

**Interim Report
on
Wet Weather Basement Flooding
in
Philadelphia**

**Prepared by:
Philadelphia Water Department
September 1, 2005**

Table of Contents:

Page No.

I.	Background & Causative Factors.....	3
	a. Rainfall Patterns.....	3
	b. Affected Areas.....	4
	c. Basement / Sewer Elevations & Plumbing Fixtures.....	5
II.	Comprehensive Flooding & Sewer Overflow Mitigation Program.....	6
	a. Sewer System Inspection and Maintenance.....	6
	b. Property Data Collection.....	7
	c. Sewer System Analysis.....	7
	d. Governmental and Regulatory Initiatives.....	8
	e. Possible Sewer System Modifications under Investigation.....	9
III.	What Homeowners can do in the near term?.....	10
IV.	Conclusion.....	11

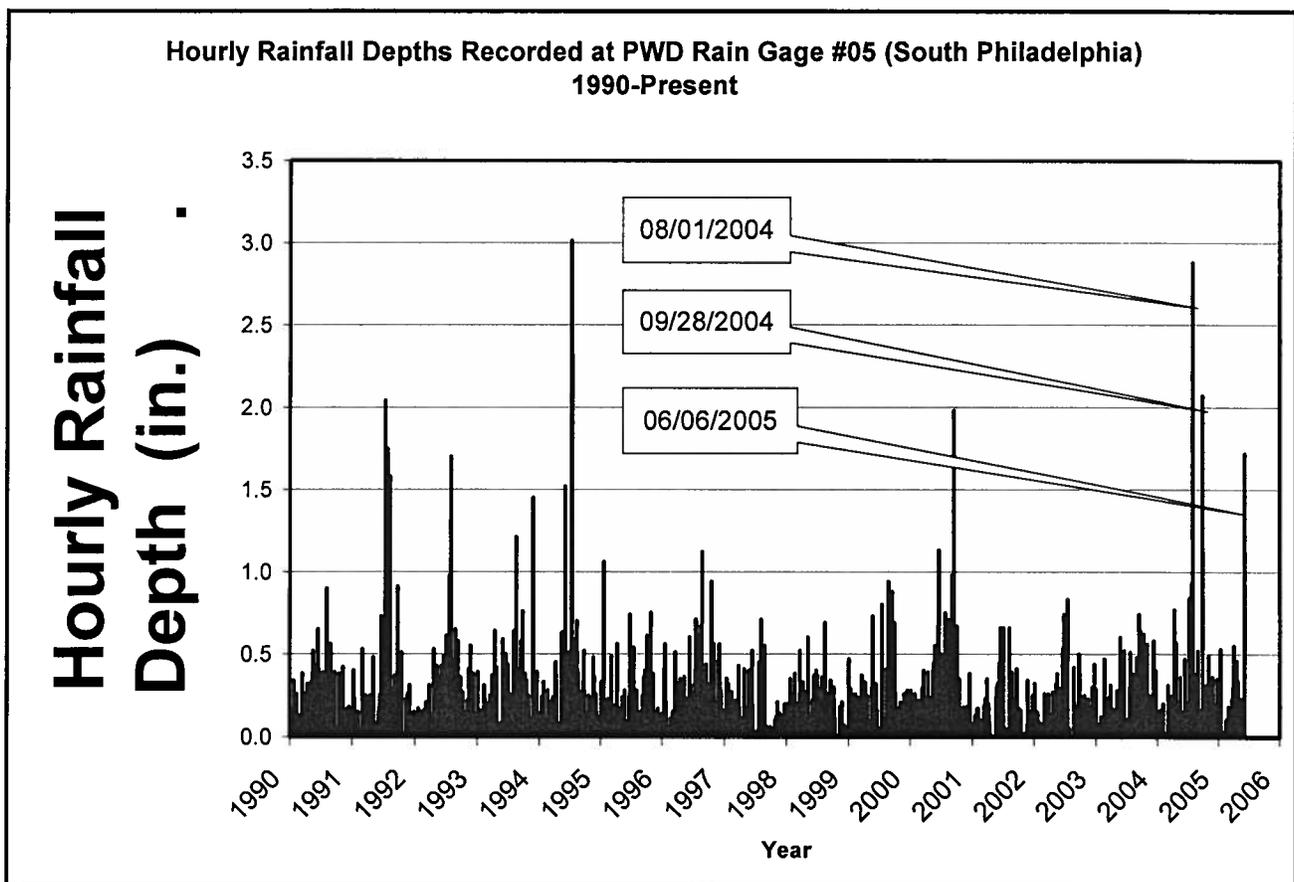
I. Background & Causative Factors

a. Rainfall Patterns

The Philadelphia region has experienced an unusual number of severe rainfall events in 2004 & 2005 that have caused basement flooding in several neighborhoods. The Water Department received many complaints of basement flooding following these rain events. The rain events of

- July 27, 2004
- August 1, 2004
- September 28, 2004 (Hurricane Ivan)
- June 6, 2005

rank in the top 21 out of 1550 rain events in the last 15 years from 1990 to 2005, based on a 1-hour rain intensity. Three of these events rank in the top 12 rain events. See graph below for data of all 1550 rain events between 1990 and 2005, with some of the most recent severe rain events labeled.



This graph demonstrates the severity of the storms in comparison to the other storms over the years. According to the National Oceanic and Atmospheric Administration's Precipitation Frequency Atlas, a rainfall event with the hourly intensity of August 1, 2004 has the probability of occurring once every hundred years in the Greater Philadelphia Region. A storm of this intensity is an unmanageable force of nature that can overwhelm both home plumbing systems as well as the municipal sewer system. While street surface flooding and backups during events like

August 1, 2004 are unavoidable, the basement flooding during smaller rain events should be managed through system optimization and/or improvement.

