

FPDP-RPT-0047

**Final Sewer Inflow and Infiltration Study and Report  
at the Paducah Gaseous Diffusion Plant,  
Paducah, Kentucky**

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at the Paducah Gaseous Diffusion Plant,  
Paducah, Kentucky**

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U.S. DEPARTMENT OF ENERGY  
Office of Environmental Management

Prepared by  
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managing the  
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Paducah Gaseous Diffusion Plant  
under Task Order DE-DT0007774

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## ACRONYMS

DOE	U.S. Department of Energy
CCTV	closed circuit television
FPDP	Fluor Federal Services, Inc., Paducah Deactivation Project
FY	fiscal year
I&I	inflow and infiltration
ROM	rough order of magnitude
SDP	sewage disposal plant
UOPP	Utilities Optimization Program Plan
VCP	vitrified clay pipe

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## EXECUTIVE SUMMARY

The Sewage Treatment System is a primary utility at the U.S. Department of Energy (DOE) Paducah Gaseous Diffusion Plant. The system supports site needs for treating sanitary sewage from administrative facilities, locker rooms, restroom facilities, and break rooms and treating water discharged to the collection system. In response to Task Order Modification 0018, Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP) conducted a field study of the sewage collection system by performing visual inspections, closed circuit TV inspection, and smoke testing of the manholes and piping. The field study formed the basis for the recommendations to rehabilitate, isolate, and abandon or clean and repair portions of the existing system described in this report.

During June and July 2016, Robinson Pipe Cleaning Company and Gonzales Companies completed the field study using the aforementioned techniques. Approximately 10,000 linear feet (lf) of sanitary sewer lines were recorded with closed circuit television inspection, approximately 23,000 lf were smoke tested, and 62 manholes were inspected as part of the study. Data interpretation of the results of the field study indicate that, while the overall condition of the sewage collection system is satisfactory, isolated areas are in need of cleaning and repair.

This report provides detail on the method and sequence of recommendations to repair or abandon sections of the system. The recommendations to repair, replace, or abandon sections of the sewage collection system are based on the condition of the system, as determined by the field study, and on assumptions related to the anticipated future occupancy of certain administrative buildings on-site. The assumptions relative to occupancy are based partially on information contained in the *Life Cycle Plan for the U.S. Department of Energy Paducah Site* (Life Cycle Plan), FPDP-RPT-0010/R1, that FPDP submitted to DOE on July 15, 2016.

Following are the recommendations for repair or abandonment of components of the sewage collection system:

- Reduce the overall footprint through isolation and abandonment of approximately 3,600 lf of sanitary sewer lines without impacting site operations or buildings with high staffing levels;
- Clean and repair multiple segments of piping, approximately 1,650 lf, identified as at risk of being catastrophic and that are vital to the overall functionality of the sewage collection system; and
- Rehabilitate and repair 20 manholes with significant defects, as identified in the field study.

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# 1. INTRODUCTION

In response to Task Order Modification 0018, Fluor Federal Services, Inc., Paducah Deactivation Project (FPDP) conducted a field study of the Paducah Gaseous Diffusion Plant sewage system in June and July 2016. The purpose of the field study was to determine potential sources of inflow and infiltration (I&I) to the piping and manholes of the system. The potential sources of I&I include cross-connections, point source inflow, faulty connections or degraded pipe or manholes. Evaluation of the C-615 Sewage Disposal Plant (SDP) was not part of the scope of the field study.

Sewage treatment is needed to support the future site mission by treating sanitary sewage from administrative facilities, locker rooms, restroom facilities, break rooms, treatment of water discharged to the collection system, and as a backup for treatment of leachate from site landfills. The field study evaluated the overall integrity of the manholes and piping that make up the sewage collection system.

The sewage collection system is composed primarily of vitrified clay pipe (VCP). Small amounts of VCP have been replaced with polyvinyl chloride or high-density polyethylene pipe. Through the performance of the field study it became apparent that the site drawings of the sanitary sewer system are not completely accurate as to the number or location of manholes. Manholes shown on the drawings may exist, but could not be found and accessed due to concrete or asphalt covering them. Removal of asphalt, concrete, or substantial soil to locate manholes was not in the scope of the field study.

