ALLEN COUNTY
Sanitary Engineering Department

204 N. Main Street, Suite 301, Lima, OH 45801

MANAGEMENT, OPERATION AND MAINTENANCE MANUAL
WASTEWATER COLLECTION SYSTEMS

Accepted by the Board of County Commissioners on

BOARD OF COUNTY COMMISSIOENRS

Dan Reiff

Sam Bassitt

Greg Sneary

Adopted:____________

Resolution No:

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 Introduction

1.1 Purpose

The Allen County Sanitary Engineering Department (ACSED) believes consistent and thorough maintenance of the collection systems will enable the collection system to serve its stated life, and meet the demands of our customer's expectations. Preventive maintenance is talked about, but seldom practiced by utility agencies. Decades of neglect, grossly inadequate maintenance of collection systems, and aging infrastructure, are three reasons why collection systems now require billions of dollars worth of rehabilitation and upgrading for the next twenty years.

This manual focuses on the inspection, repair and management practices to be utilized by the ACSED to maintain its sanitary sewer collection systems. This manual will also outline the ACSED's procedures to respond to emergency events.

1.2 Best Management Practices (BMPs)

This manual is written to help staff to be more effective in their understanding of the operations and maintenance procedures for the collection systems, and to offer ideas on how best to approach the maintenance of the collection systems. Also included is information on how to approach the inspection of the collection systems using modern technology available to identify and characterize the condition of the collection systems.

BMPs are concepts, in essence, they are measures or practices that eliminate waste and promote efficiency. There are proven methods in terms of the approach and impact on our efforts that lead consistently to the ACSED's goals. BMPs may take form of a process, activity, or physical structure. In our area of work, BMPs are those practices or work processes that result in the least impact on our environment and are the most effective or efficient management methods used to complete our work tasks. Consider BMPs as a way to search for the best practices or methods for the maintenance, management, and operation of the collection systems. They are practices that lead to improved future performance of the collection systems. BMPs will lead to properly maintained systems to allow for the following outcomes:

- Loss of, temporary, or reduced service to the customer.
- Reduce the incidence of sewage backup into basements.
- Reduce the incidence of sewage overflowing into streams or onto the ground.
- Ensure full utilization of design capacity and extend the life of the collection systems.
- Provide early identification of potential structural problems.
- Allow the ACSED become more environmentally friendly.

2.0 Public Interaction

Customers are very aware and concerned about what we do as wastewater professionals and how we do it. Like a private company or political candidate, the perception of our customers is very important. If we don't have a positive perception by our customers, it can be difficult or impossible to achieve support needed to operate, maintain, and improve our wastewater collection systems. Yearly budgets, rate increases, and public support during construction projects and difficult operational conditions are all dependent upon good public relations. We need to take a proactive approach when providing service to our customers through effective communications.

Creating and maintaining a positive image with our customers is one of the most important tasks required of wastewater professionals. To address this issue this section will provide for effective emergency response, and tasks involved with fostering good communications with the customer.

2.1 Types of Customer Concerns

2.1.1 Utility Rates

Utility rates and assessments impact all of our customers. The inevitable adjustment of rates to ensure adequate utility operating funds can be viewed by the general public as arbitrary and can lead to many complaints. Customers do not like to be surprised, especially by something that is unpleasant, such as assessments, unexpected intrusions from field studies, malfunction of the collection system, or construction that will directly impact them. The goal of a good public interaction program is to inform the customers, as close to possible real time, the causes for the rate adjustments, how it affects them, and what is being done to minimize rate increases. Customers do not like to read long communications, therefore, it is important to reduce the size of the communication to a minimum required to get the idea across. The ACSED achieves these goals through well-planned public meetings and notices, fact sheets, and information releases in the quarterly sanitary sewer bills. Finally, the most important means of fostering good public relations is through follow-up to customer concerns and treating the customer with genuine concern in understanding their problems. A well-trained staff understanding the expectations of customer service is the ultimate way of ensuring that all customers will be given the respect and attention to their issues.

2.1.2 Field Studies and Inspections

Field studies and inspections provide information and data to plan for future projects. The customer is inconvenienced during these studies from smoke testing, building inspections, and obstructions in the public right-of-way. Communication and education for the customer is the best ways to keep the customer supportive to the endeavors of the department.

2.1.3 Construction

Construction impacts residents directly by assessment, rate increases, and the lack of use of their streets and driveways during construction. Residents must deal with mud and dust, as well as utility interruptions. It is the ACSED responsibility to limit the amount of inconvenience to the customer through good construction practices and communication to the customer prior to their experiencing the inconveniences by means of public meetings, notices, fact sheets and follow-up calls.

2.1.4 New Regulations

New regulations enacted by the federal, state and local government typically produce further restrictions on how a collection system can operate. For example, recent regulations prohibit wet weather sanitary sewer overflows. Therefore, new regulations may cause new capital projects to be completed, therefore, causing inconveniences and financial impacts to the customer.

2.1.5 Collection System Failures

Failures of the collection system include sewer backups, inoperable pumping stations, plugged sewer lines, and sanitary sewer overflows. Critical information to convey to the customers include description of the problem, why it happened, what the utility is doing about it, how much it will cost the customers, and timing of the solution.

2.2 Public Education and Outreach

To satisfy public education and outreach the ACSED must implement a public education program to distribute educational materials to the community or an equivalent outreach program must be implemented. The public education program should mix local strategies to address viewpoints to all audiences. The following three general areas should be considered when implementing a public education and outreach program:

2.2.1 Forming Partnerships

Because it is generally more cost effective to use existing programs, utility departments are generally encouraged to seek assistance from governmental, civic, environmental, and industrial organizations in formulating a local program. The following educational materials and strategies may be used to develop a well-organized presentation:

- Brochures or fact sheets for general public and specific audiences.
- Alternative information, sources such as web sites, bumper stickers, refrigerator magnets, and sewer bills.
- A library of educational materials for community and school groups.
- Volunteer citizen educators to staff a public education task force.
- Event participation with educational displays at home shows and fairs.
- Educational programs for school-age children.

- Wastewater hotlines for information and for citizens reporting of polluters.
- Economic incentives to citizens and businesses.

2.3 Media

It is important that your staff know the correct person to address questions from the media. All media should be utilized when trying to communicate to your customer's the status of special projects, hearings, or meetings that may take place that will have an effect on their daily lives.

2.4 Emergency Response

The most common incidences requiring the ACSED to respond are basement flooding, sanitary sewer overflows, and temporary loss of service to the customer. Basement flooding and overflows is associated with health hazards, negative physiological impacts, and economic losses. The first two issues are significant importance, and our customer should have a high comfort level that our collection system is operating properly, and not have to worry whether their health could be compromised. As for the economical losses, basement flooding can be a major cost to the customer and insurance companies due to the fact a large number of customers have significant amount of high value possessions located in their basements (e.g. TVs, DVDs, PCs, carpet, and paneling).

Therefore, it is the ACSED responsibility to be able to respond to emergency calls whether it may be from a customer, or a call that may have been initiated through the department's alarm systems. Not only is it important that the ACSED respond quickly to emergency calls, but be fully equipped to be able to execute effective measures to reduce, or eliminate the effect that may arise from the emergency call.

Emergency Response Numbers:

ACSED	419-331-6080	3230 N. Cole St.	Lima, OH	45801
EMA	419-227-3535	333 N. Main St.	Lima, OH	45801
OEPA	419-352-8461	374 N Dunbridge Road	Bowling Green, OH	43402

3.0 Organizational and Financial Management

3.1 Organization

The ACSED operates within a single County Sewer District organized under Section 6117 of the Ohio Revised for formation and operation. The basic necessity of the organization is to have a sound management structure and adequate financial resources to operate and maintain the collection systems. The ACSED has the responsibility to operate in a manner that serves the expectations of its customer base and, at a minimum to meet the requirements of State and Federal laws. Appendix "A" Organizational Chart outlines the organization by which the ACSED operates.

3.2 Job Descriptions and Responsibilities

The Ohio Environmental Protection Agency (OEPA) requires the operator in charge to have a license with the Class designation dependent upon the complexity of the collection system. The collection system operator's supervisor should clearly communicate the responsibilities the operators/maintenance workers have and what latitude the individual has in carrying out his responsibilities. The supervisor should also meet with the operators/maintenance workers on a regular basis to review the operator's performance. The ACSED requires its supervisors to meet on an annual basis with each operator/maintenance worker to evaluate their overall performance acknowledging strengths and weaknesses of each individual so that an employee may develop to their maximum ability. Additionally, these types of one-on-one employee meetings can be scheduled as needed to address specific concerns throughout the year. The ACSED, on an annual basis, keeps on file a record of signoff by each operator/maintenance worker they have reviewed their job description and understand all responsibilities.

3.3 Staff Qualifications

Qualifications and job tasks of all operators and maintenance personnel are written and made part of individual job descriptions kept on file in the office of the ACSED. All qualifications are to be in accordance with requirements outlined by the OEPA.

3.4 Sewer Use Fees and Capital Permit Fees

The operation of the ACSED sanitary sewer collection systems is governed by the Rules, Regulations and Specifications Governing the Use of the Sanitary Sewer and Wastewater Treatment Facilities ("rules") adopted by the Board of County Commissioners, Allen County, Ohio. The rules define how the collection system is to be constructed, utilized and fees charged for the use and connection to the collection system. Sewer use fees are charged using a flat rate method of application using the OEPA water usage guidelines. Sewer Use Fees are billed on a quarterly basis to all users of the County facilities. Sewer User Fees are collected as a means to pay for the operation and maintenance of the facilities, and to provide funds for retirement of capital debt. Capital Permit Fees are collected at the time a customer connects to the County system. The amount charged for the Capital Permit Fee is also based on the OEPA water usage guidelines using a user equivalency factor to be applied to the County established Capital Permit Fee base charge for one user equivalency. The Capital Permit Fee is specifically used as a means to provide funds for retirement of capital debt.

3.5 Operational Related Expenses

Generally, the highest cost of operation of most collection systems is personnel and utility related expenses. The complexity of the sewer system determines the staffing requirements for operating the infrastructure. The ACSED operates approximately 50 pumps stations with force mains, and 200 miles of sanitary sewer. The department employs approximately 12 full-time staff to complete all of the operation of the collection systems.

Another operational cost includes utility services, such as, electric to power the sewage pump stations, cell service to operate the SCADA information-communication for the pump stations, and natural gas for backup generators. Additionally, chemicals must be purchased to control odor and corrosion within collection system, and fuel to power all other equipment and vehicles.

3.6 Maintenance Related Expenditures

Maintenance related expenses are those costs associated with maintaining the collection systems. These expenses include labor for cleaning the sewers, making repairs to the pipe, etc. Similarly, expenses associated with any equipment utilized for maintenance purposes or the maintenance of equipment associated with pump stations, including normal maintenance is included.

It is imperative the sewer system and equipment be maintained on a set schedule to ensure continued reliable service. The ACSED accomplishes this by operating a team that routinely cleans the collection system with a high pressure cleaning vehicle, and another team that performs routine closed circuit television recording of the collection system. The department also deploys a team that is responsible for the routine maintenance of the pump stations and its communication systems. Routine preventative maintenance will minimize blockages, equipment failures, and avoid higher cost replacement of the infrastructure. This manual will later provide more detail relative to the maintenance operations of the department.

3.7 Capital/Debt Service Expenditures

Many newer sewer systems have long-term debt associated with the initial construction, normally borrowed for a period of twenty to twenty-five years. The ACSED debt may be classified into two categories, assessed, and non-assessed debt. Assessed debt is generally incurred when an extension of the collection system is required to abate a pollution problem caused by failing septic systems. These types of projects are funded through borrowing general obligation bonds paid back by assessments levied upon the property owners benefiting from the collection system extension. The second classification called non-assessed debt is a type of debt that is incurred to provide adequate capacity for the expansion of the collection system, or to provide compliance to an Order from the OEPA to alleviate pollution issues or to comply with a regulatory change in the required methods for operating and maintaining a collection system.

The collection of the sewer user fees and the capital permit fees are used to allow for the repayment of the non-assessed debt incurred for capital improvements. Long-range capital plans are developed for improvements to the collection system along with long-term rate structure plans to fund the long-range capital plans. Each year funds are placed into a capital reserve fund to pay for the eventual replacement and rehabilitation of equipment and collection systems.

3.8 Budgeting/Expense Allocation

The previous expenses discussed are identified on an annual basis and compiled into an annual budget to determine the amount of revenue needed to be collected to operate, maintain and improve the sanitary sewer collection system. This amount is then divided amongst the users of the collection system to determine the appropriate amount to collect through sewer user fees and capital permit fee charges. Funds and expenses associated with operations of the department are divided into two categories: operation and maintenance.

The ACSED uses local and national rate surveys to verify and legitimize the sewer user fees and capital permit fees charged to its customers.

4.0 Safety

The Occupational Safety and Health Act (OSHA), and its State of Ohio equivalent organization, PERA, created detailed and strict guidelines to provide for the safety of utility employees. These standards were created in response to a poor safety record in one of the most dangerous occupations in its purview. Every safety precaution is for operators, their families, and the customers.

4.1 Purpose

The purpose of the ACSED safety program is to train the employee in the safe operation of equipment and methods used to perform daily tasks. This maximizes the ability of the employee to work in a safe manor and minimizes the possibility of work-related accidents thus reducing insurance claims and minimizing workers compensation costs.

4.2 Safety Meetings

The department's Safety Coordinator is in charge of the program. This person establishes the schedule and discussion topics for the monthly safety meetings. The meetings are held in the training room located in the Administrative Services Building. The training is provided through contracts with local agencies, and other safety-training consultants. The contracted provider is responsible to provide the training and related training material as well as a sign-in sheet to verify employee attendance to the meeting. A copy of the attendance sheet is on file with the Safety Coordinator.

4.3 Safety Training Topics

The monthly safety training topics, along with an employee roster, are listed on a Safety Training Matrix. See Appendix "B" for an example of the County's Safety Training Matrix.

5.0 Data Management

The key to efficient implementation of BMPs is a knowledge of your system and an understanding of past operations, maintenance, and repair activities. The key to effective data management is the establishment of a system that works for your collection system and documentation that informs a third party how the data management system is setup. With the advent of computers and database software, the ACSED has the ability to collect and retrieve a greater amount of data than in the past and with little additional help.

5.1 Data Reference-Geographic Information Systems (GIS)

In order to store and retrieve, the data must have a point of reference or physical orientation. The reference points would be manholes, pipe segments, pump stations, laterals, and sanitary sewer overflows (SSOs), outfalls and structures. The ACSED will utilize MP Digitizer as its collection system-mapping program to locate all reference points electronically to build a GIS.

The next step in the development of a data management system is to assign each reference point a distinct name or identifier. The following is a table outlining how the ACSED identification system is organized:

Main Collection System Name	Sub-Basin Identifier	Manhole Number Identifier	Manhole Extension Identifier Format
Shawnee II	SH 01	001 to 999	A, B, C etc.
American II	AM 01	001 to 999	A, B, C etc.
American Bath	AB 01	001 to 999	A, B, C etc.
Cairo	CO 01	001 to 999	A, B, C etc.
Findlay Road	FR 01	001 to 999	A, B, C etc.
Mast Estates	MA 01	001 to 999	A, B, C etc.
Woodbriar	WB 01	001 to 999	A, B, C etc.
Shawnee Oaks	SO 01	001 to 999	A, B, C etc.

Field marking will help the crews, surveyors, engineers, maintenance workers, and operators to locate collection system infrastructure.

The GIS consists of the data and the map. The data (manholes, pipe segments, etc.) will serve as an essential part of the overall electronic depiction of the collection system. Overlaying the data onto a map (aerials) yields a powerful visual tool for planning operations and maintenance of the collection system. One important aspect, that is often forgotten, is to develop a system of updating and quality assurance for the GIS to ensure the data and maps are as accurate as possible.

5.2 Computerized Maintenance Management System (CMMS)

The ACSED shall utilize the GBA Master Series Software applications for management of the collection system infrastructure. The software will enable the ACSED to link to its existing CCTV data, and GIS. Additionally, the software will allow the department, through database management, issue, track, and manage all operation and maintenance activities for the collection systems. The GBA Master Series software has separate modules to allow for specific work functions: Sewer Master, Work Master, and Equipment Master.