For instance, in South Philadelphia and Washington Square West, the rainfall rate for the June 6, 2005 storm corresponds to a 25-year return interval based upon a 1-hour intensity, however it has a 79-year return interval for the intensity that occurred during the worst 15 minutes. A nearby rain gage recorded 1.82” of rain, with 1.32” of that falling in a 15-minute period. To try to put some perspective on the tremendous volume of water that fell in a short amount of time, the typical rooftop had over 555 gallons of water or the equivalent of ten 55-gallon drums full of water fall on it in a 15-minute time frame.

Out of 1550 rain events between 1990 and 2005, the June 6, 2005 event ranked 12th out of 1550 in the last 15 years based on 1-hour rain intensity, and it ranks number 8 based on a 15-minute event. Unfortunately, these large unusual storms occurred in a relatively short time frame (15 months). Seven out of the top 30 events over the last 15 years occurred within the last 15 months. A series of events of this intensity have not been observed in the rainfall record since July 1994.

b. Affected Areas

Some of the areas hardest hit during these rain events were:

- South Philadelphia
- Washington Square West
- Northern Liberties/Old Kensington
- Overbrook
- Pennsport

The sewers serving the flood-affected areas are combined sewers. Combined sewers are sewers which convey both sewage as well as storm “wet weather” flow. During dry weather the sanitary flow goes to the City’s wastewater treatment plants. During wet weather, the flow to the wastewater treatment plants is maximized and the remainder flows to the rivers and streams, and that is referred to as combined sewer overflows (CSO).

c. Basement / Sewer Elevations & Plumbing Fixtures

Recent studies conducted by the Water Department show that the majority of basement flooding complaints in South Philadelphia and Pennsport are occurring in areas where the sewers are shallow with respect to ground surface; making basement elevations similar to sewer elevations therefore making these areas more susceptible to flooding. In most locations the sewer system was not designed with the expectation that plumbing fixtures such as toilets, showers, etc. would be connected to the system at the basement level.

