitoring wells P4C001MW, P4C002MW, P4C003MW, and P4C007MW provide utility as "upgradient" wells, and BGL003MW functions as a "background" well.*

[5] *If the trigger concentration of 500 mg/L (annual average) is exceeded, a report must be submitted that provides a technical evaluation of the concentration increase and demonstrates that continuing discharge without additional treatment or control will not cause the concentration to exceed the limit (1000 mg/L).*

Table 6: Title 22 constituents that are/were monitored at Beale AFB

Parameter	**Maximum Contaminant Level (mg/L)**
Secondary Maximum Contaminant Levels (Title 22, Section 64449)[1]	
Aluminum	0.2
Copper	1.0
Foaming Agents (MBAS)	0.5
Iron	0.3
Manganese	0.05
Silver	0.1
Primary Maximum Contaminant Levels – Inorganic Chemicals (Title 22, Section 64431)	
Arsenic	0.010
Barium	1
Cadmium	0.005
Cyanide	0.15
Mercury	0.002
Nitrate (as Nitrogen)	10

Table 7: Title 22 constituents for which no "fixed consumer acceptance contaminant level" has been established

Parameter	**Maximum Contaminant Level Ranges**		
	Recommended	Upper	Short Term
Total dissolved solids (mg/L)	500	1000	1500
Specific conductance (µS/cm)	900	1600	2200
Chloride (mg/L)	250	500	600
Sulfate (mg/L)	250	500	600

*4.3.2 **Facility Overview***

Beale AFB spans a large area as depicted in Figure 16. The flightline is in the northwest of the installation area, the main base is in the center, and the military family housing area is in the southeast. The installation is divided into 5 drainage areas, which consist mostly of undeveloped land. Ultimately, flow drains off base to the southwest, discharging into various creeks including Dy Creek, Reeds Creek, Best

Slough, and Hutchinson Creek. Industrial activity occurs in all but the east drainage area (which contains the military family housing area).

The WWTP is contained in the southern portion of the installation. Beale AFB operates a land-application-based wastewater treatment system, which consists of a collection system, secondary treatment (trickling filter), tertiary treatment (chlorine contact basin), a post-aeration basin, a series of holding ponds, land application areas, an irrigation system for an on-base golf course, an anaerobic digestion system, and sludge holding beds. Figure 17 contains a diagram of this system, excluding the collection system and the anaerobic digestion system. At the time of the CSU-CEMML team's site visit, a design process was underway for a new WWTP.

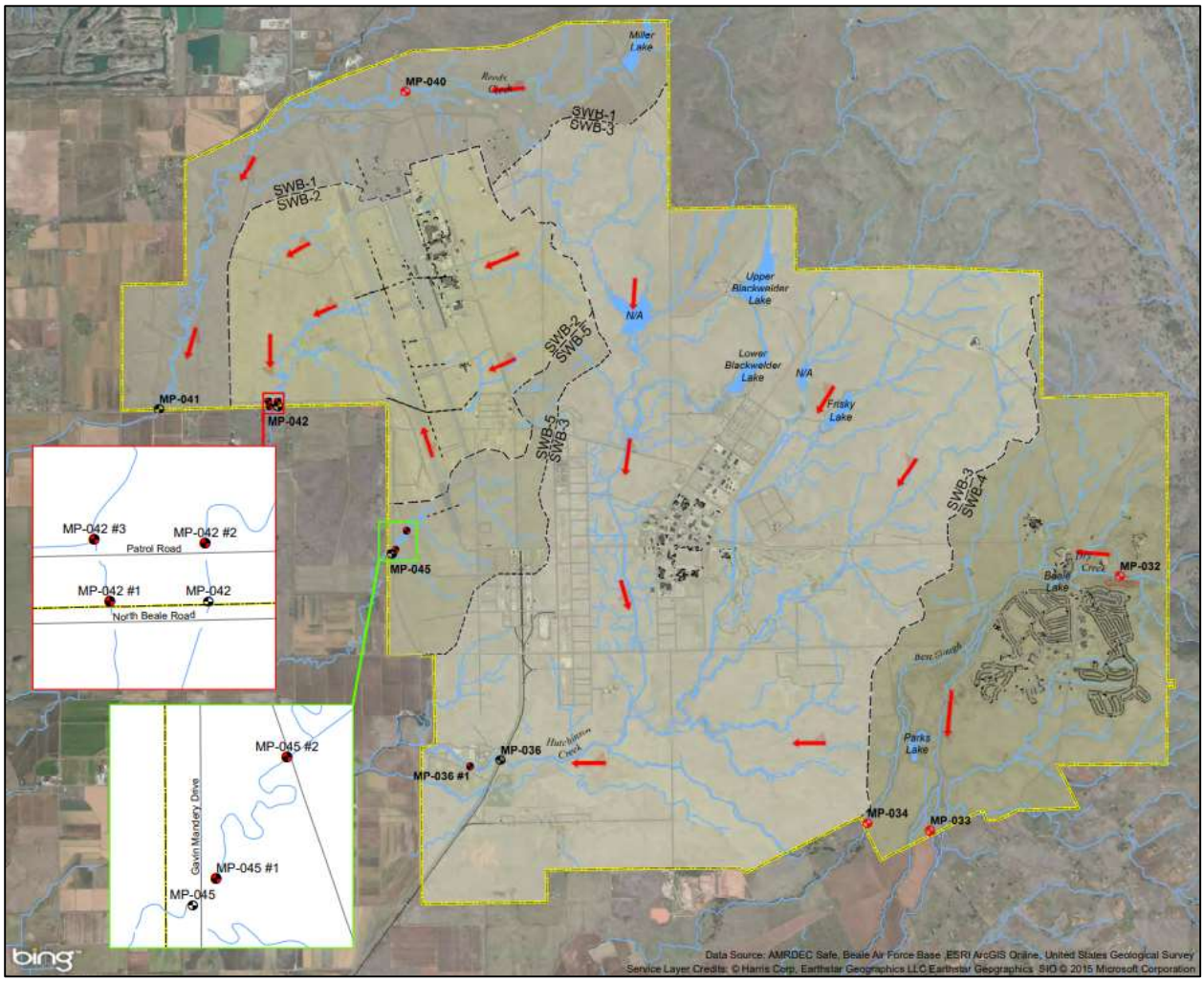


Figure 16: Beale AFB stormwater basins (5), monitoring points, and direction of flow. Source: SWPPP

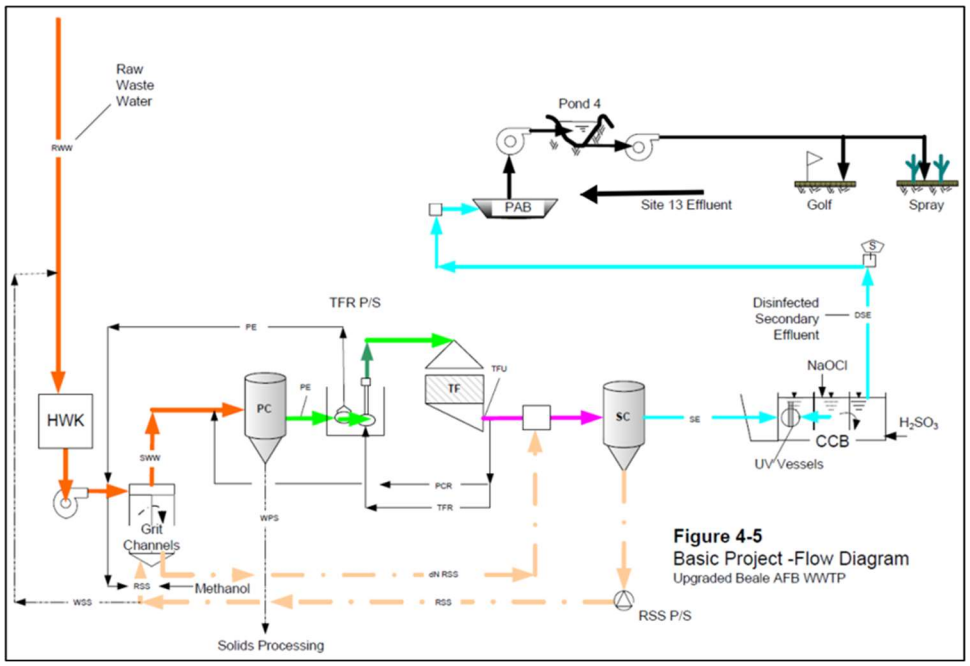


Figure 17: Schematic of BAFB wastewater treatment train, including wastewater ponds and irrigation fields. Source: File Wastewater Treatment Plant Flow Diagram 2013 - Beale

*4.3.3 **Beale AFB Compliance Summary***

Compliance analysis for wastewater data was conducted using data under the limitations of the current wastewater discharge permit (Order No. R5-2019-0086). Therefore, only data from 2020 through the time of the study (the middle of 2021) were analyzed. Data are from quarterly reports received from Installation personnel. Referencing limits in Table 5, Table 6, and Table 7, exceedances are listed in Table 8. Total coliform, manganese, and aluminum exceedances occurred in groundwater monitoring wells in 2020. Additionally, freeboard and wind speed during land application exceedances occurred in 2020 and 2021.

Table 8: Exceedances under the current WDR

Date	Parameter	Location	Value	Limit
4/2020	Total Coliform (MPN/100mL)	P4C005MW	30	2.2
		PA03	33	
11/2020	Total Coliform (MPN/100mL)	P4C006MW	130	
	Manganese (µg/L)	P4C005MW	730.7	50
	Aluminum (µg/L)	P4C004MW	433.8	200
		P4C005MW	663.4	
		P4C006MW	1100	
		P4C008MW	240.4	
		P4C009MW	2801	
		PA01	2940	
		PA02	20000	
		PA03	1302	
		PA04	1423	
7/17/20	Freeboard (ft)	Effluent Pond	1.7	2
6/18/21	Freeboard (ft)	Effluent Pond	1.7	
2/9/20	Max. wind speed (mph)	Irrigation Field #1	31	30
2/11/20	Max. wind speed (mph)	Irrigation Field #1	30	
9/8/20	Max. wind speed (mph)	Irrigation Field #1	34	
10/25/20	Max. wind speed (mph)	Irrigation Field #1	35	

*4.3.4 **Beale AFB GIS Review***

GIS data were reviewed for spatial consistency and valid attribution. There are areas of the Installation where inlets are not connected to stormwater gravity lines. These connections must be established through field surveys, as-built drawings, or CAD data. Additionally, elevation values are not present for any of the feature classes. The elevation values can be interpolated from DEM data and assigned to features. Invert elevation values, a key component for 2-D stormwater modeling, are present in less than 5% of features. Invert elevation values can be populated from as-built drawings, CAD data, and infrastructure surveys.

4.4 Langley Air Force Base

4.4.1 Water Quality Program and Permit Overview

Stormwater permits for LAFB are issued by VDEQ for point source discharges to surface waters (1) from industrial activities, (2) from MS4s, and (3) from construction activities by Virginian Stormwater Management Program (VSMP).

NPDES/VPDES permit (VAR052285) for LAFB was effective on 1 July 2019 with 20 permitted industrial outfalls. VAR052285 is a general permit issued by the Virginia Department of Environmental Quality (VDEQ) that covers outfalls, specific water quality monitoring and reporting requirements in relation to industrial activities at the installation. VPDES permit requires all outfalls to be monitored visually every quarter and Outfall 57 and 571 to be monitored and tested semi-annually for specific parameters (TSS). A visual inspection of all the industrial outfalls shall be done every quarter.

LAFB is subject to supplemental conditions, such as Chesapeake Bay TMDL that requires Total Nitrogen (TN), Total Phosphorus (TP) and Total Suspended Solids (TSS) to be monitored at each permitted industrial outfall to reduce nutrient load in Chesapeake Bay. In addition to Chesapeake Bay TMDL, LAFB is also subject to impaired water TMDL (the Back River Bacterial TMDL) due to stormwater discharge to Back River.

According to VAR052285, benchmark monitoring for the industrial outfalls under Sector AF (outfall 57 and 571) at LAFB is required. The only discharge limitation for the benchmark monitoring is that the maximum TSS concentration is 100 mg/L.

MS4 permit for LAFB was effective on 1 Nov 2018 with initial 96 non-industrial outfalls. Both the NPDES permit and the MS4 permit are valid for 5 years. Another NPDES/VPDES permit held by Eaglewood Golf Course at LAFB is Permit No. VAG750278.

No wastewater treatment plant is functioning currently at LAFB. Wastewater discharge permits held by LAFB are Hampton Roads Planning District (HRSD) Permit No. 0011, and Inflow & Infiltration Order authorized by HRSD.

*4.4.2 **Facility Overview***

The LAFB stormwater conveyance system consists of sheet flow areas, swales, ditches, and pipes. Two sub-watersheds (northwest-southwest branch of Back River) are included in LAFB MS4 jurisdictional area. Figure 18 shows a map of industrial outfalls and drainage areas.

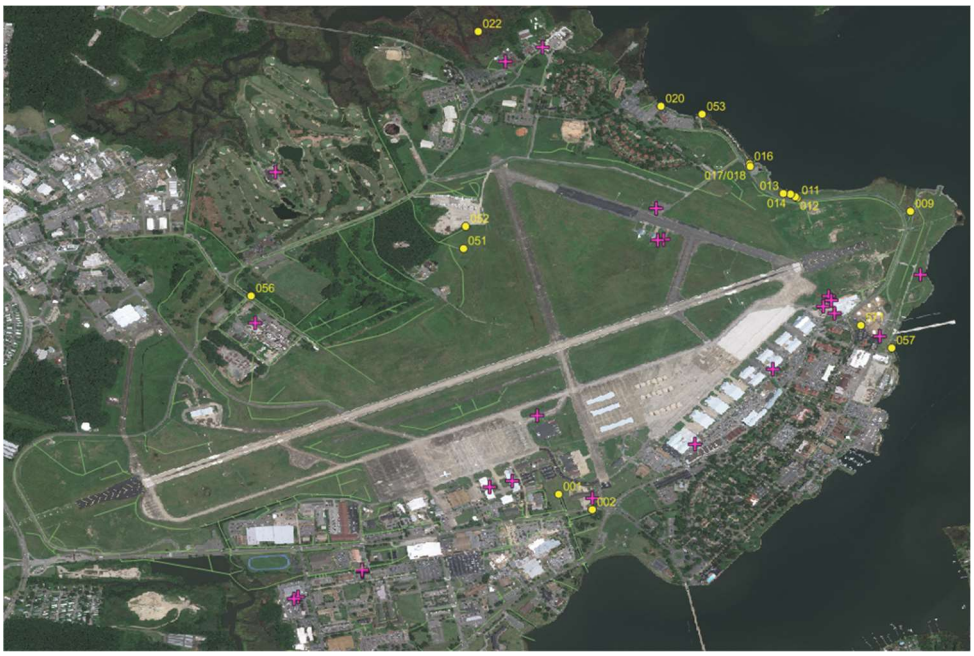


Figure 18: Langley AFB map of industrial outfalls

*4.4.3 **Langley AFB Compliance Summary***

4.4.3.1 Benchmark Monitoring Requirements

Figure 19 shows the locations of Outfall 057 and 571, which require semi-annual monitoring under VPDES VAR052285. According to base personnel, the sampling locations are slightly different from the outfall locations. The sampling point for Outfall 057 is located at Dodd Blvd. and Andrews St. Both outfalls have been classified under Sector AF: Bulk Fuel Storage with SIC code 5171.

VDEQ data shows LAFB has successfully submitted all the required monitoring data and no violation has been identified (shown in Figure 19).

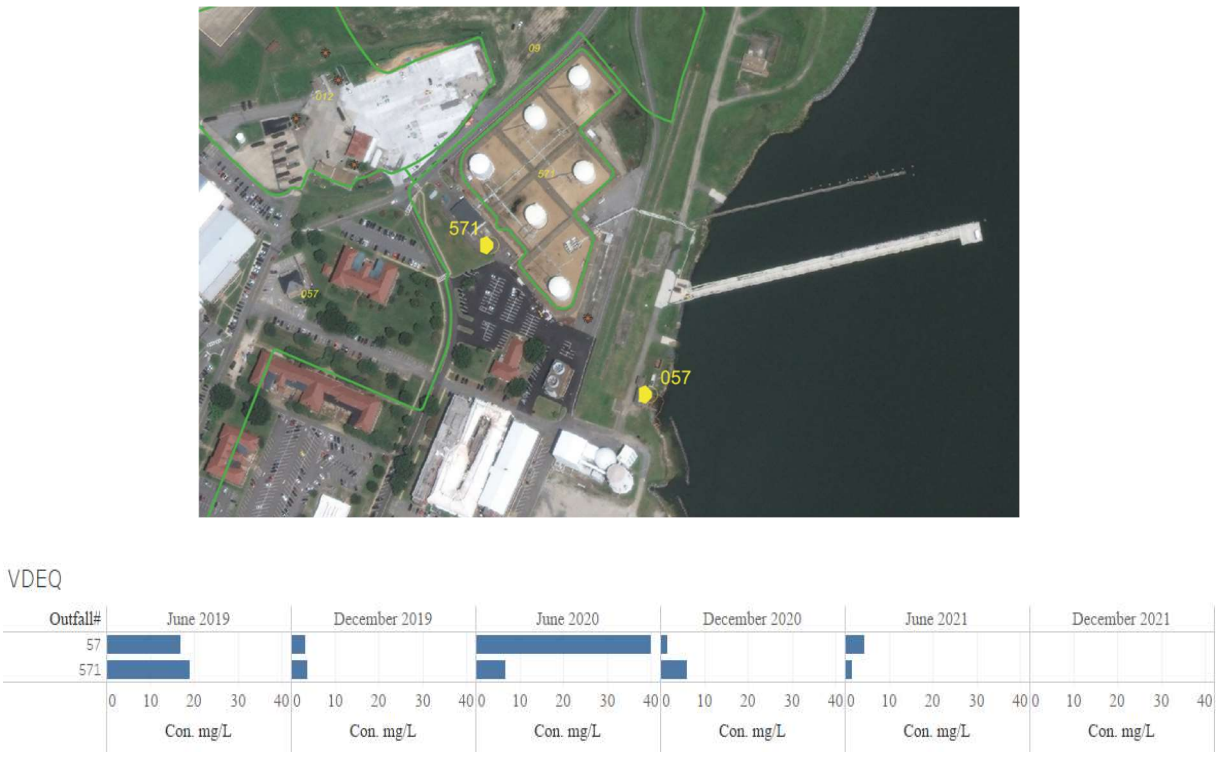


Figure 19: Langley AFB map and monitoring results of NPDES outfalls 057 and 571

4.4.3.2 MS4 Annual Dry Weather Screenings

As required by MS4 permit (VAR040140), Dry Weather Screening inspections have been conducted annually since 2018 at LAFB. Annual Dry Weather Screening reports have been received for the 3 consecutive Permit Years (PY). Table 9 summarizes the main findings from the Annual Dry Weather Screening reports.

Table 9: Dry weather screening results

Permit Year	PY 1	PY 2	PY 3
# of total screened outfalls	50	52	53
# of surveyed outfalls	47	46	50
# of outfalls with preliminary illicit discharges rated as "potential"	26 (55%)	24 (52%)	10 (20%)
# of outfalls need further upstream investigation	8	3	10
# of fully submerged outfalls by tide	5	4	—
# of fully submerged outfalls by sediments	—	—	2

The number of outfalls with a preliminary illicit discharge rating of "potential" is decreasing.

During the dry weather screening for PY 1, 26 outfalls were rated as "potential" with preliminary illicit discharge present. Three of those outfalls (outfall 030, 064 and 076) had erosion, 7 had broken pipes or cracked concrete, 12 had trash or excessive vegetation present, and 5 had been partly or fully submerged by tides.

Among the 95 non-industrial outfalls, 5 MS4 outfalls (25, 30, 40, 76 and 203) have been identified as "high priority outfalls," which are required to be inspected every year (per EPA's Illicit Discharge Detection and. Elimination [IDDE] program).

Major findings from PY 2 dry weather screening includes:

1. Trash and excessive vegetation remained the main issue for most of the inspected MS4 outfalls.
2. Outfall 217 and 218 (downstream of 217) had observed sheen and sheen accumulation with clogged pipes. These 2 outfalls might be affected by nearby car washing or oil drips.
3. Outfall 223 had sheen in standing water and erosion occurred.

Most of the previous issues have been identified in the PY 3 dry weather screening report.

The CSU-CEMML team found some consistent issues in the 3 dry weather screening reports.

- Eight outfalls rated as “potential” in PY 1 dry weather screening report have also been rated as “potential” in PY 3 dry weather screening.
- Outfall 025 has been rated as “potential” for both PY 1 and PY 2.
- Outfall 040 (high priority outfall) has been rated as “potential” for all investigated years.

MS4 permit requires a rotation inspection of MS4 outfalls with a minimum of 50 outfalls per year. The consistent outfall issue indicates an improper execution of the suggested corrective actions. None of the recommended corrective actions, such as further investigation; removal of debris, trash and excessive vegetation; or pipe repair have been implemented.

MS4 map has been out of date since PY1. Outfalls were reclassified from industrial to non-industrial, which is not reflected in the MS4 map.

According to base personnel, shortage of trained staff and lack of funding limit the execution of the recommended Corrective Actions/BMPs, including upstream or outfall investigation, repairing infrastructure, and removing excess vegetation. The CSU-CEMML team recommended allocating funding for routine maintenance of BMPs and infrastructure and addressing escaped trash at an installation level.

Lack of personnel continuity has led to incomplete documentation for quarterly high-priority MS4 facility inspections for 2019 and 2020. Records have been properly maintained since 2021 under new management. Permit complexities and transitions in staff make it difficult to track and maintain all permit-related records over time. Base personnel recommend investing in asset management software to properly track and maintain records moving forward.

4.4.4 ***Langley GIS Review***

CSU-CEMML received the stormwater utilities feature dataset from the AFCEC GIO office in February 2022. The ‘dateEdited’ attribute for all features refers to October 2020 as the last editing date.

CSU-CEMML personnel surveyed the stormwater infrastructure at JBLE-L in 2016 and delivered a geodatabase to the clean water program and the JBLE-L GeoBase office in August of 2016. The surveyed data were not integrated into the feature dataset that we received from the AFCEC GIO office in February 2022. The 2016 stormwater infrastructure survey was a major update to the feature dataset both in terms of spatial reconciliation and new feature collection and in terms of proper attribution of features.

The GIS data is inaccurate and out of date. The stormwater utilities feature dataset dated February 2022 is incorrect both spatially and within the feature attribution. The 2016 stormwater infrastructure survey geodatabase should be incorporated into the dataset to address spatial and attribution inaccuracies and reconcile features.

4.5 Charleston Air Force Base

4.5.1 Water Quality Program and Permit Overview

Joint Base Charleston (JBC) has 2 primary geographically separated areas: an air base (JBC-Air) and a naval weapons station (JBC-Weapons). Consequently, the joint installation holds 2 industrial stormwater permits, 2 MS4 permits, and 3 wastewater permits (JBC-Weapons has 2 wastewater permits for separately connected wastewater collection systems). These permits, with associated plans, are listed in Table 10.

Table 10: Relevant permits and plans for review of JBC stormwater and wastewater program

SW/WW	Type	JBC-Air	JBC-Weapons
Stormwater	Industrial Stormwater	SCR005311 (and SWPPP)	SCR005312 (and SWPPP)
	MS4	SCR031909 (and SWMP)	SCR031504 (and SWMP)
	Spill Response Plan	SPCC	
Wastewater	Industrial Wastewater	SC0024783 (Permit No. 2007)	1520003
			1520004
	Satellite Sewer System	SSS000317	SSS000836

Since becoming a joint base in 2010, the environmental management of JBC-Air and JBC-Weapons has been conducted by a single team.

The general permit for industrial stormwater (Permit No. SCR000000) that both areas of JBC operate under is issued by the South Carolina Department of Health and Environmental Control. The permit requires monitoring and reporting of parameters depending on the specific industrial activities of the facility. Additionally, control measures are required to be designed and implemented for 12 categories to prevent pollution in the stormwater system.

The general MS4 permit for both areas of JBC (Permit No. SCR030000) contains requirements for discharges to impaired waters and the development and implementation of a Storm Water Management Program (SWMP).

JBC's 3 wastewater pretreatment permits have different parameters that require monitoring and different limits; however, they generally consist of BOD, oil and grease, pH, flow, and various metals.

In addition to wastewater pretreatment permits, the state requires that JBC have satellite sewer system permits for their wastewater collection systems. These permits are required when a collection system discharges into another collection system that is operated by a separate owner. These permits contain general requirements for proper operation and maintenance of the collection system.

*4.5.2 **Facility Overview***

As stated above, JBC operates 2 primary geographically separate bases. Both JBC-Weapons and JBC-Air discharge wastewater to different POTWs. The primary industrial activity at both bases is hazardous waste storage. Hazardous waste is stored on base temporarily and is transported off-site to be treated and disposed of. Additionally, JBC-Weapons also contains an Open Burn Open Detonation/Explosive Ordnance Division (OBOD/EOD) facility.

*4.5.3 **Charleston AFB Compliance Summary***

Data review and OSD metrics revealed no non-compliances at JBC. SRC000000 and the MS4 permit require JBC to perform benchmark monitoring for outfalls with industrial-related activities and impaired streams. If measurements are below the benchmark requirements, monitoring is no longer required to be conducted. Benchmark monitoring measurements conducted at the beginning of JBC's permit cycle were below benchmarks and therefore JBC is not required to conduct further periodic monitoring of outfalls. Additionally, industrial activities at JBC are not related to the industrial activities that require monitoring as contained in SRC000000. Consequently, stormwater requirements at JBC revolve primarily around control measure performance and periodic visual inspections.

Data for pretreatment permits were received from installation personnel in periodic discharge monitoring reports. The data revealed pollutants that were well in control. However, over the 2-year period that was analyzed, monthly average flow in permit 152004 (one of the pretreatment permits at JBC-Weapons) exceeded the limit once, in August 2021. Additionally, both the previous and subsequent monthly average flow measurements were near the limit. The previous year, a near-limit measurement also occurred in

August. Although data were only from 2 years, this pattern, which occurs during the wet months for the region, suggests there may be inflow and infiltration (I&I) issues within the wastewater collection system. The CSU-CEMML team recommended that an I&I study be programmed for JBC.

4.5.4 Charleston GIS Review

GIS data were reviewed for spatial consistency and valid attribution. JBC's GIS data showed lack of spatial connectivity between features. Additionally, waterways within JBC-Weapons were depicted as stormwater lines. The CSU-CEMML team recommended the feature dataset should undergo quality control review to establish connectivity and properly identify watercourses.

4.6 Tinker Air Force Base

4.6.1 Water Quality Program and Permit Overview

4.6.1.1 Industrial Stormwater Permits

Tinker AFB follows 2 OPDES permits that allow for the discharge of industrial stormwater to state waterbodies. OPDES OK0000809 was the focus on the CSU report due to its non-compliance record and significant monitoring overlap with the multi-sector general stormwater permit OKR05. OK0000809 originally permitted the discharge of industrial wastewater from IWTPs on Tinker AFB through 9 outfalls. However, during the last few permit cycles, the outfalls have primarily discharged industrial stormwater. Outfall 008 is mentioned throughout this report; however, this outfall was removed from the current permit due to a BASH hazard.

4.6.1.2 MS4 Permit

Tinker AFB also operates a general permit for stormwater discharges associated with municipal separate storm sewer systems (MS4). The MS4 permit outlines the stormwater management plan, MCMs, and other program requirements. The permit was renewed in June 2021 and will expire in May of 2026.

4.6.1.3 Wastewater Permits

Oklahoma City has issued 2 wastewater permits to Tinker AFB:

- Industrial Wastewater Discharge Permit Significant Categorical User 0029-FC
- Industrial Wastewater Discharge Permit Significant User 0029-TAC (Tinker Aerospace Complex)

All wastewater generated at Tinker AFB is sent to the Oklahoma City POTW for final treatment. The industrial wastewater pretreatment plant receives industrial wastewater from all industrial activity at Tinker AFB except the Tinker Aerospace Complex (former GM plant). Wastewater from the TAC does not receive pretreatment and is sent directly to the OKC POTW.

4.6.2 ***Facility Overview***

4.6.2.1 Stormwater Facilities

Figure 20 illustrates the flow schematic and final discharge locations for the stormwater system under OK0000809. Figure 21 shows the approximate locations of the stormwater outfalls under OK0000809.