5.2.1 Sewer Master-Inspection Module

The Sewer Master-Inspection Module will manage the condition assessment data. The Inspection Modules comprise a structured database that archives results of field activities performed to evaluate the structural condition, inflow/infiltration (I/I) leakage potential, and maintenance requirements of the collection system assets. The Inspection Modules will provide for storage and manipulation of data for the following field inspections:

Television Inspections	Stores detailed information from CCTV work on observed pipe defects.
Manhole Inspections	Stores measurements, observations, and defect ratings for each component of the structure.
Line Lamping Inspections	Measurements made during manhole inspections used to calculate pipe invert elevations and slopes.
Smoke Testing, Building Inspections, and Dyed Water Testing	Stores detailed information observations made during smoke testing, building inspections and associated dyed water testing activities.
Flow Isolation	Provides the capabilities to track dual monitoring points and use differential flows to automatically track infiltration rates.

5.2.2 Work Master-Work Management Module

The Work Master-Work Management Module will provide for tracking of customer calls so that response time to customer concerns can be kept to a minimum. This module is also a comprehensive reactive and proactive work order system for scheduling and tracking work tasks, personnel, equipment and material usage. See Appendix “C” for a sample Work Order.

5.2.3 Equipment Master Module

The Equipment Master Module allows easy tracking of maintenance activities, requirements, and costs for any piece of equipment, any vehicle, and their respective components. This module is designed to alert managers of occurrence of several key events, including when a piece of equipment or a vehicle is due for maintenance; when the estimated lifespan of a piece of equipment or a vehicle has ended, and replacement should be considered; and when a current work order needs to be completed. The module will complete budgeting and cost analysis, tracks cost of labor used to complete work orders, and use of parts and fluids associated with a piece of equipment.

6.0 Sanitary Sewer Cleaning

The intent of collection system cleaning is to remove foreign matter from the sanitary lines and to restore the sewer to a minimum of 95% of the original carrying capacity. The success of other phases of operation and maintenance depends a great deal on the cleanliness of the lines. Removing sludge and grease deposits from sewers is an important step in extending the life of the sewer. The organic material that is deposited during low flows and low velocities starts to anaerobically decompose and creates a corrosive atmosphere within the collection system. The corrosive atmosphere can cause early degradation of the sewer lines and receiving manholes. The degradation of the system can allow root intrusion, and the eventual infiltration of stormwater. See Appendix "C" for a sample Cleaning Record.

6.1 Training

Well-trained operators are essential to the successful operation of the County's sewer cleaning equipment. The ACSED provides manufacturer training for all operators on all new/existing sewer cleaning equipment. The training is done either on site or at the manufacture's training facility. The training includes both classroom and hands-on training sessions. Training is tailored to cover the specific equipment installed on the unit. Once the training is completed it is the responsibility of the operator to maintain this knowledge. Therefore, the designated sewer cleaning crew is required to periodically review all operating and safety instructions assigned to the vehicle, and/or piece of equipment prior to starting the sewer cleaning activity.

Often, the cost of training is included in the purchase of the unit. Training on existing equipment must be financed from yearly operating budgets. A good rule of thumb for training costs is 1% of the yearly budget.

6.2 Cleaning Frequency

Generally, it is recommended that a collection system be cleaned every three to five years. However, this will not always be the correct schedule. Segments with a history of grease build-ups, poor grades, sags, root build-up will require much more frequent annual cleaning. On the other hand, for sewer lines that have good grades and flows that continually exceed 2-fps will require a less intensive cleaning program (every five to eight years).

Sewers needing more frequent cleaning should be scheduled on an as needed basis. This need can be determined by performing an analysis of slope and daily flows through each line in the collection system. A good mapping and a tabulation of pipe slopes, lengths, and sizes will make this determination a much easier process.

6.3 Cleaning Methodologies

The ACSED will use a Flex Rod Model RSR516TR Mechanical Rodder, Freightline Model FL70 High-Velocity Jet Truck and Sterling Vactor 2100 Series ("Vactor") combination vacuum/cleaning unit to perform all cleaning of the sewer lines. Primarily the Sterling Vactor 2100 Series combination vacuum/cleaning unit will be the choice for cleaning most sewers.

Typically, the selected piece of cleaning equipment will be set up at the downstream manhole of the sewer section to be cleaned. Observation of the debris being brought back by the nozzle is useful in identifying problems within the sewer. Bringing back roots or chunks of pipe have obvious implications. White chunks could indicate grease deposits. Light brown color could indicate an open joint or missing pipe. Black material is normally sludge and grit that has been in the pipe for an extended period. A clear flow and lack of odor after cleaning usually means the line is now clean. Any observations out of the ordinary should be appropriately logged.

During sewer cleaning operations, satisfactory precautions must be taken in the use of cleaning equipment. Hydraulically propelled cleaning tools depend upon water pressure to provide cleaning force. Precautions should be taken with these tools to insure that the water pressure created does not damage or cause flooding of public or private property. The hydraulic cleaning equipment can cause pressure changes as the equipment passes laterals. The high cleaning pressures can cause vacuum in laterals. This vacuum in the lateral tends to pull the water out of traps or to depress the water level in the traps and commodes. When the pressure nozzle passes the lateral, the vacuum is released. The sudden increase in pressure tends to push the water up or back toward the house causing a “blow out”. This occurs in structures that have been improperly installed or improperly sized vent pipes in the home.

6.4 Debris Removal and Disposal

Debris such as dirt, sand, rocks, grease, and other solid or semisolid material resulting from the cleaning operation should be removed at the downstream manhole of the section being cleaned. Debris should not be passed from manhole section to manhole section due to line stoppages, accumulation of grit and greases in wet wells, or even damaging pumping equipment. In order to avoid downstream problems, the crew can place a sandbag in front of the outlet in the downstream manhole. This will act as a sediment trap. The material trapped in the manhole can be removed by hand, or by the vacuum technology employed on the Vactor unit.

The material recovered will need to be disposed of properly. Material removed by vacuum will contain a large amount of water. The material will need to be stockpiled at an appropriate dewatering pad, and allowed to dry prior to disposal at a landfill.

6.5 Production Accountability

The ACSED tracks the sewer cleaning activities on a monthly/annual basis. Monthly reports are generated and reviewed which include total footage of sewer cleaned, downtime of the unit for any reason and routine/non-routine sewer cleaning activities. This allows management to monitor production trends to ensure efficient operation of the equipment.

7.0 Sewer Inspection and Defect Classification

Internal inspection of a sewer system provides valuable information regarding the condition of the sewer pipes, laterals and manholes and helps operators focus rehabilitation and maintenance on areas where it is most needed. The ACSED predominately utilizes a Peerpoint Mainline CCTV unit to conduct mainline sewer inspections. The department also utilizes a Peerpoint Model 332 push camera to investigate laterals, and in some instances, specific sites on the mainline sewer. In both inspections processes the operator is looking for defects within the system. In general, defects within a pipe or manhole develop gradually and can progress over time to a point where collapse may be imminent. Other defects arise out of external influences such as nearby excavations affecting the sewer pipe or manhole, torrential rainfalls overloading the pipes and creating washouts, broken water mains nearby, etc. Adequate identification of defects, continued observation, and proper planning can ward off many unexpected failures and lessen the reactive or emergency type repairs performed within the collection system.

This section discusses an overall inspection program for the collection system including the following topics: pre-inspection planning, inspections, condition assessment (defect categorization), recommendations and prioritization.

7.1 Training

Well-trained operators are essential to the successful operation of the County's sewer inspection equipment. The ACSED provides manufacturer training for all operators on all new/existing CCTV inspection equipment. The training is done either on site or at the manufacture's training facility. The training includes both classroom and hands-on training sessions. Training is tailored to cover the specific equipment installed on the unit. Once the training is completed it is the responsibility of the operator to maintain this knowledge. Therefore, the designated inspection crew is required to periodically review all operating and safety instructions assigned to the vehicle, and/or piece of equipment prior to starting the inspection activity.

Often, the cost of training is included in the purchase of the unit. Training on existing equipment must be financed from yearly operating budgets. A good rule of thumb for training costs is 1% of the yearly budget.

7.2 Pre-inspection Planning

Prior to beginning the inspection program it is vital to develop a plan. Whether the inspection program will be undertaken as a complete system inspection program, performed piecemeal as part of other sewer system evaluation activities, or instituted only in a reaction to customer complaints, program standards implemented early will provide many benefits. This applies to in-house crews that may perform the inspections as well as outside contractors. When soliciting outside contractors to perform inspections, having an established inspection program that lists equipment specifications, inspection standards, and protocols will ensure that all bids received are for the same level of service and consistent.

Prior to the inspection some basic elements of the program need to be established. First, the manholes and pipes need to be identified through the GIS. Second, to ensure the data is collected in a consistent format and that all necessary data is collected during an inspection, standardized inspection forms should be developed. Third, a standard defect identification or categorization needs to be established. Standardizing how defects are categorized is important to minimize the subjectivity often associated with defect observation. Adopting standard defect classifications and training those performing the inspections will make the collected data easier to interpret and more useful over the long term in evaluating the condition of the collection system. See Appendix E for the defect code and explanation.

7.3 Inspection Methods

Inspection methods to be used are personnel-entry physical inspection of the manholes, and remote closed-circuit television (CCTV). Prior to completing an inspection the designated inspection crew is required to review all operating and safety instructions developed for the specific vehicle and/or piece of equipment, and review the protocol for completing the inspection needs to be reviewed, and required equipment list to be prepared.

Field Crew Protocol for Completing CCTV Inspections
¤ When possible it is best to perform inspections of consecutive pipe reaches in order from upstream to downstream.
¤ When obstructions prevent completion of an inspection, the crew should set up at the next manhole and try to complete the inspection from the other direction.
¤ When performing the inspection of the pipe, complete the inspection from manhole to manhole, logging all defects and side connections. This applies even if the inspection is being performed to locate a blockage or for another specific purpose. The majority of the cost is mobilizing the inspection crew and getting the camera in the sewer. Therefore, you want to maximize the data collection for every inspection event.
¤ When taking photographs of surface features, orient the camera to the north.
¤ When performing an inspection provide any drawings or sketches along with the inspection form that will help in understanding the situation or mapping of the sewer.
¤ The on screen display at the start of an inspection shall include (at a minimum) the date of inspection, start and end manhole number, direction of travel, and the inspection crew.
¤ During the inspection of the footage should be displayed on screen at all times.
¤ At the beginning and end of all inspections, the camera shall be panned to view the manholes.
¤ Audio commentary shall be mandatory and shall describe the conditions and observations.

The camera shall be moved through the line in either direction (preferably upstream to downstream) at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute (FPM). Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera viewer interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation, the television camera will not pass through the entire manhole section, the equipment shall be set up so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire manhole section, the inspection shall be considered complete and the location of impasse will be documented for further investigation.

7.4 Inspection Frequency

Generally, it is recommended that a collection system be initially televised following cleaning of the sanitary sewer. The schedule for re-inspection is dependent upon the observations during the previous inspection. For pipes in good operational order with little or no minor debris, re-inspections can be scheduled as far as 15-20 years. For pipes that exhibit some defects, at first examination, do not warrant maintenance or rehabilitation, the re-inspection schedule may be accelerated so that the condition can be monitored more closely. In summary, the frequency of inspection of a sanitary sewer should be based on the condition of the sewer, and the flow history.

7.5 Defect Classification

There are two general categories of defects: structural and operational. Structural defects are pipe and manhole problems related to pipe and manhole materials or connections. Structural damage may reduce the pipeline's ability to convey wastewater without flooding, property damage, or health risk. Often structural defects are related to water surrounding the pipe, poor pipe bedding, and hydrogen sulfide corrosion. Examples of structural defects include: fractures, holes, missing bricks or tiles, broken joints, or offsets, corrosion, and misalignment of pipe and barrel sections.

Operational condition defects present a wide range of conditions that can either directly impact the performance of the sewer or are indicators of potential structural defects. Examples of operational defects include: debris, mineral deposits, infiltration, roots, service connection intrusions, and hydraulics (over capacity, low flow, slow flow, etc.). Operational conditions to be noted during inspections include silt, grease, manufactured debris, gravel/rocks, vermin, mineral deposits at the joint, infiltration, exfiltration, roots, and protruding service connections.

Assessing the condition of a pipe or manhole in order to recommend rehabilitation or continued monitoring is based not only on the observed defects and conditions noted during the inspection but on other conditions or factors as well. For example, frequency of discharge, presence of hydrogen sulfide, material of construction, surrounding soil type, condition of side sewers, groundwater conditions, construction methods, loadings on pipe, and surface features. All of the referenced factors along with other available information such as maintenance history or previous repairs are considered in order to determine if the pipe or manhole is at risk of failure.

The end result stemming from an inspection event should be a recommendation for what to do with the particular pipe or manhole being inspected. There are five levels of recommendations as follows: 1) re-inspection, 2) perform maintenance, 3) stabilize, 4) structural rehabilitation, 5) do nothing-good condition. Appendix “D” will be used as the Standard Defect Code, while Appendix “E” and “F” will be used as the Sewer Inspection Report, and Manhole Inspection Report.

7.6 Production Accountability

The ACSED tracks the sewer inspection activities on a monthly/annual basis. Monthly reports are generated and reviewed which include total footage of sewer inspected, downtime of the unit for any reason and routine/non-routine sewer inspection activities. This allows management to monitor production trends to ensure efficient operation of the equipment.

8.0 Pump Station and Force Main Operation and Maintenance

This section is designed to serve as a stand-alone document for the management of wastewater pump systems (WWPS). Wastewater collection system managers are responsible for developing a program for the operation, maintenance, and repair of wastewater pump stations and force mains. This section will focus on the various tasks associated with wastewater pump systems in Allen County, including the following:

- Classification
- Operation
- Maintenance
- Problem diagnosis
- Repair
- Record keeping

A wastewater pump system is a system that conveys wastewater to a gravity sewer at a higher elevation through the use of mechanical energy (pumpstation) and a pressure pipe (forcemanin). The pump station and forcemain system permits extension of the gravity wastewater collection system beyond the area, which naturally drains to that collection system. It is important that the pump station and forcemain system does not overload the gravity wastewater collection system to which it is connected and create problems downstream of the pumpstation. The County has an obligation to its customer base to prevent the occurrence of any such problem. From the customer's point of view, they are paying a fee for continuous wastewater collection service under all conditions. System failures can produce consequences that are unacceptable, such as basement flooding. Everything practical is done to ensure that customers are not inconvenienced and their property is not damaged.

Allen County's wastewater pump stations are made up of predominately new Gorman Rupp Model J Series aboveground valve package pumpstations that are constructed to the latest standards in safety and reliability. The department uses EONE Model GP low-pressure pump systems that are constructed to the latest standards in safety and reliability for specific areas where the installation of gravity sewer is not a practical solution. Pumpstation problems that arise are prioritized and corrected as soon as possible. Pump station repairs are confined to replacement of components such as pumps, valves, controls, etc. The actual repair of these individual components is performed in the pump repair room in the Maintenance garage or at the manufacturer service shop. See Appendix "G" for a Sample Pumpstation Work Order.

8.1 Training

Well-trained mechanics and operators are essential to successful pump station operation. Training covers all components that exist with the pump systems, including pumps, level sensors, controls, valves, auxiliary power generators, and SCADA equipment. Training includes a review of daily maintenance checks, periodic component replacement, problem diagnosis and repair, safety, and emergency response. Training comes in a variety of forms.

Most pump manufacturers offer training to mechanics and operators when new equipment is purchased. Usually manufacturers send a training instructor to Allen County's facility or County staff can be sent to a local training site. This training is tailored to the specific equipment installed at the facility under construction. Often, the cost of training is included in the bid cost of the equipment. Some manufacturers also offer training for existing equipment at their factories. Training on older equipment may be difficult to obtain as the new models are introduced.