Each section of the city, and individual properties within these sections, are unique and must be evaluated separately. Certain areas such as South Philadelphia pose many challenges. South Philadelphia is a very densely populated, low-lying, and a relatively flat area of the city. Due to this low lying topography, the sewer system is relatively shallow by the time it reaches the upper end, which is typically the area near Broad St. Where the basement elevations are low in relation to the sewer elevation, the potential for flooding increases. Another compounding factor is that just about all the land area is impervious, further increasing the amount of rainfall that needs to be handled by the plumbing and sewer systems. The streets are narrow and congested, making sewer construction difficult and disruptive to the residents.

On average, the city's sewer system was built about 89 years ago and it was not designed with all of the current land-use practices in mind. Rebuilding the entire sewer system is neither practical nor affordable to the ratepayers, therefore creative solutions must be found to deal with the flooding. The solutions may be many and may vary from neighborhood to neighborhood and even from block to block. The Department's challenge is to eliminate or at least minimize basement flooding while keeping disruption to a minimum and rates affordable.

II. Comprehensive Flooding & Sewer Overflow Mitigation Program

The Water Department has initiated a large scale, citywide program to reduce property damage from flooding and basement backups. PWD has been engaged in a comprehensive program to reduce combined sewer overflows (CSOs). This program is being modified to identify alternatives that place the highest priority on reducing basement backups while addressing CSOs.

In many areas, large increases in the size of the sewer network would not have been successful in preventing backups during the extraordinary rains of August 1, 2004. In many cases, and due to the minimal elevation between basement and sewer in the affected areas, larger sewers may be physically impossible. As much as we may like there to be a single solution (such as larger sewers), the reality is that the situation is much more complex and effective solutions will require options beyond sewer re-sizing, rehabilitation, and construction. Building an entirely new, larger sewer system is neither practical nor affordable. Effective solutions must be practical, creative, affordable, and ultimately buildable.

The Water Department has a huge effort ahead of itself to investigate, evaluate, analyze, and look for solutions to these problems. As part of this effort the Water Department will continue to:

- inspect sewers in flood prone areas to determine if there are any obstructions and schedule appropriate maintenance where problems are found
- collect and update data from property owners impacted by flooding
- analyze the sewer system by hydraulically modeling the system to determine how the sewer system responds to storm events
- coordinate with other government entities and enhance the legal framework for managing stormwater
- provide possible remedies/solutions based upon the modeling information, which in turn is based on all of the data collected

The total planning effort is expected to take over 2 years and cost several million dollars. The analysis of flood prone areas will be integrated with the combined sewer overflow mitigation planning that the Water Department is already undertaking.

a. Sewer System Inspection and Maintenance

As a matter of clarification, the pipe under the street that conveys the sanitary and stormwater flow is called a sewer. The structure, which collects rainwater from city streets, is called a stormwater inlet. Inlets are typically located at intersections. They may have grates along the curb and/or may have an opening at the curb, which captures the stormwater that flows along the curb.

The Water Department will continue to send maintenance crews to inspect sewers in the blocks that experienced flooding to look for blockages, obstructions, or other defects that may have contributed to the flooding problem. The investigation to date has identified no obstructions or accumulation of debris that would result in such flooding. The small amounts of debris that were observed in a few isolated blocks have been scheduled for cleaning.

The Water Department will continue to investigate sewers in areas where customers report incidents of flooding, to ensure that the sewer system is functioning properly.

In addition, the Water Department maintains approximately 76,000 stormwater inlets. The Department has a large inlet cleaning program which cleans approximately 90,000 inlets annually removing approximately 9,000 tons of debris.

b. Property Data Collection

Input from neighborhoods and individual customers is essential in defining the extent and cause of the problem. In order to better understand the extent and severity of backups, PWD has modified its customer complaint system to allow for data to be collected in a more useful way on basement backups. As it is impossible for us to observe conditions in every home, it is critically important that residents work with their civic leaders to accurately record, consolidate, and communicate information about the date, time, depth and duration of basement backups. It is also important to characterize the type and elevation (height from basement floor) of each basement plumbing fixture from which the backup has been observed. This information is needed to hydraulically model the storm, evaluate the sewer system response to the rainfall, and to identify measures to resolve backups.

c. Sewer System Analysis

The Water Department understands the concerns of residents and the hardship that such flooding events place upon those impacted. For this reason the Water Department has initiated a large scale, citywide analysis of the sewer system in neighborhoods which experience flooding.

