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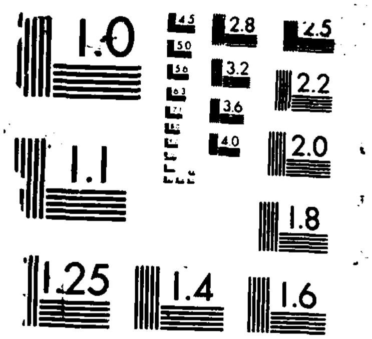

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Wright-Patterson Air Force Base, Ohio

AFIT/GEM/DEM/87S-20

WATER AND WASTEWATER TREATMENT INVENTORY AND THE PERCEPTIONS OF WASTEWATER ENGINEERS ON CONSIDERATIONS AFFECTING TREATMENT ALTERNATIVES

THESIS

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AFIT/GEM/DEM/87S-20

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THESIS

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Vincent E. Renaud

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Abstract

The purpose of this study is to compile an inventory of water and wastewater treatment methods for all CONUS Air Force installations and to determine the importance of the considerations affecting domestic wastewater treatment alternatives. This inventory provides the baseline data for managers to use in making future policy.

The inventory revealed that the majority of CONUS Air Force installations have regional connections. The most common type of treatment for bases with on base treatment plants is trickling filters. Industrial wastewater treatment is found at only 22 bases - most of these are only pretreatment facilities. The most common drinking water source is wells and, accordingly, the majority of bases treat their drinking water themselves.

Cost and pollution abatement tied for the most important factors to consider when making an analysis of treatment alternatives. Location of the regional system ranked next in importance followed by a tie between the quantity of wastewater to be treated and the importance of the wastewater operator as a critical military skill.

The findings of this research reemphasize the need for reciprocity between the states for certification of wastewater operators. Additionally, since many on base

plants were constructed prior to the mid 1950s, it is recommended that major upgrades to these plants be considered so that compliance with the increasingly stringent standards is maintained.

Additional research is recommended in this field. Specifically, a complete inventory should be compiled and maintained to keep track of problems or trends in treatment methods.

WATER AND WASTEWATER TREATMENT
INVENTORY AND THE PERCEPTIONS OF
WASTEWATER ENGINEERS ON CONSIDERATIONS
AFFECTING TREATMENT ALTERNATIVES

I. Introduction

General Issue

Currently, Air Force Regulation (AFR) 86-1 states that "As a matter of policy, Air Force installations will use municipal or regional waste collection or disposal systems to the greatest degree possible" (5:22). AFR 86-1 implies that the reason for this is environmental considerations - specifically, pollution abatement. However, a dichotomy exists. Since the wastewater operator is a critical military skill, conversions to regional connections (piping raw wastewater to a regional treatment plant nearby and paying for its treatment) severely impacts on the training of such operators (2). Hence, a decision needs to be made whether to stay with on base treatment plants or convert to a regional connection. To respond to this problem and allow the water and wastewater managers at HQ USAF, the MAJCOMs, and the Engineering and Services Center to establish future policy, an inventory of current Air Force treatment practices is needed. However, there does not exist a database that lists all processes and methods of treatment at all the various Air Force installations.

Specific Problem Statement

No baseline data exists that lists all the types and methods of treatment at each base. It is the authors opinion that such an inventory is critical to the management of Air Force water and wastewater treatment. In addition, managers at the base level have no information which could be used as a decision making tool to determine whether they should convert to a regional connection for treatment of domestic wastewater. This research effort provides management with a profile of current domestic water, wastewater, and industrial wastewater treatment within the Air Force community. However, a concentrated investigation is made into the issue of on base domestic wastewater treatment plants versus regional connections. The profile provides managers at all levels with information to aid in the development of future treatment policy.

Research Objectives

General. The main objective of the research is to obtain data on current water and wastewater treatment practices. Separate from this will be an investigation of the perceptions of Air Force wastewater engineers on the factors which affect the decision to use an on base wastewater treatment plant versus a regional connection.

Scope. A descriptive study limited to CONUS Air Force installations will be used to identify current water and wastewater treatment methods. The research consists of a survey already accomplished by HQ USAF and a second survey given to Air Force wastewater engineers. The second survey will also be used to collect data on regional connection decisions.

Research Questions

To support the research objectives, the following questions must be answered:

1) What do current Air Force regulations and policies say about domestic wastewater treatment?

2) What types of treatment processes are being used at each base?

3) What types of problems exist for on base wastewater treatment plants?

4) What is the age of existing treatment plants?

5) What is the accessibility of regional treatment plants to Air Force Installations?

6) What are the perceptions of Air Force wastewater engineers on those factors which affect the decision to use a regional connection for wastewater treatment?

7) How are we going to meet the requirement for the training of personnel for the Critical Military Skill of wastewater operator?

II. Background Review

Overview

This chapter reviews the laws, regulations, and directives governing domestic wastewater treatment in the Air Force. Additionally, many problems have been found to exist at Air Force (AF) sewage treatment plants which prevent them from complying with these applicable standards. These problems are presented along with some solutions prescribed by the EPA which are applicable toPSRsewage treatment plants.

Directives and Regulations Pertaining to Wastewater Treatment

Federal Law. Public Law 92-500 (Federal Water Pollution Control Act of 1972) and its amendments have the objective of restoring and maintaining

> . . . the chemical, physical, and biological integrity of the nations' waters by eliminating the discharge of pollutants into navigable waters of the United States by 1985 (10:1).

The objective of the act appears broad in nature. However, it also created the National Pollutant Discharge Elimination System (NPDES) which requires each federal agency to obtain a permit from the EPA or the state to discharge any pollutant into navigable waters (10:1).

> Permits are issued on the condition that the discharge will meet all applicable requirements of EPA or state regulations relating to effluent limitations, water quality standards, new source performance standards, toxic effluent standards, inspections, and monitoring and entry provisions (10:1).

As a result of this act, all sewage treatment plants, including those operated by the DOD, were required to obtain a NPDES permit. At this point, there was no difference between the compliance requirements of federal and non-federal sewage treatment plants. However, there seemed to be a feeling of sovereign immunity for federal agencies. In other words, the federal government felt as though they did not have to comply with these standards. However, in 1978, Executive Order 12088 mandated that federal agencies comply with applicable standards dealing with pollution abatement. As a result, sovereign immunity officially ended. More important, it required the head of each federal agency

> . . . to insure that facilities under his jurisdiction comply with federal and state water quality standards and to present a plan each year to the Director of the Office of Management and Budget for improvements necessary to meet federal, state, interstate, and local water quality standards and effluent limitations (10:11).

Executive Order 12088 established a significant difference between the compliance requirements of federal and non-federal sewage treatment plants. Specifically, federal agencies now had to provide a plan to achieve and maintain compliance when they were found to be in violation of applicable standards by an appropriate state, interstate, or local agency. In addition, responsibility for compliance was placed with the head of each federal agency.

In the Air Force, the above plan is known as the Pollution Status Report (PSR) which goes to the EPA. Twice a year, HQ USAF makes a call for these reports from the MAJCOMs. These reports detail all projects in all categories of pollution (air, water, etc.). Essentially, they contain the plans for upgrading the pollution abatement system in order to meet standards. A hypothetical example is where a base, which is in violation of it's NPDES permit, plans to install a new sludge digester in order to comply with it's permit. The PSR report relays this information to the EPA in order to show that something is being done. These reports also apply to those installations which foresee violations and plan to correct the problem and thus insure compliance.

Air Force Regulation (AFR) 19-1, Pollution Abatement and Environmental Quality, provides only general policy for the disposal of domestic wastewater:

> Make all practical efforts to use municipal or regional waste collection or disposal systems as the preferred method for disposal of wastes from Air Force facilities. When use of such a system is not feasible or appropriate, do whatever is necessary to satisfactorily dispose of such wastes . . . (6).

This regulation suggests that a regional tie-in with a civilian municipal system is the preferred method of obtaining treatment. It also implies that, when evaluating treatment alternatives, an adequate analysis (economic, pollution abatement, etc.) of the regional tie-in should be conducted. If such an alternative is determined not feasible or inappropriate, then on-site treatment should be performed in accordance with applicable standards and regulations.

Since the enactment of the National Environmental Policy Act of 1969 (NEPA) and the Water Pollution Control Act of 1972, no new major legislation on pollution abatement has appeared. However, in January 1987, Congress passed the Clean Water Act of 1987 which has the potential to affect all military installations.

<u>Clean Water Act of 1987</u>. This piece of legislation mandates the treatment of non-point source pollution by 1992 (i.e., storm sewers). Compliance with this law opens up a new realm of problems for wastewater engineers and operators. For example, the storm sewer system at a typical Air Force base currently discharges to various creeks, rivers, or channels in many different locations throughout the base. To treat this discharge means to 1) provide treatment at each discharge point by package plant type set ups or, 2) centralize the system and provide treatment at a central site similar to a wastewater collection system.

The laws, directives, and regulations governing wastewater treatment are getting more strict all the time. As a result, compliance with these standards will become more difficult and costly. For example, prior to 1987, only point source treatment was mandatory. However, as a result of the Clear Water Act of 1987, treatment of non-point sources will also be required. Consequently, problems with treatment plants complying with these standards will become more evident as the laws become stricter. However, Air Force sewage treatment plants currently are experiencing many problems resulting in noncompliance.

Problems with DOD Treatment Plants

The next two sections present problems which were found to exist in DOD treatment plants. The largest and most significant problem is noncompliance. Typically, noncompliance is the result of analysis, design, construction, and operation and maintenance problems.

Analysis, Design, and Construction Problems

Analysis of Alternatives. When anPSRsewage treatment plant is in need of an upgrade, a thorough analysis of the alternatives for such an upgrade is necessary. Three alternatives are available for upgrading the treatment of wastewater: 1) alter the present design, 2) replace the present system, or 3) tie into a civilian regional system.

In the 1978 GAO report, DOD Problems In Joining Civilian Sewer Systems, (LCD-77-359), it was found that "7 out of 16 military bases chose either upgrading an on-base treatment plant or joining a civilian system without analyzing the relative costs and benefits of the alternatives" (10:3). Although the report does not mention it, the remaining nine bases are assumed to have made a valid analysis. Without a valid analysis of alternatives, the Air Force cannot be sure that, economically and environmentally, the best decision is being made. Instead, the Air Force could be wasting thousands of dollars on infeasible alternatives. The report recommended that DOD provide guidance on how to assess each alternative to insure that the most economical and effective sewage disposal system is chosen (10:3). To date, no action has been taken on this recommendation. However, of the bases that performed a valid analysis, many

> . . . did not accept the conclusions and recommendations of some analyses done in support of needed sewage treatment improvements nor did they consider all feasible alternatives. Therefore, DOD cannot be assured that all plant upgrades approved were the most cost-effective and efficient treatment methods available (10:6).

An example of this is where Tyndall AFB rejected the treatment method recommended by an architect/engineer (A/E) because they questioned the A/E's cost estimates (10:39). However, they did not attempt to prove that the estimates were wrong. The A/E firm recommended that the installation continue to provide primary and secondary treatment and construct a force main to discharge the effluent into the regional system - a series of lagoons (10:39). However, the Air Force chose to use only primary treatment before discharging into the regional system while taking the secondary system off line and "mothballing" it. It was stated, but not supported by data in the 1984 GAO report DOD Can Make Further Progress In Controlling Pollution From Its Sewage Treatment Plants, that the use of both primary and secondary treatment would prove to be much more cost effective because it would require less treatment by the regional system thereby keeping the fees paid to the regional system at a minimum. Keeping the secondary treatment system activated would prevent the Air Force from having to spend a great amount of money to bring it back on line in the event that federal discharge requirements became more stringent (10:39). After being brought to the attention of senior Air Force management, the A/E's recommendation was chosen.

Another example is where, in the mid 1970's, the sewage treatment plant at Redstone Arsenal could not meet EPA water quality standards. The city of Huntsville, Alabama invited the post to participate in upgrading the municipal system and plan a regional tie-in (10:10). The post went against DOD policy and rejected the city's offer. Two years later, the post tried to become a part of the municipal system. However, the cost of the endeavor had risen to the point where upgrading their own system would be less costly (10:10).

The bottom line is that when a valid analysis is performed, the most feasible alternative must be chosen.

Even though Air Force installations are required by DOD policy and AFR 19-1 to perform an analysis of alternatives, the above findings would indicate that the DOD (and the Air Force) are not consistently performing such analyses.