Training on existing equipment must be financed from yearly operating budgets. A good rule of thumb for training costs is 1% of the yearly budget. There are a number of commercial sources of training on general topics. Many of these companies send out flyers to clients to inform them of upcoming training seminars in their area. This training is broader based than the manufacture's training. It covers all types of pump station equipment to appeal to a broader audience. The training is comprehensive and informative but may be a little more expensive. It usually lasts from one to several days and is frequently held in another city, resulting in additional travel, lodging, and food expenses.

8.2 Pump Station Configurations

The County's typical wastewater pump station system configurations are listed below:

Submersible Pumps: All of Allen County's Gorman Rupp pump stations are designed as submersible stations. The pump/motor combination is submerged in the wet well, and the control system is mounted in an enclosure above ground. Since the pumps can be pulled and reinstalled without entering the wet well, this system almost eliminates the need for a confined space entry to make repairs.

Grinder/Progressive Cavity: The EONE grinder pumps are also used in small flow situations. These pump stations are equipped with positive displacement pumps similar to progressive cavity pumps. A stainless steel rotor turns against a rubber stator.

8.3 Components

All of the County's pump stations include many of the components listed below, depending upon the type of pump station and when it was constructed.

Pump Station Protection: Every pump station has a different quality of wastewater, depending upon the type and condition of the wastewater collection system serving it, types of customers upstream, and the ability of the system to be vandalized. Apartment buildings, restaurants, and food service industries regularly contribute grease loads to their wastewater, which may or may not be intercepted by grease traps. Prisons, hospitals, and camping facilities can contribute unusually high quantities of rags, towels, and other stringy material that can clog pump impellers. Old wastewater collection systems which have leaky joints and other sources of inflow can contribute sand, gravel, and pieces of sewer conduits to the wet well which can destroy pump impellers and shafts. Pump protection structures can consist of separate screening or comminution structures accessible for cleaning and maintenance. In smaller stations whey can consist of a grease and grit trap that is not accessible for cleaning and maintenance. In larger pump stations, pump protection equipment can be located in the wet well structure, above the wet well.

Wet Well: All wastewater pump stations have wet wells. The purpose of the wet well is to store wastewater sufficiently to minimize the number of pump starts. Excessive numbers of pump starts prematurely wear out the starters. Typically, pumps are controlled upon the basis of the level of wastewater in the wet well. Wet wells serve other functions not originally intended, including a location where grit and grease is collected, if not protected by a structure upstream. A wet well is a reservoir that receives wastewater from the collection system and stores it for pumping. Wet wells are made of concrete and contain actual pumps themselves. Wet wells also include water level monitoring equipment. A wet well can vary from a manhole to a vault. A wet well is classified as a Class I Division 1 space, which mean it is considered a confined space. Certain equipment located therein must be explosion proof.

Valve Vault: Valve vaults are used in some older submersible pump stations to house valves and bypass piping, if included. In most new pump stations, the valves and bypass piping are located in a fiberglass enclosure above the wet well, eliminating another confined space.

Flow Meter Vault: Flow meter vaults are sometimes used with pump stations to house a flow meter. The County has a few retrofits that use a flow meter vault.

Pumps: Pumps are classified in one of two categories: kinetic energy or positive displacement. Centrifugal pumps are kinetic energy pumps. One of the most common pumps used in wastewater is the centrifugal pump.

Centrifugal pumps have two primary parts: the impeller and the pump casing. The pump casing directs the wastewater to the impeller. The impeller is a device that, as it spins, forces the wastewater being pumped to move circularly. This circular movement increases the velocity and pressure of the wastewater. The pump casing then leads the wastewater away. The shape of the impeller and pump casing vary with the type of centrifugal pump and the application. Wastewater pump stations in smaller communities generally need to be able to pass solids and small rags in the flow. Pumps with single-end suction and non-clog impellers are common in this type of application. Non-clog impellers typically have open passages and two vanes (in smaller pump stations). This allows solids and rags to pass through.

Pumps located in the wet well are called submersible and are powered by a close-coupled submersible motor. Prior to current technology, close-coupled motor and pump configurations were not reliable due to seal failures and impeller clogging. Close-coupled submersible pump and motor configurations are very reliable now and are the preferred configuration for pump stations.

Pump Seals: Pumps are equipped with mechanical seals to protect the pump motor from the pumped liquid. Mechanical seals consist of a set of mechanical discs and sleeves, which are forced together by spring pressure.

Piping and Valves: Valves are used after the pumps to isolate them from the rest of the system for maintenance. Check valves can also be used to control the operation of the pump and to prevent unwanted conditions, such as backflow through the pump. There is a wide selection of valve types available, each with its own advantages and disadvantages. Typically, shutoff valves used in Allen County's wastewater pump stations are plug valves, although a few gate valves are still in use. Check valves are used to prevent reverse flow in the pump, protecting it from damage.

Forcemain: Force mains are pressure pipes that convey flows from the pump station to a discharge point. Outlet structures typically consist of a manhole at the end of a gravity sewer. The design of this outlet structure usually aligns the discharge pipe with the gravity sewer outlet to minimize or eliminate splashing (which will result in odor problems).

Controls/Electronic Pump Drives: Pump station controls tell the pump system when to turn on and off. Pumps are turned on and off based on water level in the wet well. Controls may also be used to activate alarms, such as high water. Pump station controls contain hour meters and pump start counters, which will provide valuable data in diagnosing pump operational problems. Pump stations operate using either constant-speed or variable-speed drives. Pumps using constant-speed drives have motors that operate on a single motor speed. When the pump is turned on, the motor revs up to its operating rate and maintains that rate until it is turned off. Variable-speed drives operate over a range of speeds. They are best suited for situations where operating conditions change. Selection of a drive type is based on the operating conditions, energy requirements, and associated costs. Soft start and stop features decrease startup current requirement on pumps discharging in long force mains and decrease surge or water hammer conditions. In some cases, electronic drives are used to provide three-phase power where only single-phase power is available. It is generally accepted that all pumps of greater than at least 20 horsepower should be provided soft start and stop controls.

Sensors: Pump stations can use a variety of sensors to measure wet well liquid level. Most of Allen County's pump stations use an air bubbler line attached to an electronic pressure switch. The pressure switch can be set to trigger contacts at various set points. Mercury float switches can sense levels by flipping on their side when the level rises above their elevation. Pressure switches measure liquid level by the pressure of the liquid above them. All these devices can be effective if provided regular maintenance. A problem with mercury floats is their tendency to become encrusted with grease and thereby to malfunction. If these devices are not readily accessible for cleaning, they can be rapidly nonfunctional.

Power: Since wastewater pump stations convey daily flows generated by resident, businesses, etc., problems can be caused when the power is disrupted. Back-up power can be provided by a portable diesel generator, and can maintain pump operations when normal electric service is disrupted. Currently, Allen County's newest lift station was provided with a permanent natural gas powered generator, and other sites are being considered for similar installations. The decision to have back-up power is based on the type and probability of the pump station being offline and the costs associated with the back-up power system. Recent regional power outages provide a unique perspective in auxiliary power. Under regional power outages, Allen County must provide auxiliary power or portable auxiliary pumps for each wastewater pump station. The ability to supply auxiliary power (for a large number of pump stations) in a timely manner can be difficult using portable generators.

Site and Appurtenances: These include the embankment upon which the pump station sits. A paved driveway provides vehicle access.

8.4 Operation

Normal operations refer to the conditions under which the pump station generally operates. Pump stations are required to lift wastewater flow generated from residents, businesses, etc., 24 hours a day, 7 days a week. During normal operations, wet wells fill, pumps are turned on and run until the wet well level is lowered. Normal pump operation balances storing wastewater flows with frequent pump operation. Wastewater flows that are stored for too long of a period of time can produce odors and corrosive hydrogen sulfide. The time period that flows can be stored before problems begin varies with the strength of the wastewater. Pumps that operate too frequently can wear out prematurely, increasing O&M costs. In general, pumps cycle on and off no more than 4-6 times per hour. Such operation minimizes detention time and consequent odors emanating from the wet well without overworking the equipment.

Under normal operations, wastewater pump stations are operated automatically. Controls for most wastewater pump stations include a switch to alternate which pump will be used as the lead pump (the first pump to operate as wet well levels rise). Sensors are used to detect water levels in the wet well. The water levels at which pumps turn on and off are called set points. Operational control of wastewater pump stations includes modifying set points, pump alternation, compiling operational records, and installing and monitoring remote sensors.

Evaluation of Operation

Operational data can be used to identify problems in pump station systems. Operational data that is useful includes the following:

- Basement flooding complaints
- Flow metering records
- High-level alarm occurrences
- Individual power phases data
- Odor complaints
- Pump breakdown records
- Power bills
- Pump run times and start counts
- Supply voltage data

Basement Flooding Complaints: Basement flooding complaints may indicate that the pump station is either undersized or not operating properly.

Flow Metering Records: Flow metering data, when compared to the capacity of the pump station at the highest allowable liquid level, indicates whether that pump station has sufficient capacity to meet the needs of its service area. Sudden increases or decreases in flow rate can indicate problems in the collection system, such as a broken pipe or a water main break.

High Level Alarm Occurrences: Frequent occurrence of high-level alarms can indicate that the pump system is undersized, the pump level sensors are not operational, or there is a problem in the collection system, such as a water main break.

Individual Power Phase Data: The loss of a phase in a three-phase, variable frequency drive can destroy a VFD drive. All newer pump stations are provided with a phase monitor relay to shut off the pump in such situations.

Odor Complaints: Odor complaints may indicate that wastewater is remaining in the pump station too long. The wet well level set points are reviewed to check if they are set too high. Alternately, the wet well can be aerated or bioxide can be added to the wet well.

Power Bills: High power bills for the station can indicate a low power factor or inefficient pump operation.

Pump Breakdown Records: An excessive frequency of pump breakdowns for either a particular type of pump or in a particular location may indicate either that the pump is not sufficiently rugged to handle design flow conditions or that something, such as grit and rags, is causing frequent pump breakdowns and requires some means of protecting the pump. Observation of a trend may provide sufficient justification for a change in pump manufacturers or pump types. Continued extraction of rags and stones from the pump may indicate that wet well cleaning is needed on a more frequent basis.

Pump Run Times and Start Counts: Review of the pump start counts will indicate whether the pump alternator is working properly or is using only one pump as a lead pump. A disproportionate number of pump run hours from one pump to another indicates that the automatic pump alternator is not operational or that the capacity of one of the pumps has been diminished. When both pump start counts and hour run meters are both available, an even number of pump starts and disproportionate number of hours run indicates that the high hour pump is not operating properly. All of this data can be accessed via the Mission Telemetry System.

Supply Voltage Data: Fluctuations in supply voltage indicate that there are excessive power demands in the vicinity of the pump stations. Excessive voltage fluctuations may damage pumps, controls and SCADA systems.

Emergency Operations: It is the responsibility of a public utility to maintain operation of pump systems under all conditions. Weather can present serious adverse conditions for pump system operation, including flooding, high winds, and lightning.

Such natural forces could damage systems through physical force, indirect damage of electrical components by immersion (by flooding), and direct electrical damage. Pump systems are also subject to damage from the explosion of flammable liquids in the sewer system, vandalism, and traffic damage.

Flooding: Currently, pump station structures and electrical and mechanical equipment are required to be protected from physical damage by the 100-year flood. Flooding can interfere with normal operations in a variety of ways that range from prohibiting access to equipment to the destruction of electrical equipment. Flooding rarely occurs in a localized manner. Therefore, if the pump station is flooded, the sewer system upstream is likely to be flooded as well as the sewer downstream.

Damage by Tornado or Wind: Aboveground structures subject to wind damage include electrical power lines and poles, control panels, and aboveground structures. Allen County plans for minimizing service outages by recording specification data for all aboveground structures and stocking repair parts as affordable.

Loss of Power: Loss of power can occur locally or regionally. Allen County's emergency operation plans consider bother types of power loss situations since the resources available to address the problem may differ. The Collection department currently has two portable generators, eight portable pumps, and one stationary generator available for these emergencies. Plans are also in the works to install permanent natural gas fired generators at several other pump station sites.

Vandalism/terrorism: Vandalism and terrorism can attack any part of a pump station, from the building structure to the mechanical equipment to the control system. Emergency operation plans should identify weaknesses in a pump station design. Fencing and lighting are the first defenses against vandalism. More expensive protection could include SCADA monitoring and time lapse television coverage used to determine when and who is causing the damage.

Damage resulting from Vehicle Accidents: Vehicle accidents can cause physical damage to the pump station structure as well as other components that are subject to impact. Some of Allen County's pump station sites are protected by concrete-filled bollards to minimize damage from vehicle accidents. Should these measures fail, more aggressive traffic control measures may be required, including fences and site-access gates.

Lightning Damage: Direct lightning strikes can overload control boards and damage the pump equipment. Installing surge arrestors in the control panels and installing an effective grounding system on the electrical service and the control system have minimized lightning damage. Surge arrestors, once struck, must be replaced with a new one. Therefore, spares are kept on hand to place the pump station back in service as soon as possible.

Damage Resulting from Electrical Surges: As with lightning strikes, electrical surges can damage pump station controls and equipment. Surges can be caused by damage to power lines and substations as well as turning equipment with very high power requirements on and off. Pump stations located at the end of long dead-end electrical lines are especially susceptible to damage. Allen County's control panels and pumps are protected by phase monitors, which shut down the control system whenever a voltage surge or low voltage is detected.

Forcemain Breaks: During forcemain breaks the pump station must be bypassed until the forcemain can be repaired. A forcemain break is usually caused by contractors digging in the area or by directional boring of telephone or power lines.

A common means of providing continued operation through emergency situations includes the use of portable pumps or generators. Portable pumps draw from the wet well or a nearby manhole. Flexible hoses with valves constitute a forcemain. Portable generators provide power until the involved utility can make repairs and restore service. Connections to the forcemain are typically located on the side of the station enclosure, and are equipped with cam-lock type connectors. The use of such portable equipment provides a high degree of flexibility and can enable a utility to maintain operation for nearly all conditions.

8.5 Maintenance

Maintaining a wastewater pump station will help to ensure Allen County receives the complete value of its investment. Maintaining a pump station requires maintaining manufacturer data, performing periodic inspections, understanding special requirements, performing periodic lubrication, understanding the schedule for mechanical component replacement, and having the appropriate equipment. All of this information is included in the CMMS system.

8.5.1 Manufacturer Maintenance Data: Data sheets are normally shipped with equipment when new pump stations are constructed and when new equipment is installed. Startup reports are issued after the station is successfully started for the first time. Missing data sheets or startup reports can be replaced if the manufacturer is still in business and if the wastewater collection systems superintendent has nameplate data from the equipment. These data are critical to developing a good maintenance program.

Pumps: Manufacturer pump maintenance data includes:

- Parts list and the nearest location to purchase these parts
- Recommended maintenance tasks and how often these tasks must be repeated
- Procedures for maintenance tasks
- Recommended tools, lubricants, and parts for each maintenance task
- Exploded view drawings of the pump, identifying all parts included and how they fit together
- Pump performance curves
- Pump diagnostic procedures
- Recommended diagnostic instruments

Controls: Manufacturer control maintenance data includes:

- Wiring diagrams
- Plans of the control cabinet showing the placement of various components
- Parts listing
- Control diagnostic procedures
- Control performance data
- Recommended diagnostic instruments

Sensors: Manufacturer sensors include the following:
- Teardrop mercury switches
- Air bubbler
- Float switches

Plug Valves: Manufacturer maintenance data includes:
- Spare parts list
- Exploded view drawings showing all parts and how they fit together
- Parts listing and nearest location to obtain parts
- Procedures for maintaining and repairing the valve

Check Valves: Manufacturer maintenance data includes:
- Spare parts list
- Exploded view drawings showing all parts & how they fit together
- Parts listing and nearest location to obtain parts
- Procedures for maintaining and repairing the valve
- Lubricants, sources of lubricants, and recommended lubricant schedule

SCADA: SCADA maintenance data includes:
- Wiring diagrams
- Plans of the control cabinet showing placement of various components
- Parts listing
- Control diagnostic procedures
- Control performance data
- Recommended diagnostic instruments

Generators: Generator maintenance includes:
- Wiring diagrams
- Exploded view drawings of the generator, engine, and the control panel
- Parts list and the nearest location to purchase these parts
- Recommended maintenance tasks and how often these tasks must be repeated
- Procedures for maintenance tasks
- Recommended tools, lubricants, and parts for each maintenance task
- Exploded view drawings showing all parts and how they fit together
- Generator performance curves
- Generator diagnostic procedures
- Recommended diagnostic instruments

Automatic Transfer Switches: Automatic Transfer Switch maintenance data includes:

- Parts listing
- Exploded view drawing
- Cabinet plans
- Diagnostic procedures
- Listing of maintenance tasks, procedures, and recommended intervals

Ancillary Equipment: Ancillary equipment includes fencing, driveways, sidewalk access hatches, lighting, doors, antennas, structures, heaters, exhaust fans, dehumidifiers, sump pumps, and water seal systems. Manufacturer documents, including operation and maintenance manuals, are typically delivered with new installations. These documents include installation, operation, maintenance, troubleshooting, and repair information needed.

