Including Building Backups and Trend Analysis

Submitted to EPA on April 26, 2005

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A 10-year Program to Improve Our Waterways

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Executive Summary

2001–2004 SSOER, including Building Backups

The Sanitary Sewer Overflow Evaluation Report (SSOER) is an assessment tool KUB uses as part of its ongoing Collection System Improvement Program (CSIP). The 2001-2004 SSOER is a summation of the sanitary sewer overflows (SSOs) between January 2001 and December 2004. The 2001-2004 building backups are included in separate spreadsheets. The report analyzes the specific causes of each overflow or building backup and categorizes them as requiring short- or long-term corrective measures, or both.

As required by the Consent Decree, the SSOER and building backup summaries are sorted by chronological occurrence, and also by the basin number and street address. The type of sort is noted on the footer of each spreadsheet.

Key to the spreadsheet headings in the SSOER

1. **Date**: Date the overflow was discovered by/or reported to KUB.
2. **Street #**: The street number of the location where the overflow occurred.
3. **Street**: The street name where the overflow occurred.
4. **Plant**: Shows which wastewater treatment plant (WWTP) receives wastewater from the collection system in the area of the overflow. *Abbreviations*: EBR – Eastbridge WWTP; FC – Fourth Creek WWTP; KUW – Kuwahee WWTP; LC – Loves Creek WWTP.
5. **Watershed**: A natural geographic area draining to a particular waterway, such as First Creek.
6. **Basin**: A small area of the sewer system separated by natural topography or system configuration. KUB identifies basins by a number.
7. **Overflow Location**: This location information is specific to the KUB system, listing manhole numbers (MH#), pump stations, etc., or if the overflow was on a customer lateral or at a broken pipe.
8. **Private Property Location**: ‘BB’ indicates that a sewer backed up into a building in association with a reportable SSO. Building backups associated with overflows are shown in the building backup spreadsheet.
9. **Cause of SSO/KUB Response**: The causes of SSOs are inflow and infiltration (I&I) from rain or flooding and blockages caused by grease buildup, roots, or debris. This column lists immediate actions KUB took in response to the SSO, such as repairing the line, etc.
10. **Volume (gallons)**: The estimated gallons of wastewater spilled in the overflow.
11. **Duration (hours)**: The estimated number of hours an overflow lasted.
12. **Event occurred two or more times within 12 months**: Shows SSOs recurring two or more times in a 12-month period.
13. **Long-term Capital Project**: Indicates whether the SSO requires long-term resolution, such as a capital improvement project. The five-year plan is formally updated on an annual basis and at other times during the fiscal year, as needed, to reflect changing conditions, priorities, and/or needs.
Completed: Construction has been completed
Current Construction: Work (engineering design and construction) is under way at this time
Current Five-Year Plan: The project is scheduled to begin between now and June 2012
Future Five-Year Plan: The need for a capital project has been identified/scheduled for future
N/A: One-time SSOs may not require long-term projects.

14. Short-Term Controls Blockage Abatement (BA): Short-term resolutions to SSOs and building backups include activities intended to reduce and/or eliminate the cause of the overflow or building backup. These activities include equipment/pipe/manhole repairs, routine pipe cleaning, chemical root control, grease inspections/enforcement, power restoration, etc. In some cases when an overflow has occurred two or more times in a 12-month period, a long-term corrective action will also be needed.

15. BA Schedule: The frequency of scheduled maintenance for SSOs or building backups being alleviated by short-term measures.