Design Deficiencies and Construction Defects. Some installations that chose to upgrade their plants by altering the present design or by total replacement have experienced design deficiencies. These deficiencies are a result of several factors: "[(1)] limited state of the art, [(2)] insufficient monitoring and analysis of conditions prior to plant design, [and (3)] time and funding constraints . . ." (10:11). In the 1984 GAO report DOD Can Make Further Progress In Controlling Pollution From Its Sewage Treatment Plants, McGuire, Robins, K.I. Sawyer, and Tyndall Air Force Bases were singled out as having plants with serious design deficiencies.

> These deficiencies include improperly designed chlorine contact chambers, improper flow measuring devices, inadequate sludge processing equipment, and inefficient pumps used in various processes of the plant (10:11).

As of 1984, all four bases, except Robins, were rated as unacceptable by the EPA. It is interesting to note that in a 1986 survey conducted by HQ USAF/LEEV, only Robins and McGuire reported any problems.

Construction defects are a third problem resulting in noncompliance. ". . . many construction problems seemed to result from poor quality control and the services' lack of initiative in holding the responsible parties liable"

(10:16). An example of such defects are trickling filter media not meeting design specifications, inadequate concrete foundations resulting in the serious lean of a processing facility, and using the wrong type of bricks resulting in an inoperable kiln (10:16).

Failure to analyze alternatives, design deficiencies, and construction defects result in many NPDES permit violations. If compliance is ever to come about, serious efforts need to be made to alleviate these problems. It is interesting to note that the DOD is not alone in its quest for compliance. In the civilian sector, it has been found that "many wastewater treatment plants had seldom if ever met their permit requirements" (11:124). This lack of compliance is a result of the same problems experienced by DOD sewage plants. Problems not only occur when upgrading or planning to upgrade a system but also during daily operations. Such operation and maintenance problems usually result from an inadequate maintenance program and untrained operators.

Operation and Maintenance Problems

The 1976 GAO report, Improvements Needed In Operating And Maintaining Waste Water Treatment Plants, found that "many Department of Defense (DOD) facilities did not meet water quality standards and that DOD had not taken adequate measures to insure compliance . . . " (10:3). The report stated that, among others, a lack of proper operation and maintenance was the chief cause of noncompliance.

In 1983, the GAO visited the sewage treatment plants at thirteen Army, Navy, and Air Force installations.

> . . . [W]e also found that most of the DOD plants visited have been unable to consistently meet National Pollution Discharge Elimination System (discharge) permit requirements for a number of years (10:22).

The GAO stated that typical operation and maintenance (O&M) problems found were lack of DOD guidance; no action taken to correct problems found by DOD, EPA, and state agencies; equipment deficiencies; infiltration and inflow; and continuing operation and maintenance problems (10:22).

One of the primary reasons why there is a lack of proper O&M programs is that there is a lack of DOD and Air Force guidance (10:22). The DOD and each service is responsible for providing specific guidance to assist each plant in achieving and maintaining compliance (10:24). However, only general guidance has been provided through "infrequent formal O&M inspections performed by DOD, EPA, and state environmental engineers" (10:24). The only specific guidance received has been received informally from EPA and state agency inspectors (10:24). In an effort to provide the necessary guidance, the Technical Training Center at Sheppard AFB, stresses maintenance as one of most important responsibilities of the wastewater treatment plant operator. All students receive detailed instruction on the performance of maintenance techniques and the development of maintenance schedules (9).

The GAO reviewed 49 formal inspection reports at 13 bases. The inspection reports identified many problems. Examples included a lack of spare parts, broken equipment items, and lack of attention to O&M requirements. However,

> sewage treatment plant operators and base officials responsible for operating treatment plants have not been responsive to the recommendations made during evaluations of the sewage treatment plants (10:25).

Many operators claimed that corrections were not made due to lack of funds.

> This [lack of funds] has resulted from several factors including the low priority of sewage treatment plants for O&M projects and problems in getting larger projects through the military construction process (10:25).

Although the Air Force uses the PSR report to track these requirements, a review of the system is needed to ensure that these requirements are getting proper attention.

Equipment failures also affect a plant's ability to comply with it's permit. Examples of such failures include a bent scum removal arm, inoperable secondary clarifiers, broken pumps, inoperable chlorine feeders, and many others (10:26). These are items which require immediate attention and should be included in the PSR report.

Infiltration from storm sewers and groundwater, if excessive, can cause a plant to overload or exceed it's capacity. Overloading a plant leads to decreased efficiency while exceeding a plant's capacity can cause raw sewage bypassing the plant completely (10:27). As if the problems presented above do not present a big enough challenge, the level of experience or competency of operators magnifies the problem of noncompliance.

Certified Operators and the Critical Military Skill. One of the long standing problems in the Air Force is the lack of certified operators. The problem stems from the lack of reciprocity between states. For example, if an operator is certified in one state but moves to another state with more stringent certification requirements, then he must go through the entire certification process again in the new state (2,9). However, if he was certified in a state with more stringent requirements and moved to a less stringent state, then, some of the time, the latter state would accept the former's certification. Hypothetically, if an operator who is certified in Mississippi moves to California, he would not be qualified in California because Mississippis' certification requirements are less stringent than Californias'. This problem exists with military much more than civilian operators since the former frequently move from base to base. Currently, there is a push to get a national certification program established which would end the reciprocity problem.

In a contingency environment, the wastewater operator (a Critical Military Skill), has the responsibilities of running an erdalator and providing for general sanitation.

Certification is not required to perform these tasks because, according to EO 12088, the President may make an exemption to applicable standards in the interest of national security or in the paramount interest of the United States.

Since the wastewater treatment plant operator is a CMS, sufficient numbers of qualified military operators must be available. As it is DOD policy to convert to a regional connection where feasible, the requirement for on base operators decreases. However, the Technical Training Center at Sheppard AFB stated that all operator positions overseas are military and will remain military (9). In view of this overseas requirement and the decreasing need for CONUS operators, wastewater operators are being trained additional skills. Giving the operators such additional skills (i.e., plumbing) will insure that this CMS is fully manned even though operators at CONUS bases without a base sewage plant will be performing duties other than those of a wastewater operator. A key point is that during peacetime the Air Force is required to have certified operators at it's sewage plants while, in wartime, certified operators are not required.

In view of the O&M problems found at military sewage treatment plants, what type of actions shoud be taken to establish effective O&M programs? Possibly, the answer can be found by reviewing the O&M program at a plant which consistently complies with it's NPDES permit.

A Model Plant. America's best small advanced treatment plant as named by the Water Pollution Control Federation is found in Spearfish, South Dakota. This plant has improved it's efficiency and cut treatment costs by having an exemplary operation and maintenance program (1:17).

> All operators receive O&M manuals from the manufacturers. In addition, all operators are state certified and are required to attend training seminars and lectures regularly. A computer is used to schedule preventative maintenance and a complete log is kept on each piece of equipment and spare parts (1:17).

The Spearfish plant proves that effective operation and maintenance programs can result in lowered costs. The Spearfish plant should be a model for all Air Force treatment plants because 1) it has an effective O&M program, and 2) it is similar to a typical Air Force base plant. The method of treatment at Spearfish is by an extended aeration activated sludge system consisting of a raw wastewater pumping station, bar screen, two oxidation ditches, two secondary clarifiers, two flow equalization basins, three mixed media filters, chlorination facilities, and two sludge storage basins (1:16). The sludge is stored, aerated, and land injected (1:16). The design capacity is 1.0 MGD with an average daily flow of 0.85 MGD and an average peak flow of 1.6 MGD (1:16). The flow rate of the typical base is 1-3 MGD and most base plants provide advanced treatment with facilities similar to those listed above. The Spearfish plant is one example of how to handle noncompliance problems. In addition, the EPA has submitted a report to Congress outlining other solutions to noncompliance problems.

<u>EPA Solutions</u>. In 1985, the EPA submitted a report to Congress on operator training and wastewater management responsibilities for federal, state, and local officials. EPA's report to Congress included an action plan for local leaders and outlined keys to compliance through effective O&M (3:5). The keys to compliance rely on the involvement of small town management and a focus on maintenance management.

A "small town operation" is classified as one with a flow rate of less that three MGD. The majority of Air Force bases fall into this category. The EPA found that at such plants the operator tends to be inadequately trained to manage the treatment process, perform mechanical and electrical maintenance, or perform the needed laboratory tests (3:5). As a result of this finding, the Air Force should ensure that all operators are properly trained.

> Local . . . officials have three major responsibilities involving wastewater treatment: to comply with applicable federal and state water quality standards; to protect the community's public health; and to provide for development needs at an affordable cost (3:5).

The EPA prescribes that local leaders (such as the Base Commander and the BCE) need visit the treatment plant to see and understand how it operates. They need to understand what the EPA standards are, where their plant stands in regard to the standards, and exactly what is required of an operator (3:5). Along these same lines, the Chief of Operations should review the treatment plant maintenance program, a part of the Recurring Work Program (RWP), to insure all maintenance is actually being performed and not just penciled in.

Summary

This chapter has reviewed laws, regulations, and directives governing domestic wastewater treatment in the Air Force. Federal laws include the Federal Water Pollution Control Act of 1972 which brought about NPDES permits and Executive Order 12088 which mandates the submittal of plans when a federal plant is in violation. The Air Force response to the federal laws is AFR 19-1 which requires the use of a regional connection where feasible.

Many problems were found to exist with sewage treatment plants throughout the DOD. The most prominent problem, noncompliance, is the result of an improper analysis of alternatives, design deficiencies, construction defects, and operation and maintenance problems. Proper maintenance of a sewage treatment plant was stressed as a key deterent to noncompliance. As a result, the Technical Training Center at Sheppard AFB stresses the development and following of a maintenance schedule.

Overall, military sewage treatment plants are experiencing serious problems and are in need of some attention. Specifically, the PSR report needs to be investigated to see that it is receiving proper attention. A priority needs to be established so that funds can be applied to improvements in treatment facilities in order to get them back in compliance. Environmental protection and compliance with standards need to receive more attention in the area of sewage treatment plants. Even though the Clean Water Act of 1987 provides for 18 billion dollars in construction of sewage treatment plants, the Air Force and other federal agencies will not be allowed to tap into this money. Something must be done to aid the federal agencies in their quest for compliance. After all, the federal government should be setting the example instead of constantly being in violation of NPDES permit requirements.

A logical starting point to begin assessing the status of wastewater treatment in the CONUS Air Force is to build an inventory of treatment methods. Many wastewater engineers throughout the Air Force have expressed the need for such an inventory. In addition, since the GAO stated that the DOD needs to provide guidance on how to assess each treatment alternative and, to date, nothing has been provided, such guidance should be provided as soon as possible. Chapter III discusses a survey put together by HQ USAF which provides an inventory of CONUS wastewater treatment. A second survey is also discussed which fills in where the HQ USAF survey lacked and assesses factors influencing the selection of treatment alternatives.

III. Methodology

Overview

This chapter describes the approach and techniques used to answer four of the research questions stated in chapter I.

1. What types of treatment processes are being used at each base?

2. What is the age of existing treatment plants?

3. What is the accessibility of regional treatment plants to Air Force Installations?

4. What are the perceptions of Air Force wastewater engineers on those factors which affect the decision to use a regional connection for wastewater treatment?

The first section details the survey instrument used in obtaining information for the inventory. The chapter then explains how the researcher developed the data collection used to answer questions two through four above. The third section outlines the validation, approval, and distribution of the survey instrument. The final portion of the chapter explains the methods used to analyze the survey responses.

Survey Instrument

The information necessary to answer the first research question was generated by a survey conducted by HQ USAF/LEEV during the period May 1986 to August 1986 (Appendix A). The survey provides a census of treatment methods at each CONUS Air Force installation. The survey was sent to each MAJCOM who in turn compiled the data.

The HQ USAF survey was found to have some data missing. Specifically, certain bases did not correctly report flow rates, many responses were illegible, and some bases left the survey blank. Hence, the second survey attempted to fill in these voids. The remaining sections of this chapter will discuss the second survey.

Selection of Population

To generate information to answer the research questions, the data collection efforts focused on gathering facts on treatment methods for each base and opinions on the factors affecting the treatment alternatives available for domestic wastewater. The population of interest for the second survey was identified as the wastewater engineers in the Air Force. They were found at each base, each MAJCOM, HQ USAF, and the Engineering and Services Center. These are the managers of the wastewater treatment systems in the Air Force and are knowledgeable on current treatment practices. Due to the small size of the population, data collection from one hundred percent of the engineers was attempted. By analyzing the data from both surveys, a profile of current treatment practices and perceptions of regional connection decision factors was established.