8.5.2 Periodic Site Visits: As with any mechanical equipment, it is important to observe, in person, operation of all equipment at least once a week—even with the use of a SCADA system. Records are kept of the results of these weekly visits, including both operation and maintenance checks and results. The following is a check list for periodic site visit inspections:

Exterior of Station:
- General condition of station exterior
- Condition of gate, lock (if applicable)
- Condition of station lock
- Level of wet well
- Condition of wet well, grease build-up

Controls, operation
- Are there any alarms showing on panel?
- Is telemetry operating?
- Does wet well level display match the actual level observed?
- Operate pumps manually-check for amp draw, unusual noises
- Does wet well level drop at a normal rate when the pumps are run?
- Check flow meter operation
- Check piping for leaks
- Check valve operation
- Does check valve close after the pump shuts down?
- Do the pumps alternate normally?
- Check bubbler air pump and filter
- Exercise ball valves

Cosmetics
- Is the station interior clean?
- Does exterior need paint or cleaning?
- Does grass need mowing?
- Is landscaping in good condition?

8.6 Special Requirements

There are special requirements that the operator must pay special attention to in the operation and maintenance of wastewater pumpstations. The following is a list of those special requirements.

Wet Well Cleaning: Wastewater collection systems collect and convey grit and gravel to the pump station wet well. Over a period of time this material accumulates and must be removed. Typically, wet wells are cleaned using the Vactor or vac trailer at least once per year. Grit accumulation decrease the volume available in the well and increase the number of pump starts. This can prematurely wear out pump starters. In addition, grit and gravel can wear out pump impellers, seals, and check valves and reduce capacity of forcemains by collecting at low points. Grease interferes with pump level sensors. As a result, the pump does not shut off at its low water cut off elevation. This condition, in turn, results in cavitation and air entrainment, which will damage the pump and reduce pump station capacity, especially if air relief valves are not installed in the forcemain before the check valves.

Liquid Level Sensor Cleaning: Liquid level sensors (teardrop mercury switches) are cleaned as necessary, as determined during the weekly pump station check. Fouling of sensors with grease results in failing to properly turn pumps on and off.

Generator Operation: Generators must be operated routinely to ensure that they will start when they are needed. Oil is changed based on calendar time since generator operating hours is usually minimal.

Fuel Preservatives: Fuel degrades with time unless preservatives are poured into the tank. Diesel fuel is especially susceptible to algal infestations, which clog fuel filters. Gasoline also degrades with time by loss of volatile constituents. Thus, fuel preservatives are used in situations where equipment is expected to be idle for an extended period of time, such as with the back-up generator.

Monitoring Power Voltage by Phase: This requirement is most important for pumps with soft start and soft stop controls. Loss of power in one phase of a three-phase power supply will destroy a soft start and stop motor drive. The phase monitors installed in our control panels protect against this type of damage.

Periodic Lubrication:
Exposed pumps, valves, motors, sump pumps, and ventilation systems require periodic lubrication. Lubrication of mechanical equipment is done in accordance with manufacturer recommendations.

Maintenance Equipment:
Pump station maintenance equipment includes:

- Truck-mounted crane: to lift pumps and valves
- Air compressor: to provide power to air tools used to disassemble piping and to disconnect pumps and valves
- Vacuum/high pressure sewer jet cleaning equipment mounted on a truck.
- Grease guns
- Oil changing equipment

8.7 Problem Diagnosis

Operational data is used to identify a problem that exists with a pump station. Often additional testing or investigation is required to diagnose the problem. Wastewater pump stations problems fall into one of three classifications: hydraulics, controls, and power.

8.71 Hydraulic/Mechanical Trouble Shooting

Noise, vibration, and lack of capacity are indicators of a problem with the pump and forcemain system. Hydraulic problems are investigated using pressure gauges installed in the suction and/or discharge line and drawdown tests. Pumps are rated to operate at a specific flow and head, for example, 800 gpm at 70-ft TDH. If a pressure gauge indicates the head at which the pump is working against is significantly different than the pump rating, then the forcemain should be investigated for conditions that would increase head. Such conditions include grease fouling, corrosion, sedimentation, and air binding. Valve positions should be checked to verify valves are fully opened. Partially closed valves can significantly increase the head a pump is working against.

Cavitation can occur on either the suction or discharge side of the pump. Cavitation occurs when the liquid is changed into vapor and back again. The compression of the vapor back into a liquid causes a violent imploding action that damages impellers. Removal and inspection of impellers for missing material and premature wear can diagnose cavitation.

Pump capacity can gradually decrease with eroded or worn impellers. Flow with high grit content can erode impeller vanes over time. The decrease in pump capacity may be gradual enough that it is not noticeable on a daily basis. This can be diagnosed by periodically inspecting the impellers for wear. Reviewing long-term pump flow records is also useful in identifying this condition.

8.7.2 Controls Troubleshooting

Automatic controls are similar for all types of pump stations. Automatic pump system controls typically include such components as level sensors, magnetic contactors, circuit breakers, alternators (automatic switches which alternate the lead or first on pump), fault sensor indicating lights, and occasionally soft start and stop motor controls. Most commonly, malfunctions are confined to level sensors, magnetic contactors, and automatic alternators. Level sensors can be fouled by grease in the wet well. Magnetic contactors / automatic alternators are subject to wear-out.

8.7.3 Power Troubleshooting

Monitoring the voltage drawn during a drawdown test can also be useful in diagnosing pump station problems related to the power supply. Motor sizes for a pump station are selected based on the pump and head requirements. For example, 800 gpm at 70-ft TDH requires 22 hp so the next size motor, a 25-hp motor, is installed. If, during a drawdown test, the pumps drew 18 hp, the power supply should be tested.

Motor malfunctions can be diagnosed by checking the current in each of the incoming lines and the power cables connected to the control panel. Three-phase motors are susceptible to damage from unbalanced voltages applied to the motor. Unbalanced voltages cause temperature increases in the motor windings. Thermal cutouts embedded in these windings may detect this overheating and shut down the motor. Another consequence of unbalanced voltages is rotor overheating, which results in bearing or seal failure. Causes can usually be traced to the motor (windings or motors), controls (blown fuse or defective contactor point), or the power company.

8.8 Repair

Successful pump and pump station repairs begin with planning. There are several factors that must be considered in the repair process to ensure safety and effective repair procedures. The following are considerations for an effective repair program. Appendix "H" contains the Questions to Consider for a Pumpstation Repair Program.

8.8.1 Site security and layout

The County requires that all area around the repair be kept clean of debris. Removing items that may interfere with removal of the equipment that is being repaired will save time and may prevent personal injury.

8.8.2 Tools, measurement equipment, lighting

Any special tools needed to make the repair are obtained ahead of time. Tools that are routinely used to perform maintenance tasks are already kept on a maintenance truck. However, there are times when some repairs are done that are not routine, and planning ahead for this saves time. Adequate lifting and loading of equipment is provided for removing the component for repairs. Often, pump motors and valves are heavy and difficult to maneuver in a confined space of a pump station. Having the right lifting equipment on hand makes the repair proceed more quickly and safely. Another important aspect is having adequate lighting available. Not all pump stations have adequate lighting; so portable lighting is provided for when necessary.

8.8.3 Parts/Components

Arrangements are made ahead of time to order any parts needed for the repair. If the repair is unfamiliar, the mechanic reviews the manufacturer's component disassembly and assembly instructions in addition to the procedures for evaluating worn and broken parts. After the repair and or component replacement is made, the equipment is adjusted where necessary and tested prior to being returned to operation.

8.8.4 Safety

Safety is especially critical during repairs. It is important to observe all standard operating procedures for the following: lockout-tagout, confined space, electrical safety, hazardous materials, lifting and loading, fall protection, and the inclusion of appropriate personal protective equipment. The M.S.D.S. sheets are checked for the lubricants and cleaning fluids that are being used. Since the mechanic will be lifting and loading equipment, reviewing proper techniques on lifting could prevent a potential back injury. The mechanic plans how he will safely isolate the equipment electrically to prevent electrocution. This is verified through testing that the circuit is isolated. Finally, if the space that the mechanic is working in is considered a confined space, all department policies are followed for confined space entry. All employees and contractors are required to use personal protective equipment.

8.8.5 Equipment and Parts Cleaning

After the pump is disassembled, the components / parts are cleaned of foreign matter. Pressure washing is the best method, but it is not always available. Internal components are scraped with a putty knife to remove built up scale around the volute, impeller, or wear-plate. When the parts are clean, an evaluation is made as to their wear and whether to replace them. The County follows the manufacturer's guidelines or tables to assist in that decision.

8.8.6 Component Re-assembly and Adjustment

The manufacturer's instructions on proper assembly are always followed. It may be required to torque bolts to specific settings or to align parts a certain way to make the component work properly.

8.8.7 Lubrication

Manufacturers require certain types of lubricants to make their equipment work properly. They may require high temperature grease for bearings or non-detergent straight weight oil for rotating assemblies. The County adheres to the manufacture's instructions to ensure proper performance of the equipment.

8.8.8 Component Testing and Adjustment

After the component is reassembled, and with the proper lubricants installed, the component must be tested. The mechanic listens for non-typical noises and feels for vibrations. Electrical current is checked in all wiring using an amp probe.

8.8.9 Documentation of Repairs

Documentation of the work performed is important for tracking the expenses that the pump station incurred and identifying the manufacturer and model of the unit requiring maintenance. All of this information is documented in the work order module of the CMMS system. This documentation includes the following:

- Time and wages related to completion of the work
- Cost of parts and lubricants and any associated cost for the disposal of the lubricants
- Cost of any cleaning supplies
- Fees paid to out-side contractors
- Special equipment, owned by the County, used in the repair
- Special equipment, not owned by the county, that was rented or borrowed for the project
- Manufacturers, model size, and type of equipment that was replaced
- Age, operation hours, condition, and evaluation of why the component failed

The operator will document whether component failure follows a trend, such as location, conditions, type of component, manufacturer of component, or age. (If any of these trends in pump station component failure are identified, that trend will provide the utility a means to overcome the problem.) Documentation of the type of work involved provides a basis for developing a training program for repairs.

8.8.10 Lessons Learned

Every time a repair or maintenance task is performed, something is learned about what worked and what didn't work. Usually a better way to do the job is developed. However, if information regarding a repair or maintenance task is not recorded, maintenance and repair operations cannot be improved. The time immediately following a repair or maintenance job can be one of the most productive for a utility. Such documents can be used to develop and refine standard operating procedures that are vital to efficient working procedures.

Some questions that are asked include:

- What was done well?
- What was done poorly?
- What changes in procedure would have improved the project?
- What additional or alternate equipment could have been used to improve the project?
- Did we have the entire necessary manufacturer manuals and procedures required?
- What parts were worn? Did the project planning anticipate the need for these parts?
- Could we have performed the repair easier with additional or different equipment, tools, or maintenance instruments?
- Is the equipment, which was repaired obsolete? If so, why not replace it with equipment that is current?

- On the basis of an educated guess from the component maintenance and repair history, how much longer can we reasonably expect the equipment to last?

8.9 Records, Reports, and Analysis

Records, reports and analysis play a significant role it the operation, maintenance and repair of the County's pumpstations. Management utilizes the data from repair records to generate reports that are analyzed for operational and repair trends.
The following summarizes the role of each one of these as they pertain to Allen County.

8.9.1 Records

Records are used in a number of ways. Good operation, maintenance and repair records can provide the documentation necessary to:

- Obtain free warranty repairs
- Obtain reimbursement for illegal discharges and subsequent damages
- Obtain timely insurance payments
- Identify equipment that does not meet the community needs
- Support expansion of facilities
- Support request for modification to the pump station system.

Records of normal and emergency operation, maintenance, and repair include every activity and cost associated with the pump station and forcemain. Records identify those involved in each activity (hours worked per employee type), time expenditures, vehicles, parts and lubricants used, and detailed activity descriptions. Whenever possible records should include photographs.

8.9.2 Reports

ACSED uses the CMMS program to generate maintenance reports. The data used to generate these reports originate from an electronic database that is formed from completed work orders for routine pumpstation inspections and repairs. The CMMS program allows the operator to easily recall and review any/all work orders associated with a piece of equipment. The end result is an efficient way to produce maintenance reports that can be further analyzed for operational trends.

8.9.3 Analysis

ACSED analyses maintenance reports for operational trends. These trends include the history on routine pumpstation site visits, pump run-times, repairs, etc. The analysis of these reports result in improved scheduling for preventive maintenance and controlling parts inventory. Both are critical in the efficient operation and maintenance of the County's pumpstations and related maintenance logistics.

8.10 Maintenance Logistics

ACSED use the CMMS system as a basis for its maintenance logistics. This mainly includes inventory of parts and test equipment as well as technical support. The following is a brief narrative for each logistical concern as it pertains to the County.

8.10.1 Repair Parts/Components

Certain repair parts fail at such an interval and require such long lead times for replacement that continued operation can only be assured if those repair parts are stocked locally. Allen County typically stocks such parts as submersible pumps, dry pit pumps, motors, valves, contactors, alternators, and SCADA transmitters and sensor inputs. These repair parts are stocked in-house, or on the service trucks. Parts are stored in an organized way so that they can be easily inventoried and located when required. As primary equipment is replaced, out-dated spare parts must be removed, sold or disposed of.

8.10.2 Access to Pump and Control Service Companies

Many pieces of equipment are specialized and are not economical to repair at the utility level. Some submersible pumps, SCADA microprocessor boards, auxiliary transfer switches, and generators are generally too complex for local repair. These items must either be replaced or sent to a manufacturer-approved service companies for repair. Many times it is not cost effective to invest in specialized equipment that is seldom used. In this case, contractors must perform the work. Allen County maintains a listing of such companies in addition to emergency numbers for contact during non-business hours.

8.10.3 Test Equipment

As mentioned earlier, precise diagnosis and repair of pump systems can only occur with the correct equipment. Test equipment includes amp meters, multi-meters, torque wrenches, micrometers, and all other instruments required for specific equipment used by the utility.

8.10.4 Lubrication Stockage

Each piece of equipment has specific requirements for oil, grease, and other types of lubricants. By comparison of yearly requirements for each type with the current stockage, lubricants can be ordered well before expending their stockage. Minimum stockage levels are set based on actual needs and the time required to replace lubricants. Normally, a one-year stockage provides the necessary minimum level of on-hand stockage.

8.10.5 Yearly Updates of Operation, Maintenance, and Repair Manuals

It is absolutely necessary to maintain communications with both the manufacturer and manufacturer representatives for existing pump system equipment. Problems can occur when manufacturers are bought, their name changes, or they go out of business. In order to have access to current operation, maintenance, and repair materials, it is important to update telephone numbers (voice and fax) as well as internet address. All such companies are contacted at least one per year to determine if they still exist and still carry parts for pump stations as noted in the utility records.

8.11 Forcemain and Pipeline Cleaning

Forcemains can be subject to an internal accumulation of grease and debris depending upon the nature of the wastewater pumped. Prior to conducting a hydraulic analysis, the output of the pump station should be determined using a flow meter located at least one manhole downstream of the discharge point. Should flow meter readings appear much lower than the design capacity of the pump station, a hydraulic analysis of the pump and forcemain system will reveal whether the inside surface of the forcemain has deposits that must be removed and whether enough extra capacity can be gained to justify the cost of cleaning. Specialty contractors are often the best choice for pipeline cleaning. It is important to understand the cleaning process to better write a scope of services and to determine modifications necessary in the forcemain to accomplish this goal.