The Water Department has made a significant investment in the latest technology in order to understand and analyze this city's infrastructure. A Geographic Information System (GIS) which catalogs all the infrastructure of the Water Department in a digital form will be completed in the fall of 2005. The Water Department also has made a large investment in the ability to hydraulically model and analyze the sewer system and how it reacts and functions during wet weather events. It has hydraulically modeled the combined trunk sewers, which are the largest sewers in the system. As part of the expanded modeling effort in the flood prone areas, the Department is adding many more sewer segments into the model. This will help the Department better understand the system in individual blocks. In order for the hydraulic modeling results to be valid the model must be calibrated to ensure that the results reflect how the system is truly functioning. Building the computerized model of the sewer system and calibrating it is time consuming. Calibration quite often requires flow monitors to be installed in the sewers at key locations. These monitors will provide actual data of sewer flows and depths during wet weather events. This data will in turn be utilized in the hydraulic model to ensure that the model reflects the actual response of the sewer system to rainfall and that flood relief alternatives can indeed be effective.

The Water Department is committed to modeling the various neighborhoods which experience flooding and determining the cause or causes of the flooding. This information will allow the

Department to formulate cost effective solutions to the problem. It should be noted that this modeling effort will take considerable amount of time considering how widespread the flooding appears to be. It should also be noted that this is a large city with a vast system of over 3700 miles of sewers and 76,000 stormwater catch basins (inlets). Nonetheless every effort is being made to gather the data needed and model the many impacted areas in an organized, and expeditious manner.

d. Government and Regulatory Initiatives

The Water Department is pursuing several related initiatives, which would have a positive impact on flood prone areas. They are as follows:

Intergovernmental Coordination – PWD and other City Departments have continual dialogue with the federal government, FEMA, and Pennsylvania Department of Environmental Protection to explore opportunities to expand existing flood management programs to buried floodplains. In addition, PWD has already conveyed flood control issues of a regional nature to the federal government. Specifically, PWD has entered into a design agreement with the US Army Corp of Engineers to design and implement flood control and sewer overflow mitigation measures in areas of the City where runoff from other counties contributes to flooding frequency. PWD will continue to pursue this channel for all areas of the City in which the Corp has federal authority to act. PWD has also worked with the US EPA and the PA DEP to implement pilot projects to retrofit stormwater controls into urban areas.

Stormwater Regulations – In the Fall of 2005, PWD anticipates that new stormwater management regulations will be in place requiring modern stormwater management practices to be implemented in development and redevelopment projects. These provisions will prevent worsening of the flooding problem and contribute greatly to their reduction over time as the City redevelops.

Green Development and Redevelopment incentives – PWD will continue to examine a credit system or reduced rate class for development projects that provide stormwater management controls beyond the levels required in present regulations.

Backwater Valves - PWD has convened a backwater valve task force to examine the legal and practical issues of initiating a program to install backwater valves in affected areas of the city. PWD will produce a summary of code changes and resources needed to implement such a program and review them with the plumbing board.

Disconnection of roof downspouts - Evaluate whether the disconnection of roof downspouts is a viable concept and if so pursue modification of the plumbing code to allow it. Certain properties may be able to disconnect their roof downspouts from the sewer and let it flow onto their property. This solution should only be implemented when the water will flow away from the building and the drain and not cause any additional flow to neighboring properties that may be faced with a similar problem.

Legislative Action – PWD is evaluating the following:

- enacting an ordinance to require billing of and stormwater control on parking lots that do not pay water bills but still use the sewer system for drainage.
- Enacting an ordinance expanding stormwater control requirements to development and redevelopment projects that are less than 15,000 square feet
- Enacting an ordinance and a change in PWD regulations to allow for a credit system to reduce stormwater rates for control practices implemented by industrial, commercial, and residential customers that exceed required stormwater management measures.