Data Collection Plan

Survey Questionnaire. Based on the size and distance between all the population members, the collection of data was performed by a survey questionnaire (8:213). A survey was developed to identify both descriptive data and personal opinions concerning domestic wastewater treatment. Copies of the both surveys are shown in Appendix A. The rest of this section will explain how the three parts of the follow-up survey were put together.

Part I: Demographic Data. This part of the survey asked the respondents to identify whether they were a base level engineer, a MAJCOM engineer, or other. In addition, they were asked which MAJCOM their organization belonged to.

Part II: Base Level Data. This part of the survey was to be completed only by base level engineers. Others were instructed to proceed to Part III. This part asked for the name of the base, the average daily flow rate for domestic wastewater, where the base's domestic wastewater was treated, the age of the base's functioning wastewater treatment plant if it had one, whether or not a regional connection was possible, and if a regional connection was planned for in the next five years. All this information was necessary to answer two of the four research questions above: (1) What is the age of existing treatment plants? and (2) What is the accessibility of regional treatment plants to Air Force installations?

Part III: Regional Connection Considerations. This section of the survey determined which factors the respondents believe are the most important to the regional connection versus on base treatment alternatives. Several factors were listed on the survey for respondents to rank in the order of importance. The researcher decided to list these factors for the respondents in order to avoid ambiguous responses and ensure content validity of the survey. Content validity is essential to a sound survey (8:129). To accomplish this, the survey included five factors which the researcher believed would be common among respondents. The five factors listed were:

Cost

Location

Operators

Pollution Abatement

Quantity

Each respondent was asked to rank order them from (1 most important) to (5 least important). The factors were presented in alphabetical order to reduce the chance of survey-induced bias. In addition, each factor included a description to better explain what it represented. Respondents were invited to add and include in the rankings additional factors which they might consider.

Survey Validation, Approval, and Distribution. To improve the validity of the survey, the author tested and edited it. It was tested by discussions with the author's thesis advisor and wastewater engineers at HQ USAF and the Engineering and Services Center. It was presented to 10 Air Force Institute of Technology (AFIT) Engineering Management students on 13 March 87. These Civil Engineering officers recommended improvements to the instrument to ensure it's validity. In addition, Captain Carl Davis, a member of the AFIT faculty in research methods, reviewed the cover letter and survey.

A request for approval of the survey instrument was sent to HQ Air Force Manpower and Personnel Center on 3 April 87. After receiving approval of the above agency on 23 April 87, distribution of the questionnaires to the wastewater engineers at all eighty bases, HQ USAF, each MAJCOM, and the Engineering and Services Center commenced on 24 April 87.

Analysis Technique

The information collected came from two questionnaires. First was the data collected by the HQ USAF survey. This data consists of the treatment processes in use at each base along with the number of certified operators, flow rates, and National Pollutant Discharge Elimination System (NPDES) permit status. This data was consolidated into a database and categorized by command, flow rate, and treatment method. Descriptive statistics were then be used to develop basic percentages and pie charts.

The data from the second survey was broken into two parts: (1) that which supplements the data obtained from the HQ USAF survey and (2) the perceptions of wastewater engineers on those factors that affect the regional connection decision. Descriptive statistics were again used for this set of data. The respondents were asked to rank several factors affecting the regional connection decision. Data from such rankings is considered ordinal (8:268). Ordinal data is essentially data which can be ordered (8:123). To combine the rankings from the surveys into a composite set of rankings representing the entire population, a measure of central tendency was used. The median value of the various rankings of each factor from each survey was used to determine the composite ranking of each factor for the population. For ordinal data, the measure of central tendency is the median. Devore states that the median is the "middle value when the observations are ordered from smallest to largest in magnitude" (7:14). The median which was found for each factor is considered the population median. Each median was determined using the VIP Professional spreadsheet. VIP is a Lotus spreadsheet for the Atari ST personal computer. Medians were determined for each factor twice: once for the entire population and a second time for the population of base level engineers and that of MAJCOM engineers. The MAJCOM category includes MAJCOM, HQ USAF, and Engineering and Services Center engineers. The second determination of medians is to allow the investigator to visually compare the relative rankings of each population to one another.

IV. Data Analysis

Overview

Chapter IV presents a description of the data from the HQ USAF and follow-up surveys. The data from both surveys results in two findings: 1) an overall inventory of wastewater and water treatment systems throughout CONUS Air Force bases and 2) the rankings of the considerations of a regional connection versus on base treatment.

Survey Analysis

The HQ/USAF survey results will be presented first followed by the follow-up survey.

HQ USAF Survey. The survey was sent by HQ USAF to the major commands for distribution to the individual installations. Major Commands included are ATC, AFLC, AFSC, MAC, SAC, and TAC. Appendix B contains the responses from the survey categorized by domestic wastewater, industrial wastewater, and drinking water treatments. This section presents the responses of 77 out of a possible 85 bases - a return rate of 90%. Bases not responding are the USAF Academy, Pope AFB, Maxwell AFB, Little Rock AFB, Edwards AFB, Peterson AFB, Hurlburt Field, and Charleston AFB. The responses were analyzed and are presented in the following sequence: 1) domestic wastewater, 2) industrial wastewater, and 3) drinking water.

Domestic Wastewater. The analysis of the domestic wastewater portion of the survey reveals that six different domestic wastewater treatment methods exist in the Air Force. These are 1) regional connections, 2) trickling filters, 3) oxidation ponds, 4) activated sludge, 5) rotating biological discs, and 6) extended aeration package plants. Figure 1 shows the breakout of each type of treatment throughout the CONUS.

The data shows that regional connections comprise the majority of domestic wastewater treatment (48.2%). On the other extreme, Reese AFB is the only Air Force installation to use a package plant as it's method of treatment. The flow rate of this base (under 1 MGD) is small enough to allow such a treatment to be cost effective.

Table 1 shows the breakout of treatment methods by major command. Appendix C contains the pie chart percentages of wastewater treatment by major command. Congruent with the overall Air Force figures, regional connections comprise the majority of treatment for each MAJCOM. This trend demonstrates a compliance with DOD directive and Air Force regulation to utilize a regional connection where feasible. For those bases without a regional connection, trickling filters make up the majority of on base treatment methods. In SAC, two rotating biological disc plants are found at northern tier bases. This method is similar to a trickling filter except that

1986 HQ USAF Survey:
CONUS Air Force Domestic Wastewater Treatment

Method of Treatment	Number of Bases	%
Trickling Filter	23	27.1
Regional Connection	41	48.2
Oxidation Ponds	7	8.2
Activated Sludge	3	3.5
Rotating Biological Discs	2	2.4
Package Plants	1	1.2
Did Not Respond	8	9.4

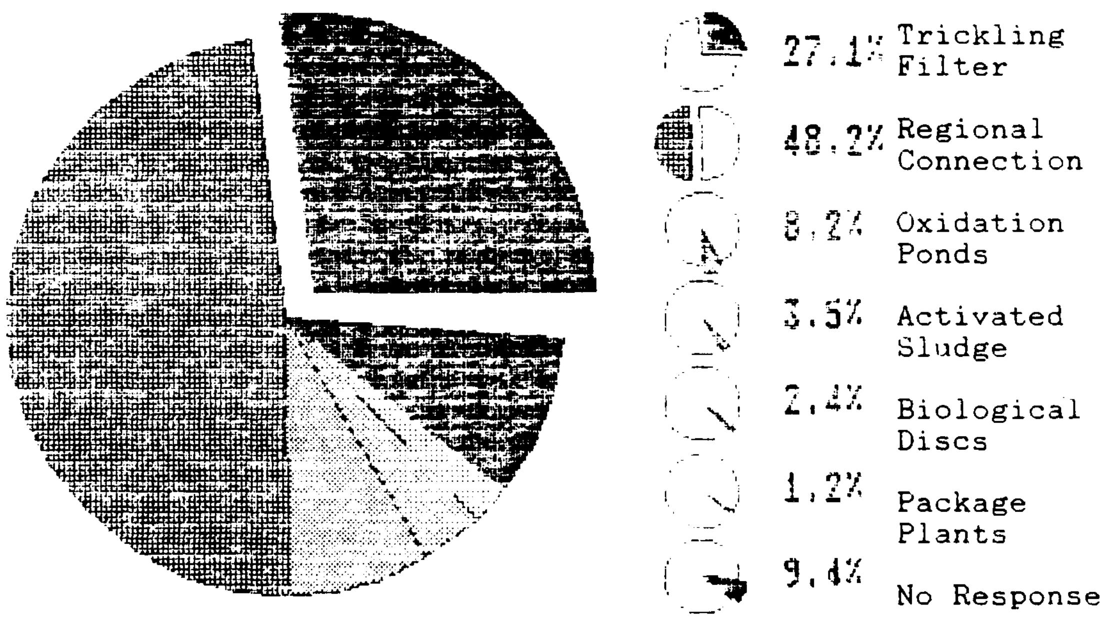

Figure 1. Air Force Domestic Wastewater Treatment (85 Bases)

Table 1

1986 HQ USAF Survey:
Domestic Wastewater Treatment Methods by MAJCOM

	MAJCOM					
Method	ATC	AFLC	AFSC	MAC	SAC	TAC
Trickling Filter	4	3	3	2	8	3
Regional Connection	7	4	3	7	10	9
Oxidation Ponds	1	-	-	-	3	3
Activated Sludge	-	-	-	-	1	2
Biological Disc	-	-	-	-	2	-
Package Plant	1	-	-	-	-	-
No Response	-	-	1	3	1	-
Total Bases	13	7	7	12	25	17

biological discs tend not to ice over. Instead, they are more efficient than trickling filters in cold climates. In TAC, of the three bases with oxidation ponds, two are located in New Mexico (Cannon and Holloman). Oxidation ponds tend to perform well in the warm and sunny weather found in New Mexico as wastes are completely broken down. The third base with this type of treatment is Mountain Home AFB, Idaho, where the weather is not as warm and sunny. They report no problems or NPDES violations with their treatment system.

Table 2 shows the breakout of treatment methods by flow rate. These figures primarily came from the HQ USAF survey but were supplemented by the follow-up survey.

Table 2

1986 HQ USAF Survey:
Domestic Wastewater Treatment by Flow Rate

Treatment Method	Flow Rate (MGD) Under 1	1-1.9	2-2.9	3-3.9	4+
Trickling Filter	6	13	-	4	-
Regional Connection	11	12	4	1	1
Oxidation Ponds	2	5	-	-	-
Activated Sludge	-	3	-	-	-
Biological Disc	-	2	-	-	-
Package Plant	1	-	-	-	-

Table B.4 in Appendix B lists the domestic wastewater flow rates for each CONUS Air Forceinstallation.

The design of a treatment plant depends on the flow rate of the specific installation you are designing for. Therefore, calculating an overall Air Forceaverage or median flow rate would be useless. However, since the flow rate is dependent on the population of the installation, it is important to recognize what makes up the overall figure. Included are those living on base (MFH, dorms, VOQ, etc.), those not living but working on base (civilians and military), and transient personnel for those bases with large passenger terminals. Industrial wastewater plant effluent also should be considered. Determination of the flow rate is essential to an efficient treatment plant design. If the calculated flow rate is too low, the result is an under capacity treatment plant and a NPDES permit violation; if it is too high, the result is an overdesigned plant and, presumably, a waste of thousands of dollars.

The responses from the NPDES permit status portion of the HQ USAF survey were inconsistent with the rest of the survey. This portion of the survey attempted to have each installation indicate if they were in compliance with the permit by answering "yes" or if they were in violation of the permit by answering "no". Instead, many bases failed to mark this section and, those that did answer, misunderstood the intent of the section. Normally, discharge to a municipal plant relieves the Air Force from obtaining a permit. However, a few bases with regional connections indicated that they had a permit. It can only be inferred that these permits are for remote treatment plants throughout the base. However, a confirmation of this hypothesis is not within the scope of this research effort.

Industrial Wastewater. The second portion of the HQ USAF survey asked for information on industrial wastewater treatment. The results are presented in Figure 2.