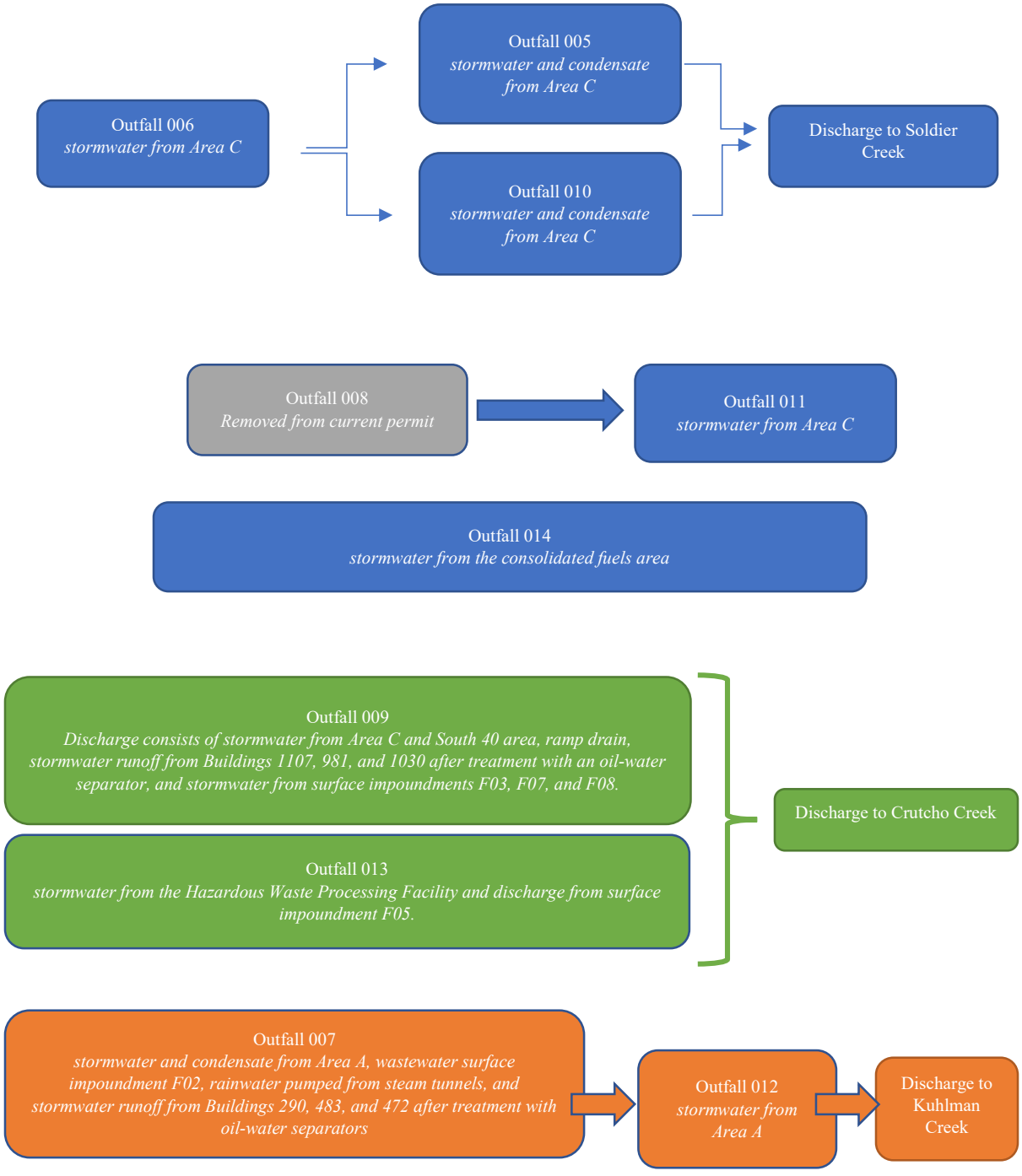


Figure 20: Tinker AFB flow schematic for outfalls under OK0000809

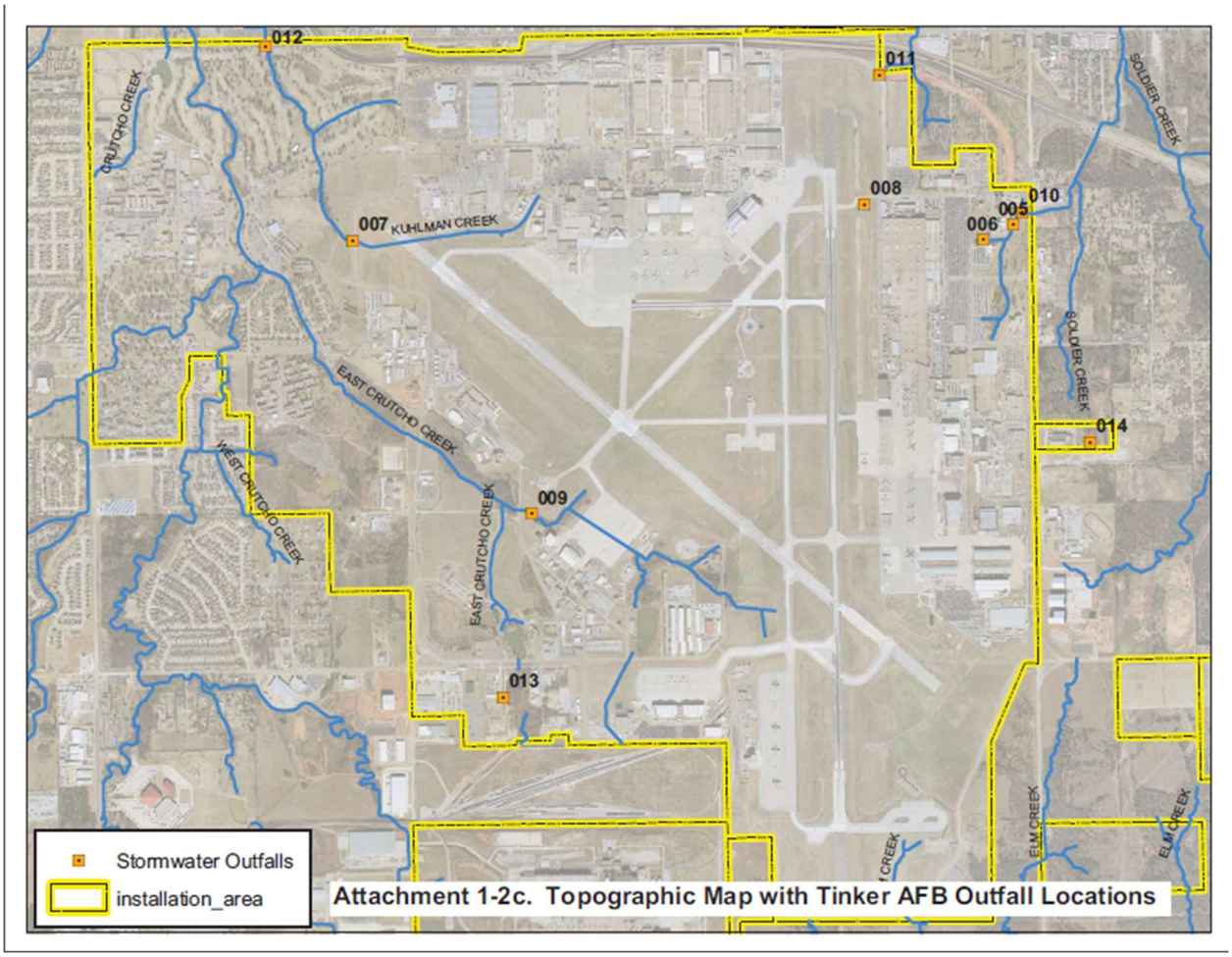


Figure 21: Summary of outfall locations under OK0000809 and drainage watersheds. Source: permit application (2015)

4.6.2.2 Wastewater Facilities

The flow and treatment processes of the wastewater treatment system are illustrated in Figure 22.

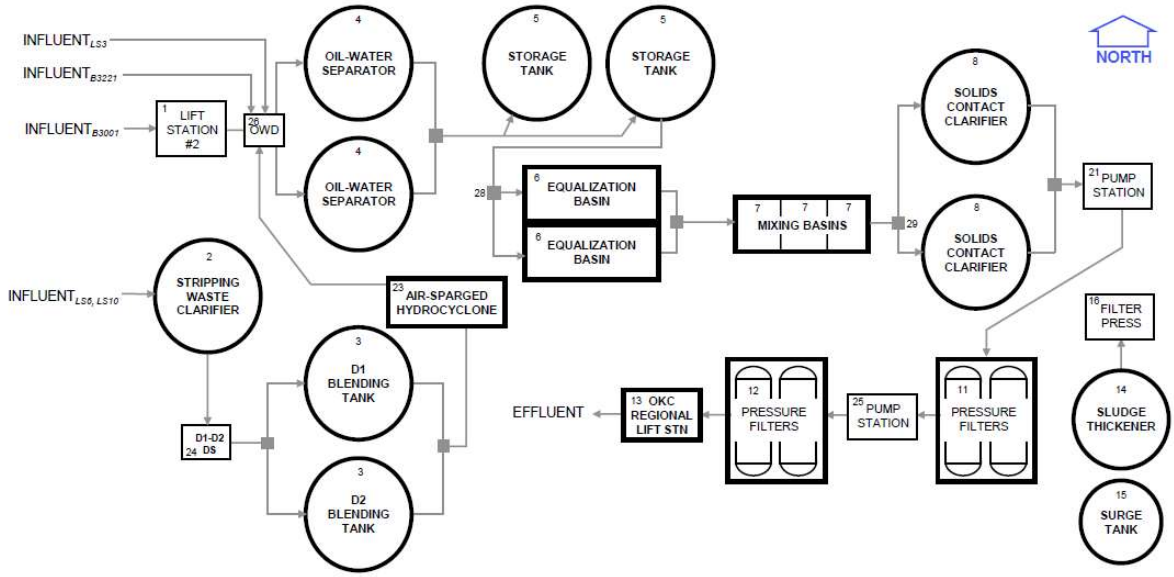


Figure 22: Tinker AFB process flow diagram of industrial wastewater treatment plant

*4.6.3 **Tinker AFB Compliance Summary***

The CSU-CEMML team analyzed DMR data from January 2015 through May 2022 and discovered 65 limit exceedances under the Oklahoma Pollutant Discharge Elimination System (OPDES) industrial stormwater permit, OK0000809. The high number of exceedances is partly due to a weekly monitoring requirement for all outfalls covered by this permit. Frequent sampling increases the likelihood of detection when pollutant concentrations exceed permit limits. More frequent sampling has enabled Tinker AFB personnel to thoroughly characterize the sources of permit exceedances. Detailed descriptions of permit exceedance root causes can be found in exceedance letters sent to Oklahoma Department of Environmental Quality (ODEQ).

The CSU-CEMML team has identified 3 chronic compliance issues at Tinker AFB. In Figure 23, the CSU-CEMML team offers examples of infrastructural improvement projects and management strategies to address the recurring violations, which include:

- Chemical Oxygen Demand (COD)/Biological Oxygen Demand (BOD) exceedances due to the discharge of deicing chemicals
- Total Suspended Solids (TSS) exceedances due to construction activity
- pH exceedances due to exposed cement and limestone, used as base material in construction projects

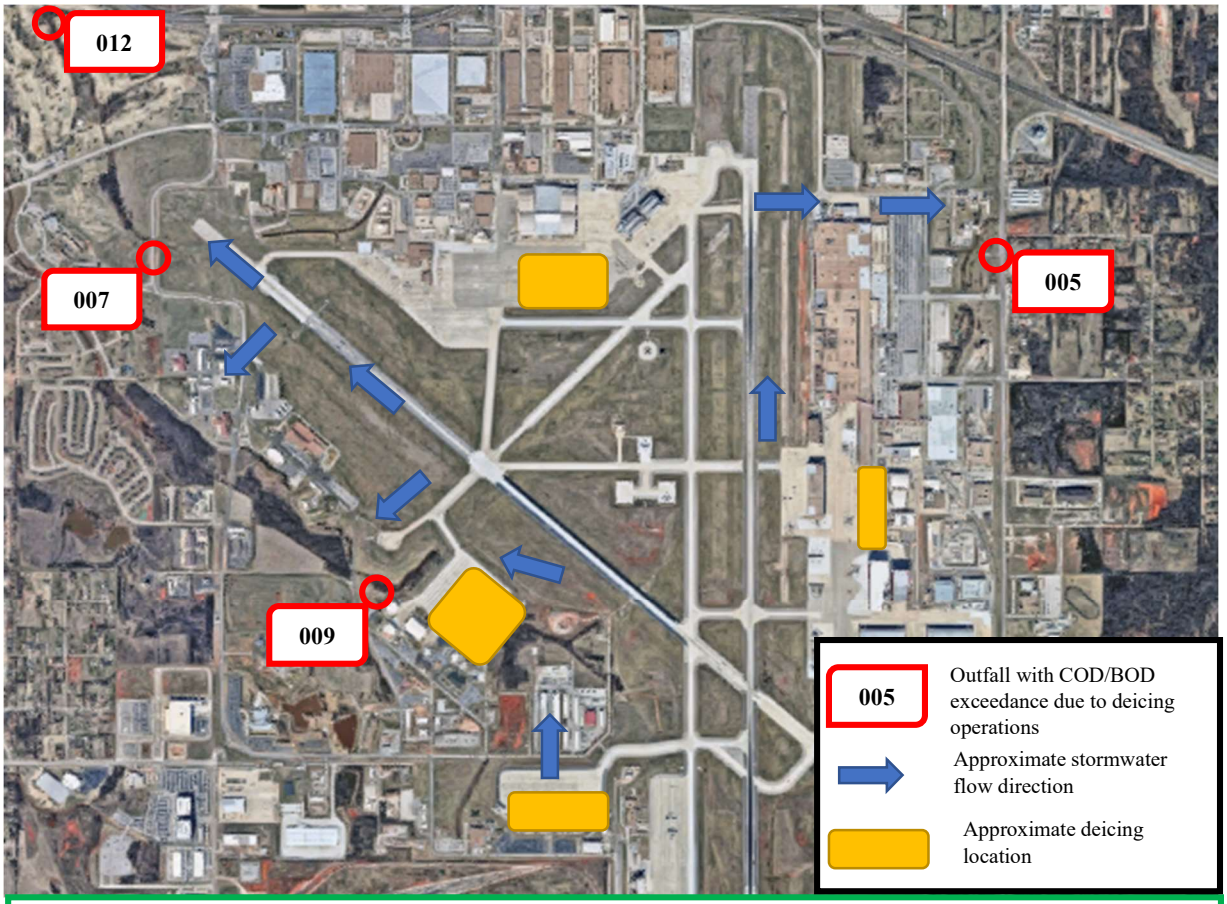
Detailed observations of compliance issues at each outfall covered by permit OK0000809 are outlined in Table 11.

Additionally, the CSU-CEMML team recommends updating the Best Management Practices (BMP; the latest version is from 2013) to reflect current compliance issues, as required by the industrial stormwater permit OK0000809.

4.6.3.1 COD/BOD

Historically, the major contributor to OPDES permit exceedances on Tinker AFB has been deicing operations, which discharge glycol-based aircraft deicing fluids and acetates into the stormwater system. The outfalls in Figure 23 have recorded exceedances for COD or BOD, attributed to the discharge of deicing chemicals. TAFB uses both sodium acetate and potassium acetate to deice airfield surfaces. TAFB uses acetate on airfield pavement surfaces because salt and sand cannot be used due to their potential to corrode aircraft. Glycols have been detected at Outfall 007, which indicates that aircraft deicers have been discharged to storm sewers. These findings suggest that BMPs designed to limit and contain deicing chemicals were not implemented properly.

The BMP management plan required by OK0000809 outlines 6 BMPs to address aircraft deicing. BMPs 1–4 include measures to limit the application of deicing fluid. The final 2 BMPs address the containment, collection, and removal processes for the spent deicing fluid.



Recommendation

Below are examples of infrastructure improvement projects and management tools to consider for reducing COD and BOD exceedances:

1. Ensure containment, collection, and removal measures (BMPs 5 and 6) are properly implemented, e.g., butterfly valves are closed to prevent illicit discharges of deicing chemicals; drain covers that restrict the discharge of spent deicing fluid are deployed; and deicing recovery vehicles remove spent deicing chemicals from ramps and pad.
2. Consider an alternative to acetates (such as potassium formate) on paved surfaces that reduces the COD/BOD concentration in stormwater runoff.
3. Consider investing in asset management software to standardize recordkeeping and information transfer related to deicing operations, e.g., aircraft deicing and the use of acetates on pavement surfaces.

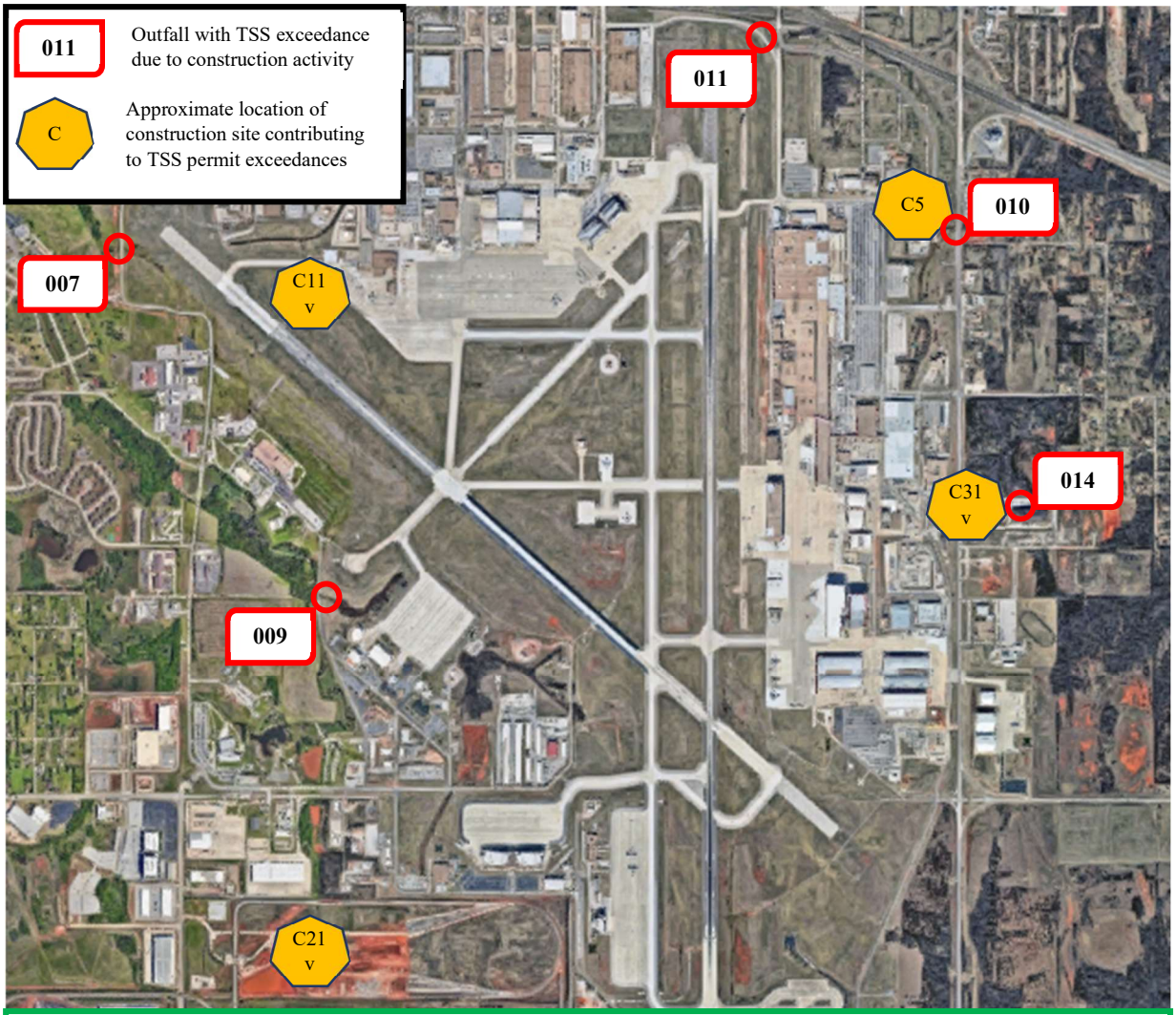
Figure 23: Tinker AFB chronic COD/BOD exceedance outfalls

4.6.3.2 Total Suspended Solids

Table 11 and Figure 24 show construction sites that have contributed to TSS exceedances under Permit OK0000809. The outfalls in Table 11 and Figure 24 have recorded exceedances for TSS that have been attributed to runoff from these construction sites, which have mismanaged sediment controls. The contractors at these construction sites are primarily responsible for the inspection and maintenance of their sites. Tinker AFB personnel routinely inspect contracting sites to ensure that BMPs in the SWPPP are implemented and maintained. The Storm Water Program Manager at TAFB is responsible for this duty with assistance from contract quality assurance inspectors.

Table 11: Construction sites and impacted outfalls related to TSS exceedances under permit OK0000809

Construction ID	**Construction site**	**Impacted Outfalls**
C1	Airfield Project	007, 012
C2	KC45A Campus Construction Site	009
C3	Lift Station Repair	014
C4	Cap for Concrete Drainage Ditch	011
C5	IWTP facility upgrade	010



Recommendation

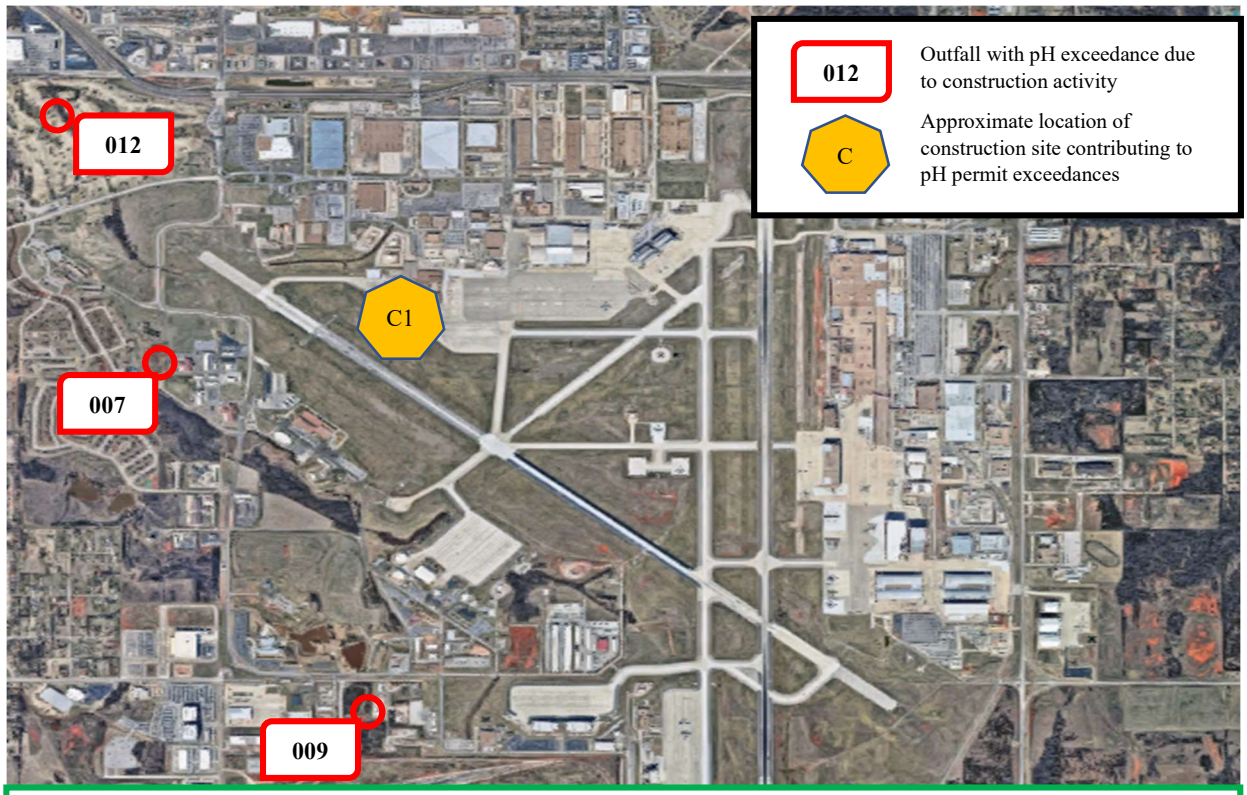
The CSU team recommends that the water quality program inspectors improve coordination with contractors prior to rain events to ensure contractors are following sediment control requirements. The CSU team recommends that each construction site maintain an individual SWPPP as well as the forms and documents required by GP OKR10, e.g.,

Figure 24: Tinker AFB chronic TSS exceedance outfalls

4.6.3.3 pH

Outfalls 007, 009, and 012 together exceeded the pH maximum limit 13 times between August 2019 and October 2021. The location of each outfall is represented in Figure 25. High pH levels were attributed to stormwater runoff from an active construction site.

Outfalls 007, 009, or 012 have not had a pH exceedance since October 2021; however, exceedance letters from Tinker AFB to ODEQ note that airfield pavement construction will continue for several years. The pH levels are expected to remain elevated until this construction is finished.



Recommendation

The CSU team recommends that additional BMPs be implemented prior to discharge when the source of elevated pH can be identified. Examples of pH reduction techniques include:

1. Implement a portable pH neutralization tank using CO_2 upstream of Outfalls 007 and 009
2. Cover stored limestone aggregates before concrete is poured
3. Avoid leaving treated base layers exposed during rainfall events
4. Add pH BMPs to 2013 BMP plan

Figure 25: Tinker AFB chronic pH exceedance outfalls

Tinker Wastewater Permit Violations

Tinker AFB's wastewater treatment plant violated Oklahoma City's surcharge limit 14 times (13 BOD violations and a TSS violation) between January 2018 and May 2022. Surcharge limits are not permit violations but do require Tinker AFB to pay an additional fee to the Oklahoma City Utilities Department. Tinker AFB violated the TSS, mercury, zinc, and acetone permit limit during the same time period. Repeated surcharge and limit violations might affect Tinker AFB's relationship with the City of Oklahoma Utilities Department. Base personnel mentioned during the site visit that the untreated Tinker Aerospace Complex waste stream concentrations have raised concerns with the Oklahoma Utilities Department in the past. CSU-CEMML team advises closer monitoring of wastewater treatment and waste-generating activities to reduce the number of limit and surcharge exceedances.

4.6.3.4 OSD Metrics Violations

OSD metrics mention sanitary sewer overflows (SSO) resulting in unpermitted discharges into storm drains. These SSOs were caused by failing infrastructure, e.g., broken sewer lines (March and April 2021) and pumps in sludge tanks (April, May, and June 2019). A punctured storage tank was identified near the WWTP during the site visit.

OSD metrics mention High expansion foam and AFFF discharged to storm sewer system on 8/19/2021 and 9/6/2021, respectively. OSD metrics do mention that the high expansion foam and AFFF systems have been repaired. No further details are included in the OSD reports. Tinker AFB provided the CSU-CEMML team with AFFF testing documents for years 2016 and 2017. No AFFF monitoring data was received for years following 2017.

4.6.4 ***Tinker GIS Review***

Feature attribution is missing/incomplete throughout the dataset. This is likely the result of the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) schema being updated from 3.1

to 4.0 and the subsequent data migration of the Tinker stormwater GIS data from SDSFIE 3.1 to 4.0. CSU-CEMML team recommends that matching attributes be paired during data migration to avoid attribute falloff or missing or incomplete attribute transfer.

4.7 Scott Air Force Base

4.7.1 Water Quality Program and Permit Overview

Scott AFB has applied for and received permits as required by the Federal Water Pollution Control Act, also referred to as the Clean Water Act (CWA). The following is a list of Scott AFB storm water permits:

- Permit Number (No.) IL0026859 NPDES Permit to Discharge into Waters of the State
- Permit Number (No.) ILR002659 General National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Discharges from Industrial Activities
- Permit No. ILR10 General NPDES Permit for Storm Water Discharges from Construction Activities
- Permit No. ILR400611 General NPDES Permit for Discharges from Small Municipal Separate Storm Sewer Systems (MS4s)

The CSU-CEMML report focused on permit IL0026859 and ILR002659 due to their compliance history and industrial components.

IL0026859 authorizes the discharge of effluent from a domestic wastewater treatment plant (WWTP) on the base. The effluent is discharged to an unnamed tributary of Silver Creek on the eastern border of the base. The permit also authorizes effluent to be stored in the Golf Course Pond and Scott Lake for golf course irrigation. In July 2021, the sampling location for fecal coliform was changed to come after tertiary treatment at Outfall 001. (Before the modification, fecal coliform samples were taken at the excess flow outfall A01.) Scott AFB operated under Administrative Continuance of the February 2011—January 2016

permit for multiple years until the current permit cycle began. The current permit cycle issued in March 2020 and expires in February 2025.

Under the General NPDES Permit for Storm Water Discharges from Industrial Activities ILR002659, Scott AFB falls under the following sectors:

- Sector S: Air Transportation
- Sector N: Scrap Recycling Facilities, Sub-Sector N2 (Source-Separated Recycling Facilities)
- Sector P: Land Transportation and Warehousing

4.7.2 ***Facility Overview***

Figure 26 shows the discharge locations and the associated outfalls covered by IL0026859. Effluent storage at Scott Lake and Golf Course Pond are also shown on this map.

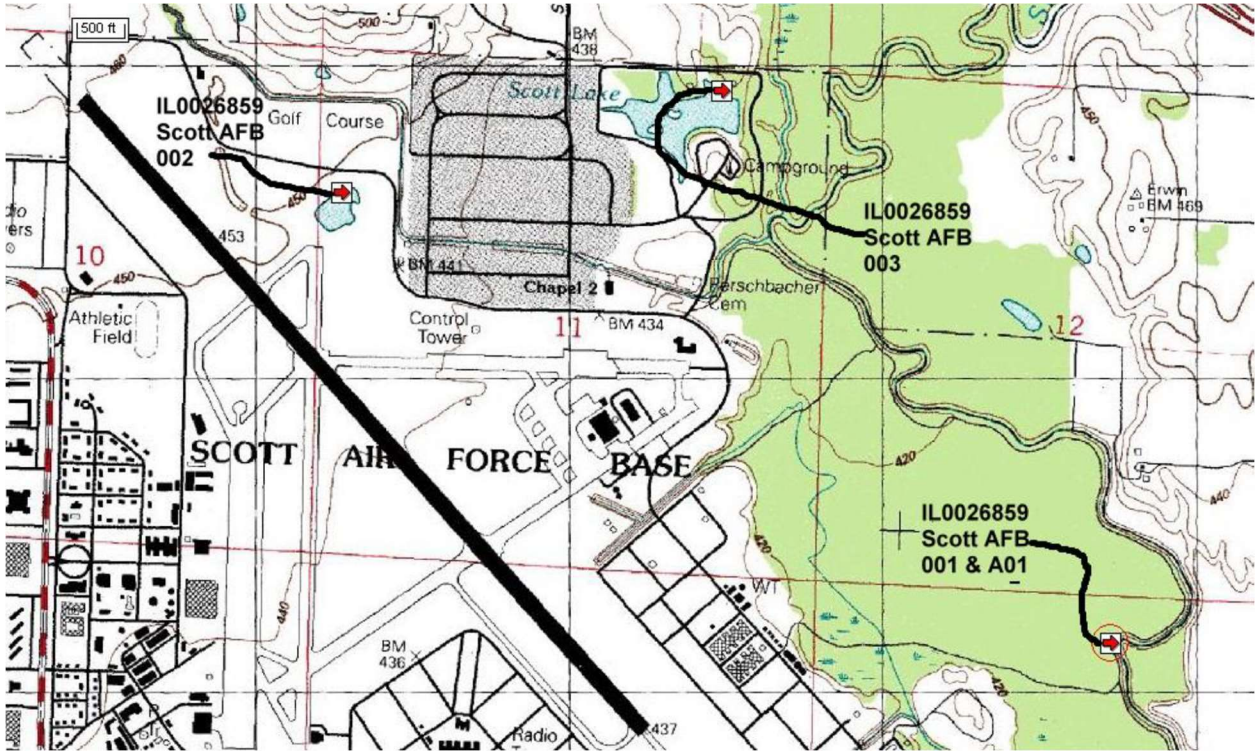


Figure 26: Discharge locations and associated outfalls under IL0026859. Source: IL0026859 Draft Permit 2021

Scott AFB treats all domestic wastewater produced on the base. **Error! Reference source not found.** shows the process flow diagram of the wastewater treatment plant. The plant includes primary clarification, 2 digesters, 2 trickling filters, a chlorine contact basin that is currently acting as an excess flow container, tertiary (disk) filters, and finally a UV disinfection unit. The WWTP is designed to treat a maximum flow of 3.0 MGD.