Although oversized, the sewage collection system is adequate for the future site mission. The lift stations and collection piping are all within original design parameters. Significant I&I to the collection system occurs during rain events. Flow almost doubles and sometimes exceeds the design maximum flow of SDP during large rain events. Overall, the collection system is deemed satisfactory, but isolated areas need repair and sections can be abandoned.

The field study utilized visual inspections, closed circuit television (CCTV) inspection of piping, and smoke testing of the manholes and piping to evaluate the sewage collection system. The work was performed by Robinson Pipe Cleaning (CCTV inspections) and Gonzales Companies (smoke testing and visual inspections of manholes), both of whom specialize in this work. Table 1 lists the type and approximate quantity of inspections and testing performed by Robinson Pipe Cleaning Company and Gonzales Companies.

**Table 1. Sewage System Type and Quantity of Inspections and Testing**

<b>Inspection/Test</b>	<b>Approximate Quantity</b>	<b>Recommendation</b>
CCTV inspections	Approximately 10,000 lf	Repair/line approximately 1,650 lf of pipe Abandon approximately 3,600 lf of pipe
Visual manhole inspections— interior and surface	62 manholes	Repair or raise 20 manholes
Smoke testing of underground lines (including manholes)	Approximately 23,000 lf	No cross connections found Repairs where smoke was observed at defects in piping are included in sections recommended for pipe lining

Smoke testing was utilized to evaluate approximately 23,000 lf of piping. Of that amount, approximately 10,000 lf (43%) was available for CCTV inspection. Approximately 13,000 lf of piping could not be inspected using CCTV due to debris in the lines. Evaluation of the 10,000 lf of pipe yielded a recommendation to repair or line approximately 1,650 lf. Additional cost and schedule impacts could be realized after the initial cleaning is completed and more pipe is available for CCTV inspection and evaluation.

To satisfy the requirements of the Modification 0018 this final report includes the following information:

- Data, photographs, and video documenting the condition of the sewage system performed by Robinson Pipe Cleaning [previously transmitted to the U.S. Department of Energy (DOE) in August 2016 via flash drive]; and
- Recommendations with a priority listing for the repair, replacement, or abandonment of portions of the sanitary sewer system.

## **2. FIELD STUDY METHODOLOGY**

The field study was performed using a combination of CCTV inspection with video capture capability, visual inspection, and smoke testing. The study area and manhole identification information were provided to the subcontractor on drawing C5E-FA1370-A01 Revision FA1, “Sewer Systems Infiltration and Inflow Study and Report Plant Sanitary Sewer System Manhole Numbers” (Figure 1). Prior to mobilization, FPDP worked closely with Robinson Pipe Cleaning Company to formulate a sequence of testing to ensure all accessible manholes were inspected, access points for smoke testing were chosen strategically, and impacts to plant operations were minimized or avoided. Manhole inspections were performed first and were followed by smoke testing. Finally, CCTV inspections were staggered one to two days behind smoke testing to ensure all smoke had dissipated from the system, allowing for clear images to be captured by the robotic camera. Robinson used this combination of inspection and testing methods and a systematic approach to the evaluation to produce a comprehensive set of reports that captures the current condition of the sanitary sewer piping.

Visual manhole inspections were conducted by Gonzales Companies using digital cameras and telescoping poles to document the physical location of the manhole, direction of sewer pipe connections, visible defects, and incoming and outgoing pipes. Structural defects were noted and recorded for each manhole that was successfully located and accessible.

In addition, Gonzales Companies also performed smoke testing to identify clearly defects or improper connections within the sanitary sewer system. The testing was done by removing the manhole cover, testing for explosive gases, then using a smoke blower and mineral seal oil to blow odorless, nontoxic “smoke” into the sewer system. Smoke was visible where defects existed, and these were photographed to capture the location of the smoke rising from potential areas of I&I.