1986 HQ USAF Survey:
Industrial Wastewater Treatment by MAJCOM

Treatment Method	MAJCOM						
	ATC	AFLC	AFSC	MAC	SAC	TAC	AF
Pretreat Only	-	-	-	1	1	14	16
Batch Treat	-	4	-	-	-	-	5*
Sludge Reduction	-	1	-	-	-	-	1
Total Bases with treatment	-	5	-	1	1	14	22
No Treatment	13	2	6	8	23	3	55
No Response	-	-	1	3	1	-	8

*Includes Bolling AFB

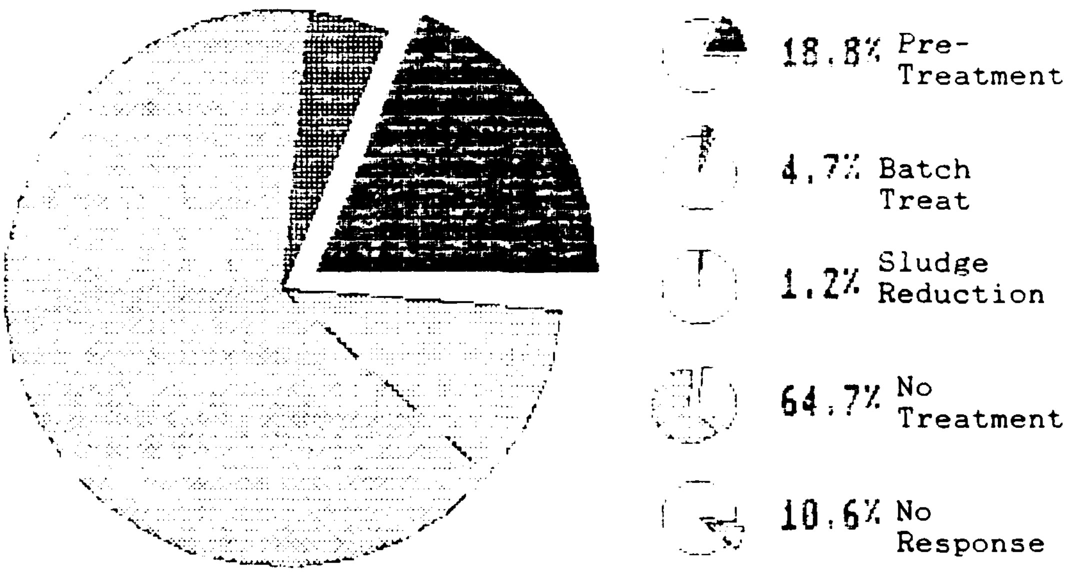

Figure 2. AF Industrial Wastewater Treatment
(85 Bases)

Table B.2 in Appendix B lists the industrial treatment facilities at each base.

Industrial wastewater treatment is not found at most bases. It is apparent that the reason for this is two-fold: 1) the base has no industrial capacity, or 2) the characteristics of the industrial wastewater do not significantly differ from domestic wastewater and, as a result, do not require pretreatment.

TAC has the most industrial wastewater facilities as fourteen of it's seventeen bases pretreat their industrial effluent. This is due probably to the large amount of aircraft maintenance performed by TAC bases. However, if this is true, then it would be expected that SAC should also have many pretreatment facilities. However, both MAC and SAC each have only one base with pretreatment. ATC and AFSC report having no treatment of any kind. Due to AFLCs depot maintenance facilities, five of the seven bases report having industrial treatment facilities. Additionally, one AFLC base (Robins AFB) reported using sludge reduction in addition to pretreatment. This means that the sludge from the pretreatment process is of such a characteristic that it must be reduced prior to ultimate disposal. It is not known how the ultimate disposal of the sludge is accomplished.

Batch treatment is commonly used for industries that use a diversity of processes. Also known as equalization, wastes are held in a basin for a certain period of time to get a stable effluent which is easier to treat at the domestic wastewater plant. The five bases using this method are all found in AFLC, with one exception (Bolling AFB).

Although the survey asked for industrial wastewater flow rates, the bases did not provide it.

Drinking Water. The final portion of the HQ USAF survey dealt with drinking water. Questions were asked on both the source of water and the types of treatment it receives. Table B.3 in Appendix B lists the source and treatment methods for drinking water throughout the CONUS Air Force. Figure 3 lists the source of drinking water by major command and Air Force. The pie chart depicts the percentages of the Air Force figures. As the chart shows, there are three sources from which bases get their drinking water: commercial or nearby cities, wells, and surface water.

Figure 3 shows that wells are the largest source of water for CONUS Air Force bases. Of course, bases that pump their own water from wells must also treat it themselves. Forty-three bases report processing their own water while 34 bases get their water from commercial sources. SAC has the most bases that use commercial sources while TAC has the most bases that process their own water. One SAC base (Loring AFB) and one AFSC base (Arnold AFS) are the only CONUS installations to get their water from surface

HQ USAF Survey:
Drinking Water Sources by MAJCOM

	MAJCOM						
Source	ATC	AFLC	AFSC	MAC	SAC	TAC	AF
Commercial	7	-	4	4	13	5	34*
Wells	6	7	1	5	10	12	41
Surface	-	-	1	-	1	-	[illegible]
No Response	-	-	1	3	1	-	[illegible]

*Includes Bolling AFB

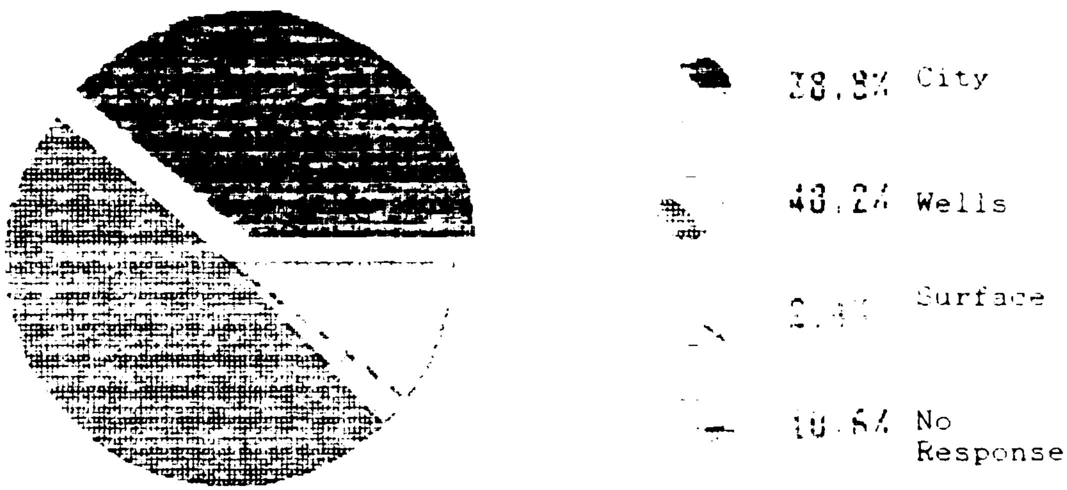

Figure 3. AF Drinking Water Source Percentages (85 Bases)

sources. Their is no correlation between the two bases as far as location since they are in different parts of the country. However, there may be many bases that utilize a commercial source which uses surface water. Generally, surface water is softer than ground water and softening is not required. Accordingly, neither Arnold AFS or Loring AFB soften their water.

The survey asked for the drinking water demand in million gallons per day of the installation. However, many respondents gave the capacity of the commercial source's treatment plant instead. Therefore, this data is unreliable and will not be used in this research.

The survey also asked for the types of treatment applied to the drinking water regardless of source. It asked for the respondents to indicate if the treatment was accomplished by the base, city, or neither. The data is presented in Table B.3 in Appendix B. However, some of the data may be unreliable due to some inconsistencies. For example, some bases that get water from a city source indicated that treatment was applied by both the city and the base. Although this may be true, it should be verified.

Having covered the HQ USAF survey, the results of the follow-up survey will be discussed.

Follow-up Survey. The follow-up survey administered by the author not only supplemented the HQ USAF survey but provided some important data in itself. This survey was sent to ninety wastewater engineers at various bases, MAJCOMs, HQ USAF, and the Engineering and Services Center. Table 3 shows the return of surveys by population. Overall, seventy surveys were returned for a return rate of 77.7%. Breaking this figure down, ten surveys were sent to the MAJCOMs, HQ USAF, and the Engineering and Services Center while nine were returned for a return rate of 90%. Eighty two surveys were sent to base level wastewater engineers and sixty two were received for a return rate of 75.6%. Figure 4 is a histogram showing the distribution of the survey returns by major command.

Table 3

Follow-up Survey
Return Rates of Surveys

Population	# Sent	# Returned	Return Rate
Overall	92	71	77.1%
MAJCOM*	10	9	90.0%
Base Level	82	62	75.6%

*Includes HQ USAF and Engineering and Services Center

SAC had the largest return because they have the most number of bases. The MAJCOM category includes not only responses from major command headquarters, but also two HQ USAF responses, one from the Engineering and Services Center, and one from the Central Air Force Regional Civil Engineer (AFRCE). The Alaskan Air Command (AAC) response came from HQ AAC.

Demographic Data. Although the surveys were sent to the wastewater engineers at each base, 38.7% of the respondents turned out to be either the Environmental

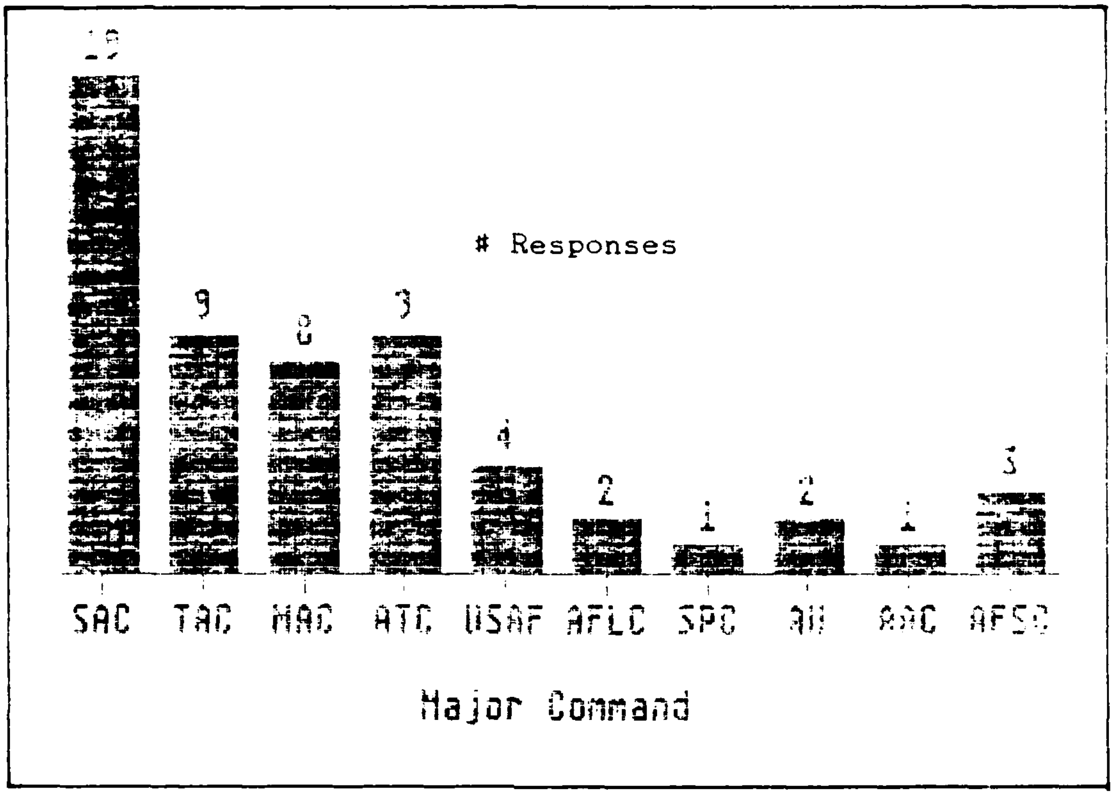

Figure 4. Follow-up Survey Returns by Major Command

Coordinator, a wastewater operator, or a contract quality assurance evaluator.