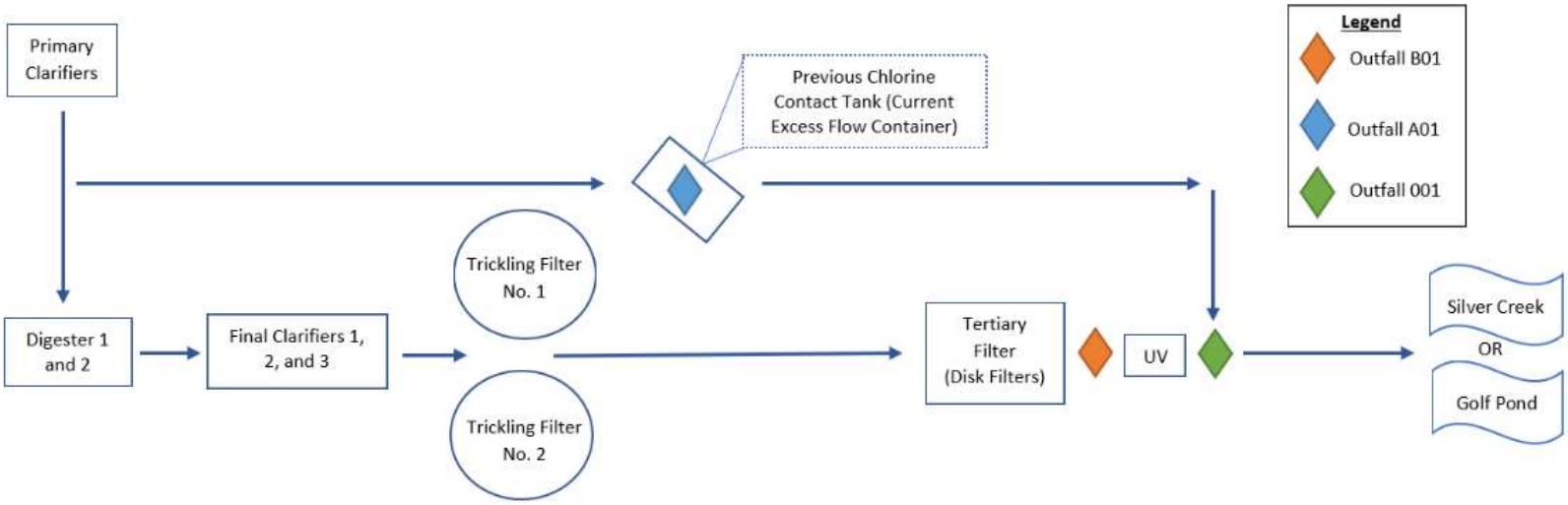


Figure 27: Process flow diagram of wastewater treatment plant

4.7.3 ***Scott AFB Compliance Summary***

4.7.3.1 Wastewater Compliance

Figure 28 shows the Scott AFB WWTP layout and the CSU-CEMML team's observations regarding the wastewater program. The observations in the red boxes describe the root causes of IL0026859 permit exceedances. The most vulnerable components of the WWTP are the trickling filters, the tertiary filter (disk filters), and the ultraviolet (UV) disinfection system. Tertiary disk filters and UV treatment system were installed in 2015. The disk filters are being updated in 2022 to avoid system failures.

Fluctuations in waste stream contaminent concentrations and in inflow volume pose challenges for WWTP operators. I&I improvement projects were completed in 2016, which restored vitrified clay sewer mains and reduced flow through the plant during storm events; however, fluctuations in waste stream volume continue.

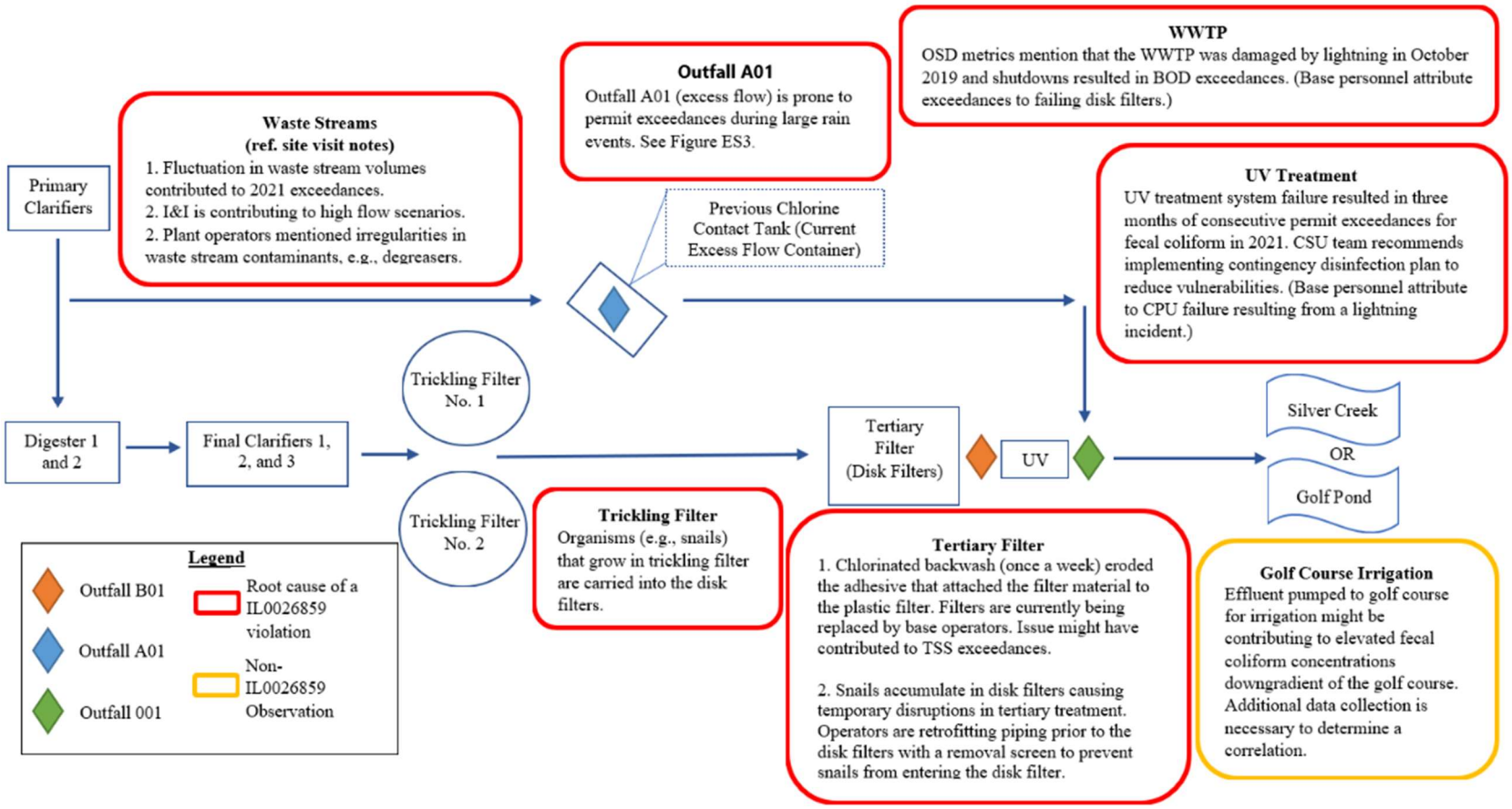


Figure 28: Wastewater treatment plant layout and root causes

Figure 29 shows time series plots of permit IL0026859 summary data at the 3 permited outfalls within the WWTP. The data represented in Figure 29 only include daily maximum exceedances because these data best represent permit exceedance trends. Observations related to the data are shown in red boxes next to the time series plots.

Scott AFB Inflow and Infiltration

An inflow and infiltration study was conducted during October 2014. The projects in that study with a risk score of "extreme" are included in Table 12. The report also includes information includes recommendations for I&I repair/replacement, operation and maintenance, and pipe repair/replacement. An I&I repair project was conducted in 2016 in response to the recommendations in the study. The CSU-CEMML team did not acquire documentation regarding the impact of this projeczt on the overall I&I. From the list of recommended projects in offered in the study, 6 received a risk score of extreme. Descriptions of those projects are included in Table 12. Beyond the 6 projects in Table 12, 18 projects received a risk score of high; and 13 were determined to be of moderate risk. Further precipitation and dry weather flow data and details regarding the most recent improvement project would be required to assess the effectiveness of the project; however, the repeated proximity to peak flow rates and the 2015 I&I study suggest that additional I&I repair and maintenance projects will be necessary to further mitigate high flow scenarios through the WWTP.

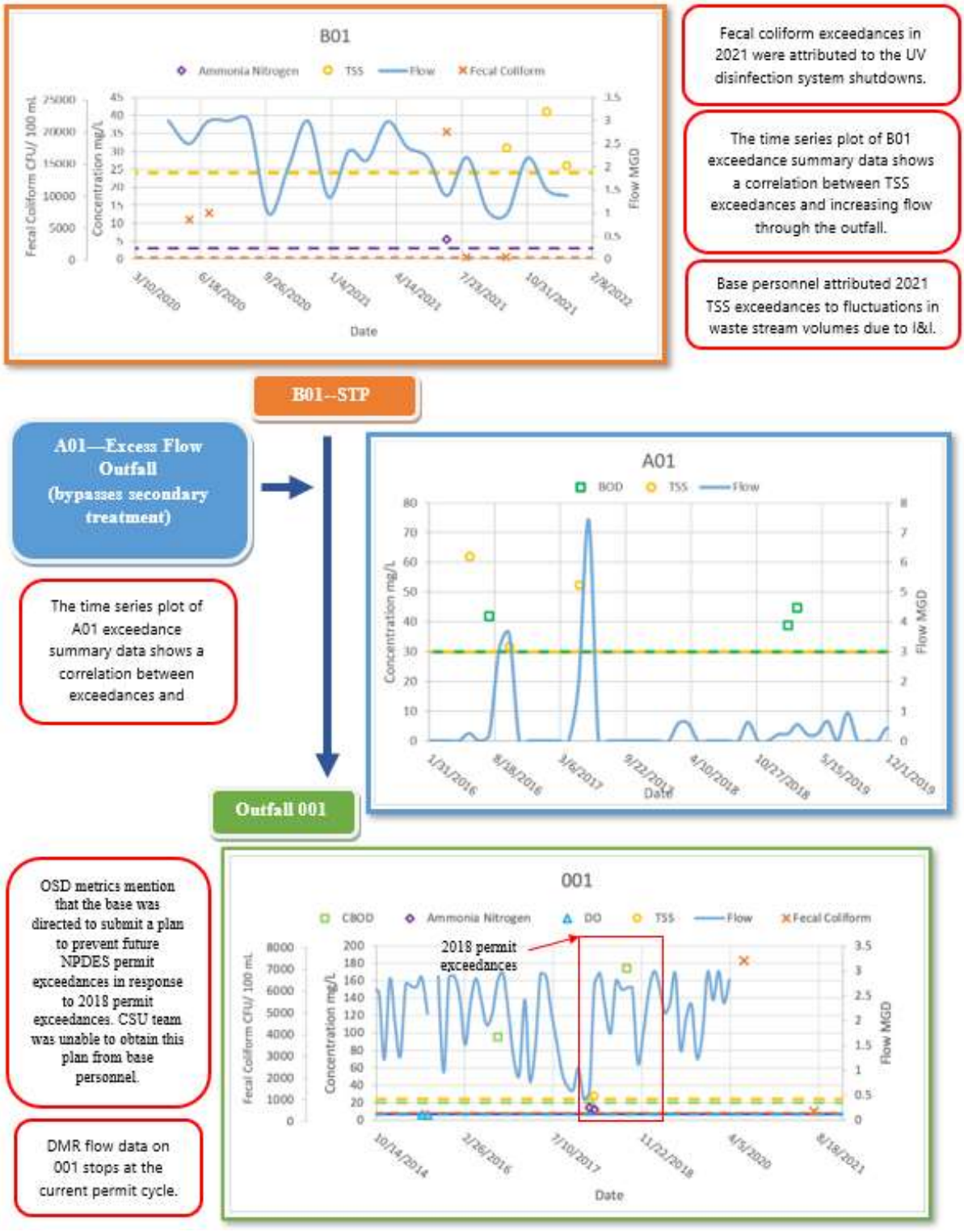


Figure 29: Daily max permit exceedances at outfalls B01, A01, and 001

Table 12: Recommendations for I&I repair/replacement

I&I Ranking	Risk Score & Classification	GeoBase IDPK	Description	Issues	Recommendations
1	42 (Extreme)	3105	12-in. vitrified clay main sewer beneath South Drive and the south ditch (high criticality)	Moderate wall displacement and deflection; past service life	Immediate pipe repair (liner)
2	41 (Extreme)	2978	Concrete manhole connected to an interceptor sewer in greenspace near the south ditch	Severe deterioration of all manhole components from I&I (ponding & flooding)	Replace manhole, seal & elevate frame above ponding level
3	36 (Extreme)	2806	12-in. vitrified clay trunk sewer between Scott Drive & Bldg. 1521 (high criticality)	Moderate breaks, cracks, & deflection; past service life	Immediate pipe replacement
4	35 (Extreme)	2826	12-in. vitrified clay trunk sewer at the corner of W Losey Street & Scott Drive (high criticality)	Visible breakthrough in pipe, appeared collapsed upon inspection; past service life	Immediate pipe replacement
5	29 (Extreme)	2966	8-in. cast iron main sewer bypass beneath Enlisted Drive, from Shiloh Housing lift station (high criticality)	Active infiltration through joint (wall displacement); past service life	Immediate pipe repair (liner)
6	28 (Extreme)	2828	12-in. vitrified clay trunk sewer beneath W Birchard Street (high criticality)	Moderate wall displacement and minor deformation; past service life	Immediate pipe replacement

The Illinois Environmental Protection Agency (IEPA) general stormwater permit does not require formal monitoring of stormwater discharges at Scott AFB. However, Scott AFB has conducted sampling for pollutants regulated by 30 IAC, Chapter 302, and other parameters to characterize the stormwater runoff from the Base and to ensure that there are no exceedances of State standards. Scott AFB has monitored water quality on a semi-annual basis at 10 locations across the Base, including 3 influent sites and 7 effluent sites.

The CSU-CEMML team used the ISWQS (Illinois Surface Water Quality Standard) as a baseline for evaluating stormwater quality data found in the annual reports. The stormwater samples are analyzed for biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), turbidity, total suspended solids (TSS), potential of Hydrogen (pH), settleable solids, oil and grease, methylene blue active substances (MBAS), nitrogen (nitrite/nitrate), total phosphorus, fecal coliform, and chlorides.

Figure 30, Figure 31, and

Figure 32 summarize the ISWQS level exceedances at each stormwater inflow and outflow locations. The date range of each location's exceedance window is included, as well as how many exceedances occurred between those dates. Figure 30 and Figure 31 summarize the fecal coliform and phosphorus ISWQS level exceedances, respectively.

Figure 32 summarizes the remaining stormwater ISWQS level exceedances, which include oil and grease, total chlorides, and total dissolved solids.

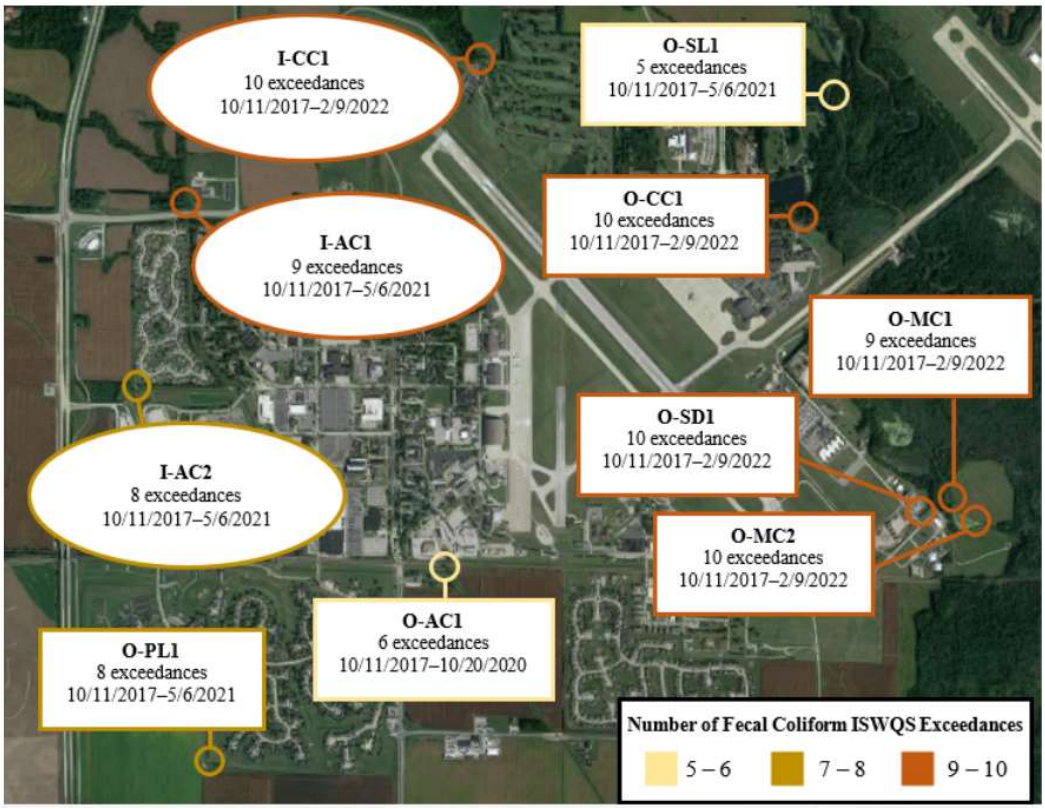


Figure 30: Fecal coliform ISWQS exceedances at inflow and outflow locations

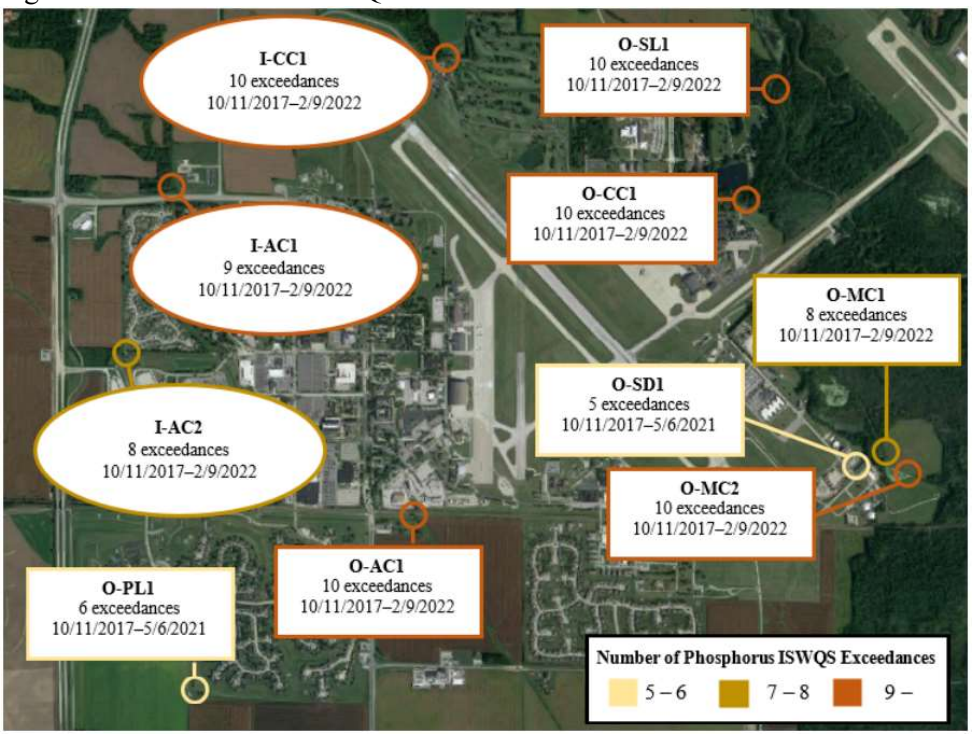


Figure 31: Phosphorus ISWQS exceedances at inflow and outflow locations

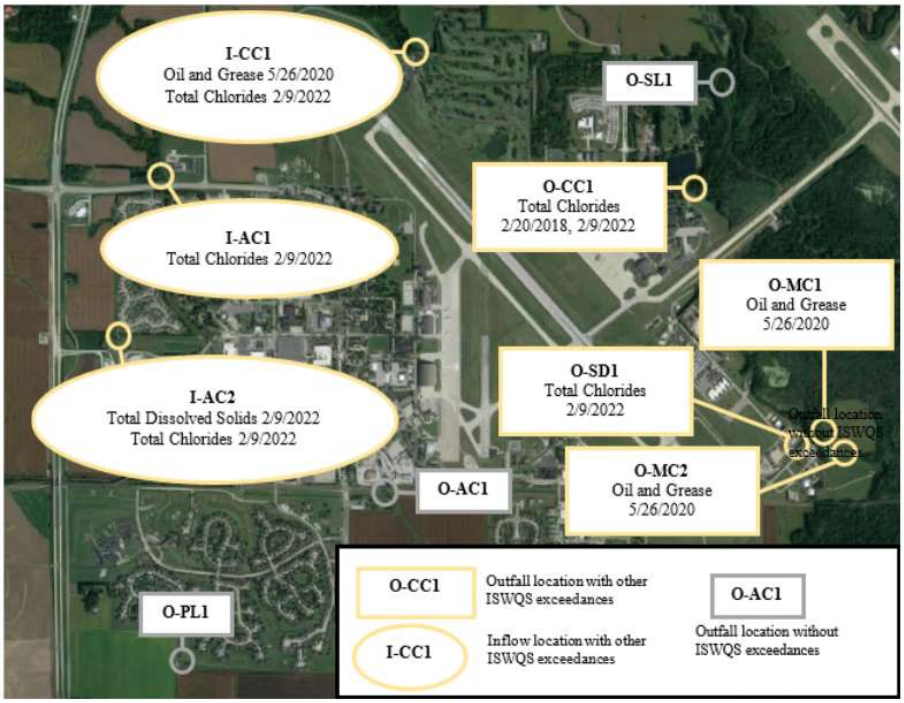


Figure 32: Additional ISWQS exceedances at inflow and outflow locations

4.8 Malmstrom Air Force Base

4.8.1 Water Quality Program, Permit, and Facility Overview

Industrial Stormwater and MS4 Permits

Malmstrom AFB's industrial stormwater permit (MTR000000) and MS4 permit (MTR040000) both cover the entirety of the installation's stormwater system and are issued by the Montana Department of Environmental Quality. MTR000000 is an MSGP. Industrial sectors applicable to Malmstrom AFB—Land Transportation and Warehousing and Air Transportation—do not contain monitoring and reporting requirements under MTR000000. Primarily, requirements of this permit are executed through control measures and periodic inspections. Since 2018, Malmstrom AFB has been required to monitor several parameters under MTR040000. These parameters have no numeric limitations, Additionally, although

Malmstrom AFB does discharge into an impaired water, the installation is not required to perform monitoring because there is not an approved TMDL for the area of the stream.

Disinfected Water and Hydrostatic Testing Permit

In addition to an industrial stormwater permit and MS4 permit, Malmstrom AFB is required to have a Disinfected Water and Hydrostatic Testing permit (MTG770036). Monitoring of total residual chlorine, total suspended solids, and pH are required only during periods of discharge. Additionally, a log must be kept containing the amount of dehalogenation chemical used, date, flow, sample results, visual observation, and description of changes in the operation.

Wastewater Permit

Malmstrom AFB holds an industrial wastewater discharge permit (Permit No. 08-17) with the City of Great Falls, Montana. The permits requires monitoring of pH, flow, BOD, oil and grease, TSS, and various metals.

4.8.2 ***Malmstrom AFB Compliance Summary***

Monitoring Data

Figure 33 highlights the primary compliance concerns for Malmstrom AFB. This includes 1) shop inspections, 2) DWHT flushing procedure, and 3) groundwater infiltration related to Outfalls 1, 2, and 3. For the period analyzed by the CSU-CEMML team (since 2018), Malmstrom AFB has had consistent issues with missing facility inspections. These include Quarterly Inspections (QI), Wet Weather Inspections (WWI), and Storm Event Inspections (SEI).

- 2018: 2 of 27 (7%) QI, 2 of 6 (33%) WWI, and 12 of 46 (26%) SEI
- 2019: 1 of 7 (14%) WWI and 8 of 70 (11%) SEI
- 2020: 5 of 9 (56%) WWI
- 2021: 5 of 36 (14%) QI and 4 of 27 (15%) SEI

The state has not issued any further violations since the first occurrence in 2018. Installation personnel have documented missing inspections in each annual report and have listed (and implemented) response actions in attempts to resolve this issue. The reasons for missing inspections vary widely, such as COVID quarantines and rotating shop personnel. The 2021 annual report states that "leadership will likely need to determine whether individual shop personnel, their superintendents, SWPPP Administrators, or perhaps even a contractor should perform these duties."

In July 2021, the limit of total chlorine discharged to the storm sewer system, as specified in the DWHT General Permit, was exceeded when performing hydrant flushing. This operation, which involves dechlorination of the source water, is conducted by personnel from the Installation's Utilities Shop. Under the current procedure, flushing to the stormwater system begins immediately; however, obtaining a total chlorine measurement takes a few minutes. If total chlorine exceeds the limit, it is already too late. Installation Water Quality (WQ) personnel are aware that this method creates a high risk of exceedance and have discussed alternative methods with Shop personnel. Future exceedances are likely to occur under this procedure.

Malmstrom AFB does not have any limits related to stormwater monitoring. Therefore, the Installation has no exceedance violations. Although monitoring data has only been collected semi-annually since 2018, the scarce data has shown abnormally high measurements at times, specifically in September 2020 at Outfall 2. Outfall 2, along with Outfall 1 and 3, continually experience dry weather flow. In a 2008 hydraulic study, groundwater flow was found to be the source of this flow. Although this dry weather flow has not raised any compliance concerns, the CSU-CEMML team recommended analyzing this inflow for permit-related parameters to establish baseline levels and help determine sources of high measurements.

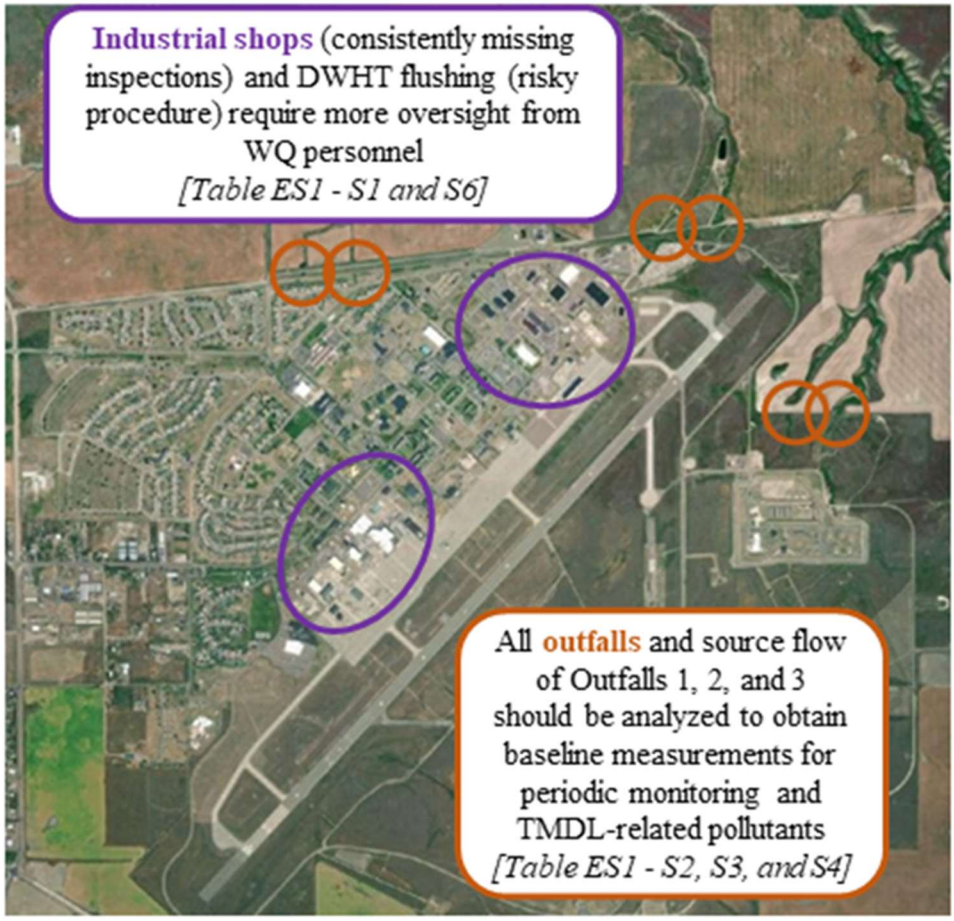


Figure 33: Graphical summary of recommendations for improvement of MAFB's water quality program. (DWHT: Disinfected Water and Hydrostatic Testing)Table 13 contains OSD and EASIER violations for Malmstrom AFB, including a description of the violation, the date, and the associated permit. In addition to the non-compliances discussed above, this list includes failure to monitor and properly report for the MS4 and DWHT permits. Additionally, an SSO also occurred in June 2021. Inoperable infrastructure (a slide gate) was cited as a reason that this SSO reached the stormwater system. At the time of CSU's review, infrastructure improvements were being programmed, which includes these slide gates.