The accepted method of cleaning pipelines is through the use of a succession of larger brushes sent through the line. These brushes are known as pigs. They are moved through the forcemain by creating a differential pressure of 60 to 100 psi. These pigs are inserted in the forcemain at pig sending stations. Both the pigs and the material they remove must be removed from the pipeline at intervals in pig receiving stations. Pig receiving and sending stations are best located in precast concrete, belowground structures. Grease and rust collected from pipeline cleaning operations must be dewatered before disposal in landfills in conformance with the paper filter test.

8.12 SCADA Systems

SCADA stands for Supervisory Control and Data Acquisition. Supervisory control enables an individual to operate a piece of equipment from a remote location. The data acquisition portion of this equipment is similar to what was once known as telemetry. The County utilizes Mission Control for its SCADA system to monitor the County's pumpstations.

The Mission Control monitoring units are model M100s. The units are programmed to trigger alarms when user-defined alarm conditions have been detected. Automatic alarms permit a reduction in the number of man hours spent monitoring data. In addition, the operator is notified of the need to monitor exceptions to routine performance of pump stations.

SCADA systems also allow for the remote diagnosis of problems. The goal is to diagnose problems remotely as these problems are occurring. Due to cost savings in the use of instruments over people, more sensors can be installed in pump stations. This results in faster response times in the diagnosis of pump station problems.

Faster response time to pump station failures lowers the chance of secondary problems occurring, such as surcharging and basement flooding.

SCADA systems also archive sensor data collected during pump station events. This data provides information necessary to evaluate and document the failure and to provide a necessary basis for correcting the problem. Ideally, to provide the best service to our customers, a person would be needed to continuously monitor each pump station continuously—24 hours a day, 7 days a week. SCADA provides this level of constant monitoring at a cost that is affordable to the community.

8.12.1 SCADA System Components

Sensors: SCADA systems can take inputs from a variety of devices to monitor a pump station's performance including the following: pump and motor data, flows, water levels, power available by phase, forcemain pressure, check valve operation, valve position, automatic transfer switch operation, generator operation, SCADA power, control operation, level sensors, communications, and intrusion.

Communications: Allen County's SCADA systems uses cellular phone technology to communicate with Mission control in Georgia. All data can be viewed via the Mission website. Alarms are received by telephone or via the Mission website.

Data Reduction Programming: Modern SCADA systems have a computer program which manages the SCADA system, performing such tasks as polling each station for data, recording the data, comparing the data to set points to determine if alarm conditions are met, sending alarm messages, and automatically notifying individuals of alarm conditions. This computer program has a graphic interface, which shows each station in a schematic diagram along with data pertinent to that station. Computer programs also store or archive data and have the capability to trend this data for future analysis of the adequacy of a particular pump station.

8.12.2 SCADA System Maintenance

Sensor Maintenance: Since Allen County uses only dry contacts for alarm set points, there is little to no maintenance to perform.

Radio Tuning: With the use of cellular technology, no tuning is required.

Backup Battery Replacement: The batteries used in the Mission system are gel cells, so there is no maintenance. These batteries are replaced every three years.

Antenna and Antenna Wire Replacement: In most cases, there is no antenna or antenna wire replacement, except in cases where these items are broken due to accidents or vandalism.

9.0 Infiltration and Inflow Evaluation

The purpose of this section is to provide the process used to locate Infiltration and Inflow (I/I) sources on the county's sewer systems. This includes the practice of using both internal / external investigative programs and related equipment to locate I/I sources.

Infiltration is defined as groundwater entering a sewer system through such means as defective pipes, pipe joints, connections, or manhole walls.

Inflow is defined as stormwater entering a sewer system from sources such down spouts, area drains, foundation drains, illegal sump pump connections, uncapped cleanouts, manhole covers, cross-connections from storm sewers, combined sewers, catch basins, and surface runoff.

The introduction of I/I into the county's sewer systems can reduce capacity and shorten the useful service life. Infiltration and Inflow can also result in basement flooding, sewer overflows, create additional burdens on the county's treatment plants and possibly cause National Pollutant Discharge Elimination System (NPDES) violations at the wastewater treatment plants.

Infiltration and Inflow can also drive up the annual average daily flow at the county's wastewater treatment plants. Most plants have a 20-year design life and are sized to accommodate growth over that timeframe. Infiltration and Inflow can negatively impact the engineer's designed annual dry weather flow for the plant, and possibly result in the Ohio EPA's refusal to approve a Permit-to-Install. Ultimately, this could result in a ban on private and commercial development on the system.

The present solutions under consideration by the county to address the I/I problem include transporting / treating all flow, and or, system remediation to reduce the excess I/I flows. The county uses flow monitoring, and system investigations to acquire data that is used to develop programs to address the I/I problems. The system investigations include smoke testing, manhole inspections, building inspections and closed circuit televised (CCTV) inspection.

As previously stated, I/I affects the operations of sewer systems, pump stations, and treatment facilities. Excessive I/I can cause reduced capacity, surcharging of sewers, basement flooding, street flooding, excessive wear on pumping facilities, higher power costs, bypassing of flow, and adverse problems to the treatment efficiencies. The following is a brief summary for each of the considerations for I/I evaluation program.

9.1 Training

Training is the first step in any successful I/I evaluation program. Well-trained operators are needed to carry out efficient flow monitoring programs, conduct meaningful manhole & building inspections and efficiently operate CCTV sewer investigation equipment. ACSED provides in-house training for manhole and building inspections. Training for flow monitoring and CCTV equipment operation originates from the manufacturer and takes place with specified personnel. These people pass the information down further to all future personnel involved in the program.

9.2 Flow Monitoring

Sanitary sewer system flow has three components: base flow, infiltration and inflow. Base flow is the wastewater flow within the sewer system and is generally computed by water consumption data and/or evaluated per capita water consumption estimates for residences and commercial establishments. Infiltration can be derived by subtracting the base flow from the total measured flow during dry weather or by estimating the minimum daily flows. Inflow is measured during wet weather flow conditions and is calculated by subtracting the base flow and infiltration from the data collected during wet weather conditions.

Flow monitoring is performed to establish the basis for the county's sanitary sewer evaluation and rehabilitation program. Allen County began this program by dividing the sanitary sewer system into basins. This was accomplished by choosing locations that easily divide the sewer sheds due to the topography of the sewer networks.

The next step included a review of flow meter manufacturers. The county selected Marsh McBirney Flow Dar flow meters for the flow-monitoring program. This type of meter is designed to measures flow ultrasonically from above the flow line under normal dry weather flow conditions, and allows for flow measurement under submerged conditions during wet weather conditions. The following considerations were taken into account for the flow-monitoring program:

9.2.1 Site Selection: The objective of the site selection is to find the best manhole locations for recording accurate depth and velocity data, two key factors in computing flow measurement. The County conducted site investigations to determine if the manholes selected are good flow monitoring sites. In general, a good site has a straight section of pipe with consistent slope upstream and downstream, contains little to no debris or silt, has easy access for confined space entry, is located away from heavy traffic issues, and is accessible.

9.2.2 Flow Meter Installation: The County follows the manufacturer's meter installation and programming requirements when installing flow meters. Once installed, the flow meters are programmed to maximize the accuracy for data collection.

9.2.3 Flow Monitoring: The County consistently monitors flow from strategically selected sites to gather flow data that is representative of year-round flow conditions. This includes dry and wet weather flows that are representative for all seasons. In Ohio, spring and fall usually feature a high groundwater table. Therefore, they are the best times to monitor the collection system for infiltration related problems. The County intends to continue the flow monitoring activities throughout the duration of the remediation activities to resolve the I/I problems.

Collecting rainfall data and the frequency of the rainfall events are important factors for inflow/infiltration analysis. The County has installed rainfall gauges within or near the monitoring areas of the flow meters. The rainfall data is remotely downloaded to a website server for storage, which can then be remotely accessed by County personnel.

9.2.4 Flow Meter Operation and Maintenance: The County's Wastewater Collection Division has personnel that are trained in the operation and maintenance of the flow meters. These personnel are trained to calibrate the flow meters prior to installation, and perform routine maintenance as needed during periodic site visits.

In addition, County personnel are trained to download the flow-monitoring data to a laptop computer, and conduct a brief review of the flow data to verify the recorded depth against a real-time depth measurement. Field verification of depth is completed by using a ruler for depth measurements and compared against real-time depth readings generated from the flow metering software. This process is used as a quality assurance / quality control tool to ensure the flow meter is performing properly or to alert the user to perform recalibration procedures. Data is downloaded every 7-10 days to ensure the most accurate data and operation of the flow meters.

Routine maintenance is performed at a minimum of once every 90 days unless problems are found during the site visit to download the flow data. Routine maintenance includes changing the battery & moisture indicators and cleaning & inspecting all components of the flow meter. Any changes are noted and addressed during the site visit.

9.2.5 Data Evaluation: Flow data evaluation begins with the creation of flow-monitoring projects for each flow metering location. The data is reviewed for overall accuracy and completeness. Irregularities in the flow data are noted, and brought to the attention of the immediate supervisor. Irregularities in the flow data include missing data, partially missing data such as a height or velocity reading and negative flow readings. Missing, or partially missing data, is usually attributed to a foreign object being lodged on the flow meter sensor thus resulting in erroneous operation of the sensor. Another cause of missing, or partially missing data, is premature failure of the battery supply. Negative flow readings are the result of hydraulic induced changes in flow direction due to extreme wet weather events. The changes in flow direction are attributed to elevated river levels that allow river water to flow backwards into some of the sanitary sewer overflow (SSO) pipes. This backward flow causes negative flow readings to be recorded on the flow meters located within the vicinity of the SSO discharge point. Once the irregularities are noted the flow data is downloaded to the County's server database. This allows other management personnel to view the flow data and evaluate the flow related to I/I or note any perceived reduction in I/I as a result of system remediation work.

Additional sources of I/I data are required for proper quality assurance and analysis to identify solutions to the County's I/I problems. These sources include various system-wide inspections such as smoke testing of the sewer mainline & lateral, manhole inspections, building inspections and closed circuit television inspection of the sewer mainline. The following addresses additional inspection activities employed by Allen County.

9.3 Smoke Testing

Smoke testing is used to detect inflow / infiltration in the county's sewer system basins. The process works by allowing smoke to exit the sewer system through defects in the sewer system. Smoke bombs and/or liquid smoke are commonly used to generate the smoke required to test a sewer system.

Smoke testing is used to detect storm sewer cross connections and point source inflow leaks, such as roof leaders, ponding areas, poor service connections, abandoned sewers, private property clean-outs, cellar, yards, foundation, and area drains. Smoke testing is not used in areas that have sagging pipes or water traps. If water is ponding, the smoke is unable to exit the sewer system. Smoke testing is not performed when sewer lines are flowing at maximum capacity.

Even though smoke testing is generally inexpensive, this procedure does not correctly identify or quantify all inflow sources accurately. Smoke testing provides an indicator that a problem exists but does not identify the specific defect and does not assist in determining the correct rehabilitation technique of the potential problems that are found in separate sewer systems.

The County performs flow monitoring to gather data from suspect basins prior to smoke testing. Internal staff reviews the flow monitoring data to determine which basins have the greatest amount of excess flow due to inflow / infiltration. These basins are selected for smoke testing.

The County sub-contracts the smoke testing work. Subcontractors are required to use non-toxic, odorless, and non-staining smoke bombs with a burn life of 3 to 5 minutes. The air blower, which mounts on the manhole to force smoke into the sanitary sewer system pipes, should have a minimum capacity of 53 cfs. If the desired amount of smoke is not attainable, sandbagging and/or plugging can be used to block sewer sections to prevent smoke from escaping through manholes and adjacent sewer pipes.

Subcontractors are required to notify local Police and Fire Departments on a daily basis as to areas scheduled for smoke testing. Residents are pre-notified by canvassing the neighborhoods with flyers and notices. Signage can also be used on major in-roads, thoroughfares, and neighborhoods. The better notified the public is, the fewer problems experienced with the project.

The following procedure is used for smoke testing:

1. Isolate lines to be smoke tested in setups of approximately 1,200 lineal feet or approximately 3 to 4 manholes.

2. Prepare a smoke sketch of the setup, including location, crew initials, and date. List the positive findings located in the setup.

3. Begin the smoke testing using the air blower and ignite the smoke bomb(s) to ensure smoke travels throughout the test section. Larger diameter pipes will require more smoke bombs and a longer testing time.

4. Utilize sand bags or inflatable sewer plugs in smaller lengths of sewer lines. This will provide better results by confining the velocity of air and smoke to shorter sewer sections.

5. Visually inspect the entire smoke test area by walking around the front and back yards and around the buildings. Take note of smoke leaks, such as roof leaders, driveway drains, area and yard drains, clean-outs, storm sewer inlets, catch basins, and the areas around manholes.

6. Photograph or video inspect all leaks.

7. Note the location of the leaks on the smoke sketch setup. Include the photograph number and directions taken, as well as a brief description of the leak. In addition, include a unique identifier to locate the leak at a later time, such as an address, dimensions, or street cross-section. Appendix "I" contains the Sample Smoke Testing Inspection Report.

9.4 Manhole Inspection

Manhole Inspection provides an additional tool for locating I/I problems and correcting map inaccuracies. The County uses the data from this process, as well as the data from smoke testing and CCTV work, to correct inaccuracies in the database for the sanitary sewer map.

Manhole inspections are performed in the flow monitoring areas. The inspection process includes opening the manhole, and performing a visual inspection of the manhole and terminal connections of the sewer pipes.

The actual inspection of the manhole can vary, depending on the type of information needed. For example, if the flow metering data indicates an inflow problem, a topside inspection may be all that is required. If an infiltration problem exists, an entry inspection to inspect the pipes for open joints and deteriorating pipes may be required. Allen County follows a strict confined space entry program for manhole entries. Appendix "J" contains the Sample Confined Space Entry Permit.

The following is a list of considerations for manhole inspections:

Data to be collected during the topside inspection process

- Location of the manhole/manhole number
- Diameter of the manhole opening
- Structural defect allowing inflow into the sanitary sewer system

- Priority rating of the problem and/or drainage area tributary to the defect
- Assessment of whether the cover is subject to ponding or surface run-off
- Type of material for the walls, chimney and frame
- Condition of the frame, steps, walls, chimney, and lid
- Direction or orientation of incoming and outgoing lines
- Estimate of active leakage or signs of previous leaks

Data to be collected during an entry inspection process

- Type of material for the apron and trough
- Estimate of active leakage from walls and pipelines
- Surcharge marks on the walls of the manhole
- Size and type of pipe on the incoming and outgoing pipes
- Depth of silt for cleaning program, if desired

9.5 Building Inspections

Building inspections are performed to locate sources of direct inflow of stormwater into the sanitary sewer system. These sources include illegal sump pump connections, downspouts, uncapped cleanouts and various types of area drains.

The inspection process consists of three main phases: Property owner notification, the building inspection process and follow-up programs to address any confirmed or suspected source of inflow.

Prior notification is provided to property owners to inform them of building inspection activities that are to be performed in the area. Methods of notification include letters, door hangers, news media and/or a combination of all. The notification provides information when the work will commence, the primary purpose of the inspection, what information may be requested and information related to identification of the personnel involved in the inspection work.

The inspection team consists of a two-man crew. The inspection process includes a general inspection of the perimeter of the building to detect any uncapped cleanouts, area drains and downspouts. Any of these sources suspected of inflow are dye tested to confirm the stormwater discharge point. There is also a general inspection of the plumbing arrangement associated with any sump pump affiliated with the building. This inspection is performed to insure the sump pump connection is within code and not responsible for the introduction of storm water into the sanitary sewer lateral. Information gathered in the building inspection process is noted on the inspection form. Appendix “K” contains the Sample Building Inspection Report.

The follow-up program consists of communication with the homeowner. A letter listing any known defects is addressed to the property owner along with a specific amount of time to address the problem, and contact the department for follow-up inspection.