<u>Base Level Data</u>. The survey asked the respondents to determine (1) if a regional connection was possible and (2) if a regional connection was planned for in the next five years. Of those bases responding, 31 reported that a regional connection is possible, 18 reported that one is not possible, and 13 did not know. Six bases reported that a regional connection is planned for in the next five years while 24 report that they are not planning for one. The six bases planning for one are McGuire AFB, Luke AFB,

Dover AFB, Chanute AFB, Lackland AFB Annex, and Hanscom AFB. Currently, these bases are operating their own treatment plants. It is interesting to note that seven of the 24 not planning for a regional connection report that one is possible. These bases include March AFB, Castle AFB, Homestead AFB, Wurtsmith AFB, Grand Forks AFB, Fairchild AFB, and Shaw AFB. Table 4 lists reasons given for why a regional connection is not possible. It should be noted that only thirteen of the eighteen bases reporting that a regional connection is not possible gave reasons why.

Blytheville AFB is the only base to report that the municipal plant does not meet NPDES standards and, therefore, a regional connection is not possible. Patrick AFB and Holloman AFB are the only two bases to report that the municipal plant nearest them is overloaded.

Table 4

Follow-up Survey
Reasons Why Regional Connections Are Not Possible

Reason	# Bases Citing Reason
None in the Area	4
Municipal Plant Too Far Away	4
Municipal Plant Can't Meet NPDES Standards	1
Municipal Plant Overloaded	2
Too Costly	2

Additionally, two bases report that cost is the prohibitive factor. One of these, Scott AFB, reports that they performed a life cycle cost analysis which favored an MCP upgrade to their on base plant.

Plant Age. The bases were asked to indicate the age of their on base treatment plants by circling the age category it fell into. The median category for on base plant age was found to be 31 plus years. This indicates that the Air Force has treatment plants which date back prior to the mid 1950's. Since that time, standards have become more stringent making it difficult for these older plants to maintain compliance. It is commonly accepted that the older a treatment plant is, the more difficult it is to keep it in compliance. The fact that most of the on base plants are old and most likely in need of upgrade, a proper analysis of alternatives for upgrading them should be considered.

Regional Connection Considerations. Table 5 shows the median values of the considerations for the MAJCOMs, base level, and overall populations. All three populations agreed on the rankings of the considerations. Although there is no consideration ranked first, cost and pollution abatement tied for second in each population. This means that not only is there a concern about the economics of the treatment alternative, but also the degree to which it protects the environment and complies with pollution

Table 5

Follow-up Survey
Median Values of Regional Connection Considerations

Consideration	Population MAJCOM	Base Level	Overall
Cost	2*	2*	2*
Pollution Abatement	2*	2*	2*
Location	3	3	3
Operators	4*	4*	4*
Quantity	4*	4*	4*

*Indicates tie between rankings

abatement regulations. Following economic and environmental concerns, location is ranked third in each population. Some of the respondents noted that cost is not only a consideration by itself, but that it is also a function of location. In other words, the cost of installing a regional connection is dependent on the distance from the base to the nearest municipal treatment plant. The operators as a critical military skill and the quantity of wastewater tied for fourth in each population. This means that we are not all that concerned about the availability of our military operators for wartime in relation to the factors of cost, pollution abatement, and location. Four respondents added some additional considerations. These include security, public relations, water reuse, and national policy. The base that listed water reuse is in Arizona where such a factor is very important (they listed it as number one). The individual that listed national policy referred to the DOD policy to use regional connections where possible. However, this research is aimed at determining the importance of the factors independent of the DOD policy.

V. Conclusions and Recommendations

Overview

The overall objective of this research effort was to compile an inventory of various water and wastewater treatments throughout the CONUS Air Force and to determine the importance of the factors affecting the regional connection decision. This goal was achieved along with some interesting insights into the status of wastewater treatment plants. Conclusions about the research questions outlined in Chapter I are presented in order. The last section of this chapter provides some final recommendations and suggestions for future research.

Conclusions

Research Question One. What do current Air Force regulations and policies say about domestic wastewater treatment?

In general, federal law mandates that Air Force sewage treatment plants comply with the applicable standards. Each treatment facility is required to have and abide by a NPDES permit. More specific, AFR 19-1 requires the use of a regional connection when feasible.

Research Question Two. What types of treatment processes are being used at each base?

The HQ USAF survey results show that six different treatment methods are utilized for domestic wastewater treatment. These methods are regional connections, trickling filters, activated sludge, oxidation ponds, rotating biological discs, and extended aerobic package plants. It was found that regional connections make up the majority (48.2%) of the methods utilized. Of those bases with on base treatment plants, trickling filters make up the majority.

Only 22 installations have industrial wastewater treatment facilities. Of these 22, fourteen of them are in TAC, five in AFLC, one in MAC, one in SAC, and one at AFDW (Bolling AFB). Due to AFLC's diverse depot maintenance operations, four of its' bases use equalization or batch treatment.

Drinking water sources are of three types: 1) wells, 2) surface water, and 3) municipal systems. The majority of installations rely on wells as their source of drinking water. Only two bases use surface water while the remainder buy water from a municipal system. Treatment of this water is accomplished either by the city or the base depending on the source. If water is purchased from the city system, the city almost always provides treatment while those bases that pump their own water treat it themselves.

<u>Research Question Three</u>. What types of problems exist for on base wastewater treatment plants?

The most prevalent problem for on base domestic wastewater treatment plants is noncompliance. Noncompliance is caused by a failure to properly analyze treatment alternatives, design deficiencies, construction defects, and operation and maintenance problems.

The literature review revealed that several bases had failed to consider all the treatment alternatives available to them when upgrading their wastewater treatment methods. Essentially, three alternatives are available: 1) redesign the existing plant, 2) build a new plant, or 3) convert to a regional connection. Some installations made a proper analysis but failed to choose the most feasible alternative.

Construction defects and design deficiencies are a result of a lack of quality control, limited state of the art, and budget limitations. However, these problems are not unique to wastewater treatment plants. Many MCP projects experience these same difficulties.

Operation and maintenance problems are those which each individual base has the most control over. These problems result from poorly trained operators, nonexistent maintenance schedules, and a lack of specific guidance from the MAJCOMs and HQ USAF. The Technical Training Center at Sheppard AFB, Texas, is focusing in on the problem by providing rigorous training to all students in maintenance techniques and maintenance schedule development. Additionally, the sewage treatment plant at Spearfish, SD. - similiar to an Air Force plant in size, flow rate, and treatment methods - proves that an effective O&M program and properly trained operators can consistently keep the plant in compliance.

Research Question Four. What is the age of existing treatment plants?

The median age category of existing on base treatment plants is 31 plus years. This means that many of the AF's plants were built prior to the mid 1950's. Since that time, the standards governing wastewater treatment have changed drastically. The Air Force should assess the compliance of these older plants to the applicable standards to determine if major upgrades are necessary.

Research Question Five. What is the accessibility of regional treatment plants to Air Force Installations?

Those bases with regional connections or planning for one obviously are accessible to a regional plant. Of those bases operating on base treatment plants, only seven report that a regional connection is possible. These seven are March, Castle, Homestead, Wurtsmith, Grand Forks, Fairchild, and Shaw AFB. Five reasons were given why a regional connection is not possible: 1) no municipal plant in the area, 2) the municipal plant is too far away, 3) the municipal plant does not meet NPDES standards, 4) the municipal plant is overloaded, and 5) it is cost prohibitive.

Research Question Six. What are the perceptions of Air Force wastewater engineers on those factors which affect the decision to use a regional connection for wastewater treatment?

In a follow-up survey to the HQ USAF survey, Air Force wastewater engineers were asked to rank the following five factors as they pertain to the decision to use a regional connection versus on base treatment: 1) cost, 2) location of the base relative to the municipal plant, 3) quantity of wastewater, 4) importance of military wastewater operators, and 5) the ability of the base or municipal plant to provide adequate pollution abatement. Overall, cost and pollution abatement tied for second, location was ranked third, and the operators and quantity considerations tied for fourth. This means that when analyzing the treatment alternatives available, the Air Force should first consider the cost of each and it's ability to provide adequate pollution abatement. Several respondents noted that the cost of a regional connection is a function of the location of the municipal plant. Therefore, location is already taken into account when cost is considered. Finally, the analysis should take into consideration the displacement of military wastewater treatment plant operators (a critical military skill) and the quantity of wastewater to be treated.

Research Question Seven. How are we going to meet the requirement for the training of personnel for the Critical Military Skill of wastewater operator?

The Technical Training Center at Sheppard AFB, Texas, stated that as more bases convert to regional connections and the need for operators decreases, personnel in this critical military skill are being trained additional skills (i.e., plumbing). This is an effort to insure that there are enough operators available to man the overseas plants and provide sanitation in a contingency environment.

Recommendations

The findings of this research effort clearly show the need for improvement in Air Force wastewater treatment plants. Specifically, three areas need to be addressed:

1. As plants receive notices of violation (NOVs), the plan to correct the problem needs to get on the PSR report as soon as possible. These plans need to get proper attention in the budget and MCP cycles in order to provide a timely fix to the NOVs.

2. The importance of a national test for the certification of wastewater operators needs to be reemphasized. Although operators are required to be certified in the state they work in, many military operators are finding it difficult to keep their certification. As military operators PCS from one state to another, many times the new state will not accept the previous states certification. Therefore, the operator must go through the lengthy certification process again in the new state.

3. The seven bases with on base treatment plants where a regional connection is possible should analyze the alternative of a tie in with the regional system. If it is determined feasible, then the conversion should be made. Additionally, those bases that analyzed the treatment alternatives before upgrading should validate their findings by reaccomplishing the analysis.

Recommendations for Further Research

Due to some of the inaccurate results of the HQ USAF survey, another such survey is warranted. Specifically, NPDES permit status and industrial wastewater and drinking water flow rates need to be determined in order to complete the inventory.

A second area suitable for additional research is the compilation of the problems that each installation is experiencing with water and wastewater treatment. This compilation should include all the NOVs that each base currently has.

AIR FORCE DOMESTIC WASTE WATER TREATMENT PLANTS

1 INSTALLATION NAME

2 PLANT CAPACITY
(DAILY AVE) Mgd

3 TYPE OF TREATMENT METHODS

	YES	NO	N/A
A. PRIMARY			
B. PRIMARY W/CHEMICALS			
C. SECONDARY			
- TRICKLING FILTER			
- PACKAGE AEROBIC TREATMENT			
- ACTIVATED SLUDGE & SLUDGE DIGESTION METHODS			
- OXIDATION POND AND/OR LAGOONS			
- ROTATING BIOLOGICAL DISCS			
D. TERTIARY			
E. COLLECTION SYSTEM ONLY			
F. *REGIONAL CONNECTION			
- NPDES PERMIT (YES/NO) STATUS			

4 TOTAL NUMBER OF OPERATORS	STATE REQ'D LEVEL	ALL OTHER LEVELS
1) CERTIFIED		
2) NON-CERTIFIED		

5 BRIEF DESCRIPTION OF OPERATIONAL DIFFICULTIES RESULTING IN NON-COMPLIANCE - LAST 12 MONTHS

*If Partial Connection - Provide Mgd to Region & On Base Mgd (Treated)

TABLE 1

AIR FORCE INDUSTRIAL WASTE WATER TREATMENT PLANTS

1 INSTALLATION NAME

2 PLANT CAPACITY (DAILY AVE) Mgd

3. INDUSTRIAL WASTE PLANT (BRIEF DESCRIPTION)

	YES	NO	N/A
- PROCESS WASTE (TYPE)			
- PRE-TREATMENT ONLY			
- BATCH TREATMENT			
- SLUDGE REDUCTION & DISPOSAL			
- NPDES AND/OR RCRA			

TOTAL NUMBER OF OPERATORS	STATE REQ'D LEVEL	ALL OTHER LEVELS
1) CERTIFIED		
2) NON-CERTIFIED		

BRIEF DESCRIPTION OF OPERATIONAL DIFFICULTIES RESULTING IN NON-COMPLIANCE - LAST 12 MONTHS

TABLE 2

AIR FORCE DRINKING WATER SOURCES & TREATMENT

1 INSTALLATION NAME

2 WATER SOURCE & CAPACITY Mgd

A. SURFACE (Base Plant)

B. WELLS (Base Wells)

C. CITY WATER (TOTAL PERCENT SHARE OF INSTALLTION DEMAND)

3 DESCRIPTION OF TYPE OF TREATMENT (Regardless of Source performed by CITY [C] BY BASE [B] & NONE [N])

- PRE-CHLORINATION
- POST DISINFECTION
- TASTE & ODOR CONTROL
- IRON, MANGENESE REDUCTION
- SOFTENING
- FLUORIDE
- VOC & OR THM TREATMENT
- ACTIVATED CARBON & AIR STRIPPING

4 NO. OF OPERATORS	STATE REQ'D LEVEL	ALL OTHER LEVELS
- CERTIFIED		
- NON-CERTIFIED		

5 DESCRIPTION OPERATIONAL DIFFICULTIES RESULTING IN NON-COMPLIANCE WITH DRINKING WATER STANDARDS

TABLE 3

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO ATTN OF: LSG

SUBJECT: Research Questionnaire (USAF Survey Control No.87-55, expires 1 Aug 87)

TO: Air Force Wastewater Engineers

1. Regional connections for the treatment of domestic wastewater have been mandated by DOD directive. There are several considerations which should be addressed before a base implements such a connection. However, no one really knows which considerations are the most important.