Table 13: OSD violations and violations based on enforcement actions

ID	Permit	Description	Date
V1	MS4	Failure to monitor correct number of samples for MS4 permit; misinterpreted permit requirement	MAR 2019
V2	Industrial	Failure to conduct routine inspections at multiple shops enrolled in the SWPPP; shops were notified/reminded ahead of time	MAR 2019
		Failure to conduct inspections and monitoring events	2019
V3	DWHT	Improper reporting of monitoring results for 3 months (in 2016 and 2017); CEIE incorrectly transferred data	MAR 2019
		Failure to correctly report hydrostatic discharges in monthly monitoring report	2019
V4	Industrial	Sewage discharge to land and storm water system due to failure of wet well pump to turn on due to fats/oil/grease buildup	JUN 2021
		Prohibited bypass/discharge due to SSO	2021
V5	DWHT	Permit limit exceedance for total chlorine during routine hydrant flushing	JUL 2021

4.9 Pittsburgh Air Reserve Station

4.9.1 Water Quality Program and Permit Overview

The CSU report focused primarily on the NPDES general stormwater permit, PAR806167. The CSU-CEMML team evaluated the industrial stormwater outfalls under PAR806167 with monitoring data that was sent to the CSU-CEMML team from base personnel. The EPA Echo website did not have any data registered under PAR806167.

Under PAR806167, the industrial activity at PARS only qualifies for monitoring under Sector S: Air Transportation or Appendix G of the general permit. However, PARS environmental personnel also monitor under Appendix K (salt storage) for outfalls containing small salt storage piles. The CSU-CEMML team used the Appendix G and K benchmark limits as a baseline for evaluating stormwater quality data.

Table 14 includes general information about the installation's stormwater program at PARS including responsible parties, points of contact, stormwater permits.

Table 14: Installation profile

Scope of Plan	All applicable industrial operations at Pittsburgh ARS. This plan covers the operations of the 911 AW and its tenants.
Facility Operator	Office Symbol: 911 AW Address: Pittsburgh ARS, 2475 Defense Avenue City, State, Zip Code: Coraopolis, PA 15108 Telephone Number: (412) 474-8506
Office of Primary Responsibility (OPR)	911 MSG/A4C has overall responsibility for implementing the Storm Water Pollution Prevention Plan (SWPPP) and is the lead organization for monitoring compliance with applicable federal, state, and local storm water regulations.
Responsible Official/Legally Responsible Person	Office Symbol: 911 AW/CC Name: John F. Robinson, Col, USAFR Telephone Number: (412) 474-8000
Water Quality Program Manager (SWPPP Contact)	Name: Jessica Brooks Title: Environmental Scientist Telephone Number: (412) 474-8428 Email address: jessica.brooks.12@us.af.mil
Permitting Authority	Pennsylvania Department of Environmental Protection (PA DEP)
Permit Type	General Permit
Permit Number/Permit Tracking Number	PAG-03/PAR806167
Permit Expiration Date	23 September 2021 (NOI for renewal sent in March 2023)
SIC Code(s)	4581, 9711
NAICS Code(s)	481, 928

*4.9.2 **Facility Overview***

All of the stormwater from the installation, with the exception of the flight line apron, flows into Meeks Creek, a tributary of McClarens Run on the eastern boundary of Pittsburgh ARS.

There are 10 outfalls through which storm water exits the boundaries of Pittsburgh ARS. Outfalls 001, 111, 114, 165, 175, 178, 181A, 201, 400, and 414 are located on the eastern side of the installation and flow into Meeks Creek, a tributary of McClarens Run. Outfall 001 also receives substantial flow from the airport and is included as a discharge point in the NPDES storm water permit for PIA. Outfall 082,

located on the south side of the installation, receives flow from the flight line apron and discharges into a separate storm sewer on PIA property and eventually discharges into McClarens Run.

The Figure 34 shows the location of each outfall under PAR806167 and the stormwater piping network. Sampling requirements at Outfall 086 are conducted upstream at Outfall 082 instead. Outfall 082 is not included in the diagram.

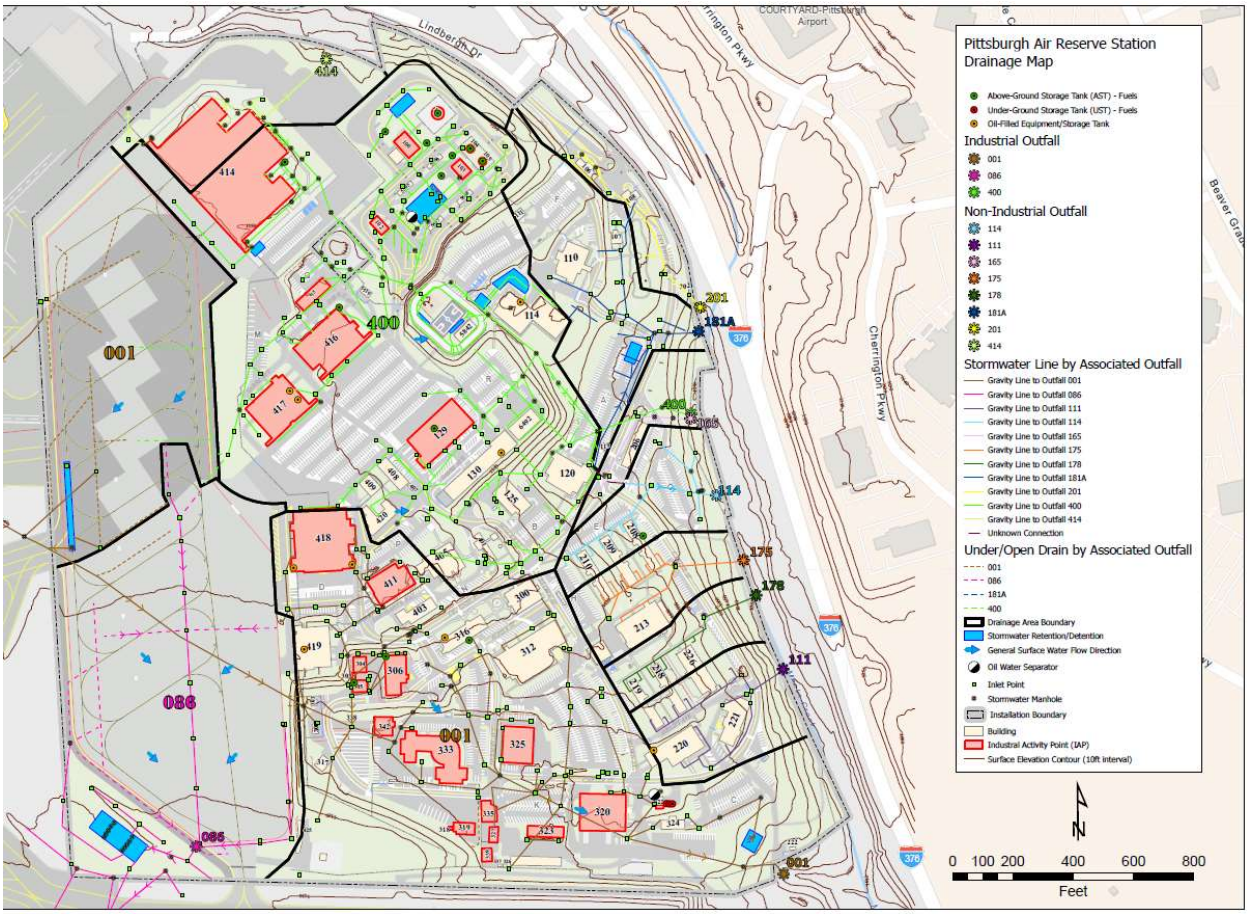


Figure 34: Outfalls under NPDES Permit PAR806167. Source: Pittsburgh911thARS_DrainageMap

4.9.3 ***PARS Compliance Summary***

Figure 35 shows a drainage map of PARS with callouts for various compliance issues. Three permit violations, highlighted in red, include a High Expansion Foam spill and BOD benchmark exceedances at Outfalls 082 and 400. Other items that might lead to future compliance problems are highlighted in yellow.

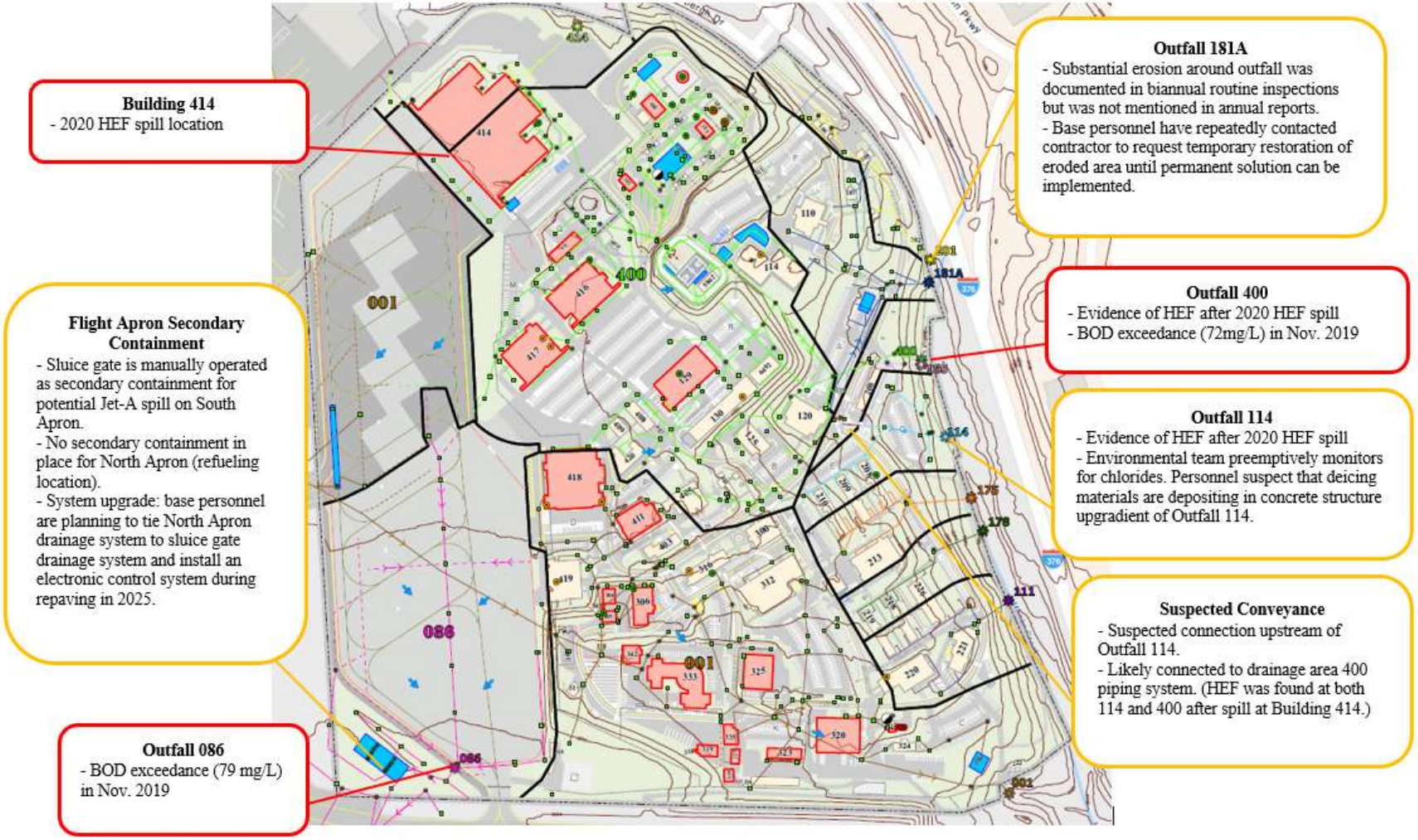


Figure 35: Summary of benchmark limit exceedance and other compliance issues at PARS

Table 15 includes 3 items that were logged in the Office of the Secretary of Defense database. The first 2 involved the failure to obtain quarterly samples and the failure to complete outfall and BMP inspections. Base personnel and annual reports claimed that the previous environmental team was unaware of the sampling and inspection protocols required by PAR806167. The corrective actions mentioned in Table 15 were completed, and the violations have been closed. Additionally, all OSD issues were mentioned in Annual Reports and Comprehensive Site Compliance Evaluations (CSCEs).

Table 15: PARS OSD metrics

Description	Corrective Actions Taken	Root Cause	Data Call
Failed to obtain quarterly samples during 2 consecutive monitoring periods.	Will sample during next sampling cycle.	Training or Awareness	2019
Failed to complete outfall and BMP inspections from January through June 2019.	Will evaluate outfalls and BMPs and will complete GPC for sampling outfalls.	Personnel Execution	2019
USACE HEF Hangar Test resulted in discharge.	Barriers and plugs added in drains for future HEF tests.	Contract Management	2020

4.10 Pittsburgh Air National Guard

4.10.1 Water Quality Program and Permit Overview

PA ANG has an NPDES stormwater permit that authorizes the discharge of industrial stormwater, PAG036240. The CSU-CEMML team evaluated the industrial stormwater outfalls under PAG036240 with monitoring data from base personnel. These data were also compared to the data downloaded from the EPA ECHO website.

Under PAG036240, the industrial activity at PA ANG qualifies for monitoring under Sector S: Air Transportation and Sector P: Land Transportation (or Appendix G and Appendix L in the general permit).

The CSU-CEMML team used the Appendix G and Appendix L benchmark limits as a baseline for evaluating stormwater quality data.

4.10.2 ***Facility Overview***

Stormwater runoff from the installation property either percolates directly into the ground or is discharged to McClaren's Run via 16 stormwater discharge outfalls (SDO) or 15 internal monitoring points (IMP), which are also called "observation points" and are used for monitoring flows within drainage areas. See Figure 36 for the location of IMPs and SDOs and their respective drainage areas. Ten of the 16 SDOs as well as 9 of the 15 IMPs located on the installation are considered industrial based on the activities occurring within the drainage areas (DAs).

Figure 36: Drainage areas, internal monitoring points, stormwater discharge outfalls at PA ANG

Table 16 shows the analytical monitoring requirements and methods across the installation. Benchmark values are assigned for land transportation and air transportation sectors.

Table 16: PAG036240 analytical monitoring requirements and methods

Industrial Sector	Parameter	Units	Benchmark Values	Analytical Methods	Sample Type
Land Transportation	TSS	mg/L	100	SM 2540D	Grab
	Oil and Grease	mg/L	30	EPA 1664A	Grab
Air Transportation	pH	SU	No benchmark value	SM 4500 H+ B	Grab
	BOD	mg/L	30	SM 5210B	Grab
	COD	mg/L	120	SM 5220D	Grab
	TSS	mg/L	100	SM 2540D	Grab
	Ammonia-Nitrogen	mg/L	No benchmark value	EPA 350.1	Grab
	TDS	mg/L	No benchmark value	SM 2540 C	Grab

4.10.3 ***PA ANG Compliance Summary***

Figure 37 shows benchmark limit exceedances at Pittsburgh Air National Guard (PA ANG) at various internal monitoring points (IMP) and stormwater discharge outfalls (SDO).

PA ANG does not deice on a conventional deicing pad that is designed for spill containment or the handling of flammable liquids. Instead, aircraft are deiced on the parking apron (Drainage Area (DA)-010B) on the northeast of the base. A deicing collection system south of the parking apron collects spent aircraft deicing fluid (ADF) (Type 1—propylene glycol) and stormwater runoff in the aboveground storage tank (AST) 400-2S. After deicing, valves southwest of the parking apron are opened and aligned to AST 400-2S until rainfall of 0.1 inch or more washes spent fluid to the AST. This runoff is sent to the local municipality for treatment.

Internal monitoring points (IMPs) immediately downstream of the parking apron (IMP-010B1, 010B2, 010C, 010D) had 12 Carbonaceous Biological Oxygen Demand (CBOD) or Chemical Oxygen Demand (COD) exceedances during deicing season (October to March). The lack of ADF containment during

deicing is likely driving the elevated CBOD and COD concentrations. Base personnel are tracking glycol at IMPs.

Deicing aircraft without a deicing pad designed to contain spills is the most significant obstacle to lowering COD and CBOD concentrations at downstream outfalls.

Sufficient support staff is necessary to assess and address water quality deficiencies. CSU-CEMML team recommends adding support staff to the PA ANG environmental program.

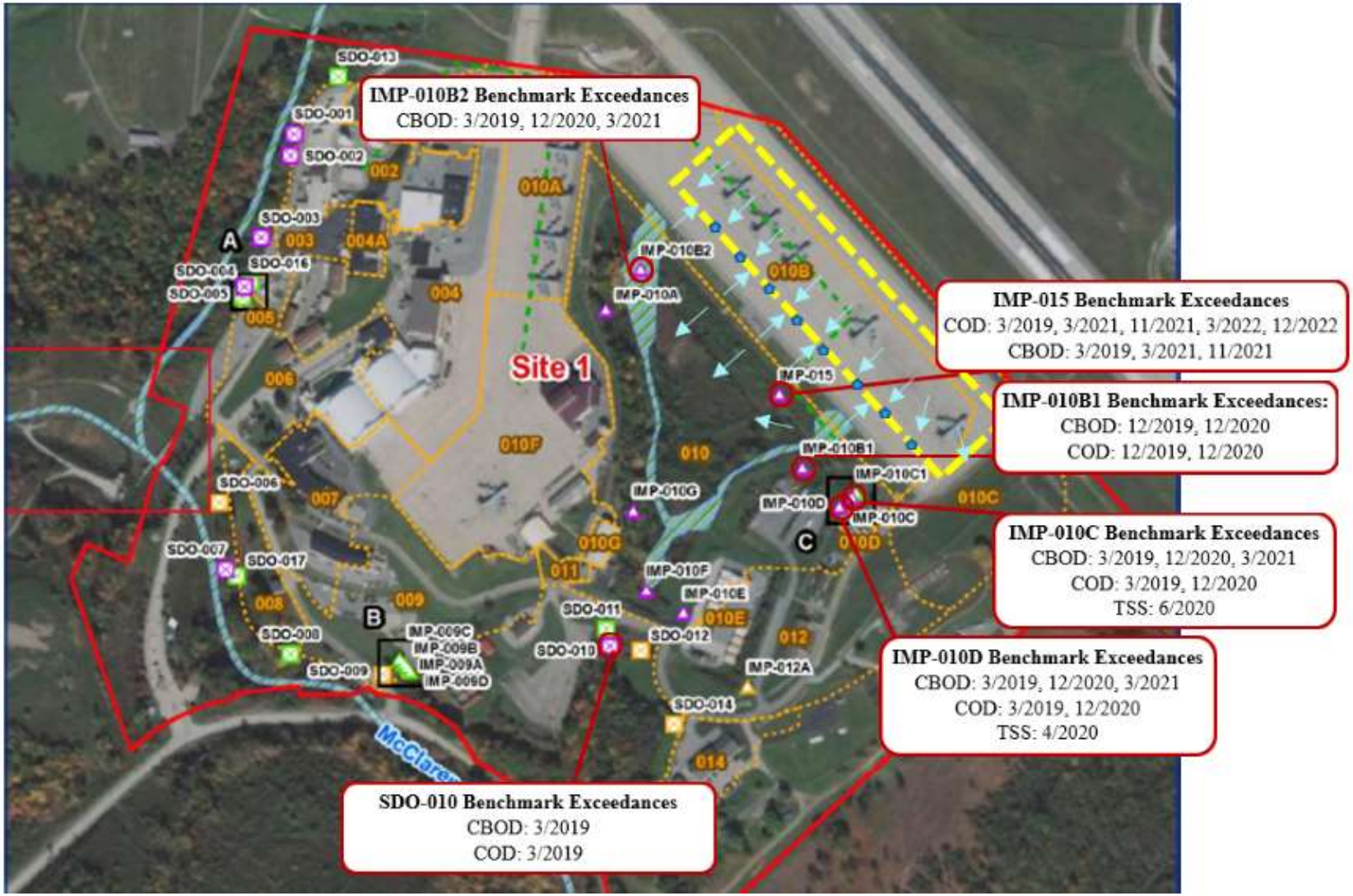


Figure 37: Summary of benchmark exceedances at IMPs and SDOs

Table 17 summarizes common observations from the ECPRs. Further details and discussion follow the table.

The table's contents are defined below:

- Checkmark ✓: the observation is not a compliance issue for the installation
- X: the observation is a compliance issue for the installation
- NA: the observation is not applicable to the installation (for example, if the installation does not have an on-site wastewater treatment plant, then observations related to on-site wastewater treatment plants are not applicable)

The definitions for "Non-compliances by Permit Type" categories are below:

- MSGP: Stormwater multi-sector general permit
- Ind.: Individual stormwater permit
- MS4: Municipal Separate Storm Sewer System permit
- Mun. WW: Municipal wastewater permit
- Cons. SW: Construction stormwater permit
- Other: Permits that are stormwater related, but do not fit in the above categories

Table 17. Summary of lessons learned/problematic observations

Problematic Observations		McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PANG	Installations Represented
OSD Compliance		X	X	X	X	X	X	X	X	X	X	0%
EASIER Compliance		X	X	X	X	X	X	X	X	X	✓	10%
ECHO Compliance		X	X	X	✓	X	X	X	X	X	✓	20%
Compliance by Permit Type	**MSGP**	NA	✓	✓	X	✓	X	✓	X	X	X	40%
	Ind.	X	X	X	NA	X	X	X	NA	NA	NA	0%
	MS4	✓	✓	NA	✓	✓	X	✓	X	NA	NA	50%
	Mun. WW	X	NA	NA	X	X	✓	NA	✓	NA	NA	20%
	Cons. SW	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	90%
	Other	NA	NA	X	NA	✓	NA	NA	X	NA	NA	10%
Management Oversight-Related Compliance	**OSD**	✓	X	X	✓	✓	✓	✓	✓	X	✓	70%
	EASIER	X	X	X	X	X	X	✓	X	X	✓	20%
	ECHO	X	X	✓	✓	X	X	✓	✓	X	NA	40%
Inflow & Infiltration Compliance		✓	X	X	✓	NA	NA	X	NA	NA	NA	20%
Complete GIS Data		X	X	X	X	X	X	N/A	X	N/A	N/A	0%
Deicing Chemicals Related Compliance		X	NA	NA	✓	NA	X	✓	✓	✓	X	40%
Effective Contractor Communication		✓	X	X	✓	X	X	✓	✓	X	✓	50%
Effective Control of Metals in Stormwater Runoff		NA	X	NA	NA	NA	X	NA	NA	NA	NA	0%
Effective Control of Variable WWTP Influent		NA	X	NA	NA	NA	✓	NA	NA	NA	NA	10%
Effective Operation of Disinfection Technology		NA	X	X	NA	NA	NA	X	NA	NA	NA	0%
Trending of Monitoring Data		X	X	X	X	X	X	X	X	X	✓	10%

4.11 Installation Timetable

The time window for data analysis varied between installations due to permit cycle duration, personnel changes, and data availability. Typically, the previous permit cycle was considered in the data analysis. Table 18 includes the typical time windows during which the data were analyzed for each base. In most cases, the data spans a period of 5 years, with the shortest duration being 2 years and the longest nearly 7 years.

Table 18. Time period analyzed during CSU review

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG
Time Period	May 2016–Feb 2021	June 2016–July 2021	Feb 2019–Jun 2021	July 2019–Dec 2021	Feb 2020–Jan 2022	May 2015–March 2022	Jan 2016–Dec 2021	Jan 2017–Aug 2022	March 2017–Aug 2022	Sept 2018–Feb 2022

4.12 OSD Metrics

The criteria for OSD Clean Water Metrics (OSD Metrics) were defined with the goals of protecting public health, meeting clean water standards, maximizing operational flexibility, protecting watersheds, ensuring the availability of discharge capacity to support the mission, and leveraging water conservation opportunities. Permits that are reportable in OSD Metrics include domestic, industrial, and stormwater National Pollutant Discharge Elimination System (NPDES) direct discharge permits and permitted discharge to publicly owned treatment works (POTWs). This excludes permits such as stormwater construction, pesticide discharges, pretreatment agreements, and wastewater collection systems. A non-overseas installation is considered out of compliance with OSD Metrics if the answer to any of the following questions is "yes".

1. Exceeded the same effluent limit at any given discharge point for 2 or more consecutive sampling events if monitored monthly or quarterly; or a single sampling period if monitored annually or semi-annually? (Yes/No) If yes, identify parameter(s)
2. Had any prohibited bypass event, unpermitted discharge, or pass-through of pollutants to a water body (excluding oil-related discharges)? (Yes/No)
3. Submitted a required report more than 30 days late? (Yes/No)
4. Failed to meet the requirements and/or schedule of a signed compliance agreement? (Yes/No)
5. Failed to develop and/or implement a special condition of the permit such as a stormwater pollution prevention plan or pretreatment program? (Yes/No)
6. Failed to satisfy sampling, monitoring, and/or testing requirements for 2 or more consecutive sampling events if monitored monthly or quarterly; or a single sampling period if monitored annually or semi-annually? (Yes/No)

If an installation is out of compliance with OSD Metrics, it must provide a written explanation for non-compliance or not meeting requirements and the corrective actions taken.

Table 19 shows the number of OSD Metrics reportable non-compliances for each installation by non-compliance category. OSD Metrics contains a binary category for violation type that includes Limit Exceedance and Operating Procedure. Prior to 2019, OSD Metrics did not contain standardized root cause categories for non-compliances; however, some of the language reflects non-compliances reported in EASIER (discussed in the following section). Therefore, root cause categories for OSD Metrics violations prior to 2019 were standardized to reflect those reported in EASIER. Violations are sometimes listed with multiple root causes.

For certain installations, compliance databases may contain data that were outside the scope of CSU's individual installation reviews, such as for certain permits or GSUs.

Table 19: OSD violations by root cause category

Violation Root Cause	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Total (10 bases)	Installations Represented
Infrastructure	1	5	3	1	0	11	2	1	0	1	25	80%
Contract Management	0	3	0	0	1	2	0	0	1	0	7	40%
Personnel - Execution	2	1	0	2	0	2	0	0	1	0	8	50%
Training & Awareness	1	2	0	1	0	0	0	2	1	0	7	50%
Resources	0	0	0	0	0	0	0	0	1	0	1	10%
Regulator	0	0	1	0	0	0	0	0	0	0	1	10%
External Factors	0	0	1	0	0	2	2	0	0	0	5	30%
Unknown	0	0	0	0	0	0	0	0	0	0	0	0%
Management Oversight	0	1	1	0	0	0	0	0	0	0	2	20%
Total Violations per Installation	4	12	6	4	1	17	4	3	4	1	56	—

Root causes found at half or more of the installations cited for non-compliance include Infrastructure (80%), Personnel – Execution (50%), and Training & Awareness (50%). Infrastructure is the most cited root cause; it accounts for 25 (45%) of the non-compliances. Personnel – Execution and Training & Awareness are the next most-cited root causes, accounting for 8 (14%) and 7 (13%) of the non-compliances, respectively. Contract Management also accounts for 7 (13%) of the non-compliances but was cited as a root cause by only 40% of installations. The remaining root causes, cited by 30% or less of the installations, include External Factors (cited 5 times), Management Oversight (cited 2 times), Resources (cited 1 time), and Regulator (cited 1 time).

4.13 EASIER

Violations reported in the EASIER database are typically regulator-initiated. Sources of violations include self-reporting, reviews of regulatory records, and inspections. Table 20 shows EASIER violations for each installation by root cause category. These root cause categories are explicitly listed in EASIER and were used to standardize OSD Metrics root cause categories.

Table 20: EASIER violations by category

Violation Root Cause	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Total (10 Bases)	Installations Represented
Infrastructure	1	4	0	2	1	1	0	1	0	0	10	60%
Contract Management	0	0	7	0	3	0	0	0	0	0	10	20%
Personnel – Execution	1	4	1	4	0	1	0	4	0	0	15	60%
Training & Awareness	0	1	0	0	0	0	0	0	0	0	1	10%
Resources	0	1	0	0	0	0	0	0	0	0	1	10%
Regulator	0	0	0	1	0	0	0	0	0	0	1	10%
External Factors	0	6	1	0	2	2	0	0	0	0	11	40%
Unknown	0	2	1	0	0	0	1	0	1	0	5	40%
Total Violations per Installation	2	18	10	7	6	4	1	5	1	0	54	—

60% of the installations have non-compliances in EASIER with Personnel – Execution and Infrastructure cited as root causes. Personnel – Execution accounts for 15 (28%) of the non-compliances. Infrastructure accounts for 10 (19%) of the non-compliances. This is similar to Contract Management (10, or 19% of non-compliances) and External Factors (11, or 20% of non-compliances), although these root causes were not cited by as many of the installations. 40% of the installations have non-compliance with External Factors and Unknown listed as root causes. Root causes that 20% or less of the installations have listed for non-compliances include Contract Management, Training & Awareness, Resources, and Regulator.

4.14 DMR Data

Most state-issued permits require Discharge Monitoring Reports (or DMRs), which are periodic submissions of monitoring data for NPDES permits. While some permit holders report directly to the EPA through an online submission system, some report to the state agency that issued the permit. Table 21 shows violations within EPA ECHO DMR data for each installation. Within EPA ECHO, violations are documented by a code of E90 (Exceedance), D80 (Non-receipt without limit), and D90 (Non-receipt with limit).

Table 21: EPA ECHO DMR violations by category

Violation Type and Root Cause	McAFB	RAFB	BAFB*	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG**	Total (Ten Bases)	Installations Represented
Exceedance	4	24	10	0	15	44	32	1	0	N/A	120	70%
Non-receipt	37	8	0	0	36	63	0	0	12	N/A	146	50%
With Limit	0	2	0	0	24	40	0	0	0	N/A	66	30%
Without Limit	37	6	0	0	12	23	0	0	12	N/A	80	50%
Total Violations per Installation	41	32	10	0	51	107	32	1	12	N/A	266	—

* Beale AFB's DMR data is checked through SMARTS, a state-operated water quality monitoring database
** Pittsburgh ANG does not have DMR data contained in EPA ECHO

70% of the installations have exceedances reported in EPA ECHO. 50% of the installations have non-receipts (data that was not submitted at all or not submitted on time). 30% of installations have non-receipts related to data that had effluent limitations (Non-receipt with Limit).

4.15 Comparison between the 3 databases

As shown in Table 22, of the 10 installations, 100% of them had non-compliances reportable by OSD Metrics, 90% had non-compliances within EASIER, and 90% had violations reported in EPA ECHO. In both OSD Metrics and EASIER, Infrastructure was the root cause that most installations cited. Personnel – Execution was represented in both OSD Metrics and EASIER by 80% and 60% of installations, respectively. Reported non-compliances across each of the compliance databases are not consistent. In other words, an installation's performance according to one database does not reflect its performance as reported by the other databases.