Key to the headings in the building backup spreadsheets
1. Date: Date the backup was discovered by/or reported to KUB.
2. Street #: The street number of the location where the backup occurred.
3. Street: The street name where the backup occurred.
4. Plant: Shows which wastewater treatment plant (WWTP) receives wastewater from the collection system in the area of the backup. Abbreviations: EBR – Eastbridge WWTP; FC – Fourth Creek WWTP; KUW – Kuwahee WWTP; LC – Loves Creek WWTP.
5. Watershed: A natural geographic area draining to a particular waterway, such as First Creek.
6. Basin: A small area of the sewer system separated by natural topography or system configuration. KUB identifies basins by a number.
7. Backup Location: Identifies if the backup occurred in a building and/or other private structure (manhole, clean-out, etc.).
8. Event Included in SSOER: A check mark indicates if this building backup was associated with a public overflow event on the SSOER.
9. Cause of backup/KUB Response: The causes of backups are inflow and infiltration (I&I) from rain or flooding and blockages caused by grease buildup, roots, or debris. This column lists immediate actions KUB took in response to the backup, such as repairing the line, etc.
10. Volume (gallons): The estimated gallons of wastewater spilled in the backup.
11. Duration (hours): The estimated number of hours a backup lasted.
12. Event occurred two or more times within 12 months: Shows backups recurring two or more times in a 12-month period.
13. Long-term Capital Project: Indicates whether the backup requires long-term resolution, such as a capital improvement project. The five-year plan is formally updated on an annual basis and at other times during the fiscal year as needed to reflect changing conditions, priorities, and/or needs.
o Completed: Construction has been completed
o Current Construction: Work (engineering design and construction) is under way at this time
o Current Five-Year Plan: The project is scheduled to begin between now and June 2012
o Future Five-Year Plan: The need for a capital project has been identified/scheduled for future
o N/A: One-time SSOs may not require long-term projects.

14. Short-Term Controls Blockage Abatement (BA): Short-term resolutions to building backups include activities intended to reduce and/or eliminate the cause of the building backup. These activities include equipment/pipe/manhole repairs, routine pipe cleaning, chemical root control, grease inspections/enforcement, power restoration, etc. In some cases when a backup has occurred two or more times in a 12-month period, a long-term corrective action will also be needed.

15. BA Schedule: The frequency of scheduled maintenance for backups being alleviated by short-term measures.
2001-2004 SSO and Building Backup Report Trend Analysis

The information contained in the SSOER and Building Backup Report was compiled into one overall trend analysis. These events were analyzed based on four major components:

- Annual Number of SSOs
- SSO Cause
- SSO Volume
- SSO Duration.

Annual Sanitary Sewer Overflow Totals
Figure 1 illustrates the annual number of overflows and building backups. The number of overflows and building backups increased from 2001 to 2003. As illustrated in this graph, both categories decreased in 2004 to the second lowest total within this analysis. The reasons for this decrease are discussed in the analysis of each category of overflows.

Causes of Sanitary Sewer Overflows
Figure 2 presents a comparison of SSOs by causes. In this graph, the SSOs were grouped into four categories:

- Heavy Rainfall
- Blockages (Debris, Grease, and/or Roots)
- Broken Pipe
- Other (Construction Failures, Flushing Operations, Grinder Pumps, Vandalism, WWTP, and Pump Stations).
The Heavy Rainfall category includes SSOs that were a direct result of rain events. This category represents events that were generally caused by heavy rainfall in the area that resulted in high flows in the collection system.

The Blockages category represents SSOs that were caused by debris, grease, roots, or some combination of the three.

The Broken Pipe category includes SSOs that were a direct result of a broken or damaged pipe.

The Other category includes SSOs that were caused by construction failures, flushing operations, grinder pumps, vandalism, or WWTP or pump station failure (mechanical, electrical, or electronic).

The SSOs for 2001 through 2004 are grouped into one of four general categories by each year. As illustrated in Figure 2, blockage-related events were the major cause of SSOs in 2001 and 2002. Rain was the largest contributor in 2003 and 2004. The number of blockage-related SSO events increased from 2001 to 2002; however, the number decreased by 44 percent from 2002 to 2004. Increased cleaning, root removal, and Grease Control Program improvements contributed to the reduction.
Sanitary Sewer Overflow Causes

Figures 3.A-D illustrate the specific causes of SSOs that occurred from 2001 to 2004. The causes listed in the graph include:

- **Blockages**
  These events were a result of debris, grease, or roots in the sewer lines that triggered upstream overflows. The events may have occurred during dry or wet weather but were included in this category because blockage was involved.