9.6 CCTV Inspections

The ACSED employs the use of CCTV Inspection technology as a means to document inflow/infiltration sources, and provide a basis for the appropriate sewer system rehabilitation technique. The CCTV data that is recorded during the inspection process includes the upstream/downstream manhole numbers, the length in feet of the pipe inspected, the location of any lateral taps and any defects that are found within the sewer pipe. The information is stored in electronic and paper format, and used to generate repair work orders.

The CCTV Inspection process involves the use of either a push camera, and or a mainline camera. The push camera is a portable hand-operated unit that is used to investigate the portion of the sewer lateral in the right-of-way. Access is provided via a cleanout located at the road right-of-way or on the customer's property. The mainline camera is a self-contained mobile unit that is used to investigate all mainline sewers. Access is provided via the manhole. During these investigations the operator is looking for separated pipe, leaking joints, cracks, calcium buildups and root intrusion.

10.0 Sewer System Rehabilitation

This section provides information on collection system rehabilitation methods used by the ACSED. A sewer system is primarily made up of three components: the mainline, manholes and laterals. The points that are most susceptible to infiltration of groundwater are the individual pipe joints and the point connections between these three main components. The main causes for failure at these points are due to various factors including freezing and thawing, construction techniques used at the time of design & construction, traffic loads due to location within & adjacent to roads, corrosion from chemical reactions within the system and construction activity adjacent to the system. When infiltration is detected within the system the county must review the problem and execute an appropriate repair technique. The three main techniques include: Point Repairs, Renovation and Replacement.

10.1 Point Repairs

A point repair is defined as a repair made to a specific defect in a specific location. An example would be a leaking pipe joint or a leaking tap connection. The repair could be as simple as pointing and grouting to repair the leak, or in more severe cases, excavating the site to perform the repair by another method. When a repair is performed without the use of excavation it is referred to as trenchless technology.

Trenchless technology rehabilitation methods are generally less expensive than pipeline renovation or replacement and are the least disruptive of the rehabilitation options. However, pointing and internal grouting do not provide any degree of structural improvement. Although these methods are effective at eliminating infiltration, erosion at the repair location can result in the reintroduction of ground water into the collection system. For this reason, problems can reoccur and sewer repairs often become a routine maintenance item. Some studies indicate that the useful life expectancy of sewer system repairs is approximately ten years. Therefore, scheduled inspection of the County's collection systems are required to address new problems that develop over time.

Pipe or manhole grouting, involving injecting grout under pressure into and /or through the wall to seal the brick and reduce inflow and infiltration, may be necessary prior to renovation at spot locations. This method can also be used to repair the connection of the sewer lateral to the main line sewer. Any voids in the manholes will also need to be filled with grout to provide structural stability prior to renovation. Missing bricks or concrete will need to be replaced and, normally, areas of displaced bricks or heavy missing mortar/concrete will need to be spot repaired. There are two methods of grouting available: External and Internal.

<u>External</u>
External rehabilitation methods are performed from above ground surface, excavating adjacent to the pipe or from inside the pipe through the wall, depending upon the pipe diameter. The common methods are variations of chemical and /or cement grouting and are appropriate for solving problems of significant groundwater movement, washouts, soil settlement, and filling soil voids.

<u>Internal</u>
Internal grouting or chemical grouting is the most commonly used method for sealing leaking joints in structurally sound sewer pipes. Using special techniques and tools, chemical or epoxy grouts can be applied to pipeline joints, manhole walls, wet wells in pumping stations, and other leaking

structures. Chemical or epoxy grouting may also seal small holes and radial cracks.

The following table provides a summary of the advantages and disadvantages of various repair methods.

Technology	Advantages	Disadvantages	Potential Applications
Cleaning and Root Removal	Increases Effective Capacity.	May become routine. Could cause more damage to existing pipe.	Any size, but larger pipes require different techniques.
Pointing	Restores original condition with minimal disruption.	Man-entry sewers only.	Greater than 36” in diameter.
Internal Grouting	Seals leaking joints and lateral connections. Is low cost with minimal disruption. Can reduce infiltration. Can include root inhibitor.	May become routine. Infiltration may find other routes of entry. Existing sewer must be sound.	Any size, but larger pipes require different techniques.
External Grouting	Improves soil conditions around pipe. Can reduce infiltration and soil loss.	Difficult to assess effectiveness. Can be costly.	Any
Spot Repairs	Deals with isolated problems. Can be done trenchless	Difficult on brick sewers	Any

10.2 Renovation

Renovation is defined as repairing the existing structure back to a like-new condition. An example would be relining a leaking sewer pipe. The new lining within the original host pipe stops any leaks or root intrusion and brings the structural integrity back to the condition of when the pipe was installed originally.

Renovation methods are generally more expensive than repairs and can sometimes be more expensive than renewal methods, such as open-cut replacement. Renovation methods typically minimize disruption to the Allen County sanitary sewer collection system and surrounding area and can be installed relatively quickly. They are effective at significantly reducing water infiltration into the system without the pitfalls common to pointing, grouting, or spot repairs. Renovation systems usually provide some degree of structural reinforcement of the sewer depending on the design thickness of the new material. Routine re-inspection of the sewer is typically reduced. Useful life expectancy of many renovation products can be 50 years or more, depending on the stability of internal and external conditions. The following are the most common renovation techniques utilized today:

10.2.1 Cured-in-Place Pipe (CIPP)

The CIPP process consists of inserting a flexible line into the sewer, typically utilizing an inversion technique. The liner is a woven polyester felt tube with an elastomer coating. The felt is impregnated with polyester or an epoxy resin. Compressed air or water pressure is used to invert and propel the liner through the pipe from an access pit, usually a manhole. After the liner reaches the receiving pit, a curing process is initiated. Heat or ambient temperature is used to cure the epoxy resin and to adhere the liner to the inside surface of the host pipe. The ends of the liner are then cut off and end seals installed. Service laterals are reconnected by mechanically or manually cutting the liner at each connection. Extensive grouting is typically not necessary prior to inserting the liner. CIPP is available in all sizes and can accommodate small deformations in the system.

The interior surface of the CIPP is smoother than both brick sewer (with its inherent undulations) and clay pipe (which has offset joints at rather short intervals). The effective Manning's "n" value for this material is 0.013. This is a typical value for sanitary sewers that accounts for bacterial slim, grease on the walls, and sediments in the sewage.

The installation of the CIPP typically takes place from manhole to manhole. Construction access must be provided at both ends of the section being rehabilitated. However, lining through several manholes is quite common. Continuous installation of over 1000′ for small diameter and 2000′ for larger diameter has been successful. This work can be coordinated with proposed improvements to the tops of existing manholes as well as the proposed locations of the additional manholes.

Upon installation of the CIPP, dimples in the pipe wall will be observed at the location of pipe connections. The lateral connections are reinstated with a robotic cutter for small diameter pipe and with electrical saws in large diameter sewers.

10.2.2 Sliplining with Round Pipe

The sliplining rehabilitation method consists of pulling or pushing a new pipe inside the existing pipe. The new pipe is usually grouted into place with a low-strength grout by injecting the grout into the annular space between the host pipe and the new pipe. When the new pipe is grouted inside the existing pipe, the structural importance of the host sewer pipe is minimized. This method is most suitable for larger diameter straight pipes, such as Allen County trunk sewers. On smaller diameter pipes that have a large number of private service connections, this method can result in a large number of pipe excavations along the route in order to reestablish the private sewer connections discharging into the new pipe.

Pipe manufacturers make a wide variety of pipes suitable for sliplining, including:

- Butt-fused polyethylene pipe
- Bell & Spigot corrugated polyethylene pipe
- Polyvinyl Chloride (PVC) pipe
- Fiberglass pipe

To install a sliplined pipe, access pits are usually required at each manhole. Existing manholes may be removed with the excavations serving as access pits. New manholes would be constructed following insertion of the sliplined pipe. Access pits must be excavated around the existing pipe for slip lining. Therefore, if the existing pipe is in the street, the access pit must be in the street. Once a piece of the existing pipe is removed, liner pipe in 15′ to 20′ lengths is lowered into the access pit and pushed into the existing pipe. Subsequent segments are joined to the end of each previous segment. Pipelines with a large number of angle points or sharp curves usually require more access pits and more excavation, increasing the cost of the project and the community impacts. Straight sections of pipe or large radius curves are ideal for slip lining. Once the new pipe is inserted within the host pipe, the annular space between the host pipe and the new pipe is filled with low-density cellular grout.

The outside diameter of the pipe to be inserted into the host pipe must be sufficiently less than the inside diameter of the host pipe to permit successful installation. It is necessary to install a pipe with an inside diameter at least one standard size less than the host pipe. For example a 42″ diameter pipe would be installed inside a 48″ diameter pipe. In these instances, a strong, thin-walled pipe is desirable. The smaller the host pipe size, the greater the impact of pipe size reduction to accommodate installation. The final hydraulic capacity of the sliplined pipe would likely be less than the host pipe.

With sliplined pipes there is no direct method of determining the location of sewer service connections because service connection locations are not visible from the inside of the pipe. Connections between house sewage laterals and the main sewer are made by digging from the surface to the depth of the host pipe. Each one of these would have to be dug up at its point of connection to the sewer and the connection completed from that excavation. This can result in substantial disruptions to the residents, businesses, and traffic.

10.2.3 Deformed/Reformed Pipe (Fold & Form)

Fold & Form pipe is a pipeline rehabilitation technique that utilizes a pre-manufactured PVC, HDPE, or PVC Alloy pipe to reline an existing storm or sanitary pipe ranging in size from 6″ to 24″. The liner is constructed round and deformed into a U shape or folded shape in the factory.

The pipe is banded and put into a spool. It is pulled into the existing pipe with a winch. The pipe is reformed to the shape of the host pipe with steam and pressure. After the cool-down process is complete, the ends are trimmed and a robotic cutting device reinstates the existing live laterals.

10.2.4 Sanitary Sewer Manholes

There are numerous components in a typical sanitary sewer manhole that may require rehabilitation or replacement. Their functions are described as follows:

Manhole Component	Function
Cover	The cover provides access to the interior of the manhole. There should be an adequate means of lifting the lid. Note: The top should not be worn smooth, or it can become a safety hazard for pedestrians or cause vehicles to slide when stopping.
Frame	The frame is the cast or ductile iron ring that supports the cover. The frame should match the cover.
Frame Seal	The frame seal is the material or device designed to prevent intrusion of water at the joint between the frame and the chimney.
Clear-opening	The clear-opening is the smallest entryway into the manhole. Note: It must be large enough to permit access of personnel with safety equipment and sewer cleaning tools.
Chimney	The chimney is the narrow vertical section that is located just below the frame.
Cone/Corbel	The cone is the reducing section that tapers concentrically or eccentrically from the top of the wall joint to the chimney or the frame and cover. When made of brick, it is sometimes referred to as the corbel.
Wall	The wall is the vertical portion of the manhole that supports the chimney.
Channel	The channel is the portion of the manhole where the wastewater normally flows.
Benching	The benching is the portion of the manhole that contains and directs wastewater flow through the manhole at higher than normal flow rates.
Base	The base is the supporting slab structure of the manhole.
Steps/Ladder	The steps or ladder assist in manhole entry or exit.
Pipe Seal	The pipe seal is the means of sealing the interface between the pipe entering or leaving the manhole and the manhole wall.

Conditions that Warrant Manhole Rehabilitation

Conditions that would warrant manhole rehabilitation include structural deterioration, operation and maintenance considerations, and infiltration and inflow (I/I) removal. These conditions are discussed in greater detail in the following sections.

Structural Deterioration

Structural deterioration is generally defined as any damage to the structural components of the manhole. Displacement in brick constructed manholes can occur due to traffic loading, unstable soil conditions, or groundwater movement. Freeze/thaw cycles can cause deterioration of the frame seal, chimney, and cone sections. Manholes located in streets are also more likely to experience some degree of vertical separation in the upper components than manholes located outside of the pavement. Corrosive environments and the natural process of mortar deterioration can also result in structural problems.

Operation and Maintenance

Operation and maintenance issues that would warrant rehabilitation include offset frames, deteriorated steps, and buried covers. Replacement steps can be difficult to properly anchor in an existing brick manhole. Thus, Allen County policy and procedure access is now typically provided using tripod and harness systems, making steps unnecessary.

I/I Removal

Manholes can be a significant source of I/I in sewer systems. Groundwater movement and inflow/infiltration can result in future structural deterioration similar to brick sewer pipes. For this reason, inflow/infiltration sources in the manhole structure or around the sanitary sewer manhole should be corrected.

Available Manhole Rehabilitation Methods

A brief description and assessment of the various manhole rehabilitation methods is provided in the following sections:

Chemical Grouting

Chemical grouting is generally used to reduce I/I and is commonly applied to brick manholes, as well as pre-cast manhole joints and pipe seals. It is also an effective method of filling voids in the surrounding soil. Grout can be applied internally or externally depending on the nature and extent of voids to be filled. However, grouting alone does not provide any structural properties. Therefore, it is only effective in manholes with tight joints and without structural deficiencies.

Coating Systems

Coating systems include cementitious and non-cementitious mortars, epoxy coatings, and sealants. They are available under a variety of trade names and have been in use for a number of years in rehabilitating brick and pre-cast manholes. Although mix designs vary by manufacturer, most are based on a combination of cementitious material, such as Portland cement, mineral fillers, and chemical additives. They can be applied in one or more layer and finished with an epoxy coating depending on existing conditions and the desired results. They are ideally suited for brick and pre-cast manhole structures that are basically structurally sound but contain missing or deteriorated mortar/concrete, or joint defects. Because coating systems have minimal shear or tensile strength properties, some cracking can develop over the lifetime of the system, depending on the degree of movement in the original structure.

Structural Linings

Structural lining systems include cast-in-place concrete, gunite, prefabrication Inserts, spiral-wound liners, and CIPP. These systems provide for complete structural rehabilitation of the manhole and are commonly used in brick manholes with extensive deterioration and/or structural integrity issues. These systems are also effective at eliminating I/I and groundwater pressure problems. They are not generally designed to carry vertical loads and are not effective at mitigating freeze/thaw cycle problems. Structural linings are more expensive compared to pressure grouting or coating systems.

Replacement

Replacement involves the excavation and complete removal of the existing manhole structure. In cases of advanced deterioration or structural failure this is considered a viable alternative. This is generally the most expensive alternative and the most disruptive to the surrounding street and neighborhood. Replacement is also often the most time-consuming of the manhole rehabilitation options. The primary advantage of constructing new manholes is the maximized design life compared to other alternatives.

Chimney, Frame, and Cover Rehabilitation

Defects in the manhole chimney and with the frame and cover are common in older brick manholes due to thermal expansion and contraction, pavement and sub-base movement, and the resulting water infiltration. Wearing of the cover from traffic movement over time is a frequent occurrence. Minor settlement around the frame and chimney is also common. Replacement of the frames and covers will extend their service life, improve the wearing surface in the roadway, allow for grade corrections, and eliminate problems caused by infiltration.

Reconstruction of the chimneys will typically involve the removal of deteriorated or cracked adjusting rings and will permit any existing voids around the upper section of each manhole to be corrected. In addition, the clear coating in the reconstructed chimney can be increased to accommodate overlaying with the coating system without reducing accessibility.

The following table provides a summary of the advantages and disadvantages of various renovation methods:

Technology	Advantages	Disadvantages	Potential Applications
Cured-In-Place Pipe	Continuous pipe with no joints; quick installation; trenchless. No grouting required; non-round pipes feasible; accommodates bends. No loss in capacity	Relies on host pipe for support; styrene fumes possible; bypass pumping necessary.	4" to 108"
Deformed/Reformed and Fold & Form Pipe	Trenchless; no grouting required; no loss in capacity.	Lateral locating sometimes difficult. Relies on host pipe for support. Bypass pumping necessary.	4" to 24"
Sliplining (continuous)	Quick installation; large range of pipe sizes.	May require large insertion pits. Must grout annular space.	4" to 60"
Sliplining (short pipe/ segmental)	May be done "in the wet" to eliminate bypassing needs.	Larger pipes require support during grouting. Must grout annular space. Requires fusing joints. Small radius bends not possible. Labor intensive.	4" to 144"

10.3 Replacement

Replacement is defined as replacing the existing structure with new material. An example would be excavating a section of old sewer pipe and replacing it with new sewer pipe. This is referred to as open-cut technology. Another method of replacing the same section of old pipe is to run a pipe-bursting machine through it and pull new pipe into place.