Table 22: Violations by database

Compliance Database	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Total (Ten Bases)	Installations Represented
OSD	4	12	6	4	1	17	4	3	4	1	56	100%
EASIER	2	18	10	7	6	4	1	5	1	NA	54	90%
ECHO DMR	41	32	32	0	51	107	32	1	12	NA	266	90%

Figure 38 compares the characteristics of different root causes of OSD Metrics violations (left) and EASIER violations (right). The OSD database indicates that most installations have infrastructure issues (42%) that contributed to a violation. Personnel – Execution (28%) and external factors (20%) contributed most to the EASIER violations. 55% of the violations from EPA ECHO database are Non-receipt violations and 45% are Exceedance violations. Correlation analysis was conducted to determine how closely these 2 databases are related. The results of this analysis are contained in Appendix **Error! Reference source not found.**.

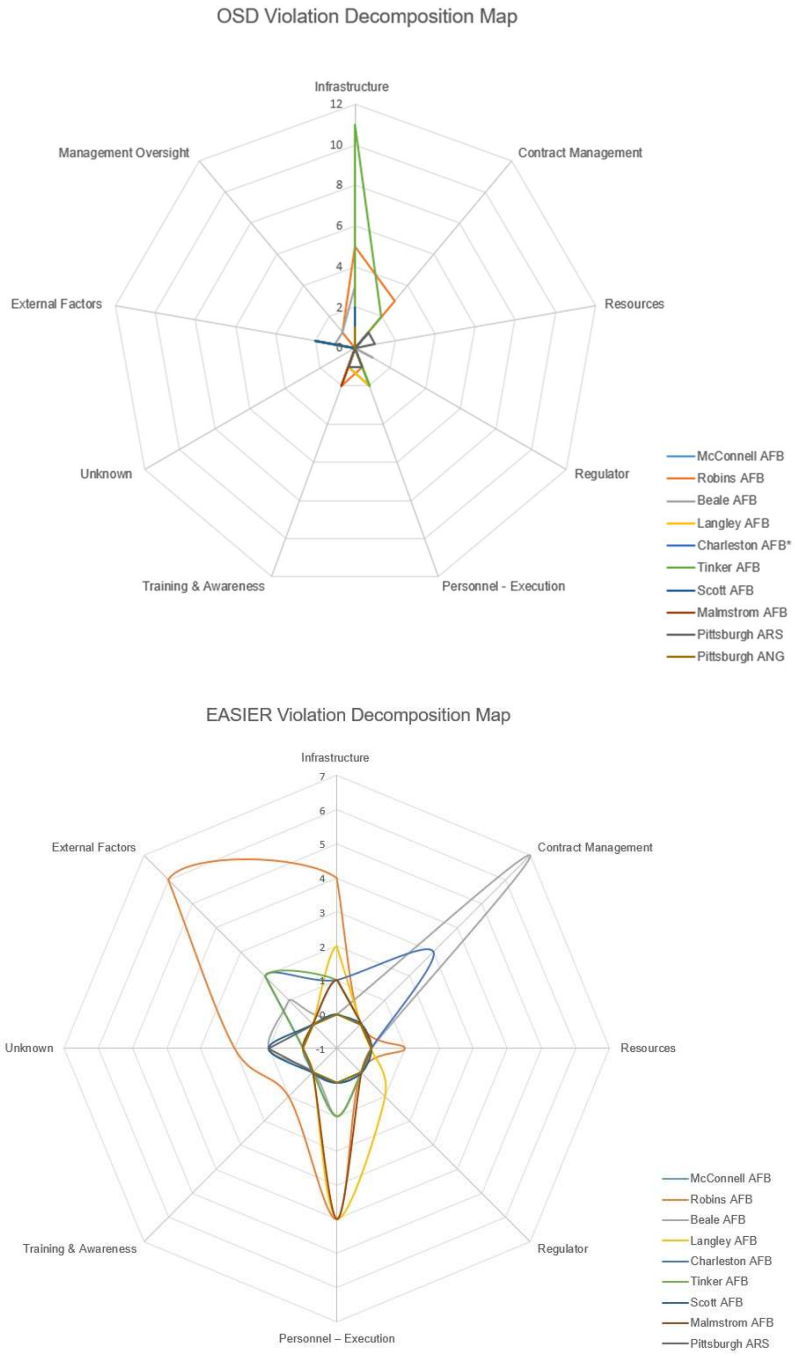


Figure 38: OSD (left) and EASIER (right) violation decomposition by root cause

4.16 Permit Variations

4.16.1 NPDES Permits

Across the 10 installations, discharge requirements were represented in 3 primary NPDES permits: Multi-Sector General Permits (MSGPs), Individual permits, and Municipal Separate Storm Sewer System (MS4) permits.

MSGPs are written by the state agency and contain requirements such as implementation of monitoring and stormwater pollution prevention plans (SWPPP). While they contain general requirements for all applicants, they also contain additional requirements specific to facility types and industrial activities. Nine of the 10 installations represented in the CSU study operated under a general permit that required some form of monitoring. Not all industrial stormwater permits require the reporting of stormwater data to the state regulatory agency (e.g., Scott AFB).

- 9 installations operated under at least 1 NPDES MSGP

Individual NPDES permits are generally issued when an installation discharges effluent from a wastewater treatment plant on the base (e.g., Robins AFB, Scott AFB); however, they can be issued as an alternative to an MSGP when there has been a history of compliance issues or when there were wastewater discharges covered by the permit in the past (e.g., Tinker AFB). They contain requirements specific to the permit applicant based on facility details.

- 5 installations operated under at least 1 NPDES Individual permit

MS4 permits are required by municipalities, counties, and certain other governments with separate storm sewer systems that receive stormwater discharge from urban development (e.g., housing, roadways, etc.).

- 7 installations operated under at least 1 NPDES MS4 permit

4.16.2 Municipal Wastewater Permits

Municipal wastewater permits are administered when a base discharges untreated or pretreated wastewater to a municipality for treatment.

- 4 installations operated under at least 1 municipal wastewater permit

4.16.3 ***Other Permits***

Other relevant permits included in CSU's review are construction permits, Satellite Sewer System permits, Disinfected Water and Hydrostatic Testing permits, and Limited Threat Discharges to Surface Water.

- 3 installations operated under at least 1 "other" permit

Table 23 shows the permits administered at each installation. A check mark (✓) indicates that the installation has a particular permit. The "Installations Represented" column shows the proportion of bases that have a particular permit. For example, 70% of bases have an MS4 permit.

Table 23: Permit overview

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Total	Installations Represented
NPDES Multi-Sector General	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	90%
NPDES Multi-Sector General Permit Violations	N/A	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—N/A	OSD—1 EA—2 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—7 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—2 EA—2 ECHO—0	OSD—4 EA—1 ECHO—12	OSD—1 EA—0 ECHO—0	OSD—15 EA—5 ECHO—12	
NPDES Individual Permit	✓	✓	✓	X	✓	✓	✓	X	X	X	—	60%
NPDES Individual Permit Violations	OSD—4 EA—1 ECHO—10	OSD—12 EA—18 ECHO—32	OSD—6 EA—1 ECHO—N/A	N/A	OSD—1 EA—4 ECHO—0	OSD—8 EA—4 ECHO—107	OSD—4 EA—1 ECHO—32	N/A	N/A	N/A	OSD—35 EA—29 ECHO—181	
NPDES MS4 Permit	✓	✓	X	✓	✓	✓	✓	✓	X	X	—	70%
NPDES MS4 Permit Violations	OSD—0 EA—0 ECHO—31	OSD—0 EA—0 ECHO—0	N/A	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—1 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—1 ECHO—0	N/A	N/A	OSD—1 EA—1 ECHO—31	
Municipal Wastewater	✓	X	X	X	✓	✓	X	✓	X	X	—	40%
Municipal Wastewater Permit Violations	OSD—0 EA—1 ECHO—N/A	N/A	N/A	OSD—3 EA—4 ECHO—0	OSD—0 EA—2 ECHO—51	OSD—0 EA—0 ECHO—0	N/A	OSD—0 EA—0 ECHO—N/A	N/A	N/A	OSD—3 EA—7 ECHO—51	
Construction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	100%
Construction Permit Violations	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—7 ECHO—	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—0 ECHO—0	OSD—0 EA—7 ECHO—0	
Other	X	X	✓	X	✓	X	X	✓	X	X	—	30%
Other Permit Violations	N/A	N/A	OSD—0 EA—2 ECHO—0	N/A	OSD—0 EA—0 ECHO—0	N/A	N/A	OSD—1 EA—2 ECHO—1	N/A	N/A	OSD—1 EA—4 ECHO—1	

Multi-Sector General stormwater permits are the most common permit among participating installations due to the industrial activity that occurs at each installation. All 9 of the MSGPs permit the discharge of industrial stormwater and require some form of SWPPP. Not all general permits require the base to report to ECHO DMR. As a result, violations under MSGPs are generally fewer than under other permits, especially individual permits.

Half of the bases operate under an individual permit—typically due to effluent discharge out of a wastewater treatment plant (e.g., Robins, Scott). OSD, EASIER Enforcement Actions (EA), and ECHO violations occur the most frequently under individual permits, which typically require more regular monitoring and reporting than any other NPDES permit.

Seven out of the 10 participating installations operated under an MS4 permit. MS4 permits are generally required when an installation has residential development. The CSU-CEMML team found that MS4 permit violations were rare, given that these permits have fewer reporting requirements that might result in violations.

The CSU-CEMML team found that construction contractors are typically responsible for complying with construction permits. However, Beale AFB's construction permits required the contractors to submit monitoring data to ECHO, and these contractors did not always comply with the requirement. As a result, some construction permit violations were associated with Beale AFB.

Figure 39 shows the proportion of specific permit types across the 10 installations that participated in the CSU study. For example, roughly one-third of the active permits in the study were Multi-Sector General permits.

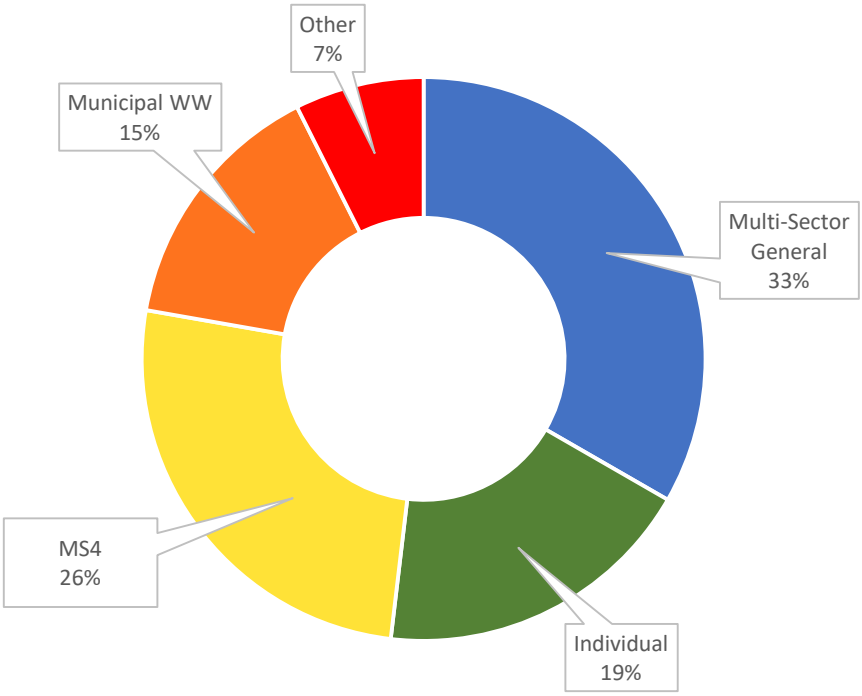


Figure 39: Total permit overview across 10 installations

Different types of industrial and non-industrial activity occur across AF installations. Permit variability presents challenges for effective enterprise-wide management. Thus, water quality program management varies depending on permitting requirements and industrial activity specific to each installation.

4.17 Personnel Variation in Executing Permit Requirements

The CSU-CEMML team's compliance review indicates that the water quality program managers decide how to execute permit requirements. For instance, some programs (e.g., Malmstrom AFB) are organized such that base personnel (e.g., airmen) perform shop inspections and report the results to environmental personnel. Other installations contract sampling requirements (e.g., Scott AFB) while some are conducted by environmental personnel. These decisions are typically governed by the amount of industrial activity at the installation and environmental personnel availability. One of the primary goals of the CSU analysis is to determine if certain management approaches are more effective at fulfilling specific permit

requirements (e.g., effluent sampling, inspections, and maintenance). Table 24**Error! Reference source not found.** summarizes the various management strategies across the 10 water programs represented in the study. The data came directly from water quality managers, SWPPPs, and annual reports.

The primary tasks to be carried out and/or allocated by each installation's environmental personnel are in the first column of Table 24**Error! Reference source not found.**. A description of each task is below.

- Discharge Monitoring: The party that performs sampling to fulfill permit monitoring requirements.
- Discharge Monitoring Reporting: The party that is responsible for the submission of monitoring data.
- Shop/Facility Inspections: The party that performs routine inspections of shops and facilities and fills out associated forms.
- Inspection Reporting/Annual Report Submission: The party that is responsible for the submission of annual reports to the regulator.
- MS4/SW BMP Maintenance: The party that performs maintenance on structural stormwater BMPs.
- Management Strategy Compliance: Indicates if a management related compliance issue was recorded.
    - ✓: The compliance record is clear of management violations.
    - X: A management related compliance issue was recorded at the installation.

The management strategy descriptors in Table 24 are below.

- Environmental Personnel (EP): includes Stormwater Pollution Prevention Team (SWPPT), wastewater environmental compliance personnel, or any other individual on the environmental staff who has direct responsibility to maintain water quality.
- Contractors (C)

- AF Personnel (AFP): Air Force employees without direct responsibility to maintain water quality. Examples of AF Personnel include:
    - Operations and Maintenance
    - Shop Supervisors
    - Environmental Representatives: coordinates with the Storm Water Pollution Prevention Coordinator to prevent storm water pollution in their areas of responsibility.
    - Unit Environmental Coordinators: coordinates with SWPP personnel to prevent stormwater pollution in their department.
- Unknown (UK): the management strategy data was not collected at the time of the CSU review.

Permit management strategies refer to how the installation executes permit requirements. The CSU-CEMML team evaluated permit management strategies based on records including (1) failures to submit data on time, (2) sampling/monitoring errors, (3) contractor coordination errors, and (4) any violation in the OSD Metrics or EASIER database that was marked with the root cause code of "E", indicating a "Personnel – Execution" error.

Table 24 also includes an evaluation of the installation's strategy impact on non-compliance. If an installation had one or more OSD, EA, or ECHO Reporting violations, the CSU-CEMML team determined that their current strategies impacted their non-compliance record. This determination was shown by a ✓ in the final row of Table 24**Error! Reference source not found.**.

Table 24. Summary of permit requirements and management strategies

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Totals
Discharge Monitoring Strategy	C	C	C	C	N/A	EP	C	UK	EP / C	EP	EP—3 C—6
Discharge Monitoring Reporting Strategy	EP	EP	UK	EP	N/A	EP	EP	EP	EP	EP	EP—8
Shop/Facility Inspections Strategy	EP	C	AFP	EP / C	AFP	EP	AFP	AFP	EP / C	EP	EP—5 AFP—4 C—3
Inspection Reporting/ Annual Report Submission Strategy	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP	EP—10
MS4/SW BMP Maintenance Strategy	AFP	AFP	AFP	AFP	AFP / C	EP / AFP	AFP	C	C	AFP	EP—3 AFP—8 C—3
Management violations	OSD—0 EA—1 ECHO—37	OSD—3 EA—3 ECHO —8	OSD—3 EA—3 ECHO —0	OSD—0 EA—4 ECHO —0	OSD—0 EA—1 ECHO—36	OSD—2 EA—1 ECHO—63	OSD—0 EA—0 ECHO—0	OSD—0 EA—3 ECHO—0	OSD—2 EA—1 ECHO—12	OSD—0 EA—0 ECHO—N/A	OSD—10 EA—16 ECHO —156
Management Strategy Compliance	X	X	X	X	X	X	✓	X	X	✓	20% Installations

Table 24 shows the management strategy variability across installations. “Inspection Reporting/Annual Report Submission” is the only permit requirement that is executed with the same management strategy at all 10 installations. “Shop/Facility inspections” has the highest variability.

A total of 184 management violations occurred across the 10 bases. Eight of the 10 installations recorded management-related violations; however, the CSU-CEMML team did not find any significant correlation between management strategies and non-compliance impact.

Table 25 shows non-receipt violation categories developed based on EPA ECHO reporting data across the AF enterprise. All installations with EPA ECHO data are included.

Table 25: AF ECHO Non-receipt violations and percentile

Non-receipt violations	Percent of AF ECHO Installations
0	0–30%
1–37	30–70%
37–587	70–100%

Almost 30% of installations in the AF with EPA ECHO data do not have recorded non-receipt violations. Approximately 40% of installations have recorded between 1 and 37 non-receipt violations, and 30% of installations have recorded between 38 and 587 non-receipt violations. Figure 40 shows the non-receipt rank categories graphically.

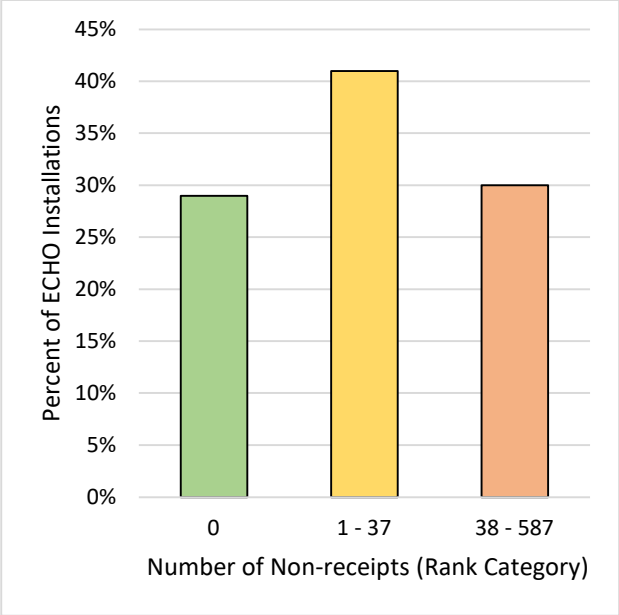


Figure 40: Non-receipts ranking categories

Of the installations included in the CSU environmental compliance program reviews, 1 had 38 or more non-receipt violations, 4 installations had between 1 and 37 non-receipt violations, and 4 installations had no non-receipt violations.

4.18 Inflow and Infiltration Response

Unless specified above, the possible answers to the I&I components in the first column are listed below.

- ✓: A particular I&I function has occurred or is represented at the respective installation.
- X: A particular I&I function has not occurred or is not represented according to the CSU review of the installation.

Table 26 shows an overview of the I&I problems and response for each base. The non-compliance impact rating represents the likelihood of a compliance issue being caused by I&I in the future based on the CSU-CEMML team's understanding of the installation's wastewater program. The first column's categories are described below.

- Wastewater I&I: I&I is present in the installation's wastewater collection system.
- Stormwater I&I: I&I is present in the installation's stormwater collection system.
- Recent I&I Study: An I&I study has been conducted at the installation within the last 10 years.
- Recent Restoration Project: Collection system infrastructure has been restored within the last 10 years.
- Future Project Planning: Projects to remedy I&I issues are in the planning phase.
- Future Project Programming: Projects to remedy I&I issues are in the programming phase.
- Cited Funding Challenges to Programming: The installation's environmental personnel communicated that it was difficult to get funding for programming.
- I&I Compliance: Indicates if an I&I related compliance issue was recorded.
    - ✓: The compliance record is clear of I&I related violations.
    - X: An I&I related compliance issue at the installation was recorded.

Unless specified above, the possible answers to the I&I components in the first column are listed below.

- ✓: A particular I&I function has occurred or is represented at the respective installation.
- X: A particular I&I function has not occurred or is not represented according to the CSU review of the installation.

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Table 26: Inflow and infiltration overview

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Installations Represented
WWTP on Base	✓	✓	✓	X	X	✓	✓	X	X	X	50%
Wastewater I&I	✓	✓	✓	✓	X	X	✓	X	X	X	50%
Stormwater I&I	X	X	X	X	X	X	X	✓	X	X	10%
Recent I&I Study	✓	✓	✓	✓	X	X	✓	✓	X	X	60%
Recent Restoration Project	X	X	✓	✓	X	X	✓	X	X	X	30%
Future Project Planning	X	✓	✓	✓	N/A	X	✓	X	N/A	N/A	40%
Future Project Programming	X	✓	✓	✓	N/A	X	✓	X	N/A	N/A	40%
Cited Funding Challenges to Programming	X	✓	X	X	N/A	N/A	✓	N/A	N/A	N/A	20%
I&I Compliance	✓	X	X	✓	✓	✓	X	✓	N/A	N/A	50%

I&I impacted non-compliance at Robins, Beale, and Scott AFB. In all 3 cases, I&I in wastewater conveyance infrastructure had elevated flow through WWTPs and was decreasing treatment time within WWTPs. All 3 bases have conducted I&I studies within the last 10 years and 2 installations have implemented restorations projects to mitigate I&I; however, additional projects are needed to further reduce I&I to levels that would no longer impact compliance. Two of the 3 bases cited funding challenges to programming I&I related projects.

4.19 Incomplete GIS Data

Stormwater utilities feature datasets for 7 bases were reviewed by the CSU-CEMML team. Datasets were received from the AFCEC GIO office.

Table 27 provides a summary of the CSU-CEMML observations.

The primary observations of GIS data are in the first column of

Table 27. A description of each observation and possible answers is listed below.

- GIS data exists: The installation has compiled a water utilities GIS dataset.
- GIS data received: The CSU-CEMML team received water utilities GIS data for the installation.
- GIS features are connected: All water utilities features (primarily points and lines) are correctly spatially connected in the GIS dataset.
- As-builts are included: All relevant as-builts have been included in the water utilities GIS dataset.
- Changes to infrastructure updated: When there are changes to water utilities infrastructure, it is updated in the GIS dataset.
- Recent survey data integrated: Data from recent water utilities surveys (within the last 10 years) have been integrated into the GIS dataset.
- Feature Attribution Complete: Attribute tables contain all relevant components.
- GIS Compliance: Indicates if a GIS related compliance issue was recorded.
    - ✓: The compliance record is clear of GIS related violations.
    - X: A GIS related compliance issue at the installation was recorded.

Unless specified above, the possible answers to the GIS components in the first column are listed below.

- ✓: A GIS observation is represented at the respective installation's GIS data.
- X: A GIS observation is not represented at the respective installation's GIS data.
- N/A: Not applicable because a prerequisite was not satisfied (e.g., data does not exist, data was not received, or a recent survey has not been performed).
- UK: An answer was not determined from the data analysis.

Bases that submitted data to CSU-CEMML were evaluated based on 3 criteria: GIS features are connected, changes to infrastructure updated, and feature attribution completed.

Table 27: CSU-CEMML GIS review summary

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Installations Represented
GIS data exists	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	90%
GIS data received	✓	✓	✓	✓	✓	✓	X	✓	X	N/A	78%
GIS features are connected	X	X	X	X	X	UK	N/A	X	N/A	N/A	0%
Feature attribution completed	X	X	X	X	X	X	N/A	X	N/A	N/A	0%
GIS Compliance	X	X	X	X	X	X	N/A	X	N/A	N/A	0%

GIS data was received by 7 of the 9 installations with existing GIS data. Of the sets of GIS data reviewed by the CSU-CEMML team, all showed some level of inaccuracies and incompleteness across all installations that submitted data (e.g., missing feature attribution, construction updates, elevation data). Because stormwater permits require updated GIS data, all bases that were reviewed showed non-compliance impacts from missing or incomplete GIS data.

4.20 Deicing Chemicals in Stormwater

Unless specified above, the possible answers to the deicing components in the first column are listed below.

- ✓: A particular deicing component is represented at the respective installation.
- X: A particular deicing component is not represented at the respective installation.
- N/A: Not applicable because a prerequisite was not satisfied.

Table 28 shows the permit violations across all 10 installations that were likely driven by deicing chemicals in stormwater. The components in the first column and possible answers are defined below.

- Aircraft Deicing: Deicing operations are conducted on aircraft at the installation.
- Deicing Pad: The installation has a designated deicing pad for aircraft deicing.
- Pavement Deicing: Deicing operations are conducted on pavements or roadways at the installation.
- Deicing Violations: Base personnel specified a deicing-related violation or oxygen demand parameters (BOD, CBOD, and COD) exceeded permits limits at outfalls downstream of deicing pads.
- Deicing Compliance: Indicates if a deicing related compliance issue was recorded.
    - ✓: The compliance record is clear of deicing related violations.
    - X: A deicing related compliance issue at the installation was recorded.

Unless specified above, the possible answers to the deicing components in the first column are listed below.

- ✓: A particular deicing component is represented at the respective installation.
- X: A particular deicing component is not represented at the respective installation.
- N/A: Not applicable because a prerequisite was not satisfied.

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Table 28: Deicing program overview

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Installations Represented
Aircraft Deicing (glycols)	✓	X	X	X	X	✓	✓	X	X	✓	40%
Deicing Pad	✓	N/A	N/A	✓	N/A	✓	✓	N/A	N/A	X	40%
Pavement Deicing (acetates)	✓	X	X	✓	X	✓	✓	✓	✓	✓	70%
Deicing Violations	16*	N/A	N/A	0	N/A	10	0	0	0	22	30%
Deicing Compliance	X	✓	✓	✓	✓	X	✓	✓	✓	X	70%

*Data from EPA ECHO do not list McConnell AFB's data with included limits, which apply only during November–March. However, 12 of the reported monthly average values in recent (2017-2023) EPA ECHO data exceed the permit-listed limit during November—March.

Of installations that use glycols for aircraft deicing, 75% have 10 or more permit exceedances due to deicing fluid entering the stormwater conveyance system. Deicing BMPs, containment infrastructure, and protocols varied between bases. Compliance records do not seem to correlate with the type of deicing containment structures. Tracking the time and quantity of chemicals used in deicing application is necessary and typically required by the Air Transportation sector of general stormwater permits.

4.21 Contractor Communication Breakdowns

The Contractor Oversight Compliance row indicates if a deicing related compliance issue was recorded.

- ✓: The compliance record is clear of deicing related violations.
- X: A deicing related compliance issue at the installation was recorded.

Table 29 shows the number of contractor oversight violations at each installation. Contractor oversight violations were determined if contractor management or contractor oversight was mentioned in the EASIER database (as Contract Management Code, C) or OSD metrics. Site visit information and regulator correspondence was also considered in determining if a violation was due to a communication breakdown between environmental personnel and contractors.

The Contractor Oversight Compliance row indicates if a deicing related compliance issue was recorded.

- ✓: The compliance record is clear of deicing related violations.
- X: A deicing related compliance issue at the installation was recorded.

•

Table 29: Contractor oversight violations

Installation	McAFB	RAFB	BAFB	LAFB	JBC	TAFB	SAFB	MAFB	PARS	PA ANG	Installations Represented
Contractor oversight violations	0	2	7	0	3	4	0	0	2	0	50%
Contractor Oversight Compliance	✓	X	X	✓	X	X	✓	✓	X	✓	50%

Installations completing large construction projects had the highest number of contractor oversight violations. For instance, Beale AFB and Tinker AFB documented the highest number of contractor violations out of the 10 bases studied, most of which were directly related to construction projects. (If a construction site disturbs more than 1 acre of land, contractors are required to apply for and operate under a separate construction permit. Under such permits, contractors are responsible for maintaining sediment and erosion control BMPs.) In cases where repeated contractor oversight violations occurred, base personnel cited issues with implementing effective communication with contractors.

An additional contractor oversight violation occurred because contractors with sampling responsibilities did not understand details in the sampling protocols required by the permit. Other contractor violations involved administration errors by contractors, including failures to obtain permits and failures to file NOTs after completing construction.

4.22 Metals in Stormwater Runoff

The presence of metals in stormwater runoff was common at the larger installations with industrial activities and highly active air strips. From CSU-CEMML's study of larger industrial programs, the following scenarios increase the likelihood of metals entering stormwater.

- Industrial activity (e.g., aircraft maintenance) that requires outdoor scrap metal storage
- Airstrips with heavy traffic create brake dust containing metals (e.g., cadmium, copper, lead)
- Uncovered galvanized metal surfaces (e.g., zinc)

4.23 Wastewater Treatment Lessons Learned

4.23.1 Variable Influent Concentrations at WTPs

Of the 4 bases that treated wastewater on base, 2 of them pretreated industrial wastewater at a WWTP. Both pretreatment programs cited variabilities in waste streams as a major challenge during the pretreatment process. In these scenarios, the CSU-CEMML team recommended that communication protocols be in place so that WWTP operators can anticipate altering treatment processes to mitigate irregularities in the waste stream.

4.23.2 Disinfection Technology at Domestic WTPs (Beale AFB, Robins AFB, Scott AFB)

Table 30 shows disinfection technologies used at installations with an on-site WWTP. The components in the first column and possible responses are defined below.

- Disinfection technology available: Disinfection technologies are installed and available for use at the WWTP
- Disinfection technology currently used: Disinfection technology currently integrated and used to disinfect wastewater prior to effluent discharge
- Number of disinfection-related exceedances: Number of exceedances caused by a failure in disinfection, determined by written explanation to a regulator or bacterial exceedance at the effluent monitoring location
- UV: Ultraviolet disinfection technologies
- Chlorine: Chlorinated disinfection technologies

Table 30: Disinfection technologies at WWTPs

Installation	RAFB	BAFB	TAFB	SAFB
Disinfection technology available	UV and chlorine	UV and chlorine	N/A	UV
Disinfection technology currently used	Chlorine	Chlorine	N/A	UV
Number of disinfection related exceedances	1	17	N/A	5 (UV system was down)

All bases that discharged treated water to groundwater or surface waters had an ultraviolet (UV) treatment system in their WWTP; however, only one installation routinely used UV as its primary disinfection technology. Two other bases that installed UV technology reverted to chlorine treatment systems, citing personnel concerns and potential issues with UV operation, effectiveness, maintenance, and access.

In multiple cases, the CSU-CEMML team recommended revisiting in-place UV systems, including the proper allocation of resources to better integrate the technology into the wastewater program (e.g., operator training and procedures).