To inspect the sanitary sewer system piping, a small robotic device with an integral video camera was used to document the condition of the sewer mains and laterals and to locate and identify sources of I&I. Robinson Pipe Cleaning Company used a color camera capable of panning 275° and rotating 360° to

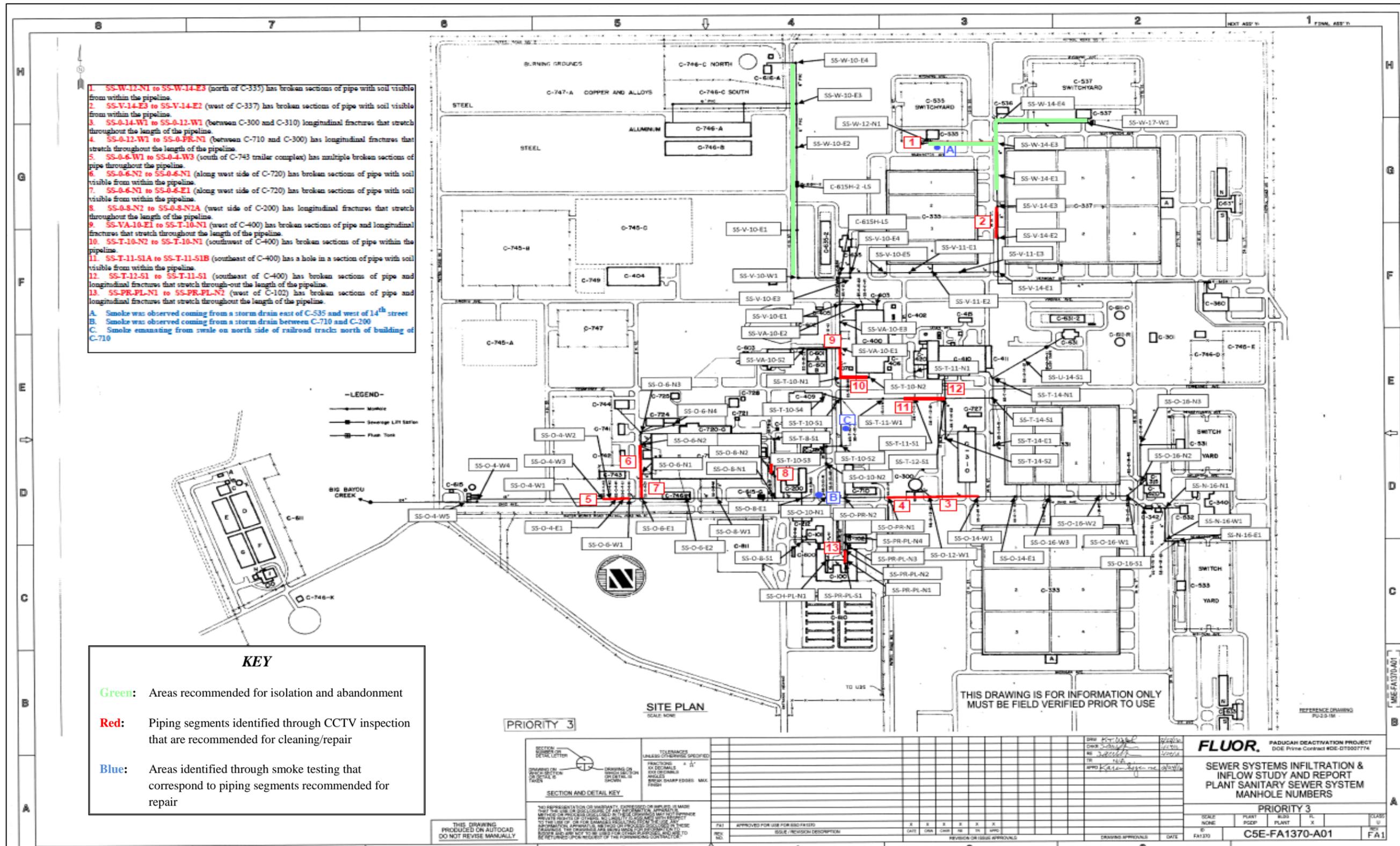


Figure 1. Drawing C5E-FA1370-A01 Revision FA1

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provide the location of damage or defects. Each sewer line that was accessible was videotaped to document the structural conditions of the line such as cracked or broken pipe, offset joints, blockages or debris, and other evidence of I&I. Inspection information was recorded electronically with voice-over narration, which included upstream and downstream manhole numbers, date and direction of inspection, clock position of observations, length of segment observed, pipe diameter and material, and severity of defects found.

Figure 1 indicates areas for which isolation/abandonment or cleaning and repair are recommended.

### **3. MATERIAL CONDITION**

The *Fluor Federal Services, Inc., Paducah Deactivation Project Utility Optimization Program Plan* (UOPP), CP2-UT-0004/R0, employed a rating system utilized to rate the material condition of the site sewage system. It was determined that while the overall flow was found typically to be below maximum operational design levels, piping and associated equipment were oversized significantly for the near-term and long-term mission. The UOPP deemed the lift stations and manholes to be in satisfactory condition. Upon completion of the Field Study, Robinson Pipe Cleaning Company agreed that the collection system was in satisfactory condition, but recommended that certain manholes and segments of pipe be repaired. Segments of pipe identified by Robinson as areas in need of repairs were closely aligned with those identified in the UOPP and are outlined in Section 5, “Recommendations.”

### **4. ASSUMPTIONS**

The recommendations to repair, replace, or abandon sections of the sanitary sewer collection system are based on the condition of the system as determined by the field study and on assumptions related to the anticipated future occupancy of certain administrative buildings on site. The assumptions relative to future occupancy are partially based on information contained in the *Life Cycle Plan for the U.S. Department of Energy Paducah Site* (Life Cycle Plan), FPDP-RPT-0010/R1, which FPDP submitted to DOE on July 15, 2016.