Renewal systems, such as pipe bursting and open-cut replacement, offer the best opportunity to correct hydraulic capacity deficiencies. Structural deficiencies are also relatively easy to correct with renewal systems because new independent pipeline is used. However, they are the most disruptive of rehabilitation methods available. It should be noted that useful life expectancy of new pipeline is similar to that of renovation systems and depends on future stability of internal and external design conditions. Another advantage of full replacement is that it may allow the existing facility to remain in service while the replacement is being constructed. It also allows the designer to accurately estimate the service life of the replacement facility without the complication of analyzing a composite facility that includes the existing pipeline and a new liner or pipe within the pipe. Finally, it allows the new facility to be designed for increased capacity or flow. The Pipe Bursting and Replacement methods are described as follows:

10.3.1 Pipe Bursting

Pipe bursting is achieved by inserting a machine with an expandable head inside the host pipe. The machine is pulled forward and then the head is expanded. This expansion bursts the host pipe into smaller fragments that are then driven into the earth surrounding the pipe. A new pipe is connected to the rear of the expansion machine and is pulled into place as the expanding head machine is advanced. In this way, the new pipe can be the same size or sometimes even larger than the host pipe. Various types of pipe can be inserted in this manner. Often butt-fused polyethylene pipe is used to provide the benefits of a seamless/jointless pipe. Service lateral connections can be relatively difficult to make since they require excavation to the mainline and installation of a new sewer tap. In general, pipe bursting is only used in diameters up to 24″.

10.3.2 Replacement

For those portions of the pipeline where rehabilitation is not possible due to excessive deterioration and structural reline is impractical, pipe replacement should be considered. Pipe replacement may also be more cost effective in pipe segments where neighborhood or traffic disruption is not a key issue. The replacement pipe can be designed in such a manner to prevent similar deterioration from occurring in the new pipe. Open-cut replacement allows for relatively simple lateral reconnection, and pipe is available in a wide variety of materials and sizes. However, this approach often requires extensive trench de-watering. Trench de-watering is discouraged in some areas because disturbing the groundwater can have a negative impact on street-side trees.

Pipe replacement is particularly applicable when the condition of the host pipe is severely deteriorated or when the host pipe is too small to convey the required flows. The new pipe could be installed using either open-cut or trenchless technology methods. The advantage of pipe replacement is that the installed pipe is new and has an excellent chance of having a long service life.

The following table provides a summary of the advantages and disadvantages of various replacement methods:

Technology	**Advantages**	**Disadvantages**
Open-Cut	Traditional design with new pipe.	Disruptive; typically more expensive than relining.
Pipe Bursting	New pipe; can increase size of pipe.	Damages laterals; potential ground heave; disposal of slurry. Requires brittle host pipe.
Directional Drilling	New pipe, long distances possible; underwater installations possible.	Damages laterals; disposal of slurry; difficult in sandy soils. Very difficult to do gravity sewers.

11.0 Sanitary Sewer Overflows (SSOs)

It should be noted that the Clean Water Act strictly prohibits discharges from SSOs. It is the responsibility of the county to eliminate the SSOs from the collection system and report any discharges from the SSOs in accordance with the County's NPDES permit(s). The reporting requirements are contained in the County's NPDES permits.

In addition, every effort must be made to identify and eliminate extraneous sources of rain and ground water entering the system. In some cases, especially those areas where no other feasible alternative exists, U.S. EPA in conjunction with state regulators may allow for alternative treatment technologies such as chemical and high rate primary treatment of wet weather flows or even flow blending of primary effluent with the wastewater treatment plant discharge. Activation of these treatment alternatives are typically tied to specific operating restrictions such as conditions above treatment plant design capacity or downstream conveyance capacity. However, excessive infiltration and inflow of stormwater into the collection system, and history of basement flooding caused the ACSED to install bypasses (SSOs) into the collection system to protect the health and safety of its customers.

11.1 History of ACSED SSOs

11.1.1 American-Bath Collection System

The American-Bath Sewer Sub-District is a service area created to facilitate the installation of public sewers to alleviate pollution problems from failing private septic systems. The sewers were constructed in the late 60's using vitrified clay pipe construction material for the mainline and service lateral sewer construction. Vitrified clay pipe construction was typical for that period in time. However, upon completion of the project it was evident the system was experiencing a large amount of infiltration and inflow of stormwater due to its joint makeup of the vitrified clay pipe and the connection of sump pumps to the sewer system causing sewage backups to customers of the district.

Therefore, the ACSED in the early 70's took steps to install one bypass (SSO) into the collection system to relieve the backups being caused by the overabundance of stormwater entering the collection system. The ACSED is presently undertaking steps to close the bypass by rehabilitating the collection system, eliminating sump pump connections, and increasing trunk sewer capacity to the wastewater treatment plant.

11.1.2 Shawnee Collection System

The Shawnee Sewer Sub-District is a service area created in the early 70's to facilitate the installation of public sewers to alleviate pollution problems from failing packaged wastewater treatment plants constructed by private developers to serve isolated subdivisions. Developers also constructed the collection systems serving the areas and discharging to the packaged wastewater treatment plants in the late 50's and early and late 60's. The sewers were constructed using vitrified clay pipe construction material for the mainline and service lateral sewer construction. Vitrified clay pipe construction was typical for that period in time. However, upon completion of the Shawnee Collection System it was evident the system was experiencing a large amount of infiltration and inflow of stormwater due to its joint makeup of the vitrified clay pipe and the connection of sump pumps to the sewer system causing sewage backups to customers of the district.

Therefore, the ACSED in the mid 70's took steps to install nine (9) bypasses (SSOs) into the collection system to relieve the backups being caused by the overabundance of stormwater entering the collection system. The ACSED is presently undertaking steps to close the bypasses by rehabilitating the collection system, eliminating sump pump connections, and increasing trunk sewer capacity to the wastewater treatment plant.

11.2 Sanitary Sewer Overflow Structures

Sanitary sewer overflow structures are points in the collection system with passive relief capacity to the receiving stream but which lack a direct method of controlling the overflow quantity, such as a sluice gate. The County's structures consist of a relief conduit located above the existing sewer. Once the capacity of the sewer is exceeded, the wastewater flow must rise to a fixed height prior to discharging to the receiving stream.

The design and operation of the sanitary sewer overflows are such that the maximum peak dry weather flow is passed to the treatment plant. Design and operation also maximizes the storage capacity of the collection system, while minimizing wet weather discharges.

Some of the County's SSO discharge conduits are fitted with a control device to prevent backflow of river water in situations where the levels in the receiving waters exceed the level of the SSO conduit. The County uses self-actuating flap gates or tidal gates to address this problem. It is imperative that these structures be inspected and maintained on a frequent basis to prevent limited service and basement backups during wet weather events. Maintenance of these structures includes periodic inspection and removal of debris.

12.0 Professional Development

The ACSED promotes professional development to all levels of personnel within the department. Professional development opportunities include technical training, personal development, secondary education, seminars and workshops. Personnel are trained in classroom environments with certified instructors. In most cases certificates are issued for successful completion of a class or course and have contact hours associated with them. These contact hours are necessary for the bi-annual renewal of OEPA Operator Licenses. Each year the department budgets money to finance these types of professional development opportunities that pertain to the employee's job description and trains them to be more proficient in their daily work. The following is a brief summary for each of the aforementioned professional development opportunities:

12.1 Technical Training

Technical Training includes training on becoming an Ohio EPA licensed plant operator, pumpstation / pump repairperson, fabricator, excavator, etc. The Operator Training Committee of Ohio (OTCO), along with equipment manufacturers, local vocational schools, and consultants, provide this form of training.

12.2 Personal Development

Personal Development includes training to become a better public speaker or a team / community leader. The local Chamber of Commerce, along with local colleges and private consultants, provide this form of training.

12.3 Secondary Education

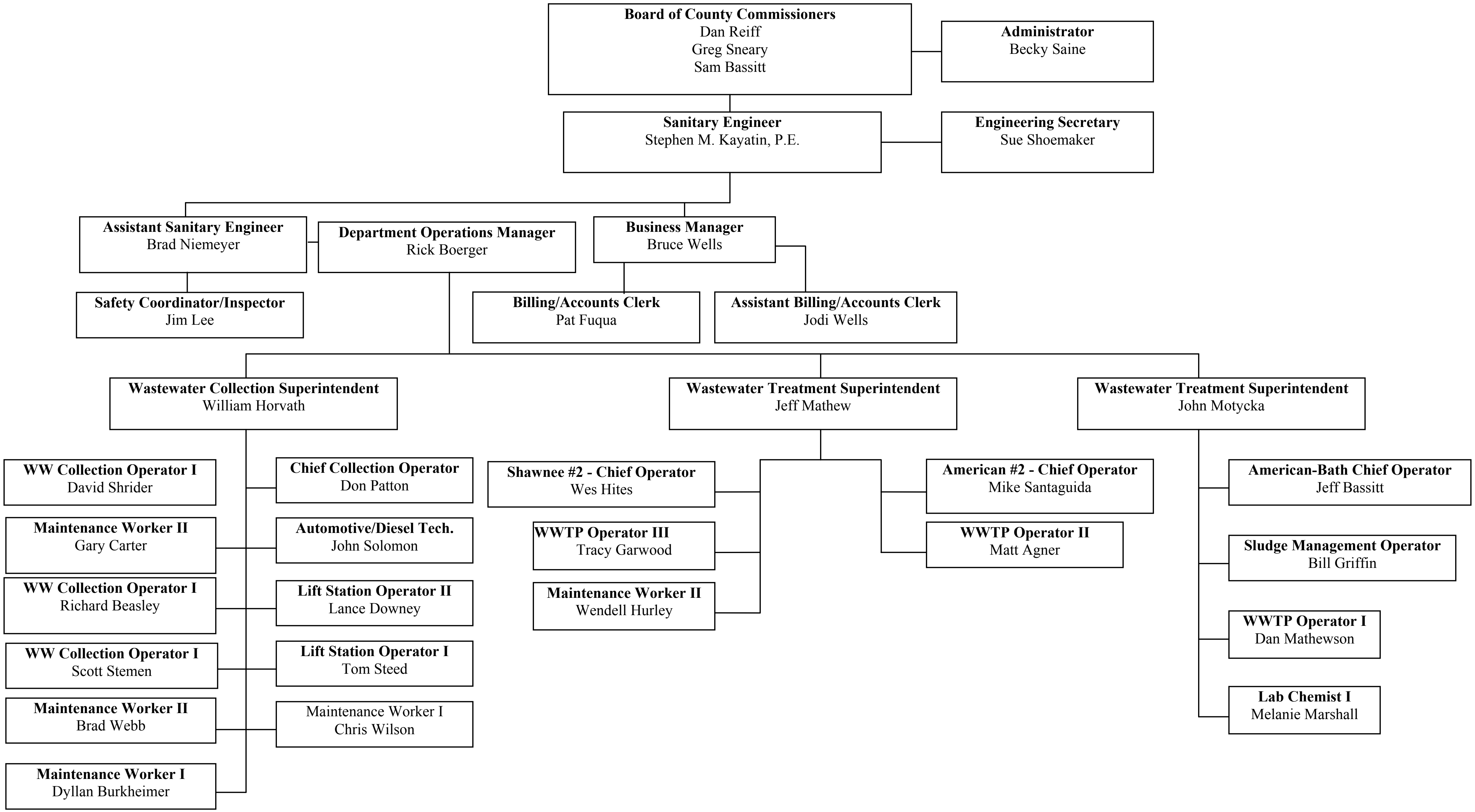
Secondary Education includes training to improve the employee's ability to work in a more efficient capacity for the benefit of the department and the public. Local colleges and universities provide this form of training.

12.4 Seminars and Workshops

Seminars and Workshops include training on specific topics to improve the employees understanding of the subject. This type of training is usually done by a consultant or agency and is conducted in a classroom type of environment.

APPENDIX A

ORGANIZATIONAL CHART
2007 ALLEN COUNTY SANITARY ENGINEERING DEPARTMENT



APPENDIX B

ALLEN COUNTY SANITARY ENGINEERING
SAFETY AND HEALTH TRAINING MATRIX
2006

TRAINING PROGRAM	Jan 25th	Feb 15th	Mar 15th	April 19th	May 17th	June 21st	July 17th	Aug 14th	Sept 18th	Oct 16th	Nov 13th	Dec 11th
Agner, Matt												
Bassitt, Jeff												
Beasley, Richard												
Boerger, Rick												
Burkheimer, Dyllan												
Carter, Gary												
Downey, Lance												
Fuqua, Pat												
Garwood, Tracy												
Griffin, Bill												
Hites, Wes												
Horvath, Bill												
Hurley, Wendell												
Kayatin, Steve												
Lee, Jim												
Mathew, Jeff												
Mathewson, Dan												
Marshall, Melanie												
Motycka, John												
Niemeyer, Brad												
Patton, Don												
Santaguida, Mike												
Shoemaker, Sue												
Shrider, Dave												
Solomon, John												
Steed, Tom												
Stemen, Scott												
Webb, Brad												
Wells, Bruce												
Wells, Jodi												
Wilson, Chris												

All Meetings Are Held From 7:30-8:30 a.m.

1 *Bloodborn Pathegens*
2 *Lockout Tagout*
3 *Personal Protective Equipment*
4 *Confined Space*
5 *Red Cross - split session 7:30 /11:30 11:30/3:30*
6 *Fire Safety*
7 *Fire Safety*
8 *Slips Trips and Falls*
9 *Traffic Control*
10 *Emergency Response*
11 *Back Safety*
12 *Holiday Safety*

APPENDIX C

Work Order Number: 07-0003

2/20/200
9:49 AM

Category: Pipe
Priority: Medium
Problem:
Crew:
Cause:
Supervisor: Don Patton
Main Task: High Pressure Cleaning
Status: New Work Order
Work Order Start Date/Time:
Work Order End Date/Time:

Location (s)

Comments from Request

Comments for Crew

CHECKLIST

Comp.	Item	Condition
☑		

Task Start Date/Time:
Task End Date/Time:
Task Code:
Task Description:

Employee Number	Employee Name	Time Type: Reg	OT	Normal	Type	Units

Equipment Code	Equipment Description	Units

Material Code	Material Description	Units

Fluid Code	Fluid Description	Units

Asset List (Sewer Pipes)

US Structure / DS Structure	US Address / DS Address	Length / Diameter	US Map Page / Material	DS Map Page	Completion Date
SH04 034 / SH04 033	3325 SHAWNEE RD / 2190 REED RD	658.7	034	033	
SH04 087 / SH04 006	LIFT ST	1,096.4	087	006	

APPENDIX D

VIDEO INSPECTION DATA SHEET

LOCATION

Subdivision:	Street Name & No.:

MANHOLE – LATERAL DATA

Manhole No. / Depth	__________ / __________
Type of Pipe	☐ PVC ☐ Vitreous ☐ Armco ☐ Concrete ☐ Other
	If other, please explain:
Size of Pipe	☐ 6 In. ☐ 8 In. ☐ 10 In. ☐ Other
	If other, please explain:
Number of Laterals & Length	
Location of Lateral Footage	
Type of Mainline	
Size of Mainline	
Type of Action Taken Through Pipe	☐ Crawler ☐ Skidd

CONDITION OF MAINLINE		CONDITION OF LATERAL	
❑	Cracks	❑	Cracks
❑	Roots	❑	Roots
❑	Broken/Separated	❑	Broken/Separated
❑	Inflow	❑	Inflow
❑	Intrusions	❑	Intrusions
❑	Plugged	❑	Plugged

WEATHER CONDITIONS

- ❑ Sunny/Dry
- ❑ Rain
- ❑ After Rain

How many days? _____

APPENDIX E

Work Order
Contract
Video
Setup 15
Facility
Operator rb
Van Ref 89
Surveyed On 01/05/2007

Street Name BRADFORD
City
Location type Berm
Surface Hotmix road
Survey purpose Random survey of pipes and things
Weather Light rainfall

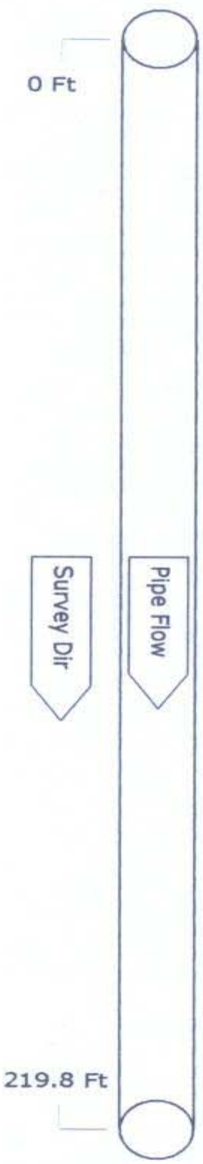
Pipe Use Sanitary
Shape Circular
Material Polyvinly chloride
Lining

Schedule length 219.8 Ft
Size 8 **by** ins
Joint spacing 12.0 Ft
Year laid

From SH05 256 **Depth** 8.00 Ft
To SH05 255 **Depth** 8.00 Ft
Direction Downstream
Pre-clean N **Last cleaned**

General note
Location note

Structural Service Constructional
Miscellaneous Hydraulic



0.0 Ft	Start of Survey Manhole/Node [SH05 256] Water level 0
3.8 Ft	Lateral or connection exists OK 12 o'clock [TAP-1 909 BRADFORD]
46.3 Ft	Lateral or connection exists OK 12 o'clock [TAP-2 943 BRADFORD]
104.7 Ft	Lateral or connection exists OK 12 o'clock [TAP-3 945 BRADFORD]
181.5 Ft	Lateral or connection exists OK 12 o'clock [TAP-4 950 BRADFORD]
219.8 Ft	Manhole/Node [SH05 255] Finish of Surveys

APPENDIX F

MANHOLE INSPECTION

Allen County, Ohio

Date: ___ / ___ / ___

Crew: _____, _____, _____

Project No. **0103**

Manhole No. (   ) ______________________________

Address: House No. ______________________________

Street: ______________________________

Locality: ______________________________

Map No.: ______________________

Precipitation: ______________________
1 = None, 2 = Light Rain, 3 = Heavy Rain, 4 = Snow

Ground Conditions: ______________________
1 = Dry, 2 = Damp, 3 = Wet, 4 = Standing Water

Downstream Pipe Length: ______________ (ft.)