2. I am developing a management tool for Air Force Wastewater Managers by building an inventory of all domestic water, wastewater, and industrial wastewater processes at all Air Force installations. As a part of this tool, I am determining if the issue of regional connections should be readdressed by defining the important considerations of such a connection. Thus, I am asking wastewater engineers at all levels what they believe are the important considerations for regional connections. Your opinion is an essential input to this effort.

3. The instrument should take no more than 5 minutes to complete. Of course, your participation is entirely voluntary, and your responses will remain anonymous. I appreciate your cooperation in completing this instrument and returning it in the envelope provided as soon as possible. If you have any questions, please contact me at AUTOVON 785-5435.

Vincent E. Renaud

VINCENT E. RENAUD, 1st Lt, USAF
AFIT Graduate Student

2 Atch
1. Survey
2. Return Envelope

STRENGTH THROUGH KNOWLEDGE

WASTEWATER MANAGEMENT SURVEY

PART I. DEMOGRAPHIC DATA

1. What is your position? (circle one)

    A. Base level Wastewater Engineer
    B. MAJCOM Wastewater Engineer
    C. Other (please specify) ______________________________

2. To what MAJCOM does your organization belong? (circle one)

    A. AFLC   E. SAC
    B. AFSC   F. TAC
    C. ATC   G. Other(specify) ____________________
    D. MAC

IF YOU ARE NOT AT A BASE LEVEL POSITION, PLEASE SKIP TO PART III.

PART II. BASE LEVEL DATA

3. What base are you assigned to? (write in space below)

    ____

4. What is your base's average daily flow rate for domestic wastewater? (circle one)

    A. Less than 1 million gallons per day (MGD)
    B. 1-1.9
    C. 2-2.9
    D. 3-3.9
    E. 4 or greater

5. Where is your base's domestic wastewater treated? (circle one)

    A. Base plant
    B. Publicly Owned Treatment Works (POTW)
    C. Regional Wastewater Treatment Plant
    (If you circle C, please skip to Part III)

6. If your base has a functioning wastewater treatment plant, what is it's age? (circle one)

    A. Less than 5 years   E. 31 years or older
    B. 6-10 years   F. Not applicable
    C. 11-20 years
    D. 21-30 years

7. Is a regional connection possible at your base? (circle one)

   A. Yes
   B. No (briefly explain why) ______________________________
   ____
   C. Don't know

8. Is there a regional wastewater connection planned in the next 5 years? (circle one)

   A. Yes
   B. No
   C. Don't know

PART III. REGIONAL CONNECTION CONSIDERATIONS

Below is a list of some <u>REGIONAL CONNECTION CONSIDERATIONS</u>. I would like for you to distinguish among these considerations by ranking them by their importance for judging regional connection versus on base treatment applications. Place a one (1) beside the <u>most</u> important consideration, and two (2) through five (5) beside the others to indicate your opinion of their relative importance. You may add and then include in the ranking additional areas by using the spaces provided.

______	COST	(building and running an on base plant versus installation of a *regional connection* and it's associated utility rates)
______	LOCATION	(proximity of a regional wastewater treatment plant)
______	OPERATORS	(role of the military wastewater operator, i.e., critical military skill)
______	POLLUTION ABATEMENT	(National Pollutant Discharge Elimination System (NPDES) compliance either by the AF or the regional treatment plant)
______	QUANTITY	(quantity of wastewater produced by installation)
______	______________________________	
______	______________________________	

Thank you for your assistance.

Table B.1

Domestic Wastewater Treatment

BASE	TRICKLING FILTER	REGIONAL CONNECTION	OXIDATION PONDS	ACTIVATED SLUDGE	ROTATING BIO DISCS	PACKAGE PLANTS	NOT REPORTED
ALTUS AFB		X					
ANDREWS AFB		X					
ARNOLD AFS	X						
BARKSDALE AFB		X					
BEALE AFB	X						
BERGSTROM AFB		X					
BLYTHEVILLE AFB	X						
BOLLING AFB		X					
BROOKS AFB		X					
CANNON AFB			X				
CARSWELL AFB		X					
CASTLE AFB	X						
CHANUTE AFB		X					
COLUMBUS AFB	X						
DAVIS-MONTHAN AFB		X					
DOVER AFB		X					
DYESS AFB		X					
EDWARDS AFB							X
EGLIN AFB	X						
ELLSWORTH AFB	X						
ENGLAND AFB		X					
F.E. WARREN AFB		X					
FAIRCHILD AFB	X						
GEORGE AFB		X					
GOODFELLOW AFB		X					

BASE	TRICKLING FILTER	REGIONAL CONNECTION	OXIDATION PONDS	ACTIVATED SLUDGE	ROTATING BIO DISCS	PACKAGE PLANTS	NOT REPORTED
GRAND FORKS AFB			X				
GRIFFISS AFB		X					
GRISSOM AFB				X			
HANSCOM AFB							X
HILL AFB		X					
HOLLOMAN AFB			X				
HOMESTEAD AFB		X					
HURLBURT FIELD							X
K.I. SAWYER AFB					X		
KEESLER AFB		X					
KELLY AFB		X					
KIRTLAND AFB		X					
LACKLAND AFB		X					
LANGLEY AFB		X					
LAUGHLIN AFB			X				
LORING AFB					X		
LOS ANGELES AFS		X					
LOWRY AFB		X					
LUKE AFB	X						
MACDILL AFB				X			
MALMSTROM AFB		X					
MARCH AFB	X						
MATHER AFB		X					
MAXWELL AFB							X
MC CHORD AFB		X					
MC CLELLAN AFB	X						
MC CONNELL AFB		X					
MC GUIRE AFB	X						
MINOT AFB			X				

BASE	TRICKLING FILTER	REGIONAL CONNECTION	OXIDATION PONDS	ACTIVATED SLUDGE	ROTATING BIO DISCS	PACKAGE PLANTS	NOT REPORTED
MOODY AFB	X						
MOUNTAIN HOME AFB			X				
MYRTLE BEACH AFB		X					
NELLIS AFB		X					
NEWARK AFS		X					
NORTON AFB		X					
OFFUTT AFB		X					
PATRICK AFB	X						
PEASE AFB	X						
PETERSON AFB							X
PLATTSBURGH AFB		X					
RANDOLPH AFB		X					
REESE AFB						X	
ROBINS AFB	X						
SCOTT AFB	X						
SEYMOUR JOHN. AFB		X					
SHAW AFB				X			
SUNNYVALE AFS		X					
TINKER AFB	X						
TRAVIS AFB		X					
TYNDALL AFB	X						
USAF ACADEMY							X
VANCE AFB	X						
VANDENBERG AFB		X					
WHITEMAN AFB	X						
WILLIAMS AFB	X						
WRIGHT-PATTERSON AFB		X					
WURTSMITH AFB			X				

Table B.2

Industrial Wastewater Treatment

BASE	PRE-TREATMENT	SLUDGE REDUCTION	BATCH PROCESSING	NONE	NOT REPORTED
ALTUS AFB				X	
ANDREWS AFB				X	
ARNOLD AFS				X	
BARKSDALE AFB				X	
BEALE AFB	X				
BERGSTROM AFB	X				
BLYTHEVILLE AFB				X	
BOLLING AFB			X		
BROOKS AFB				X	
CANNON AFB	X				
CARSWELL AFB				X	
CASTLE AFB				X	
CHANUTE AFB				X	
COLUMBUS AFB				X	
DAVIS-MONTHAN AFB	X				
DOVER AFB	X				
DYESS AFB				X	
EDWARDS AFB					X
EGLIN AFB				X	
ELLSWORTH AFB				X	
ENGLAND AFB	X				
F.E. WARREN AFB				X	
FAIRCHILD AFB				X	
GEORGE AFB	X				
GOODFELLOW AFB				X	

BASE	PRE-TREATMENT	SLUDGE REDUCTION	BATCH PROCESSING	NONE	NOT REPORTED
GRAND FORKS AFB				X	
GRIFFISS AFB				X	
GRISSOM AFB				X	
HANSCOM AFB					X
HILL AFB			X		
HOLLOMAN AFB	X				
HOMESTEAD AFB	X				
HURLBURT FIELD					X
K.I. SAWYER AFB				X	
KEESLER AFB				X	
KELLY AFB			X		
KIRTLAND AFB				X	
LACKLAND AFB				X	
LANGLEY AFB	X				
LAUGHLIN AFB				X	
LORING AFB				X	
LOS ANGELES AFS				X	
LOWRY AFB				X	
LUKE AFB	X				
MACDILL AFB	X				
MALMSTROM AFB				X	
MARCH AFB				X	
MATHER AFB				X	
MAXWELL AFB					X
MC CHORD AFB				X	
MC CLELLAN AFB			X		
MC CONNELL AFB				X	
MC GUIRE AFB				X	
MINOT AFB				X	

BASE	PRE-TREATMENT	SLUDGE REDUCTION	BATCH PROCESSING	NONE	NOT REPORTED
MOODY AFB				X	
MOUNTAIN HOME AFB				X	
MYRTLE BEACH AFB	X				
NELLIS AFB	X				
NEWARK AFS				X	
NORTON AFB				X	
OFFUTT AFB				X	
PATRICK AFB				X	
PEASE AFB				X	
PETERSON AFB					X
PLATTSBURGH AFB				X	
RANDOLPH AFB				X	
REESE AFB				X	
ROBINS AFB		X			
SCOTT AFB		X			
SEYMOUR JOHN. AFB	X				
SHAW AFB	X				
SUNNYVALE AFS	X				
TINKER AFB			X		
TRAVIS AFB				X	
TYNDALL AFB				X	
USAF ACADEMY					X
VANCE AFB				X	
VANDENBERG AFB				X	
WHITEMAN AFB				X	
WILLIAMS AFB				X	
WRIGHT-PATTERSON AFB				X	
WURTSMITH AFB				X	

Table B.3

Drinking Water Treatment

BASE	SOURCE	PRE-CHLOR	POST DISINF	TASTE & ODOR CONTROL	FE & MG REDUCTION	SOFT-ENING	FLUOR	VOC/THM TMT	ACTIVATED CARBON
ALTUS AFB	CITY	C	C	C	C	C	N	N	N
ANDREWS AFB	CITY	C	C	C	C	N	C	C	C
ARNOLD AFS	SURFACE	B	B	B	B	N	N	B	B
BARKSDALE AFB	CITY	C	B	N	N	N	N	N	N
BEALE AFB	WELLS	N	B	N	N	N	B	N	N
BERGSTROM AFB	CITY	C	N	N	N	N	N	N	N
BLYTHEVILLE AFB	WELLS	N	B	N	B	N	B	N	N
BOLLING AFB	CITY	C	C	C	C	N	C	N	N
BROOKS AFB	CITY	C	N	N	N	N	C	N	N
CANNON AFB	WELLS	N	N	N	N	B	N	N	N
CARSWELL AFB	CITY	C	B	N	N	N	N	N	N
CASTLE AFB	WELLS	N	B	N	N	N	N	N	N
CHANUTE AFB	WELLS	B	B	B	N	B	B	N	N
COLUMBUS AFB	WELLS	B	B	B	B	N	B	N	N
DAVIS-MONTHAN AFB	WELLS	B	N	N	N	N	B	N	N
DOVER AFB	WELLS	B	N	N	N	N	B	N	N
DYESS AFB	CITY	N	B	N	N	N	B	N	N
EDWARDS AFB	NOT REPORTED								
EGLIN AFB	WELLS	N	B	N	N	N	B	N	N
ELLSWORTH AFB	CITY	C	B	N	N	N	N	N	N
ENGLAND AFB	CITY	C	N	N	N	N	C	N	N
F.E. WARREN AFB	CITY	N	C	N	N	N	N	N	N
FAIRCHILD AFB	WELLS	N	B	N	N	N	B	N	N