Not all bases have contingency technologies in place if the primary treatment system fails. If UV is used, the CSU-CEMML team recommended that installations maintain an operable contingency system (e.g., chlorine) to prevent violating disinfection-related permit limits.

4.24 Trending Monitoring Data

In the CSU-CEMML team's observations, no permits require environmental personnel to trend monitoring data (e.g., plot monitoring data on a time series graph). However, in certain cases, time series graphs were required to be submitted with periodic reports.

In CSU's reports, installation data were trended in time series graphs that include means, 3-sigmas, and associated limits for each discharge point and parameter. Values for 3-sigma were typically added to a time series plots of DMR data for each permitted parameter. These values were used to predict the likelihood of future data being within specific bounds. Specifically, 3-sigma values provide upper and lower bounds of a 99.7% confidence interval, based on the mean and standard deviation. The CSU-CEMML team recommended trending monitoring data to all installations to provide insight into the system and allow for the identification of system patterns and states. This data allows installations to respond proactively to water quality changes.

All of the bases in the CSU study, except PA ANG, provided records of trending monitoring data on a regular basis as a best practice procedure. PA ANG kept a log of each monitoring event and trended the data on a time-series graph.

5.0 AIR FORCE WATER PROGRAM SURVEY

5.1 Survey Overview

AFCEC tasked the CSU-CEMML team with a comprehensive Clean Water Act (CWA) compliance review of 10 Air Force (AF) bases. Because the review was limited to 10 installations, the CSU-CEMML team designed a survey to collect CWA compliance information for bases across the AF enterprise. Survey results were used to inform installations of the challenges, limitations, and solutions shared across AF water quality programs.

5.1.1 ***Survey Framework Design***

The survey categories were selected from common compliance observations from the 10 environmental compliance program review reports. Figure 41 is an example of a framework design map made prior to writing survey questions. The initial categories of the survey are characterized by the titles of each colored box. The categories included: base characteristics and operations, permits, management methods, data analysis, and compliance vulnerability.

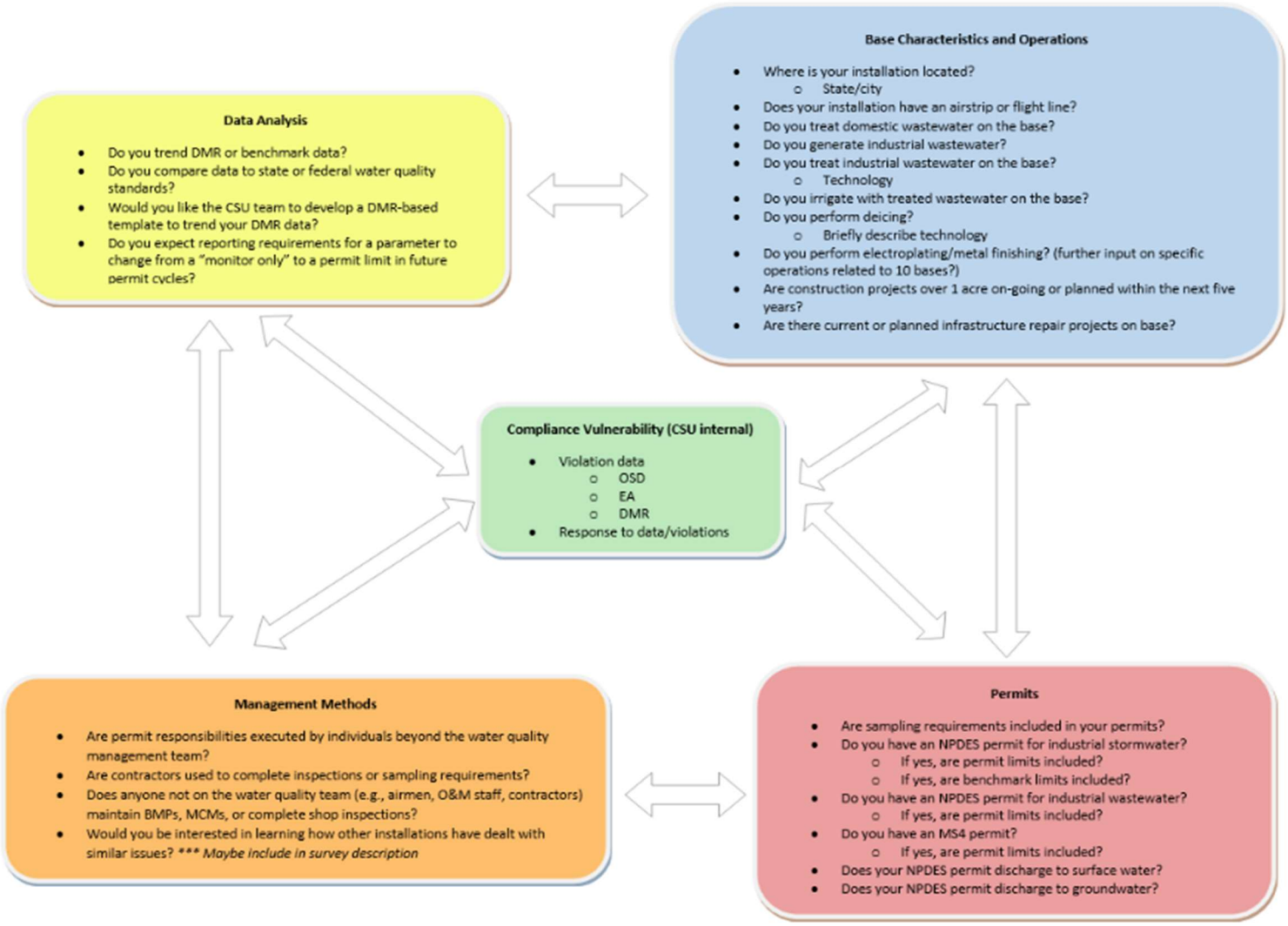

Figure 41: Survey framework design

Figure 41 shows how the primary components of the compliance program evaluations were integrated into the survey design. The questions in the boxes refer to specific observations derived from the 10 program review studies. The CSU-CEMML team also conducted a compliance vulnerability study based on OSD, EA, and EPA ECHO data to add performance indicators to the survey data. Figure 41 shows the relevance of compliance performance data to each section of the survey. The arrows indicate the connection between survey categories and the potential to integrate program effectiveness into the survey results.

The final survey was organized into 7 categories and included installation-level questions about active permits, permit requirements, personnel responsibilities, management strategies, communication protocols, industrial activities, GIS data management, asset management, and inflow and infiltration (I&I) responses.

Table 31 shows the categories and describes the sub-topics that were the focus of each section.

Table 31: Survey categories and sub-topics

Survey Categories	Category Details	
Industrial Stormwater NPDES Program	• Permit type • Permit management personnel • Industrial activity • Sampling, inspection, and reporting protocols • Airstrip information • Deicing information	• Data tracking • BMP maintenance • Repair and replace projects • Contractor management • Updates to BMPs in real property records/category codes • Non-compliance impact
Municipal Separate Storm Sewer System Program	• Permit management personnel • Annual report requirements • Sampling, inspection, reporting requirements	• Contractor management • BMP maintenance • Updates to BMPs in real property records/category codes
Wastewater NPDES Program	• Active WWTP on base • NPDES effluent discharge monitoring and reporting requirements • Industrial wastewater generation and treatment • Domestic wastewater treatment	• WWTP communication protocols • Secondary and tertiary treatments • Chlorination and dechlorination methods • Ultraviolet disinfection • WWTP non-compliance impact • WWTP repair and replacement • Effluent used for irrigation
Data Collection, Reporting, and Programming Solutions	• EPA ECHO database usage • eDMR reporting • EPA ECHO trending • EPA ECHO DMR trending template	
GIS Updates and GIS-compatible Asset Management Software	• GeoBase office and GIS maintenance • Current conditions of GIS data • GIS connectivity • GIS-compatible asset management software	
Inflow and Infiltration Response	• Recent I&I study • I&I repairs or replacements • Current I&I projects • I&I stress on WWTP • I&I non-compliance impact	

*5.1.2 **Survey Feedback and Distribution***

A draft version of the survey was sent to various water quality program managers and ISS personnel (AFCEC/CZOE) for feedback. As a result, the CSU-CEMML team modified the survey language to include AF-specific terms and other syntax improvements. Approximately 10 questions were added to provide further details regarding tracking structural BMPs and wastewater fees.

When finalized, the survey was administered by Kevin Leachman, the AF Water Quality Subject Matter Expert (SME) at the Air Force Civil Engineer Center (AFCEC/CZTQ). Mr. Leachman delivered the survey to Water Panel EQ leads from the CZO regions who forwarded it to AFB, ANG, and AFRC installations for voluntary completion.

5.2 Survey Response Overview

The CSU-CEMML team received responses from 15 Air Force installations. The 10 installations that participated in the compliance program studies were also evaluated and included as participants in the surveys, for a total of 25 participants. The breakdown of survey participants and installation type is in Table 32.

Table 32: Survey participants

Installation Type	Number of Installations	Installations
Air Force Base (AFB)	17	Altus, Arnold, Beale, JB Charleston, Eielson, FE Warren, JBLE Eustis, JBLE Langley, MacDill, Malmstrom, McConnell, Minot, Offutt, Robins, Scott, Shaw, Tinker
Air Reserve Base (ARB) or Air Reserve Sation (ARS)	6	Avon Park, Dobbins, Grissom, Homestead, Minneapolis—St. Paul, Pittsburgh
Air National Guard (ANG)	1	Pittsburgh
Space Force Station (SFS)	1	Clear

The 25 survey respondents are represented in Figure 42 below.

Figure 42: Survey response installations

The survey respondents were distributed across the United States. Twenty-one installations are located in the contiguous US. Thirteen are located east of the Mississippi River. Two, Clear SFS and Eielson AFB, are located in Alaska.

5.3 Survey Results and Analysis

The survey results are presented in 8 sections: Permit Overview, Management Strategies, Inflow and Infiltration, GIS, Deicing, Contractor Oversight, Disinfection Technology, Data Trending, and Additional Topics. These sections were selected based on the survey categories and common observations made throughout the compliance program reviews.

*5.3.1 **Permit Overview Results***

Figure 43 represents the CWA-related permits that are active at the installations represented in the survey. The 5 permits represented are described below.

- Multi-Sector General Permit (MSGP)—an NPDES stormwater permit that authorizes the discharge of industrial stormwater and specifies monitoring, reporting, BMP, and bookkeeping requirements based on industrial sectors represented at the installation.
- Individual Permit (IP)—an NPDES permit that authorizes the discharge of stormwater or WWTP effluent and specifies monitoring, reporting, BMP, and bookkeeping requirements based on specific parameters that have been proven to be present in discharge.
- Municipal Separate Storm Sewer System (MS4) Permit—an NPDES stormwater permit required by municipalities, counties, and certain other governments with separate storm sewer systems that receive stormwater discharge from urban development (e.g., housing, roadways, etc.)
- Municipal Wastewater Permit—administered when a base discharges untreated or pretreated wastewater to a municipality for treatment.
- Construction Permit—permits administered to contractors responsible for CWA compliance through maintaining site-specific SWPPPs, typically on construction projects that exceed one acre of disturbed land.

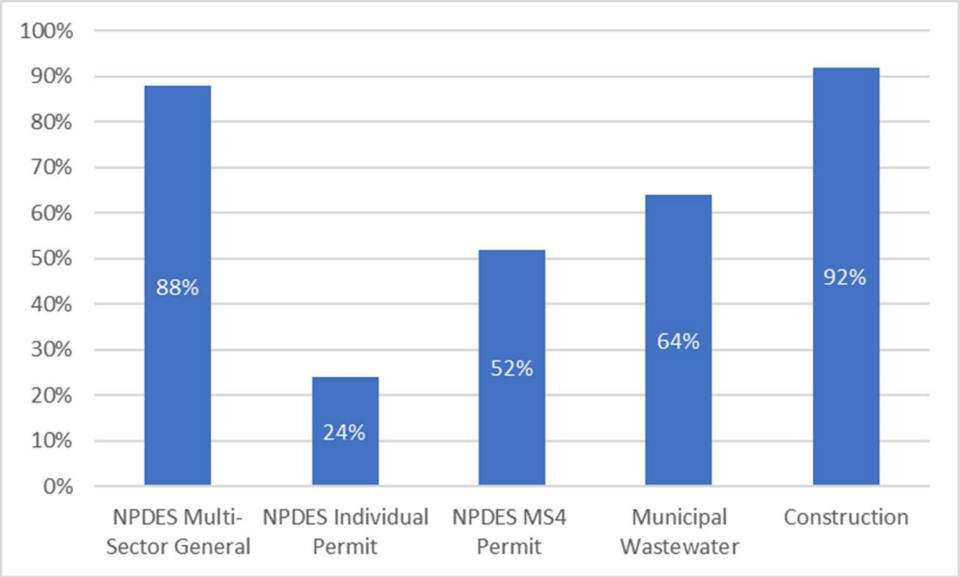

Figure 43: CWA active permits

88% of the installations that participated in the survey operate under an MSGP. This finding is expected insofar as MSGPs are typically required by state regulators if industrial activity occurs on the base. The compliance program review analysis provided a similar result in which 90% of installations operate under a MSGP.

Nearly one quarter (24%) of the installations represented in the survey operate under an individual permit. Of the 6 bases that have an IP, 2 of them discharge WWTP effluent directly to waterways.

Over half (52%) of the installations represented in the survey have an MS4 program.

Municipal wastewater agreements are common (64%) among participating installations. These agreements likely indicate that municipalities are receiving domestic wastewater and/or pretreated industrial wastewater from over half of AF installations.

Just over 90% of installations have active construction permits that require contractors to develop and maintain their own SWPPPs. Based on the compliance program review, it is uncommon for environmental personnel at an installation to have monitoring and reporting responsibilities from construction permits.

Figure 44 shows the percentage of installations that have active CWA permits. The number of active permits in this study range from 0 to 4 and include MSGP, IP, MS4, and municipal wastewater permits. Construction permits were not included in Figure 44 due to the lack of monitoring and reporting responsibilities for environmental personnel in construction permits.

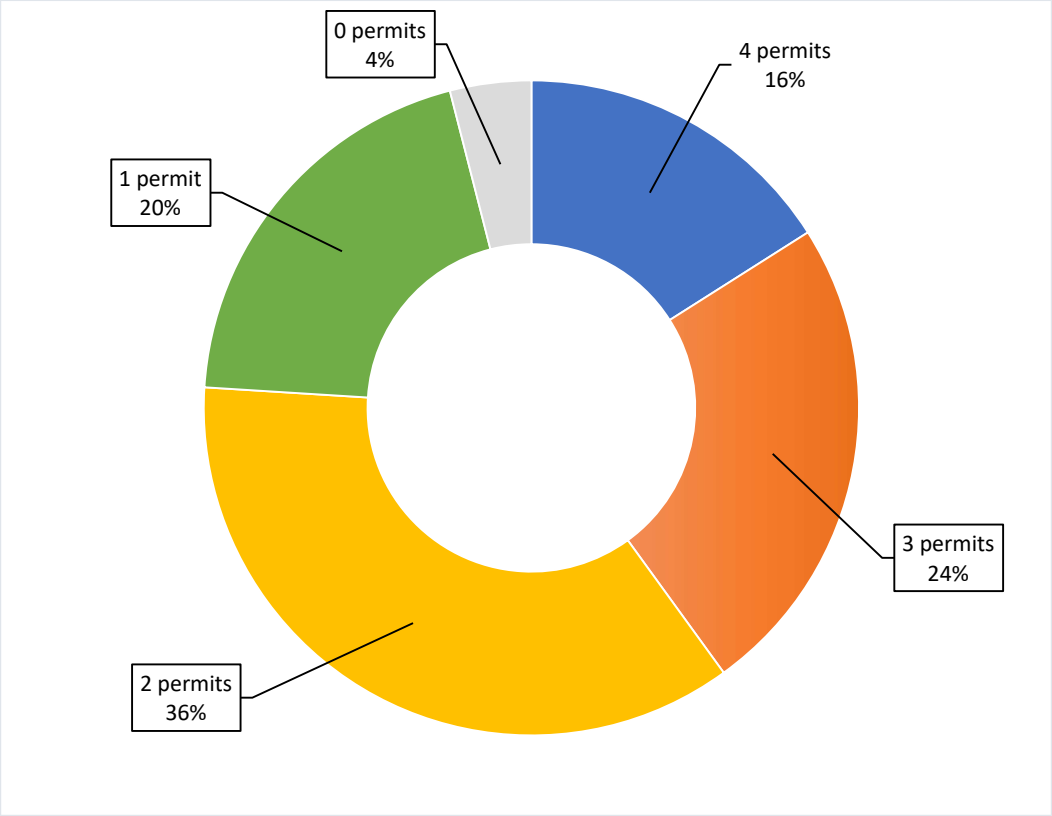

Figure 44: Percent of installations with CWA permits

Four installations, or 16% of surveyed installations, operated under 4 active CWA permits. Over half of the installations operated with 2 or more active permits. Five installations or 20% had just 1 permit, which varied between MSGP, IP, and MS4 permits. Clear SFS was the only installation that did not operate under an active CWA permit.

The number of active permits does not have a direct correlation with any compliance performance indicators (e.g., ECHO, EASIER, or OSD) (with a p value greater than 0.05).

*5.3.2 **Management Strategy***

The program review reports indicated that permit requirements were not executed by the same personnel across installations. Environmental Personnel (EP), Contractors (C), and Air Force Personnel (AFP) were all used with varying degrees of success. The survey data were designed to determine if similar trends in permit management strategies were apparent at a larger sample size.

Figure 44 presents 4 common permit requirements and each installation's management strategy for completing such requirements. The 4 permit requirements are:

- Discharge Monitoring Strategy: personnel responsible for sampling and recording results required by CWA permits
- Discharge Monitoring Reporting Strategy: personnel responsible for reporting sampling results, typically to eDMR through a state or national regulatory website
- Shop/Facility Inspections: personnel responsible for shop and facility inspections required by CWA permits
- SW BMP Maintenance: personnel responsible for maintaining stormwater BMPs (including industrial and MS4)

The survey presented the following management strategy options in the survey:

- Environmental Personnel (EP)— Stormwater Pollution Prevention Team (SWPPT), wastewater environmental compliance personnel, or any other individual on the environmental staff that has direct responsibility to maintain water quality.
- Air Force Personnel (AFP)—Air Force employees or airmen without direct responsibility for water quality. Examples of AF Personnel are below.
    - Operations and Maintenance (O&M)
    - Shop Supervisor
    - Environmental Representatives (ER): coordinates with the Storm Water Pollution Prevention Coordinator to prevent stormwater pollution in their areas of responsibility

    - Unit Environmental Coordinator (UEC): coordinates with SWPP personnel to prevent stormwater pollution in their department
- Contractors (C) —entities contracted to carry out specific permit requirements

Figure 45 through Figure 48 map the common permit requirements and management strategies to the installations that participated in the survey. The management strategies selected for each permit requirement are represented in the colored circles.