These initiatives in themselves will not solve all of the flooding problems in the City, but over time they will have a positive impact on the situation.

e. Possible Sewer System Modifications under Investigation

PWD will evaluate the following concepts to determine their effectiveness in reducing or eliminating the flooding of basements:

- Trunk Sewer Flap Gates and Supplemental Combined Sewer Storage – Design and construction of flap gates and supplemental storage on neighborhood-level branch sewers that have difficulty draining due to high downstream trunk sewer levels. This requires detailed hydraulic modeling of each affected neighborhood.
- Disconnection of large parcels of Impervious Area in Waterfront Zones – Construction of storm sewers to discharge storm flows directly to the Delaware or Schuylkill rivers. (e.g. Quatermaster Plaza, Columbus Commons, Columbus Blvd. Home Depot/ WalMart, etc.) This would eliminate that volume of stormwater from the combined sewer system.
- Match Inlet Capacity to Sewer Capacity to more evenly transport high flows – Past practices have increased the number of inlets and the cleaning frequency in flood prone areas. This practice may be worsening basement flooding by unevenly using sewer capacity. Modification of the street inlets to utilize the street surface for short-term storage of street and rooftop runoff has been implemented effectively in other urban areas to control local basement flooding. The basic concept is to allow flood volumes to be allocated to the street instead of the basements. The Water Department will investigate the feasibility of this concept.
- Surface and Subsurface Detention – Vacant land, parking lots, public open space, and street medians can be utilized to further drain the streets to the groundwater or return the flow slowly to the combined sewer.
- Storage Tanks and Tunnels – Planning design and construction of large scale public works to provide tanks or tunnels to store sewer overflows and provide delayed transport for treatment. These projects are complex, disruptive to the community, and require many years to plan, design, and construct. PWD will examine these alternatives as part of the comprehensive flood relief and sewer overflow master plan.

III. What Homeowners can do in the Near Term

Even with extraordinary investment in large-scale infrastructure renewal and expansion over the next two decades, property level control is still necessary for protection in the near term.

Homeowners that experience frequent backups are advised to:

- call the Philadelphia Water Department at 215-685-6300 to report the flooding. This information is extremely important to the Water Department in helping identify flooding areas as well what types of storms produced the flooding and which blocks of the city are being impacted and how often. The Water Department will use this information to study the situation.
- evaluate their insurance coverage for such events. Most homeowners' insurance policies do not provide coverage for sewer backups. Affected homeowners should inquire with their insurance company about a supplemental policy that can provide coverage while the longer-term components of the flood mitigation program are developed.
- plug, remove, or elevate low lying plumbing fixtures in their basements, if feasible.
- relocate valuables above the level of flooding that occurred on August 1, 2004.
- evaluate whether individual property backwater prevention is a feasible interim solution for their property. This solution may be particularly valuable for properties that were originally designed with a sub-grade kitchen or other living space. Backwater Valves are permitted to be used in the property's main house drain as described in the plumbing code and should be considered by homeowners in cases where basement flooding has occurred. A backwater prevention approach must be specifically engineered for each home, in order to take into consideration the specific plumbing configuration of that property. Homeowners interested in pursuing such a solution should contact a registered plumber to determine the scope of work at their property. Of particular concern is the location and configuration of roof rainwater conductors and yard drains. They should be connected to the main house drain downstream of the backwater valve. It is important for homeowners to understand that backwater valves require regular maintenance in order to keep them clean and functioning properly.

IV. Conclusion:

The Water Department appreciates the hardship of sewer backups into basements. The existing sewer system was built on average 89 years ago. It was designed to handle sewage flow and the vast majority of rain events. However it cannot handle all severe rain events. Basement flooding has been brought to the highest priority for the Water Department. This is a complex problem without a quick fix, and will require a considerable amount of time and resources to analyze the problem, determine possible alternatives, and finally implement chosen solutions.