B=Base, C=City, N=Neither

BASE	SOURCE	PRE-CHLOR	POST DISINF	TASTE & ODOR CONTROL	FE & MG REDUCTION	SOFT-ENING	FLUOR	VOC/THM TMT	ACTIVATED CARBON
GEORGE AFB	WELLS	B	N	N	N	N	N	N	N
GOODFELLOW A⁻B	CITY	N	C	N	N	N	N	N	N
GRAND FORKS AFB	CITY	C	B	N	N	N	C	B	N
GRIFFISS AFB	CITY	C	B	N	N	N	B	N	N
GRISSOM AFB	WELLS	B	B	N	B	B	N	N	N
HANSCOM AFB	NOT REPORTED								
HILL AFB	WELLS	B	N	N	N	N	B	N	N
HOLLOMAN AFB	WELLS	B	N	N	N	N	B	N	N
HOMESTEAD AFB	WELLS	B	N	N	N	B	N	N	N
HURLBURT FIELD	NOT REPORTED								
K.I. SAWYER AFB	WELLS	N	B	N	N	N	B	N	N
KEESLER AFB	WELLS	N	B	N	N	N	B	N	N
KELLY AFB	WELLS	B	N	N	N	N	B	N	N
KIRTLAND AFB	WELLS	B	N	N	N	B	N	N	N
LACKLAND AFB	CITY	N	C	N	N	N	B	N	N
LANGLEY AFB	CITY	C	N	N	N	C	N	N	N
LAUGHLIN AFB	CITY	N	B	N	N	N	B	N	N
LORING AFB	SURFACE	B	B	B	N	N	B	N	N
LOS ANGELES AFS	CITY	C	N	C	N	N	N	N	N
LOWRY AFB	CITY	N	C	N	N	N	N	N	N
LUKE AFB	WELLS	B	N	N	N	N	N	N	N
MACDILL AFB	CITY	C	N	N	N	N	N	N	N
MALMSTROM AFB	CITY	C	B	N	N	N	N	N	N
MARCH AFB	CITY	C	B	N	N	C	B	N	N
MATHER AFB	WELLS	B	B	N	B	N	B	N	N
MAXWELL AFB	NOT REPORTED								
MC CHORD AFB	WELLS	B	N	N	N	N	B	N	N
MC CLELLAN AFB	WELLS	B	N	N	N	N	B	N	B

B=Base, C=City, N=Neither

BASE	SOURCE	PRE-CHLOR	POST DISINF	TASTE & ODOR CONTROL	FE & MG REDUCTION	SOFT-ENING	FLUOR	VOC/THM TMT	ACTIVATED CARBON
MC CONNELL AFB	CITY	C	B	N	N	C	B	N	N
MC GUIRE AFB	WELLS	B	N	N	B	N	B	N	N
MINOT AFB	CITY	C	N	N	N	C	N	N	N
MOODY AFB	WELLS	B	N	B	N	N	B	N	N
MOUNTAIN HOME AFB	WELLS	B	N	N	N	N	B	N	N
MYRTLE BEACH AFB	WELLS	B	N	N	N	N	N	N	N
NELLIS AFB	WELLS	B	N	N	N	C	N	N	N
NEWARK AFS	WELLS	N	B	N	B	B	N	N	N
NORTON AFB	WELLS	N	B	N	N	N	N	N	N
OFFUTT AFB	CITY	C	N	C	N	C	C	N	N
PATRICK AFB	CITY	N	C	N	N	N	N	N	N
PEASE AFB	WELLS	N	B	N	N	N	N	B	B
PETERSON AFB	NOT REPORTED								
PLATTSBURGH AFB	CITY	C	N	N	N	N	N	N	N
RANDOLPH AFB	WELLS	N	B	N	N	N	B	N	N
REESE AFB	CITY	C	N	N	N	N	N	N	N
ROBINS AFB	WELLS	N	B	B	B	N	B	N	N
SCOTT AFB	CITY	C	C	C	C	B	C	C	N
SEYMOUR JOHN. AFB	WELLS	B	N	N	B	N	B	N	N
SHAW AFB	WELLS	B	N	N	N	N	B	N	N
SUNNYVALE AFS	CITY	C	N	N	N	N	N	N	N
TINKER AFB	WELLS	B	N	C	C	N	B	N	N
TRAVIS AFB	CITY	C	B	N	N	N	C	N	N
TYNDALL AFB	CITY	C	N	N	N	C	B	N	N
USAF ACADEMY	NOT REPORTED								
VANCE AFB	CITY	N	C	N	N	N	N	N	N
VANDENBERG AFB	WELLS	N	B	N	N	B	B	N	N
WHITEMAN AFB	WELLS	N	B	N	N	B	N	N	N

B=Base, C=City, N=Neither

BASE	SOURCE	PRE-CHLOR	POST DISINF	TASTE & ODOR CONTROL	FE & MG REDUCTION	SOFT-ENING	FLUOR	VOC/THM TMT	ACTIVATED CARBON
WILLIAMS AFB	WELLS	N	N	B	N	N	B	N	N
WRIGHT-PATTERSON AFB	WELLS	N	B	N	N	B	B	N	N
WURTSMITH AFB	WELLS	N	B	N	N	N	B	N	N

B=Base, C=City, N=Neither

Table B.4

Domestic Wastewater Flow Rates

BASE	AVERAGE DAILY FLOW RATE (MGD) UNDER 1	1-1.9	2-2.9	3-3.9	4+
ALTUS AFB	NO RESPONSE				
ANDREWS AFB		X			
ARNOLD AFS	NO RESPONSE				
BARKSDALE AFB	X				
BEALE AFB		X			
BLYTHEVILLE AFB	X				
BOLLING AFB	NO RESPONSE				
BROOKS AFB	NO RESPONSE				
CANNON AFB	NO RESPONSE				
CARSWELL AFB				X	
CASTLE AFB	X				
CHANUTE AFB			X		
COLUMBUS AFB	NO RESPONSE				
DAVIS-MONTHAN AFB		X			
DOVER AFB		X			
DYESS AFB	NO RESPONSE				
EDWARDS AFB		X			
EGLIN AFB	NO RESPONSE				
ELLSWORTH AFB		X			
ENGLAND AFB	NO RESPONSE				
F.E. WARREN AFB	X				
FAIRCHILD AFB	X				
GEORGE AFB	NO RESPONSE				
GOODFELLOW AFB	X				
GRAND FORKS AFB	X				
GRIFFISS AFB	NO RESPONSE				
GRISSOM AFB	X				
HANSCOM AFB		X			
HILL AFB	NO RESPONSE				
HOLLOMAN AFB			X		
HOMESTEAD AFB			X		
HURLBURT FIELD	X				
K.I. SAWYER AFB	X				
KEESLER AFB			X		
KELLY AFB	NO RESPONSE				
KIRTLAND AFB	NO RESPONSE				
LACKLAND AFB		X			
LANGLEY AFB		X			
LAUGHLIN AFB	X				
LORING AFB	NO RESPONSE				

BASE	AVERAGE DAILY FLOW RATE (MGD) UNDER 1	1-1.9	2-2.9	3-3.9	4+
LOS ANGELES AFS	NO RESPONSE				
LOWRY AFB		X			
LUKE AFB		X			
MACDILL AFB	NO RESPONSE				
MALMSTROM AFB	X				
MARCH AFB		X			
MATHER AFB	NO RESPONSE				
MAXWELL AFB		X			
MC CHORD AFB	NO RESPONSE				
MC CLELLAN AFB	NO RESPONSE				
MC CONNELL AFB	NO RESPONSE				
MC GUIRE AFB		X			
MINOT AFB		X			
MOODY AFB	NO RESPONSE				
MOUNTAIN HOME AFB	NO RESPONSE				
MYRTLE BEACH AFB	X				
NELLIS AFB	NO RESPONSE				
NEWARK AFS	NO RESPONSE				
NORTON AFB		X			
OFFUTT AFB					X
PATRICK AFB			X		
PEASE AFB		X			
PETERSON AFB	X				
PLATTSBURGH AFB	NO RESPONSE				
RANDOLPH AFB	NO RESPONSE				
REESE AFB	X				
ROBINS AFB			X		
SCOTT AFB		X			
SEYMOUR JOHN. AFB		X			
SHAW AFB		X			
SUNNYVALE AFS	NO RESPONSE				
TINKER AFB		X			
TRAVIS AFB		X			
TYNDALL AFB	NO RESPONSE				
USAF ACADEMY	NO RESPONSE				
VANCE AFB					
VANDENBERG AFB		X			
WHITEMAN AFB					
WILLIAMS AFB	X				
WRIGHT-PATT AFB					X
WURTSMITH AFB	X				

Appendix C: MAJCOM Domestic Wastewater Treatment Percentages

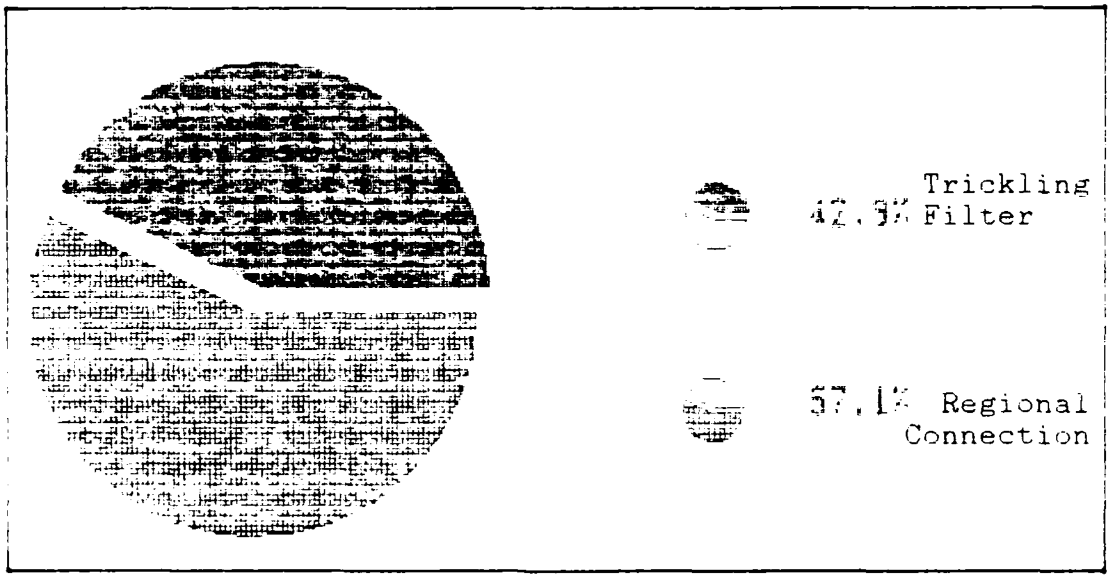

Figure C.1. AFLC Wastewater Treatment (7 Bases)

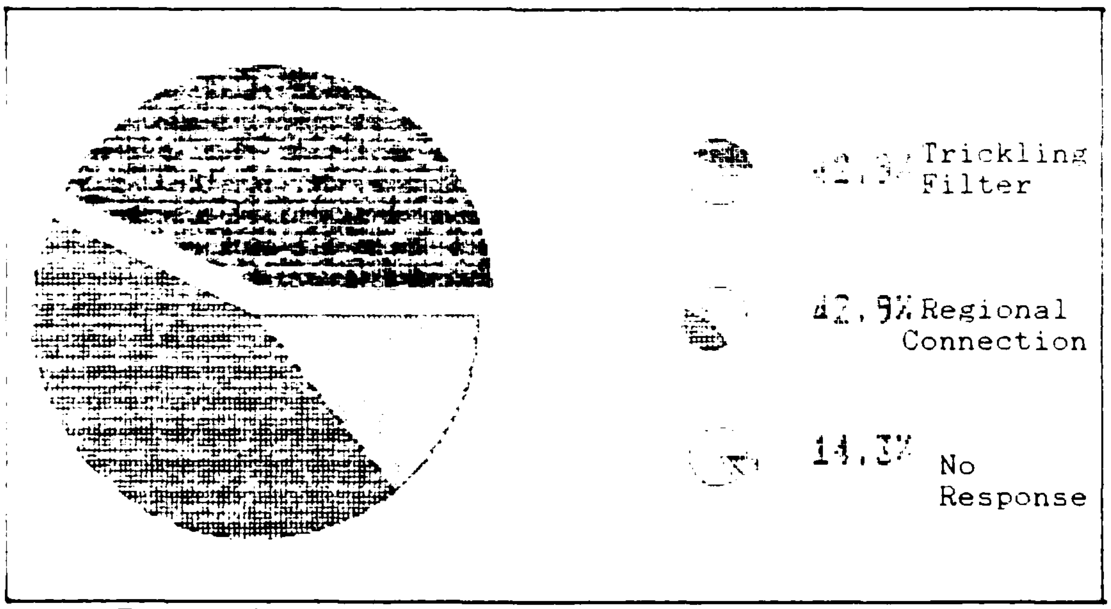

Figure C.2. AFSC Wastewater Treatment (6 Bases)