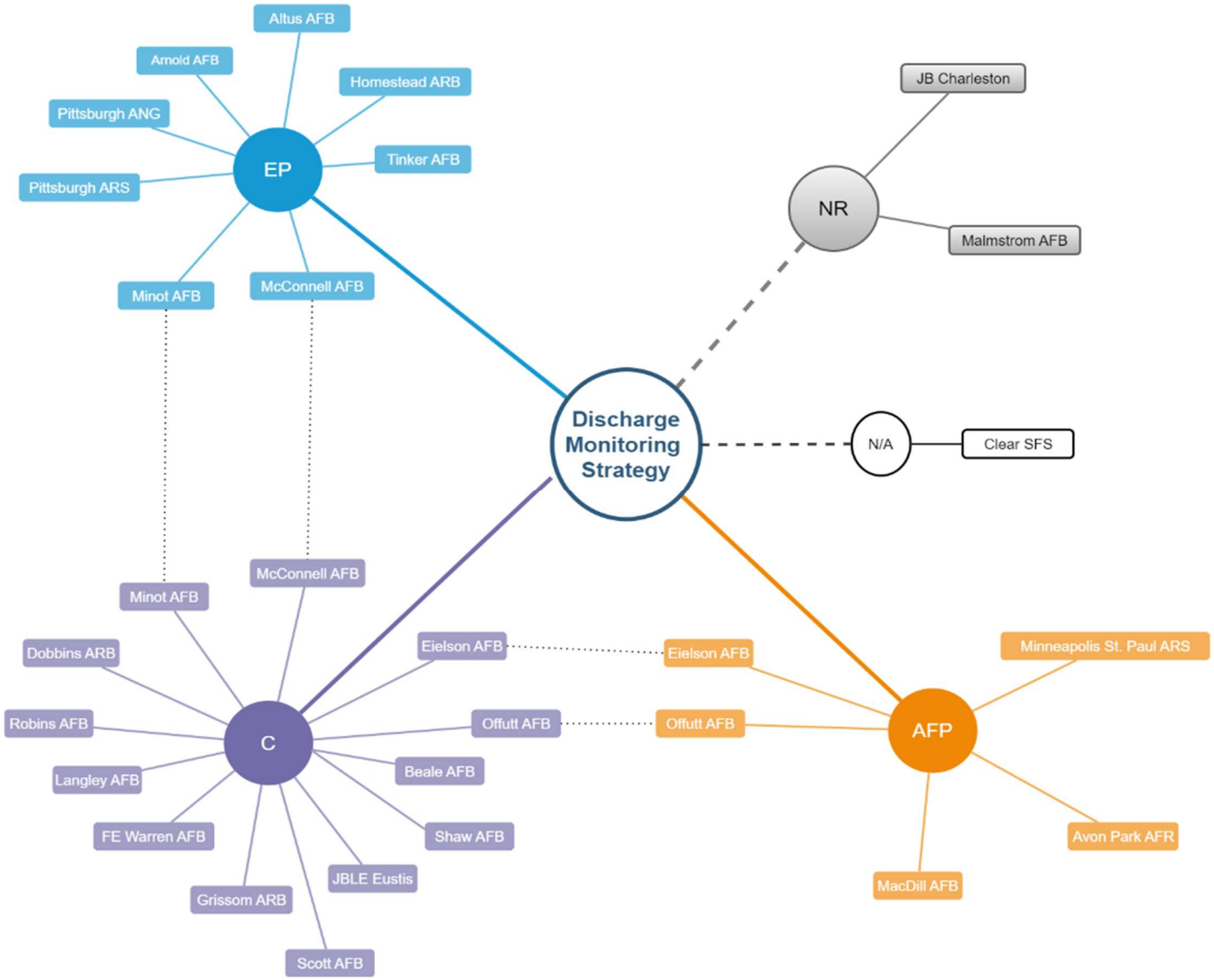

Figure 45: Discharge monitoring strategy map

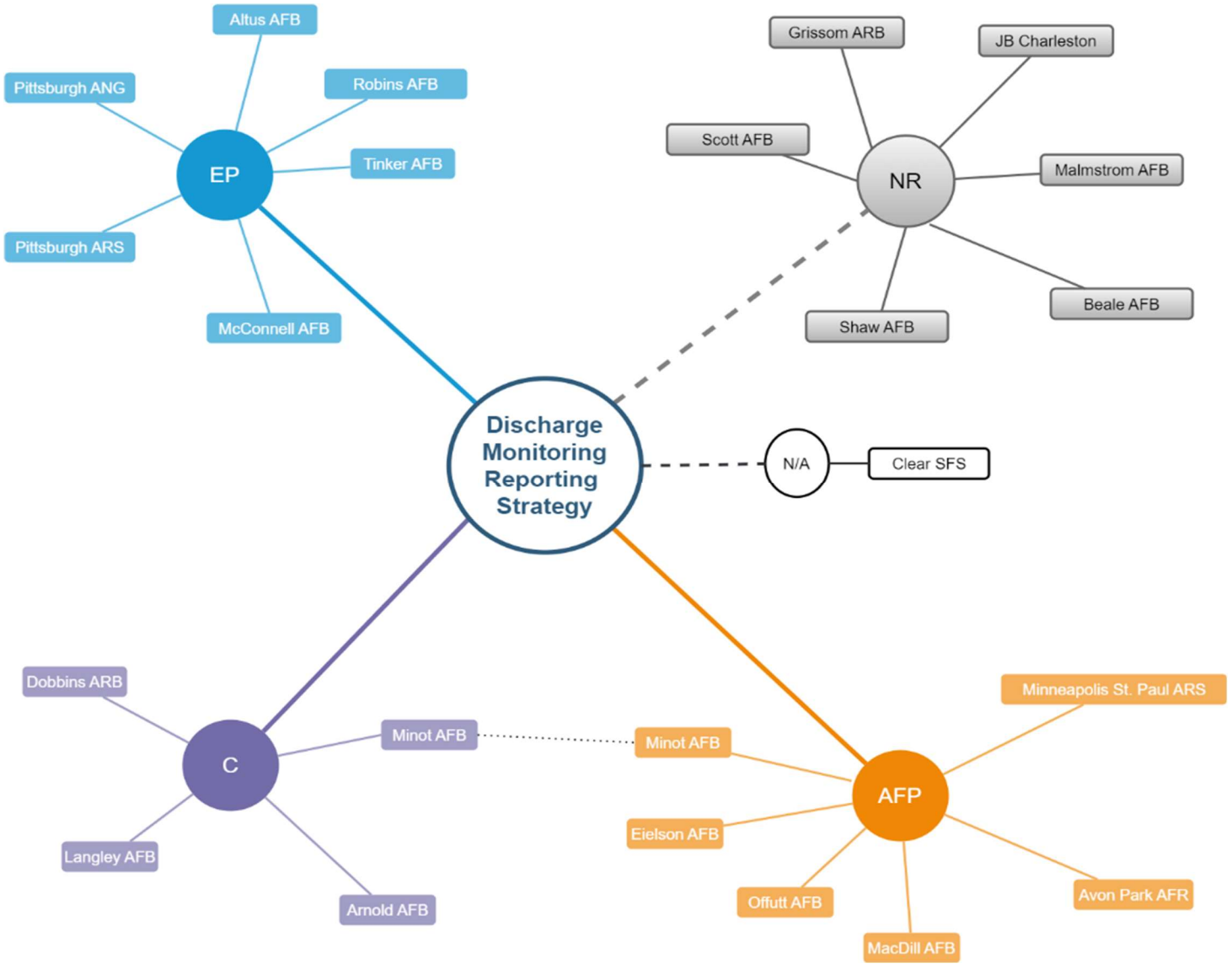

Figure 46: Discharge monitoring reporting strategy map

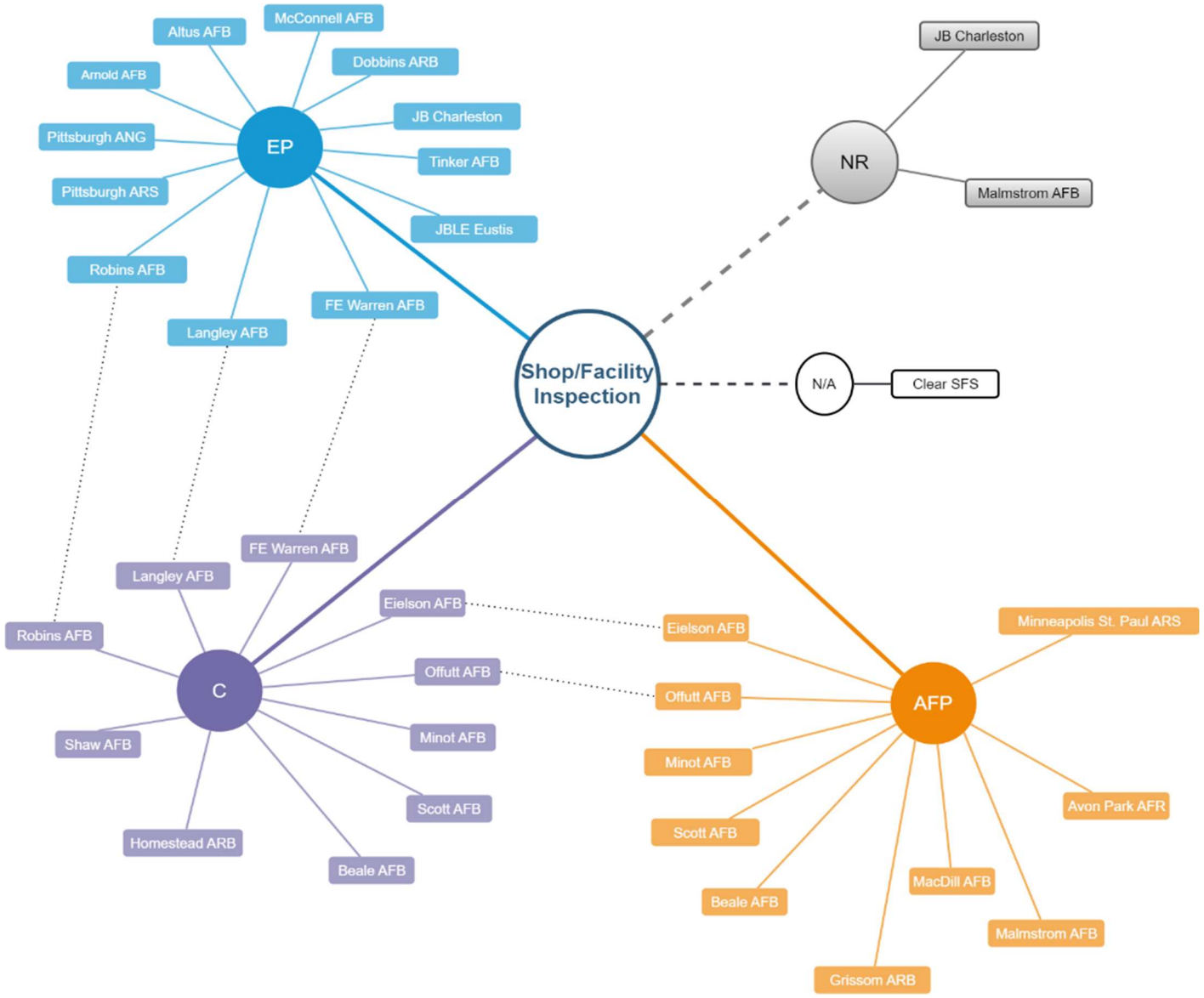

Figure 47: Shop/facility inspection strategy map

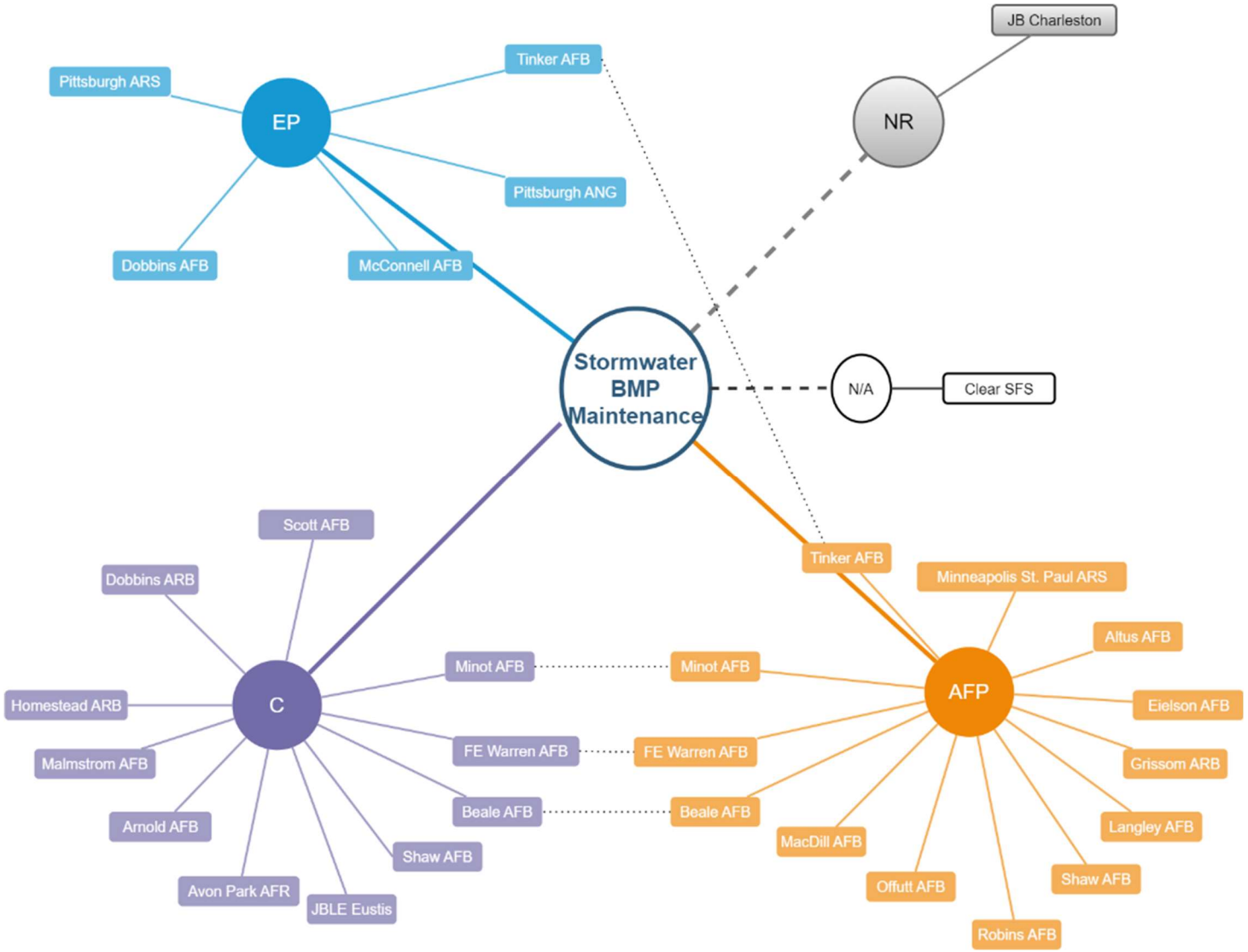

Figure 48: Stormwater BMP maintenance strategy map

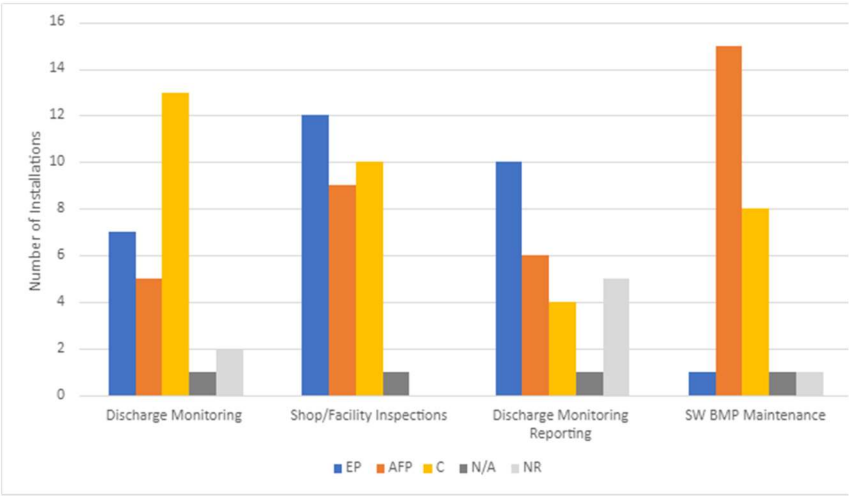

Figure 49: Management strategy summary

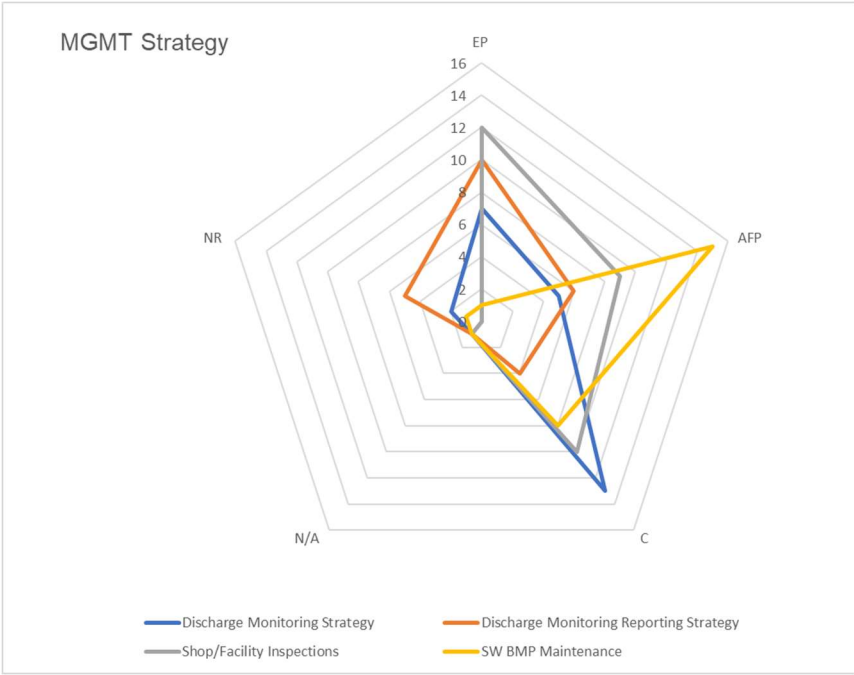

Figure 50: Management strategy radar chart

Figure 49 and Figure 50 show that environmental personnel, AFP, and contractors execute all 4 permit requirements at the installations represented in the survey. Thirteen installations in the survey, or 52%, use contractors for discharge monitoring, making contractor usage the most common strategy for discharge monitoring. This finding aligns with the ECPRs in which contractors were used most for discharge monitoring. (Refer to Table 24.)

Discharge Monitoring Reporting is conducted mostly by environmental personnel (10 installations), followed by AFP (6 installations) and contractors (4 installations). This finding aligns with the compliance program analysis in which 80% of installations used environmental personnel to report discharge monitoring data. (Refer to Table 24.)

Shop and Facility inspections show the most balanced distribution of management strategies, with environmental personnel accounting for 48% of installations and contractors and AFP accounting for 40% and 36% of installations, respectively. Note that some installations cited shared responsibilities between parties for some permit requirements.

Additionally, AFP is the most common management strategy for maintaining stormwater BMPs. Survey comments indicate that O&M personnel, which fall under the AFP label, are commonly used to maintain stormwater BMPs. Contractors and AFP make up 88% of the SW BMP Maintenance execution, which is expected as environmental personnel are typically not responsible for this activity.

Compliance violations from the OSD, EASIER, and ECHO databases were investigated to determine any correlation between management strategies and management related compliance issues. Table 33 summarizes (1) the number of violations recorded in each database and (2) the number of installations with OSD, EASIER and ECHO non-receipt data. Note that not all OSD and EASIER violations are related to management strategies; however, EPA ECHO non-receipt violations occur only if EP or contractors failed to report monitoring data.

Table 33: Number of violations and installations with OSD, EASIER, and ECHO non-receipt violations

	OSD	EASIER	EPA ECHO non-receipts
Number of Violations	17	23	1,006
Number of Installations with Violations	9	11	13

Table 33 shows a significantly larger number of ECHO non-receipt violations corresponding with slightly more installations reporting ECHO non-receipts. As mentioned above, the OSD and EA violations shown in Table 33 are not exclusively management violations. As a result, the CSU-CEMML team decided to use the EPA ECHO non-receipts as an indicator of management performance.

An analysis was conducted with EPA ECHO non-receipt data and management strategy survey data to determine if the number of non-receipt violations correlated with a particular management strategy. Among the 3 different management entities, EP, APF and C, contractors were associated with a higher occurrence of ECHO non-receipt violations. Thus, greater engagement of EP and APF could potentially reduce EPA non-receipt violations.

*5.3.3 **Inflow and Infiltration Results***

The compliance program reports indicated that I&I was a compliance vulnerability at installations with WWTPs that discharged effluent via an NPDES or state equivalent permit. In all cases, I&I in wastewater conveyance infrastructure elevated flow through WWTPs such that the treatment processes were unable to adequately treat wastewater prior to discharge.

Figure 51 shows the inflow and infiltration (I&I) data collected in the survey. Descriptions of the data are below.

- WWTP on Base: Active WWTP on the installation grounds
- NPDES Effluent Discharge from Base: Installation NPDES permit authorizes the discharge of effluent from a WWTP on the installation

- Wastewater I&I Present: I&I occurs in the wastewater conveyance system prior to a WWTP or final outfall location
- Recent I&I Study: I&I study conducted at the installation within the last 20 years
- Recent Restoration Project: I&I improvement projects completed in response to recommendations of an I&I study within the last 10 years
- Future Project Planning/Programming: I&I projects underway or being programmed
- Challenges in funding I&I projects: Survey respondent mentioned funding challenges to I&I repair/replace projects
- I&I Compliance: ("No" indicates that I&I causes stress on the wastewater treatment program such that it threatens water quality; I&I increases flow through the WWTP beyond the WWTP's capacity; or I&I negatively impacts stormwater quality at discharge locations.

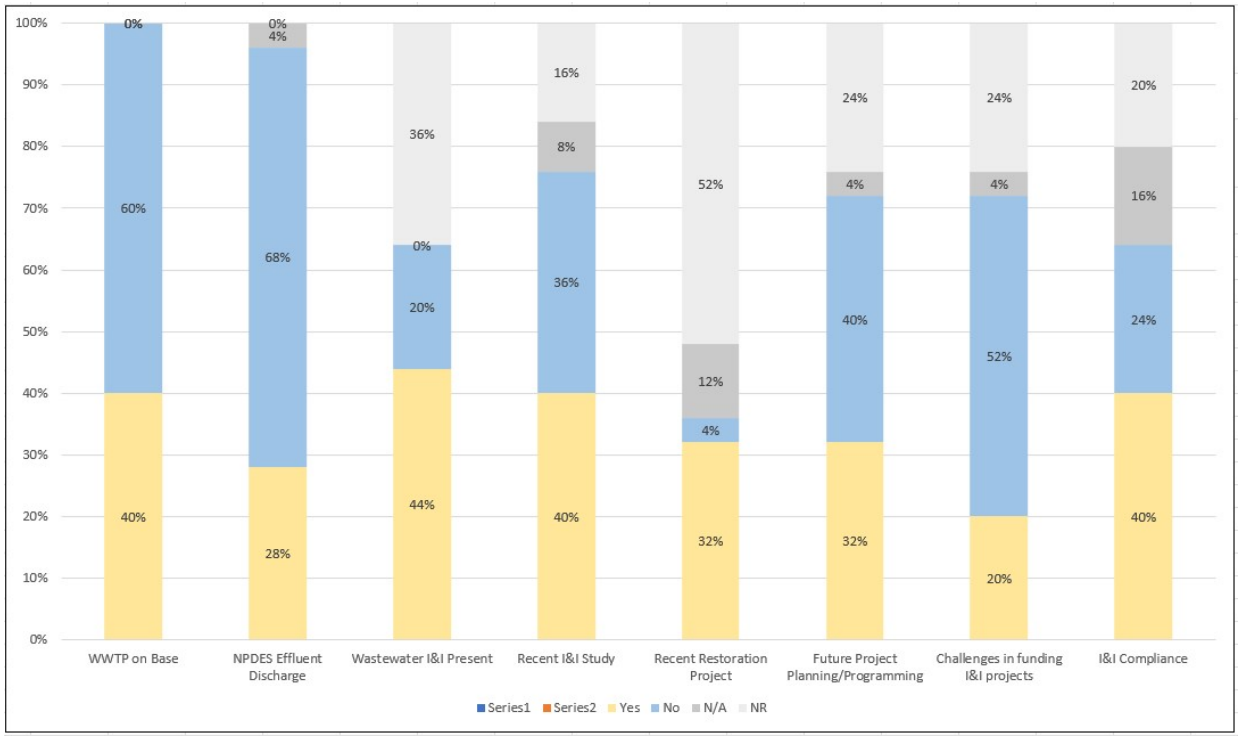

Figure 51: I&I survey results

The survey indicates that at 44% of installations, I&I occurs in the wastewater conveyance system prior to a WWTP or final outfall location. Approximately 30% of installations discharge effluent under an NPDES or state discharge permit.

All but 1 installation with WW I&I have had a study within the last 20 years to document the extent of I&I. Approximately 90% of installations with reported I&I have begun acquiring data to plan restoration projects. Roughly 30% of surveyed installations (73% of installations with reported WW I&I) have either completed an I&I-related restoration project or have one in the planning or programming phase. In other words, all but 3 installations reporting I&I issues have taken some kind of action. This finding varies slightly from that of the compliance program review reports, which indicated that all installations with WW I&I had undergone an I&I study.

About 20% of surveyed installations (or 36% of installations with WW I&I) reported challenges in funding I&I-related projects. This proportion is significantly smaller than that indicated in the ECPRs, in which 60% of installations with WW I&I reported funding challenges in addressing them.

Lastly, 24% of installations (or 54% of installations with WW I&I) reported an I&I-caused threat to water quality (i.e., I&I results in non-compliance). This is similar to the program reviews, which reported that 60% of installations with WW I&I have a non-compliance impact.

The survey results support the conclusions of the compliance program review reports: installations with WW I&I face a significant risk to water quality and steps to mitigate I&I are being taken but are impeded by financial challenges.

*5.3.4 **Disinfection Technologies Results***

Figure 52 and Figure 53 show data related to disinfection technologies used in domestic WWTPs that were collected in the survey. Descriptions of the data collected in Figure 52 and Figure 53 are below.

- Domestic WWTP on Base: A domestic (nonindustrial) WWTP is on the installation grounds

- NPDES Effluent Discharge: The installation has an NPDES permit that authorizes the discharge of treated wastewater
- Tertiary Treatment Present: The domestic WWTP includes tertiary treatment
- Chlorine Used for Disinfection: In installations that include a domestic WWTP, the WWTP uses chlorine for disinfection
- UV Used for Disinfection: In installations that include a domestic WWTP, the WWTP uses ultraviolet technology for disinfection
- Dechlorination required: Dechlorination is required by a permit or municipal agreement before dischargeFigure 52 shows results from all 25 installations that participated in the survey. Figure 53 includes data only from the 5 installations that actively treat wastewater with a tertiary treatment system.

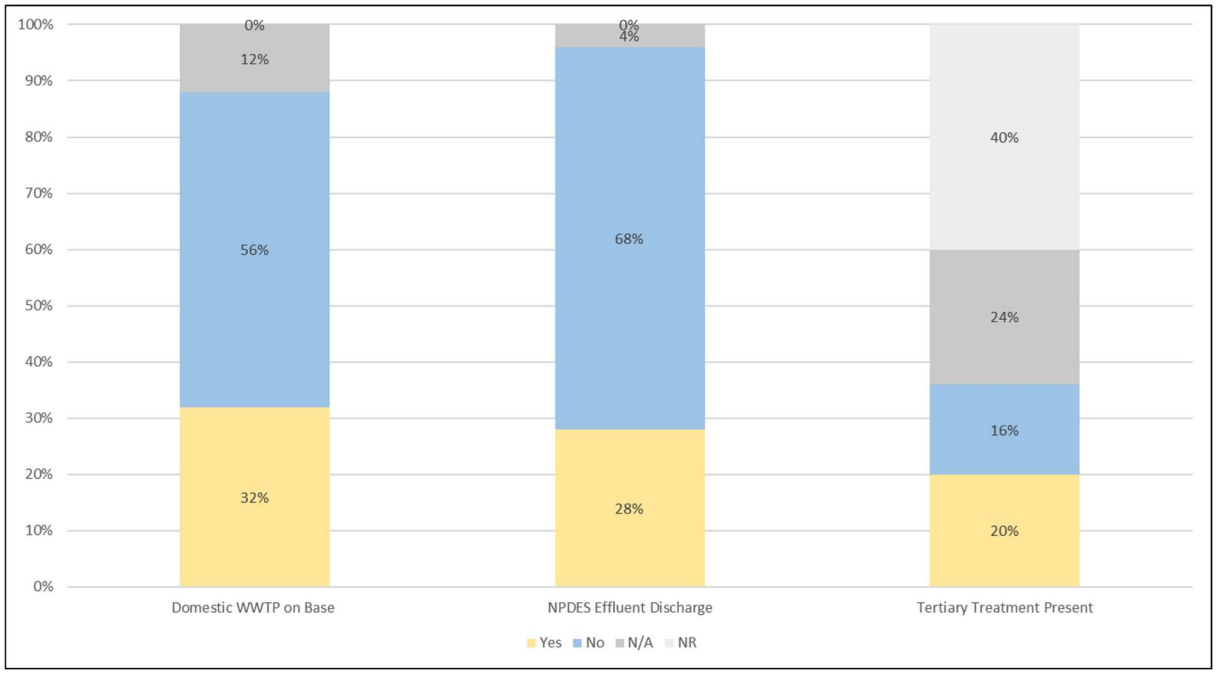

Figure 52: Domestic WW treatment survey results

Of the 32% of installations that have a domestic WWTP, approximately 88% discharge effluent to waterways via an NPDES or state equivalent permit. Moreover, 20% of surveyed installations (or

approximately 63% of domestic WWTPs represented in the survey) perform tertiary treatment of wastewater prior to discharge.

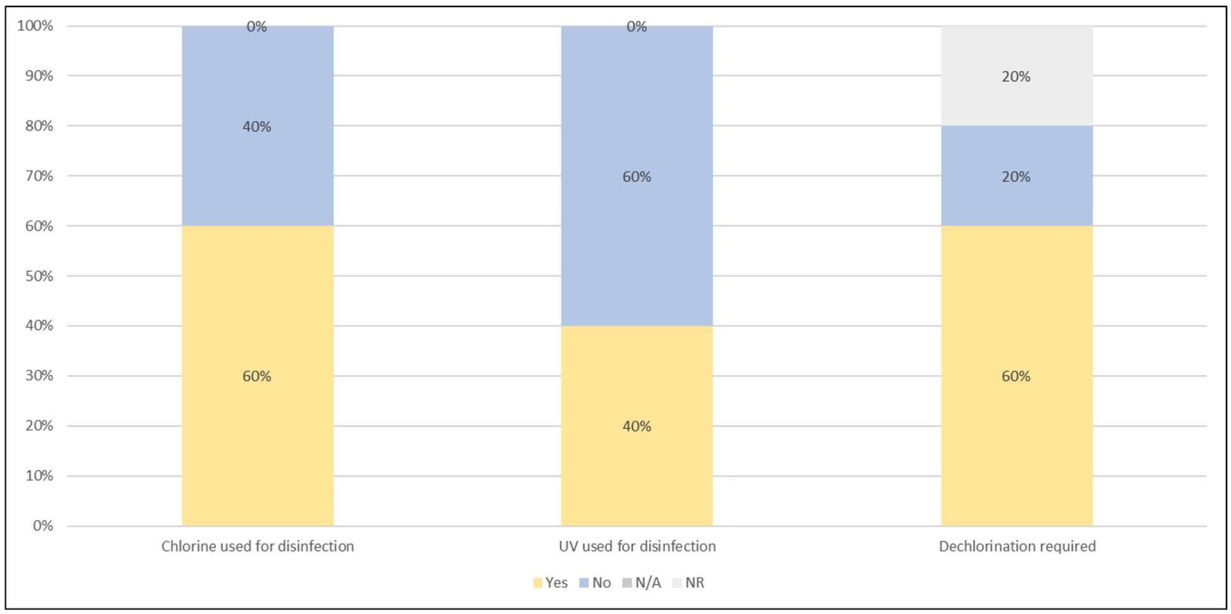

Figure 53: Tertiary treatment survey results

Figure 53 includes data only from the 20% of installations that used a tertiary treatment system prior to effluent discharge. Chlorinated and UV systems are the primary tertiary treatment technologies implemented across surveyed installations. Figure 53 shows that 60% of installations used a chlorine system for disinfection and 40% used UV for tertiary treatment. That is, of the 5 installations that use a tertiary treatment system, 3 have a chlorine system and 2 use UV. Two bases in the compliance program review had installed a UV system but did not use it due to operational complications. These findings are similar to those from the compliance program reviews, which indicated that 2 bases used chlorine for treatment and 1 used UV.

Two bases in the ECPRs had installed a UV system but did not use them due to operational complications. It is unclear from the survey data if additional installations have installed UV technology but have reverted back to chlorinated systems. The CSU-CEMML team suspects that as UV technology

becomes the industry standard, and WWTP operators become more familiar with the technology, UV technologies will eventually replace chlorinated systems.

5.3.5 ***Deicing Results***

In the compliance program reports, the CSU-CEMML team determined that deicing operations posed a major risk to stormwater quality. The findings of the compliance program reports suggests that glycol and acetate application were the most common drivers behind permit violations related to deicing. The most severe cases of deicing-related permit violations were caused by deicing fluid entering stormwater conveyance systems and discharging at stormwater outfalls. The most common violations were oxygen demand exceedances (e.g., BOD5, CBOD, COD).

Figure 54 shows deicing procedure data collected in the survey. Descriptions of the data are below.

- Active deicing: Deicing occurs on aircraft, airstrips, or roadways at the installation
- Glycols to deice aircraft: Glycols used to deice aircraft
- Flushed containment systems: Deicing containment systems flushed after each deicing season
- Acetates to deicing paved surfaces: Acetates used to deice paved surfaces
- Urea-based compounds to deice: Urea-based compounds used in any deicing application
- EP notified during deicing: EP notified when deicing chemicals administered
- EP track deicing chemicals: EP tracks application of deicing chemicals

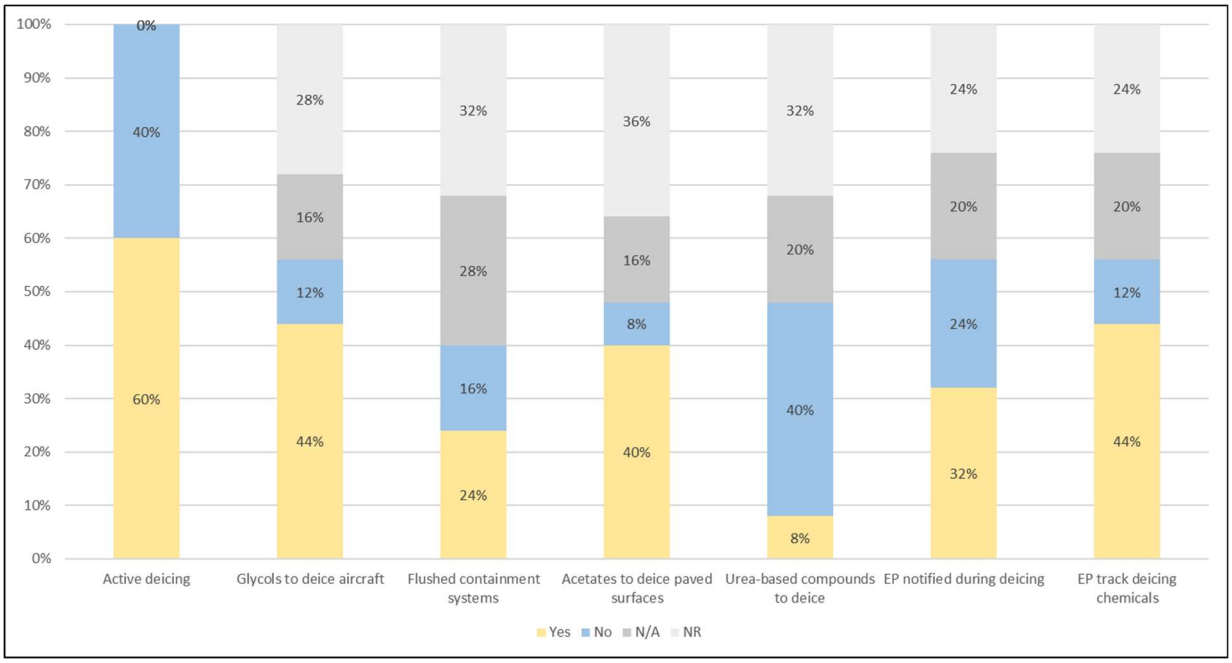

Figure 54: Deicing survey results

Figure 54 shows that approximately 60% of installations surveyed use deicing chemicals on base. Just under 45% use glycols to deice aircraft and 40% use acetates to deice paved surfaces.

In the compliance program reports, communication protocols between deicing operators and EP were recommended if not already implemented. Survey results indicate a discrepancy between the number of installations that deice (60%) and the number of installations that have established communication protocols for deicing (32%). Of the installations that deice, 73% of them track the application of deicing chemicals.

About 16% of installations reported that they do not flush containment systems after the deicing season. Flushing deicing containment systems is critical for maintaining permit compliance. The CSU-CEMML team suggests that all AF installations flush deicing containment systems after the final deicing operation in the spring.

Additional ECHO and EA analysis might lead to further clarity on the effectiveness of deicing programs across the AF enterprise. The CSU-CEMML team recommends that any installation with a deicing

program implement containment flushing, communication protocols between deicing applicators and EP, and track deicing applications with EP to mitigate their impact on stormwater quality.

Installations that conduct deicing and those that use glycols to deice aircraft are represented spatially in Figure 55.

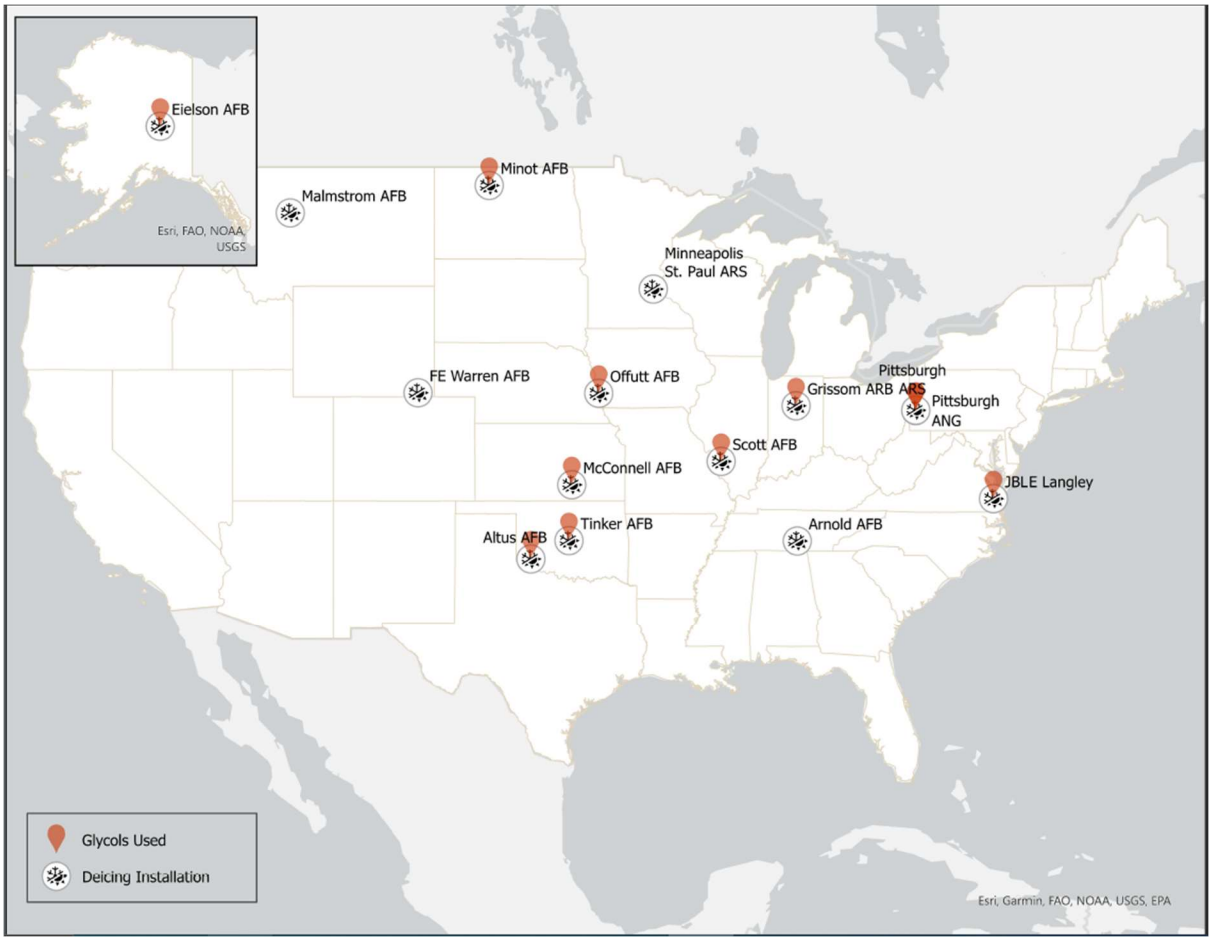

Figure 55: Spatial representation of deicing installations

As expected, deicing is most common in the Midwest, because snow and ice are common in the winter and spring months. Installations that use acetates but not glycols typically do not deice aircraft on base. In such cases, deicing might be conducted by adjacent airports (e.g., Pittsburgh ARS) or an installation's aircraft may not need deicing (e.g., Malmstrom AFB).