Rebuilding the entire sewer system would take many years and is neither practical nor affordable to the ratepayers. Creative solutions must be found to deal with this problem. The solutions may be many and may vary from neighborhood to neighborhood and even from block to block.

The Water Department is committed to analyzing the problem, and searching for and implementing solutions. Information regarding flooding is critical to understanding the problem and finding the appropriate solution. Anyone experiencing flooding should contact the Water Department as soon after the flooding incident as possible. This information is used to better understand the sewer system and how it responds to wet weather events. Flood prone areas will be modeled, analyzed, and flood management solutions/alternatives will be identified.

Homeowners experiencing basement backups should evaluate whether basement fixtures can be elevated, plugged, or eliminated. Homeowners can also have a licensed engineer or registered plumber evaluate the feasibility of installing a backwater valve.

Further updates will be issued, as new information becomes available.

March 1, 2006

**Update
to
Interim Report
on
Wet Weather Basement Flooding
in
Philadelphia**

**Prepared by:
Philadelphia Water Department**

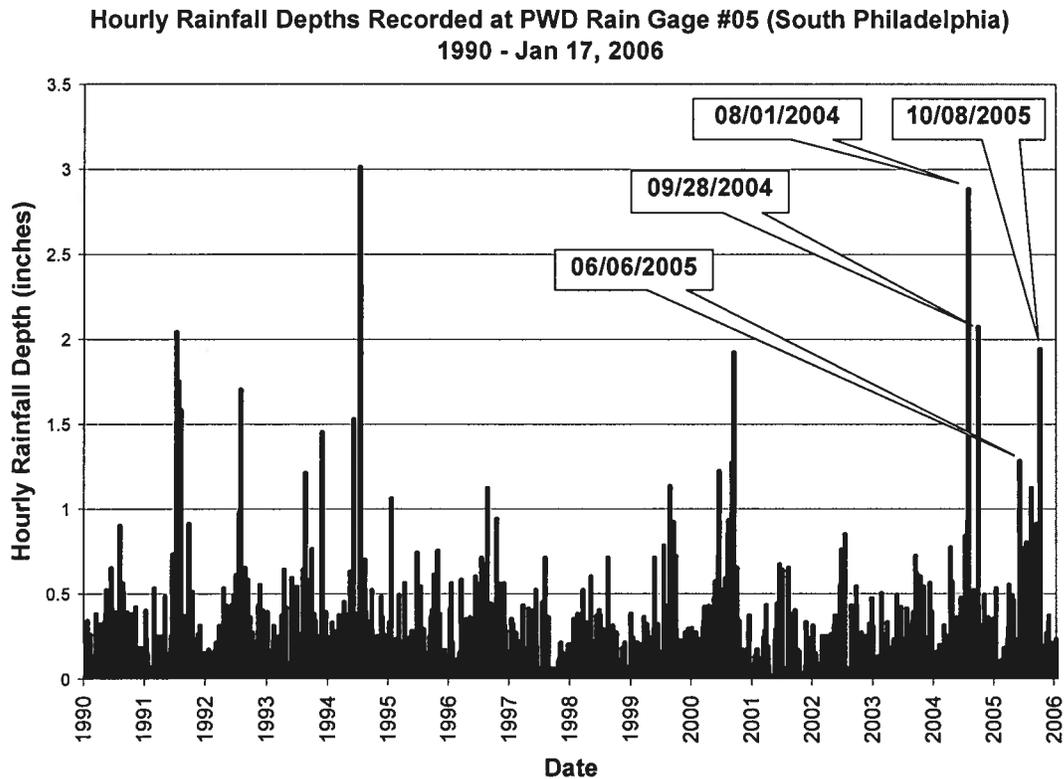
Table of Contents: **Page No.**

I.	General Introduction	3
II.	Update on Comprehensive Flooding & Sewer Overflow Mitigation Program	4
	a. Sewer System Inspection and Maintenance.....	4
	b. Property Data Collection.....	5
	c. Sewer System Analysis.....	5
	d. Governmental and Regulatory Initiatives.....	6
	e. Possible Sewer System Modifications under Investigation.....	7
III.	Conclusion.....	8

I. Introduction

Since the release of the Water Department's "Interim Report on Wet Weather Basement Flooding in Philadelphia" on September 1, 2005, there has been one severe rain event that has caused additional basement flooding in certain blocks within the flood prone areas. The severe rain event occurred on October 8, 2005. This event was associated with severe flooding along the northeast coast of the country.