- **Heavy rainfall**
  These events were a result of extraneous water entering the collection system due to rain events that exceeded the hydraulic capacity of the system.

- **Broken pipe**
  These events were a direct result of structural failure in the collection system.

- **Other**
  The “Other” category represents five specific causes. They were encapsulated into one category to improve the readability of the chart. The causes represented in the “Other” category include:
  - **Construction Failures**
    This category includes causes that occurred during the repair activities of the collection system or through damage of the collection system by a third party. Types of causes that comprise this category include failed bypass pumping, third-party installation of gas line that damaged sewer line, etc.
  - **Flushing Operations**
    These events are backups during the operation and maintenance of the collection system.
  - **Grinder Pumps**
    These events are failures, mechanical or electrical, of KUB-maintained grinder pumps.
  - **Vandalism**
    These events are a result of damage or blockage to the collection system caused by intentional placement of foreign objects into the sewer system or other destructive actions.
  - **Wastewater Treatment Plant (WWTP) and Pump Station Failures**
    These events resulted from a failure at a WWTP or pump station, such as a mechanical or electrical failure.
Figure 3.A
KUB Causes of SSOs in 2001
(Including Building Backups)

- Other: 4%
- Broken Pipe: 11%
- Heavy Rainfall: 16%
- Blockages (Debris, Grease and Roots): 69%

Figure 3.B
KUB Causes of SSOs in 2002
(Including Building Backups)

- Other: 7%
- Broken Pipe: 5%
- Heavy Rainfall: 37%
- Blockages (Debris, Grease and Roots): 51%
Analysis

Blockages
Figures 3.A-D illustrate that blockage-related SSOs have declined since 2001. KUB’s Blockage Abatement (BA) Program, an operational and maintenance approach to blockage-related overflows, has also continuously improved over that period. For example, KUB restructured the program in 2004 to maximize cleaning efforts by updating the frequencies and type of maintenance activities. KUB also selected a contractor to perform BA maintenance in 2004 so internal resources could focus on proactive maintenance and assessment.

Along with the BA Program, KUB’s successful Grease Control Program also played a role in the decrease in blockage-related SSOs. Each of those programs is described in greater detail in submittals for the Gravity Line Preventive Maintenance Program and Grease Control Program.

Heavy Rainfall
The Heavy Rainfall events increased dramatically in 2002 and 2003 and decreased slightly in 2004. That increase corresponded to a dramatic increase in rainfall in the Knoxville area that caused rain-derived inflow and infiltration (RD I/I) to exceed system capacity. In just two weekends in February 2003, for example, heavy rains that flooded roads, homes, and businesses and caused mudslides also led to 115 SSOs.

KUB’s wet weather survey, referred to as the Hot Spot Program, describes the inspection of areas within the collection system that are negatively impacted by I/I. Along with increased rainfall, KUB’s proactive monitoring of these 28 Hot Spot locations during heavy rain events is responsible for the rise in the number of identified SSOs. Refer to Figure 4 for an example of a KUB Hot Spot location.

KUB has initiated several find and fix rehabilitation projects to address areas of the system most susceptible to RD I/I. System storage projects are also under way to control overflows at several strategic points in the collection system. Those project plans will be defined in greater detail in the Phase 1 Corrective Action Plan/Engineering Report (CAP/ER).

The “Long-term Capital Improvement” column of the SSOER identifies areas that are susceptible to impacts of I/I and it lists ongoing or planned system improvements to address I/I issues.
Broken Pipe
The Broken Pipe cause decreased from 2001 to 2003, but increased slightly in 2004. KUB’s Sewer Overflow Response Plan (SORP), which was updated and implemented in 2003, requires follow-up inspections of SSOs. This standard of performing root/cause analysis has helped KUB identify opportunities for point repairs. Increased follow-up inspections and point repair activities account for some of the 2004 increase.