## **5. RECOMMENDATIONS**

Three main objectives were the focus in formulating recommendations for the sanitary sewer:

- (1) Reduce the overall footprint through isolation and abandonment of approximately 3,600 lf of sanitary sewer lines without impacting site operations or buildings with high staffing levels;
- (2) Clean and repair multiple segments of piping, approximately 1,650 lf, identified as at risk of catastrophic and that are vital to the overall functionality of the sewage collection system; and
- (3) Rehabilitate and repair 20 manholes with significant defects as identified in the field study.

Figure 1 indicates areas for which isolation/abandonment or cleaning and repair are recommended. Areas to be isolated and abandoned include the northwest segment of the sanitary sewer that runs from the north end of the site near C-616 to the southwest corner of the C-635 Cooling Towers, the segment that runs south of C-535, and the segment that is located south of C-537. Isolation and abandonment of these areas is recommended based on the assumption that the C-535 and C-537 switchyards will be shut down in the very near future and that portable toilet facilities can be used in these switch houses and at C-616 and C-757. Additionally, C-400 personnel have been relocated and the building's sanitary sewer line will be

isolated under current deactivation scope; therefore, this section of pipe will not require repair or isolation. Isolation and abandonment activities will be performed by FPDP personnel.

Cleaning and repair is recommended for several segments identified as a result of the field study. Areas of sanitary sewer pipeline considered to be main transport paths for sewage were given first priority as catastrophic failures of these sections would result in the greatest impact to the site by causing sitewide outage of the sewage system. Areas servicing buildings with current and anticipated high staffing levels will be cleaned and repaired once the highest priority segments are completed. The recommended segments of pipe to be cleaned and repaired are listed and prioritized in Table 2.