---

o **Inspected**

Reason Not Inspected: _______

1 = C.N.L.	6 = Sealed Lid
2 = D.N.E.	7 = Traffic
3 = Buried	8 = Dog
4 = Haz/Atmos.	9 = Other
5 = Unsafe	

Location Code: ____________

1 = Paved Street	6 = Sidewalk
2 = Unpaved Street	7 = Parking Lot
3 = Paved Intersection	8 = Backyard
	9 = Ditch
4 = Unpaved Intersection	10 = Curb/Gutter
	11 = Easement
5 = Alley	12 = Private Residence

Manhole Diameter: _____._____ (ft.)

Manhole Depth: _____._____ (ft.)

o **Subject to Ponding**

Ponding Depth: _____._____ (ft.)

Tributary Area: _______ (sq. ft.)

Grade Elevation Code: _______

1 = Even

2 = Above ______ (in.) no decimal

3 = Below ______ (in.) no decimal

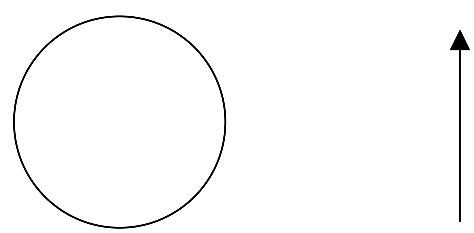
Structure Type Codes:

1 = Brick	9 = PVC
2 = Precast	10 = PVC-coated
3 = Block	11 = Rebar
4 = Clay Pipe	12 = None
5 = Concrete Pipe	13 = Bitumastic
6 = Poured	14 = Grout
7 = Rehab Coating	15 = Other
8 = Cast Iron	

See Attachment "A" for General Observation Codes.

	Type	Condition	I/I (gpm)	General Obs.	Comments
Cover:		G F P		____,____,____,____	______________________
a. Diameter: ____.____ (in.)					
b. Thickness: ____.____ (in.)					
c. Type Code: _________ 1=Light Duty, 2=Heavy Duty 3=Bolt Down, 4=Locking					
d. o Vented Cover					
e. No. of Vents: ________					
f. Vent Dia.: ____.____ (in.)					
Cover-to-Frame Fit:		G F P	____	____,____,____,____	______________________
Frame:		G F P	____	____,____,____,____	______________________
a. Inside Dia.: ____.____ (in.)					
b. Outside Dia.: ____.____ (in.)					
c. Dwell: ____.____ (in.)					
d. Height: ____.____ (in.)					
Frame-to-Chimney Seal:	_____	G F P	____	____,____,____,____	______________________
Chimney:	_____	G F P	____	____,____,____,____	______________________
a. Height: ____.____ (in.)					
Corbel:	_____	G F P	____	____,____,____,____	______________________
Wall:	_____	G F P	____	____,____,____,____	______________________
Bench:	_____	G F P	____	____,____,____,____	______________________
Invert:	_____	G F P	____	____,____,____,____	______________________
Steps:	_____	G F P		____,____,____,____	______________________
a. No. Missing: _______					

Pipe Seal:	**Condition**	**I/I (gpm)**
Seal #1.	G F P	______
Seal #2.	G F P	______
Seal #3.	G F P	______
Seal #4.	G F P	______
Seal #5.	G F P	______
Seal #6.	G F P	______



o **Evidence of Surcharge**

Surcharge Depth: _____._____ (ft.)

Comments: __________________

APPENDIX G

Work Order Number: 06-0174

2/20/200
10:10 A

Category:	Station	**Priority:**	
Problem:	Lift Station Alarm	**Crew:**	
Cause:		**Supervisor:**	Don Patton
Main Task:	Telemetry Maintanance	**Status:**	New Work Order
Work Order Start Date/Time:		**Work Order End Date/Time:**	

Location (s)

Comments from Request

Install telemetry system

Comments for Crew

Equipment is located in server room

CHECKLIST

Comp.	Item	Condition
☑		

Task Start Date/Time: **Task End Date/Time:**

Task Code: **Task Description:**

Employee Number	Employee Name	Reg (Time Type)	OT (Time Type)	Normal (Time Type)	Type (Time Type)	Units

Equipment Code	Equipment Description	Units

Material Code	Material Description	Units

Fluid Code	Fluid Description	Units

Asset List (Sewer Pump Stations)

Station ID Structure	Station Name Type	Address Capacity	Completion Date
Lake Cody LC 01 001	Lake Cody Station with Force Main	State Route 65 24.00	

1 Pump Stations

APPENDIX H

Questions to Consider for a Pumpstation Repair Program

1. Will the repairs be made by in-house staff or out-side contractors?

2. How many people will be needed to make the repair?

3. How will the pump station continue in operation during the repair?

4. Will a pump station bypass be required using a portable pump and a tee connection into the forcemain?

5. What manufacturer's manuals on operation, maintenance, disassembly, and repair are required?

6. Are these manuals available or must they be obtained before the repair can be initiated?

7. Is there adequate lifting equipment to both remove the component and load it on a truck for transport?

8. What components are expected to be worn or damaged and what procedures and tools will be required to evaluate their condition?

9. Must some parts be removed using machine shop equipment?

10. Has a machine shop been hired to perform this work on call?

11. Is adequate lighting available for the work?

12. How will correct assembly be verified (gages, micrometers, vibration analysis, laser shaft alignment between motors and pump or shaft joints)?

13. Has confined space safety planning been completed and has all equipment needed for confined space been gathered?

14. Do maintenance personnel have all personal protective equipment required for repair?

15. Have working components been procured for replacement of non-functional components?

16. Are special tools gathered for the work, including wrenches and flange spreaders?

17. Have replacement gaskets and gasket compound been acquired for the work?

APPENDIX I

Date: ____/____/____

Crew: ____, ____, ____

Crew No. ________

SMOKE TESTING

Allen County, Ohio

Project No. **0103**

Line Segment: ( ) ______________ **To** ( ) ______________

Upstream — Downstream

Weather Conditions: ______________
1 = 110-90°, 2 = 90-80°, 3 = 80-70°, 4 = 70°-below

Ground Conditions: ______________
1 = dry, 2 = moist, 3 = wet, 4 = saturated

Precipitation: ______________
1 = dry, 2 = drizzle, 3 = rain

Last Rain Event: ____/____/____

Pipe Length (ft.): ______________

Pipe Diameter (in.): ______________

Status Code: ______________

Measure Code: ______________

Status Code:
1=C.N.L. 4=Line too long
2=D.N.E. 5=Diameter too large
3=Buried 6=Complete

Measure Code:
1=Scaled from Map 5=Estimated
2=Walking Wheel
3=Tape Measure
4=Total Station

PART A: PRIVATE SECTOR

Smoke Defect No.	Bldg. Defect No.	Address	Defect Type	*Optional*: Footage (0=DS MH)	Offset (L/R)	Offset Footage	Tributary Area (sq. ft.)	Smoke Intensity	Comments:
A									
B									
C									
D									
E									
F									
G									
H									
I									
J									

Defect Type:
1 = Downspout
2 = Uncapped Cleanout
3 = Driveway Drain
4 = Stairwell Drain
5 = Foundation Drain
6 = Area Drain
7 = Service Lateral
8 = Window Well
9 = Plumbing Defect

Smoke Intensity:
1 = Light
2 = Medium
3 = Heavy

PART B: PUBLIC SECTOR

Defect No.	Defect Type	Footage (0=DS MH)	*Optional*: Offset (L/R)	Offset Footage	Tributary Area (sq. ft.)	Smoke Intensity	DYED WATER TEST: Dyed:	Result: Pos.	Neg.	Sus.	Date:	Comments:
S							o	o	o	o	__/__/__	
T							o	o	o	o	__/__/__	
U							o	o	o	o	__/__/__	
V							o	o	o	o	__/__/__	
W							o	o	o	o	__/__/__	
X							o	o	o	o	__/__/__	
Y							o	o	o	o	__/__/__	
Z							o	o	o	o	__/__/__	

Defect Type:
1=Curb Inlet
2=Area Drain
3=Line Defect
4=Indirect Storm
5=Manhole Defect
6=Drainage Crossing
7=Water Valve
8=Direct Storm

Smoke Intensity:
1=Light
2=Medium
3=Heavy

Additional Comments: ______________

CONFINED SPACE ENTRY PERMIT

COMPANY/LOCATION ______________________ DEPARTMENT ______________________

CONFINED SPACE TO BE ENTERED ______________ PERMIT EXPIRATION DATE/TIME: ______________

DESCRIPTION OF WORK TO BE PERFORMED: ______________________

NATURE OF HAZARDS IN CONFINED SPACE: (check)

- ☐ Oxygen deficiency (Less than 19.5% at sea level)
- ☐ Flammable gases or vapors (greater than 10% of the lower flammable limit, or greater than 23.5% oxygen at sea level
- ☐ Toxic gases or vapors (greater than the permissible exposure limit)
- ☐ Mechanical hazards
- ☐ Electrical shock
- ☐ Materials harmful to the skin
- ☐ Engulfment
- ☐ Configuration hazard
- ☐ Other ______________________

PREPARATION: (check)

- ☐ Notify affected departments of service interruption
- ☐ Isolate-blanked or double valve, with lock and tag
- ☐ Zero energy state (Lock Out all energy sources)
- ☐ Cleaned, drained, washed and purged
- ☐ Ventilation to provide fresh air
- ☐ Emergency response team available
- ☐ Employees informed of specific confined space hazards
- ☐ Secure area (post, sign and flag)
- ☐ Procedures reviewed with each employee
- ☐ Atmospheric test in compliance
- ☐ Attach hot work permit
- ☐ Other ______________________

EQUIPMENT REQUIRED FOR ENTRY AND WORK: (check)

- ☐ Lighting (Explosive Proof)
- ☐ Fire Extinguishers
- ☐ Emergency Escape Retrieval Equipment
- ☐ Other ______________________
- ☐ Lifeline and safety harness
- ☐ Protective clothing
- ☐ Hearing protection
- ☐ Resuscitators-Inhalator

Electrical equipment/tools:

_______ Low voltage

_______ Ground-fault current interrupters

_______ Approved for hazardous locations

Respiratory protection (specify) ______________________

Communication aid (specify) ______________________

Rescue equipment (specify) ______________________

AUTHORIZED ENTRANTS:

____

____

____

____

____

AUTHORIZED ATTENDANTS:

____

____

____

STAND BY SAFETY PERSONNEL:

____

____

TEST	Allowable Limits	Check (√) If Required	Result :	AM PM	Result :	AM PM	Result :	AM PM	Result :	AM PM	Result :	AM PM	Result :	AM PM
Time														
Oxygen-min.	19.5 %													
Oxygen-max.	23.5 %													
Flammability	10 % LEL													
H_2S	10 ppm													
Toxic (alert)														
Heat														
Other														
Other														

Name of employee conducting atmospheric monitoring: ______________ Instrument(s) used: ______________

Statement of acceptable entry conditions ______________________

____

AUTHORIZATION:

I certify that all required precautions have been taken and necessary equipment is provided for safe entry and work in this confined space

Time: ______________ Date: ______________

Name (Print) ______________________

Signature ______________________

APPENDIX K

BUILDING INSPECTION

Date: ______/______/______

Allen County Sanitary Engineer

Line Segment: ____________________________ **To:** ______________________________

Upstream MH Downstream MH

Parcel Number_________________________________ **Lot**

Number_________________________________

Occupant: _________________________________ **Owner:**

____

Address: _________________________________ **Address:**

____

City: ________________ **State:** ______ **Zip:** ___________ **City:** ________________ **State:** ______

Zip: ___________

Phone: _____________________ **Status:** ____________ **Phone:**

____

Inspection Attempt:	Date:	Status:	Comments:
1	____/____/____	______	______________________________
2	____/____/____	______	______________________________
3	____/____/____	______	______________________________
4	____/____/____	______	______________________________

Status:
1 = Inspected
2 = Not at Home
3 = Refusal
4 = Not Inspected

❑ **History of Flooding**

Flood Date:	Source	Maximum Depth (ft.)	Duration (hrs.)	Action Taken
____/____/____	______	______	______	______
____/____/____	______	______	______	______
____/____/____	______	______	______	______

Source:
1 = Sanitary Backup
2 = Stairwell Stormwater
3 = Window Well Stormwater
4 = Wall Seepage
5 = Blockage (private line)
6 = Unknown
7 = Other (See Back)

Action Taken:
1 = Called Plumber
2 = Installed Sump Pump
3 = Eliminated Stormwater Source
4 = Removed Blockage
5 = Called County
6 = None
7 = Other

Building Type: _______

Building Age (approximate): _______ yrs.

Years Occupied By Present Owner/Occupant: _______yrs.

Basement Type: _______

Building Type:

1 = Ranch	5 = Duplex	9 = Industrial
2 = Raised Ranch	6 = Townhouse	10 = Institutional
3 = Split Level	7 = Apt. Building	11 = Other
4 = Two-Story	8 = Commercial	12 = Vacant Lot

Basement Type:
1 = Full
2 = Half
3 = Crawl Space
4 = Slab
5 = Other

BUILDING SUMP PUMPS: **DYE TEST:**

Sump Number	Location	Sealed	Drain	Source of Water	Discharge	Dyed	Pos.	Neg.
1	_____	☐	☐	________________	________________	☐	☐	
2	_____	☐	☐	________________	________________	☐	☐	

STATUS Suspect

1: ☐☐

2: ☐☐

Location:
1 = Inside Drain
2 = Outside w/Drain

Source of Water:
1 = Foundation Drain
2 = Sanitary
4 = Storm
5 = None

Connection Type:
1 = Sump Pump with Single Discharge
2 = Sump Pump with Diverter Valve
4 =
5 = Pit

Discharge:
1 = Sanitary
2 = Outside
3 = Storm
4 = Unknown