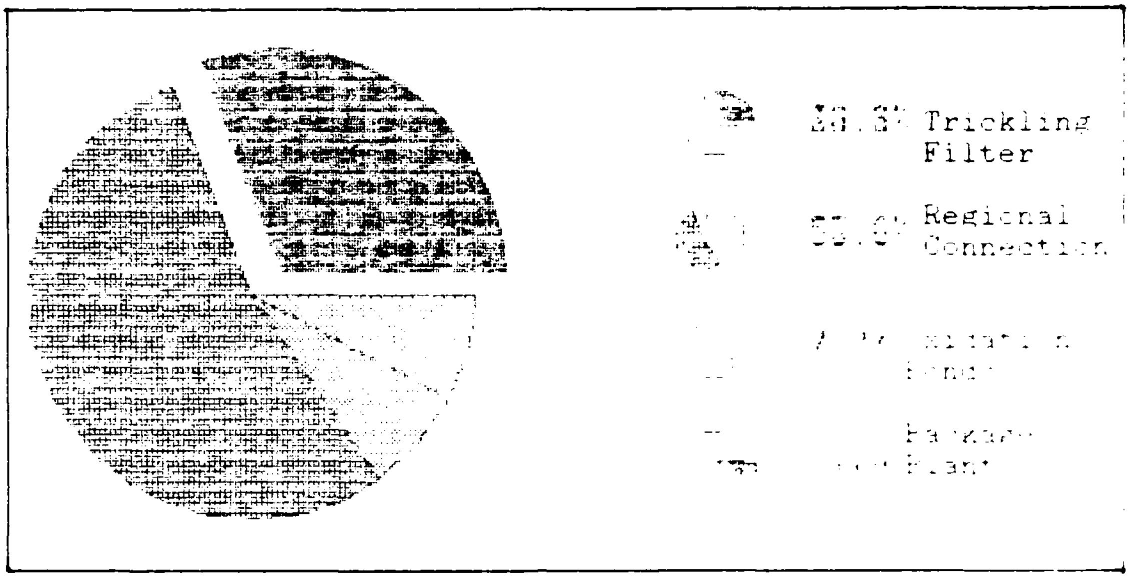

Figure C.3. ATC Wastewater Treatment [illegible]

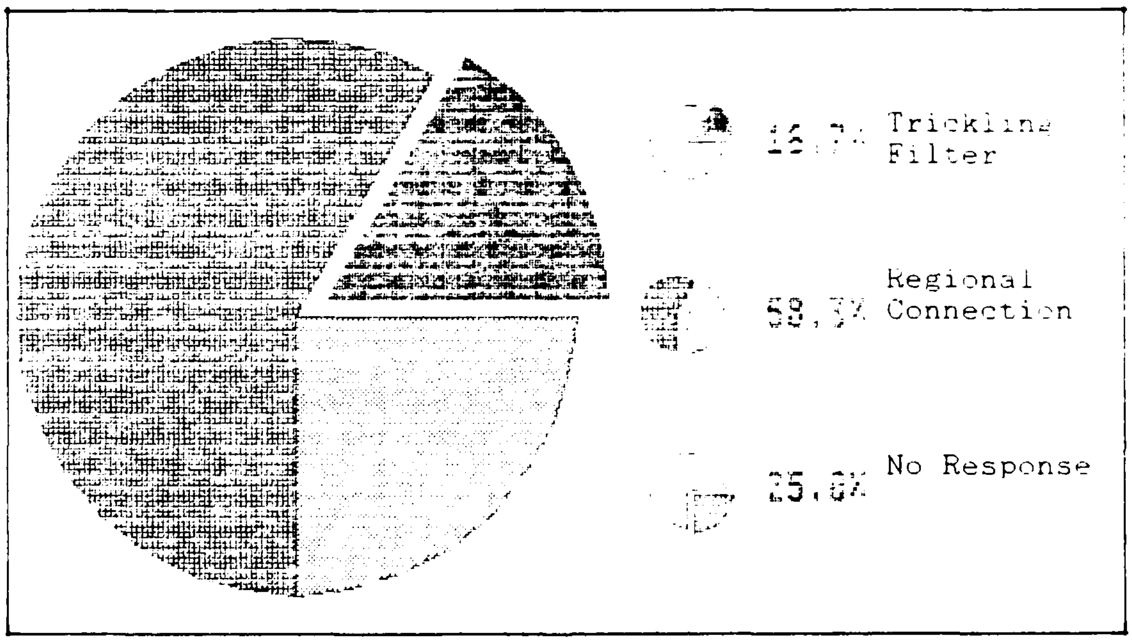

Figure C.4. MAC Wastewater Treatment (12 Bases)

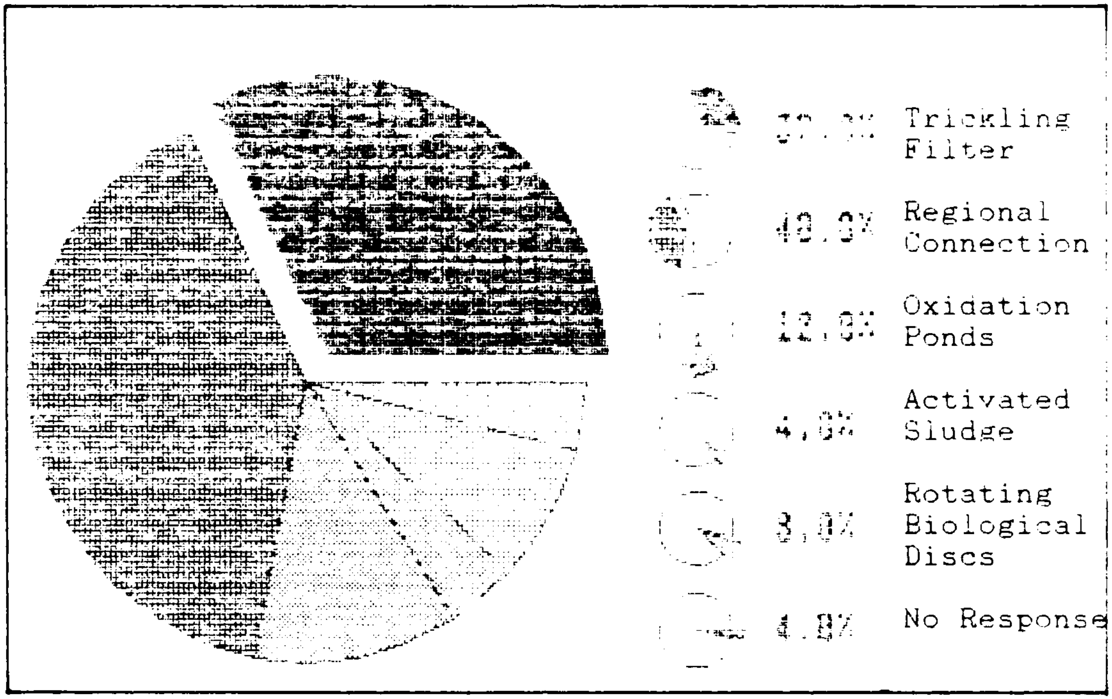

Figure C.5. SAC Wastewater Treatment (25 Bases)

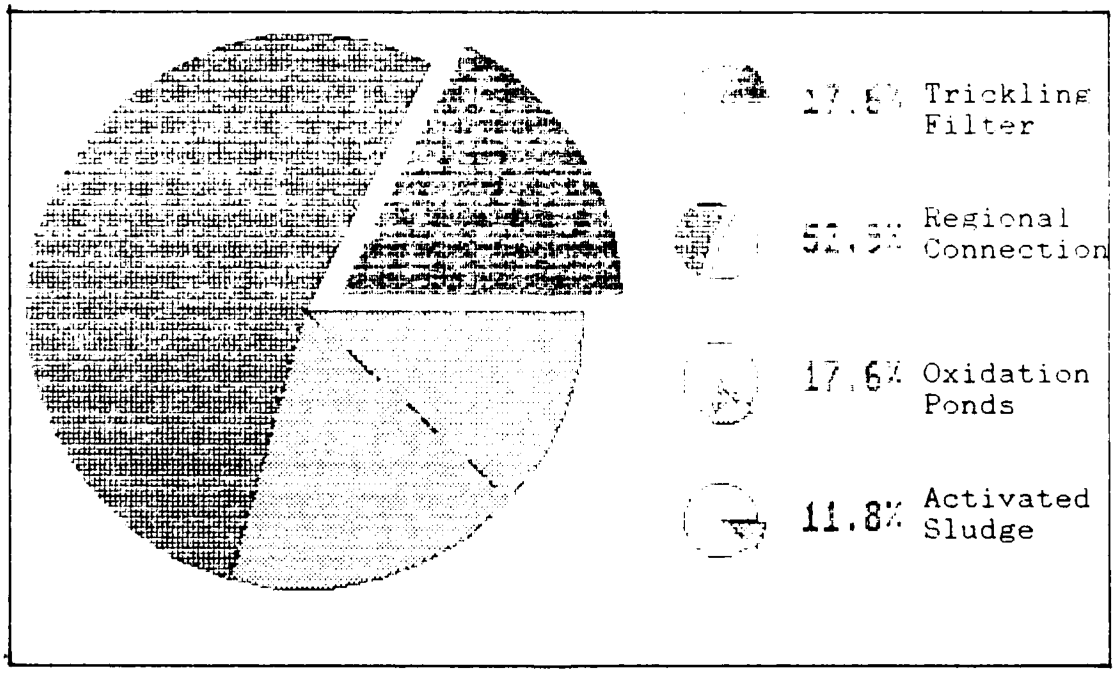

Figure C.6. TAC Wastewater Treatment (17 Bases)

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Vita

Captain Vincent E. Renaud was born 25 September 1960 in Santa Clara, California. He graduated from high school in Concord, California, in 1978 and attended the United States Air Force Academy. He received the degree of Bachelor of Science in Civil Engineering and a commission in the USAF in June of 1983. He then served as an Environmental Engineer, Design Engineer, and Chief of Logistics with the 4392nd Civil Engineering Squadron at Vandenberg AFB, California until entering the School of Systems and Logistics, Air Force Institute of Technology, in May 1986. His next assignment will be as a Construction Programmer for Headquarters Air Force Systems Command at Andrews AFB, Maryland.

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Thesis Chairman: Scott E. Streifert, Captain, USAF

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The purpose of this study is to compile an inventory of water and wastewater treatment methods for all CONUS Air Force installations and to determine the importance of the considerations affecting domestic wastewater treatment alternatives. This inventory provides the baseline data for managers to use in making future policy.

The inventory revealed that the majority of CONUS Air Force installations have regional connections. The most common type of treatment for bases with on base treatment plants is trickling filters. Industrial wastewater treatment is found at only 22 bases - most of these are only pretreatment facilities. The most common drinking water source is wells and, accordingly, the majority of bases treat their drinking water themselves.

Cost and pollution abatement tied for the most important factors to consider when making an analysis of treatment alternatives. Location of the regional system ranked next in importance followed by a tie between the quantity of wastewater to be treated and the importance of the wastewater operator as a critical military skill.

The findings of this research reemphasize the need for reciprocity between the states for certification of wastewater operators. Additionally, since many on base plants were constructed prior to the mid 1950s, it is recommended that major upgrades to these plants be considered so that compliance with the increasingly stringent standards is maintained.

Additional research is recommended in this field. Specifically, a complete inventory should be compiled and maintained to keep track of problems or trends in treatment methods.

END
Feb.
1988
DTIC