Other
Other causes increased steadily from 2001 to 2004. Construction failures, grinder pumps, WWTP, and pump station issues were the primary drivers in this category. The construction failures were a result of operational failures during construction projects by internal and external forces. For example, a sewer line damaged by the improper placement of a utility pole is categorized as a construction failure. KUB-maintained grinder pumps received more attention, which led to an increase in the number of overflows reported. The number of WWTP and pump station driven SSOs steadily increased until 2003, then decreased by approximately 61 percent in 2004. That decrease in SSOs is a result of process control improvements at the plant and continued preventive maintenance improvements at the pump stations.

Sanitary Sewer Overflow Volumes
Figures 5.A and 5.B represent the SSO volumes between 2001 and 2004. For Figure 5.B, the SSO volumes were grouped into four volume ranges:

- Between 0 and 1000 gallons
- Between 1001 and 10,000 gallons
- Greater than 10,000 gallons
- Not available.

The last range describes events for which volume information was not available or was not recorded, such as for building backups.
Figure 5.A

Total SSO Volume per Year
(Including Building Backups)

Volume per Year - Millions of Gallons
(Bars)

Number of SSOs per year
(Line)

2001: 0.744
2002: 14.861
2003: 95.658
2004: 12.381

Figure 5.B

Sanitary Sewer Overflow Volumes
(Including Building Backups)

Number of SSOs

0 to 1000 gal
1001 to 10,000 gal
Greater than 10,000 gal
Not Available

2001
2002
2003
2004
The SORP, updated in 2003, provided structured volume estimating techniques for field crews. The SORP provides three basic techniques to determine the amount of discharge that occurred:

- Calculating Rectangular Spill Areas
- Calculating Based on Duration and Number of Residential Services
- Calculating Based on Duration and Flow Rate.

0 to 1000 gallons
In all four years, this volume range accounted for the most SSO events. Most of these events were related to blockages or other non-rain-related events.

1001 to 10,000 gallons
This volume range can again be related to non-rain events. The trend for this range is similar to the 0 to 1000 gallons trend.

Greater than 10,000 gallons
This volume range represents the larger volume overflow events within the 2001-2004 period. These volumes are normally associated with rainfall-related events. The trend from 2001-2003 is similar to the previous categories and the number of events decreased slightly in 2004.

Not Available (N/A)
This volume range captures the volume estimations that responders were either not able to calculate or were not required to calculate according to KUB’s record-keeping practices. Over 90% of the occurrences each year were related to building backups. KUB has not recorded the volume related to backups. Under KUB’s revised SORP, crews will calculate volumes for both overflows and building backups, where sufficient data is available.

Sanitary Sewer Overflow Durations
Figure 6 represents the SSO durations between 2001 and 2004. Durations are based on the amount of time elapsed since the overflow was first observed until the time the overflow was observed to have stopped. In many cases, KUB mitigated the overflow shortly after confirmation of the event. The SSO durations were grouped into four ranges:

- Between 0 and 2 hours
- Between 2.1 and 5 hours
- Greater than 5 hours
- Not available.

The last category describes events for which duration information was not available or was not recorded, such as for building backups.
0 to 2 hours
This category shows a steady increase until 2003 and then a decline in 2004. The only year that this category had the largest number of events was in 2001. The lowest annual number of occurrences was 84 in 2001, and the highest was 117 in 2003. This duration range is typically associated with blockage-related events.

2.1 to 5 hours
This category fluctuates over the timeframe. The range was from a low of 42 in 2001 to a high of 71 in 2004. This category had the lowest number of events in the time period evaluated. Again, this duration is related to blockage and/or rain events.

Greater than 5 hours
This duration range represented the largest number of events from 2002 to 2004. The lowest annual number of occurrences was 52 in 2001, and the highest was 177 in 2003. The number of occurrences dropped significantly between 2003 and 2004. These durations are typically associated with rainfall events.

Not Available (N/A)
This category captures the durations for which responders were either not able to document or were not required to document according to KUB’s record-keeping practices. Over 90% of the occurrences each year were related to building backups. KUB has not recorded the duration related to backups. Under KUB’s revised SORP, crews will document durations for both overflows and building backups, where sufficient data is available.