**Table 2. Recommendations for Abandoning or Cleaning and Lining Sanitary Sewer Lines by Priority**

Priority	Corresponding Item on Field Study Map (Figure 1)	Item Description
1	1 and Area A	Segment 1 and Area A will be isolated and abandoned based on the assumption that the C-535 and C-537 switchyards will be shut down; repair of this section and nearby area is not recommended. Included in the isolation and abandonment activities is the area south of C-537 and the northwest segment of the sanitary sewer running from the north end of the site (near C-616) to the southwest corner of the C-635 Cooling Towers.
1	5	SS-0-6-W1 to SS-0-4-W3 (south of C-743 trailer complex) has multiple broken sections of pipe throughout the pipeline.
2	9	SS-VA-10-E1 to SS-T-10-N1 (west of C-400) has broken sections of pipe and longitudinal fractures that stretch throughout the length of the pipeline.
3	3, 4, and Area B	SS-0-14-W1 to SS-0-12-W1 (between C-300 and C-310) has longitudinal fractures that stretch throughout the length of the pipeline. SS-0-12-W1 to SS-0-PR-N1 (between C-710 and C-300) has longitudinal fractures that stretch throughout the length of the pipeline. Area B is slightly downstream of segment 4.
4	13	SS-PR-PL-N1 to SS-PR-PL-N2 (west of C-102 in the C-100 loop) has broken sections of pipe and longitudinal fractures that stretch throughout the length of the pipeline.
5	6 and 7	SS-0-6-N2 to SS-0-6-N1 (west side of C-720) has broken sections of pipe with soil visible from within the pipeline. SS-0-6-N1 to SS-0-6-E1 (along west side of C-720) has broken sections of pipe with soil visible from within the pipeline.
6	11 and 12	SS-T-11-S1A to SS-T-11-S1B (southeast of C-400) has a hole in a section of pipe with soil visible from within the pipeline. SS-T-12-S1 to SS-T-11-S1 (southeast of C-400) has broken sections of pipe and longitudinal fractures that stretch through-out the length of the pipeline.
7	8	SS-0-8-N2 to SS-0-8-N2A (west side of C-200) has longitudinal fractures that stretch throughout the length of the pipeline.
8	Area C	CCTV inspection and smoke testing of this section of pipe (east of C-409, near railroad track) revealed a defective repair patch approximately 61ft from the upstream manhole. Smoke was visible coming from a small hole in the ground at this location.
9	2	SS-V-14-E3 to SS-V-14-E2 (west of C-337) has broken sections of pipe with soil visible from within the pipeline.

Cleaning all pipe segments identified for repair will be by a combination of subcontractor and FPDP personnel. The existing King Vac truck will be operated by site personnel first to remove debris and sediment from the interior of the lines. The specialty subcontractor will provide oversight to ensure that the pipe is sufficiently clean to accept a liner. To minimize excavation and generation of excess soil, the proposed method for repair will be to employ a trenchless technique of pipe bursting or cured in place pipe lining. Lining the piping segments by one of these trenchless methods will be performed by a specialty subcontractor.

Manhole rehabilitation and repair will be performed by the same specialty subcontractor after the abandonment/isolation of sections of piping and in parallel with cleaning and repair of vital sections of the collection piping. Manholes selected for repair will be based on detailed engineering analysis of the field study. Unless otherwise damaged or clearly below adjacent grade, manholes where smoke was detected through pick holes in the lids are not included in the number estimated to need repair.

## **6. SCHEDULE**

Figure 2 illustrates the schedule for sanitary sewer collection system isolation, abandonment, cleaning, or repair.

## **7. ESTIMATE**

The cost estimate is contained in the appendix to this document. The estimate is ROM, based on evaluation of the field study and conceptual approach to repair or lining of the sanitary sewer collection piping and rehabilitation/repair of existing manholes. The labor and material estimate is approximately \$525,000. Escalation and other indirect costs are estimated at 15%, bringing the total estimate to approximately \$600,000. A detailed estimate cannot be completed until formal engineering analysis and the solicitation of proposals from specialty contractors to repair and line the piping are performed. Cleaning of currently inaccessible piping could result in identification of substantial additional pipe repair or lining. Risk is not included in the ROM estimate.