5.3.6 ***GIS Results***

Of the GIS data reviewed by the CSU-CEMML team in the ECPRs, all installations represented showed some level of inaccuracies and incompleteness (e.g., missing feature attribution, construction updates, elevation data). Incomplete stormwater GIS data violate NPDES permits that have GIS update requirements.

Figure 56 shows the GIS program data collected by the survey. Descriptions of the data are below.

- Reflects current conditions: GIS data reflects current conditions
- Spatially continuous: GIS data is spatially continuous
- Field verified: GIS data is field verified
- As-builts included: GIS data includes as-built drawings
- Interest in additional GIS resources: EP are interested in additional resources to update and maintain GIS data
- Need asset management software: EP have identified a need for GIS-compatible asset management software

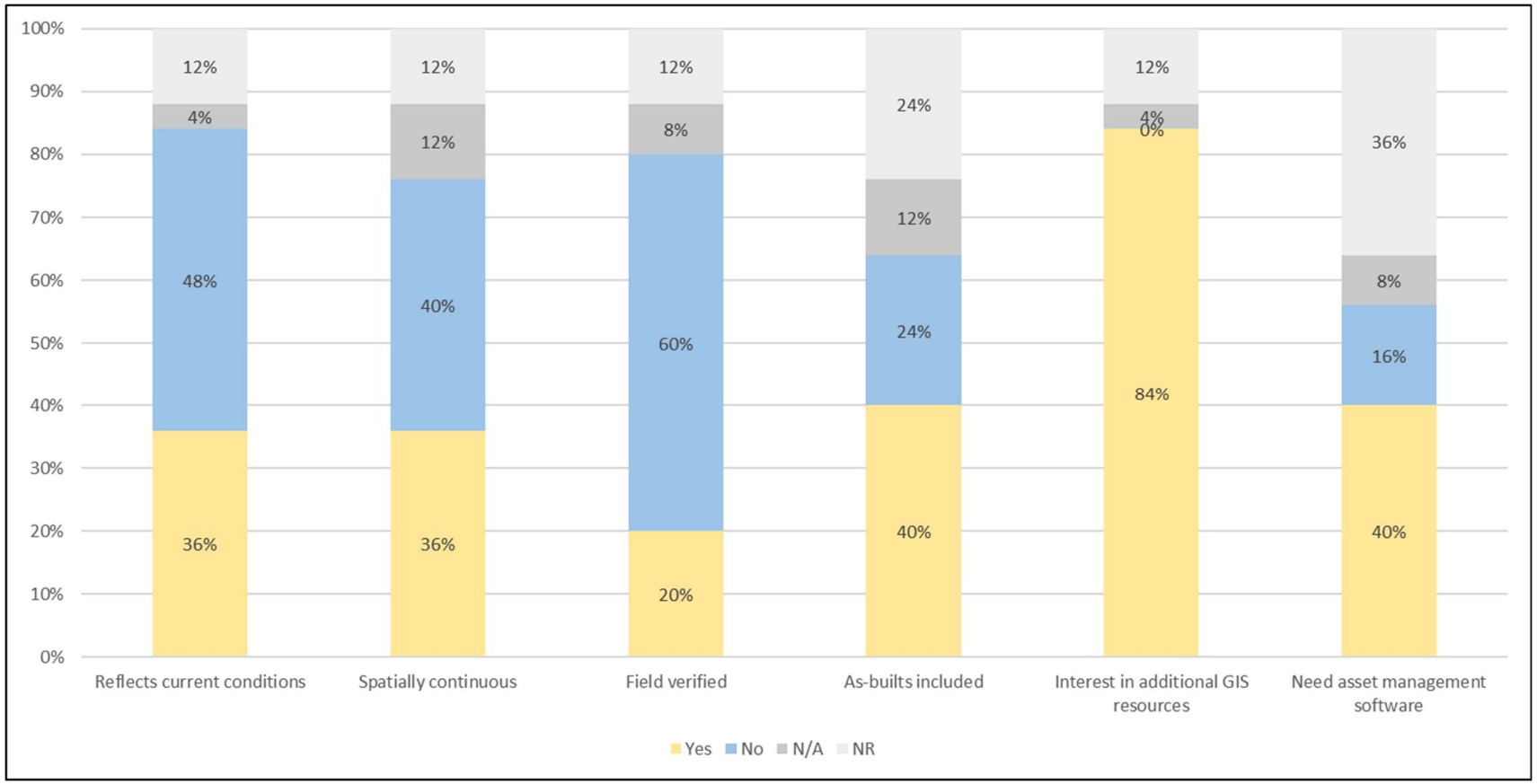

Figure 56: GIS survey results

Figure 56 shows the limitations of GIS programs. The first 4 question categories in Figure 56 reveal shortcomings in GIS programs. Almost 50% of surveyed installations reported that GIS data did not reflect current conditions; 40% of installations reported that GIS data were not spatially continuous; 60% of survey responses indicated that the GIS data has not been field verified; and as-builts were not included in 24% of installations' GIS data.

Nearly all survey respondents (84%) showed interest in additional resources to update and maintain GIS data, and 40% of respondents reported a need for a GIS-compatible asset management software.

As stated in the compliance program reporting, outdated GIS is a significant compliance risk as most stormwater permits require GIS updates. The compliance program reports and survey analysis clearly indicate compliance risk associated with outdated GIS data. Moreover, the survey results showed that base environmental personnel need additional resources to support GIS updates.

*5.3.7 **Contractor Oversight Results***

In the compliance program reports, the bases completing large construction projects showed the highest number of contractor oversight violations. (If a construction site disturbs more than 1 acre of land, contractors are required to apply for and operate under a separate construction permit. Under such permits, contractors are responsible for maintaining sediment and erosion control BMPs.) In cases where repeated contractor oversight violations occurred, base personnel cited issues with implementing effective communication with contractors. Survey questions were designed to investigate similar trends in contractor behavior and communication with EP.

Figure 57 and Figure 58 show contractor oversight data collected by the survey. Descriptions of the data are below.

- Construction specific SWPPP: Contractors operate under a construction site-specific SWPPP
- Contractor updates SWPPP documents: Contractors regularly update documents required by a construction site SWPPP (e.g., training records, inspection forms, site maps, maintenance records, and corrective action reports)

- Coordination between EP and Contractors: EP coordinates with construction contractors about maintaining sediment and erosion control BMPs during construction kickoff meetings or otherwise
- Contractor improvement: Construction contractors have improved BMP maintenance strategies when asked to do so

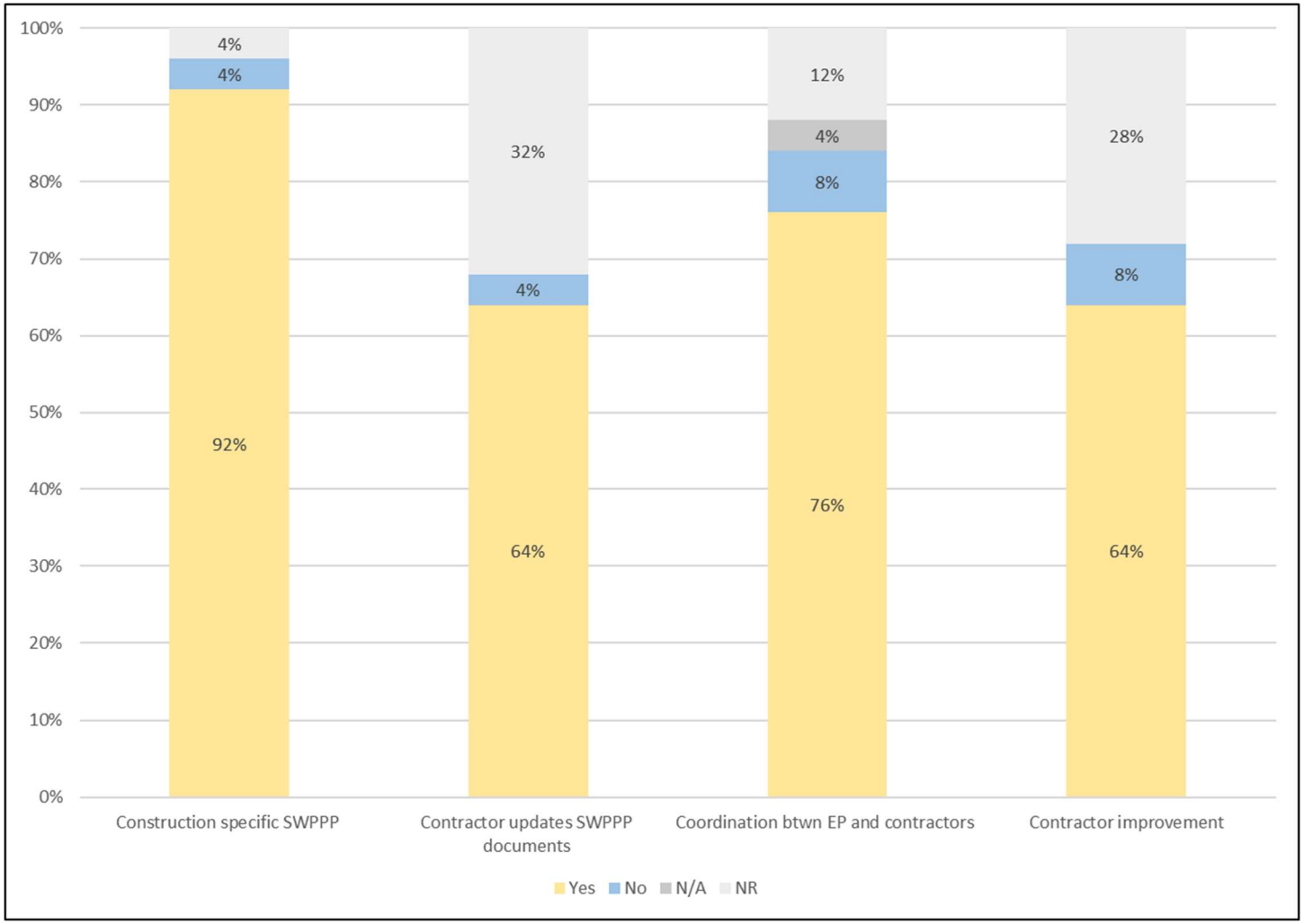

Figure 57: Construction contractor survey results

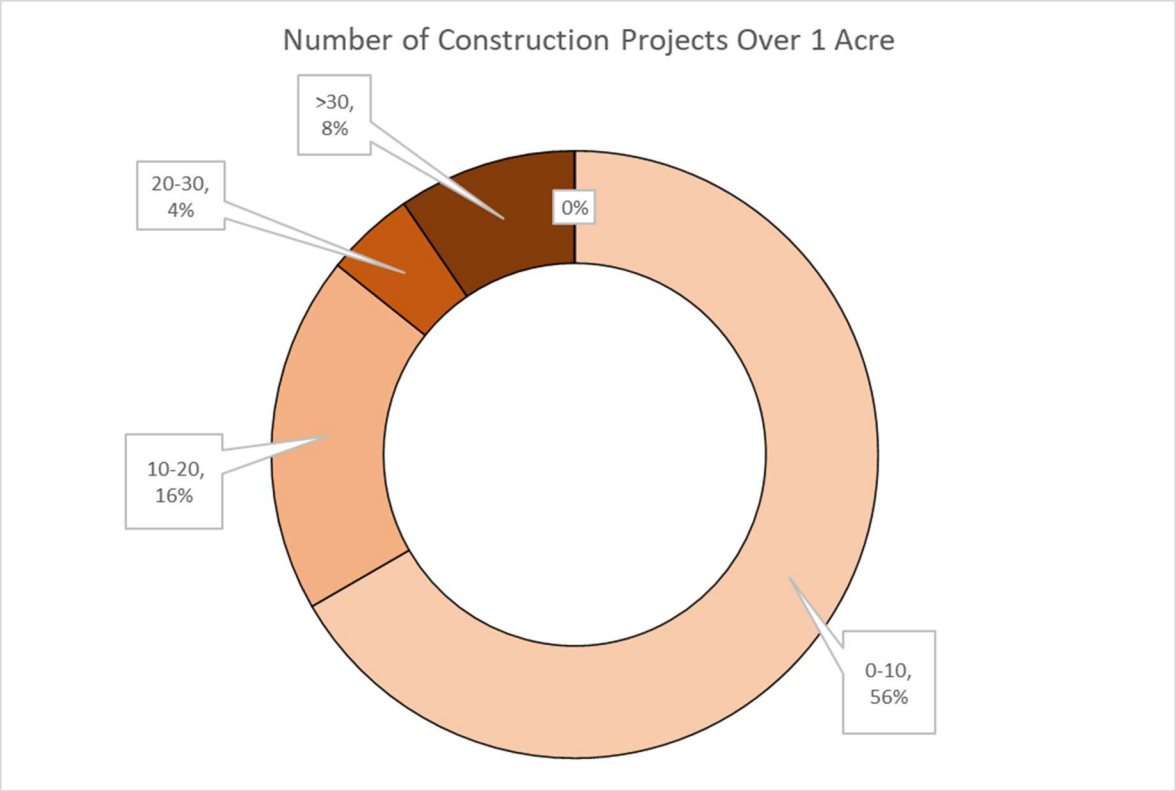

Figure 58: Construction projects over 1 acre survey results

As expected, the survey indicates that contractors generally operate under construction-specific SWPPPs and manage construction permit requirements. A small number of installations (8%) reported that EP personnel do not coordinate with construction about maintaining sediment and erosion control BMPs. Similarly, 8% of respondents reported that contractors failed to improve BMP maintenance when asked to do so by EP.

Most installations (67%) have between 0 and 10 active construction projects greater than 1 acre in size, and only 9% have over 30 active construction sites. More than 85% of installations have less than 20 active construction sites.

Based on the findings in the compliance program reports, active construction sites can be a risk to stormwater permit compliance, especially when coordination between EP and construction contractors is

inadequate. However, the survey results do not indicate that contractor coordination with EP has been a significant issue across surveyed installations.

*5.3.8 **Data Trending Results***

It is uncommon for NPDES permits to require data trending or comparing data to historical results. However, the CSU-CEMML team found that trending monitoring data can be a key indicator of future compliance issues. The survey questions were designed to investigate any data trending activities occurring at the participating AF installations.

Figure 59 shows the data trending survey results. Descriptions of the data are below.

- ECHO database awareness: EP are aware of EPA's DMR database via EPA ECHO
- EP Report via eDMR: EP reports monitoring data to a regulatory agency via eDMR
- Contractors report via eDMR: Contractors reports monitoring data to a regulatory agency via eDMR
- AFP report via eDMR: AFP report monitoring data to a regulatory agency via eDMR
- Data collected not reported to eDMR: EP collects monitoring data that is not submitted to a regulator via eDMR
- EP trend monitoring data: EP compares monitoring data to historical results
- Comparison to State/Fed WQS: EP compares monitoring data to state or federal water quality standards
- DMR-based template interest: EP would be interested in a DMR-based template for trending data

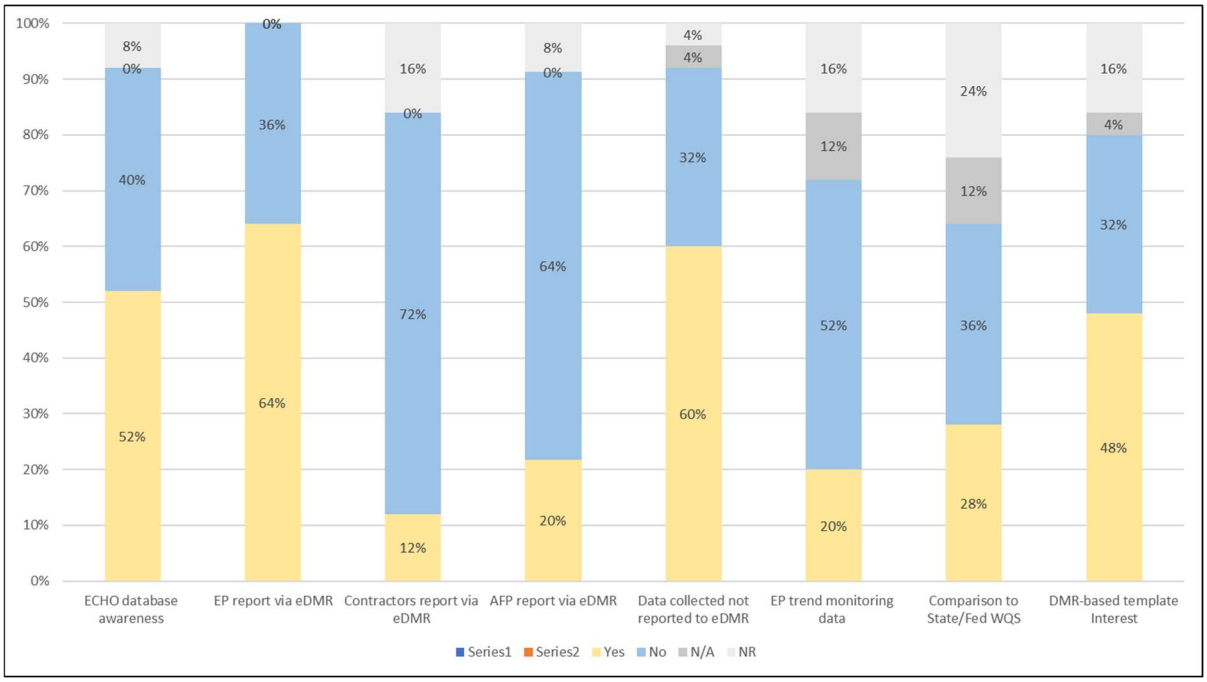

Figure 59: Data trending survey results

Comparing monitoring data to historical records does not appear to be a common practice among the survey participants. Of the 25 installations that participated in the survey, 5 installations reported that they trend monitoring data. This finding is consistent with the compliance program reports, in which one of 10 installations trended data.

Out of the 3 management entities typically involved in permit management (EP, AFP, and contractors), EP most commonly reports ECHO data. This proportion is similar to findings in the compliance program review in which EP reported monitoring data for 8 of 10 bases. Because EP are most commonly responsible for data reporting, EP is likely best positioned to trend monitoring data. If other AFP or contractors report data, EP trending data might be more necessary to ensure that data are being internally monitored.

60% of installations collect data that are not reported via eDMR. Installations are likely to sample for unreported parameters when EP expects elevated concentrations or is investigating the source of a

pollutant. The CSU-CEMML team suggests sampling unreported parameters to ensure EP maintains a comprehensive understanding of the pollutants present in stormwater and effluent discharges.

Currently, the AF does not provide a trending template as a tool to support base personnel. Nearly half (48%) of installations reported interest in a DMR-based template that would streamline trending for DMR data. The CSU-CEMML team was shown a WET software tool that was in development; however, a simple Excel file using the ECHO data output format might be more effectively used by EP.

6.0 CONCLUSIONS

The Center for Environmental Management of Military Lands (CEMML) at Colorado State University (CSU) was tasked by the Air Force Civil Engineering Center (AFCEC) to provide expertise on Clean Water Act (CWA) compliance review to support the United States Air Force (AF) installations. CEMML partnered with CSU's Center for Energy Water Sustainability (CEWS) team in the Department of Civil and Environmental Engineering (CEE) to leverage their combined expertise and institutional knowledge in the fields of stormwater and wastewater and work with the AF CWA programs. This study includes 3 main components. First, environmental compliance program reviews (ECPRs) of ten AF bases investigated the permits, programs, and compliance records at an installation level. Due to the depth of the ECPRs, detailed performance metrics were integrated into the ECPRs findings. Second, a survey further investigated trends identified in the ECPRs across 25 participating installations. Any relevant performance metrics were used to evaluate the effectiveness of water programs that participated in the survey.

A cursory review of the AF environmental management system was started by the CSU team. The CSU team identified the final two chapters of AFI 32-7001, Chapter 7—Compliance and Chapter 8—Environmental Inspection Program, and the respective key personnel as the components of the EMS that would elevate and mitigate compliance issues.

6.1 Environmental Compliance Program Review and Survey Lessons

Permit Overview

- Installations that operate under an individual permit (IP) have more stringent monitoring and reporting requirements and might pose a significantly higher compliance risk. IPs are typically associated with WWTP effluent discharges.
    - Half of the 10 installations from the ECPRs operated under an IP, and 66% of ECHO violations at those installations were from IPs.

    - Nearly one-quarter (24%) of the 25 installations represented in the survey operate under an IP. The survey did not collect permit-specific ECHO data.
- Multi-sector General Permit (MSGP) is the most common type of permit across the installations studied under the ECPRs and the surveys.
    - 90% of the installations studied as part of the ECPRs operate under a MSGP.
    - Similarly, 88% of the installations in the survey operate under an MSGP.
- The survey and data analysis indicate that the number of active permits does not directly correlate with any compliance performance indicators (e.g., ECHO, EASIER, or OSD).

Management Strategy

- The ECPRs did not find a correlation between management strategies and ECHO non-receipt violations (which reflect a failure to submit data). However, among the 3 different management entities represented in the survey analysis (environmental personnel, Air Force personnel, and contractors), contractor involvement was associated with greater numbers of ECHO non-receipt violations.

Inflow and Infiltration

- The survey analysis results support the conclusions in the ECPRs; namely, that installations with wastewater inflow and infiltration (I&I) and discharge effluent from a wastewater treatment plant (WWTP) have non-compliance issues related to elevated flows through the WWTP.
- Most installations with wastewater (WW) I&I have conducted recent studies to understand the extent of the I&I.
- Most installations with WW I&I face financial challenges in programming restoration or replacement projects.
- The extent of I&I issues at an enterprise level could not be inferred from the compliance databases (ECHO, EASIER, and OSD).

Disinfection Technologies

- Survey results align with compliance program review results indicating that chlorination/dechlorination is the most common form of tertiary treatment. Ultraviolet (UV) treatment is also commonly used.
- Compliance program studies indicate that correctly operating UV systems can be a challenge for WWTP operators and additional training might be required.
- Maintaining contingent disinfection technologies is critical to maintaining compliance in case of an equipment malfunction.
- The impact of specific disinfection technologies could not be inferred at an enterprise level from the compliance databases.

Deicing

- Compliance program reviews and survey results indicate that compliance risk is best mitigated if environmental personnel implement the following:
    - Establish communication protocols between deicing applicators and environmental personnel.
    - Track applications of deicing fluid.
    - Ensure containment systems for spent deicing fluid are flushed after the last deicing application of the season.
- Additional ECHO and EA analysis could clarify the effectiveness of deicing programs at an enterprise level.
- Biological oxygen demand (BOD), which is generally associated with deicing chemicals, is among the most common parameters that installations exceed.

Geographic Information Systems (GIS)

- The compliance program reports and survey analysis show compliance risks related to outdated GIS data. The GIS deficiencies identified in the compliance program reviews and survey include:

    - Missing or incomplete feature attribution
    - Lack of recent field verification survey
    - Past surveys not integrated
    - As-builts not integrated
- The compliance program reviews and survey results show that base environmental personnel need additional resources to support GIS updates.
- Most survey respondents (84%) showed interest in additional resources to update and maintain GIS data, and 40% reported a need for GIS-compatible asset management software.

Contractor Oversight

- Based on the findings in the ECPRs, active construction sites can pose a risk to stormwater permit compliance related to TSS containment. Communicating erosion and sediment control responsibilities with contractors can mitigate compliance risks.
- The survey results do not indicate that contractor coordination with EP has been a significant issue across surveyed installations.

Data Trending

- 20% of survey respondents reported that monitoring data is trended. This finding is similar to that of the ECPRs indicating that 1 out of 10 installations trended monitoring data.
    - Trending ECHO monitoring data and the application of deicing chemicals is underused and could potentially reduce the risk of non-compliance at applicable installations.

Key indicators of compliance risk and systemic issues are included in **Error! Reference source not found.**

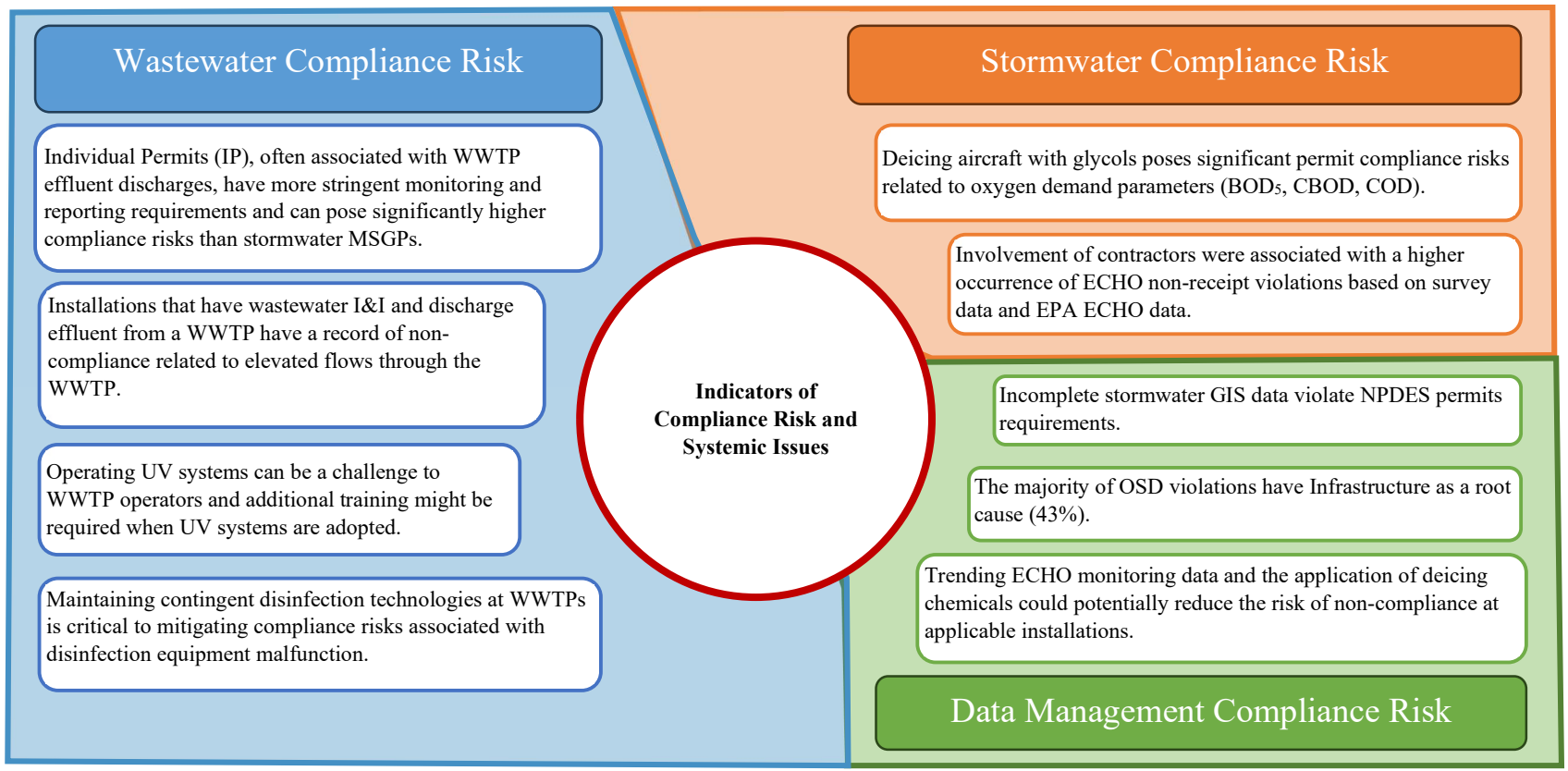

Figure 60: Indicators of Compliance Risk and Systemic Issues

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LIST OF ABBREVIATIONS

AF	Air Force
AFCEC	Air Force Civil Engineer Center
AFFF	Aqueous Film-Forming Foam
BAFB	Beale Air Force Base
BMP	Best Management Practice
BOD	Biological Oxygen Demand
CAFB	Charleston Air Force Base
CBOD	Carbonaceous Biological Oxygen Demand
CEE	Department of Civil and Environmental Engineering
CEMML	Center for Environmental Management of Military Lands
CEWS	Center for Energy Water Sustainability
COD	Chemical Oxygen Demand
CSU	Colorado State University
CWA	Clean Water Act
CZTQ	Environmental Quality Technical Support Branch
DMR	Discharge Monitoring Report
EA	EASIER Enforcement Actions
EASIER	Enforcement Actions, Spills, and Inspections Environmental Reporting
ECHO	Enforcement and Compliance History Online
ECPR	Environmental compliance program review
eDMR	Electronic Discharge Monitoring Report
EP	Environmental Personnel, including water quality program manager
EPA	Environmental Protection Agency
ERA	Exceedance Response Action
FGS	Final Governing Standards
GIS	Geographic Information Systems
HEF	High Expansion Foam
IDDE	Illicit Discharge Detection and Elimination
I&I	Inflow and Infiltration
IP	Individual Permit
ISWQS	Illinois Surface Water Quality Standard
IWTP	Industrial Wastewater Treatment Plant

LAFB	Langley Air Force Base
MAFB	Malmstrom Air Force Base
McAFB	McConnell Air Force Base
MBAS	Methylene Blue Active Substances
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-sector General Permit
NAL	Numeric Action Level
NG	National Guard
NPDES	National Pollutant Discharge Elimination System
ODEQ	Oklahoma Department of Environmental Quality
OPDES	Oklahoma Pollutant Discharge Elimination System
OSD	Office of the Secretary of Defense
P&T	Pump and Treat
PA-ANG	Pittsburgh Air National Guard
PARS	Pittsburgh Air Reserve Station
POTW	Publicly Owned Treatment Works
RAFB	Robins Air Force Base
SAFB	Scott Air Force Base
SF	Space Force
STP	Sanitary Treatment Plant
SW	Stormwater
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TAFB	Tinker Air Force Base
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UV	Ultraviolet
VPDES	Virginia Pollutant Discharge Elimination System
WW	Wastewater
WWTP	Wastewater Treatment Plant
WOTUS	Waters of the United States