This event was not as severe as some of the events in our original report and the level of reported flooding was much less than in those previously reported events. This new event has been added to the graph below.



II. Update of Comprehensive Flooding & Sewer Overflow Mitigation Program

The Water Department has initiated a large-scale project to analyze and reduce property damage from flooding and basement backups. Since we generated the interim report on basement flooding, the Water Department has been working hard on multiple fronts to both understand the causes of flooding as well as to start implementation of items that would be helpful to flood prone properties.

The Water Department has a huge effort ahead of itself to investigate, evaluate, analyze, and look for solutions to these problems. As part of this effort the Water Department has begun and will continue to:

- inspect sewers in flood prone areas to determine if there are any obstructions and schedule appropriate maintenance where problems are found or schedule capital projects if structural problems are observed
- collect and update data from property owners impacted by flooding
- analyze the sewer system by hydraulically modeling the system to determine how the sewer system responds to storm events
- coordinate with other government entities and enhance the legal framework for managing stormwater
- provide possible remedies/solutions based upon the modeling information, which in turn is based on all of the data collected

Following is updated information on what the Water Department has done in each of the identified areas.

a. Sewer System Inspection and Maintenance

The Water Department has been and will continue to send maintenance crews to inspect sewers in the blocks that experienced and reported flooding, to look for blockages, obstructions, or other defects that may have contributed to the flooding problem.

To date the Water Department has inspected 59 blocks of sewers and has identified no obstructions or accumulation of debris that would result in such flooding. The small amounts of debris that were observed in a few isolated blocks have been cleaned. As part of this investigation the Water Department has identified 2 blocks that have sewers that are structurally failing. These blocks have been added to the Water Department's sewer reconstruction capital program and given a high priority.

In addition, the Water Department maintains approximately 76,000 stormwater inlets. The Department has a large inlet-cleaning program, which cleans approximately 90,000 inlets annually removing approximately 9,000 tons of debris. In the time period since we issued the Interim report on September 1, 2005 through January 31, 2006, the Water Department has cleaned approximately 30,000 inlets citywide.

b. Property Data Collection

As stated in our original interim report, input from neighborhoods and individual customers is essential in defining the extent and cause of the problem. In order to better understand the extent and severity of backups, PWD has modified its customer complaint system to allow for data to be collected in a more useful way on basement backups. As it is impossible for us to observe conditions in every home, it is critically important that residents work with their civic leaders to accurately record, and communicate information about the date, time, depth and duration of basement backups. It is also important to characterize the type and elevation (height from basement floor) of each basement plumbing fixture from which the backup has been observed. This information is needed to hydraulically model the storm event, evaluate the sewer system response to the rainfall, and to identify measures to resolve backups.

The Water Department has met with several community groups to discuss the flooding issue and attempted to obtain more information from the affected property owners. To facilitate information gathering the Water Department has generated a flooding questionnaire to help standardize the data collection. The information gathered is vital in helping the Water Department understand the limits of the affected areas as well as in calibrating and verifying the hydraulic modeling of the sewer system in these areas. The questionnaire has been distributed at all community meetings on the subject as well as given to community group leaders for distribution to individuals who may have been unable to attend the public meetings.

c. Sewer System Analysis

As stated in the original interim report, the Water Department has made a significant investment in the latest technology in order to understand and analyze this city's infrastructure. The Water Department also has made a large investment in the ability to hydraulically model and analyze the sewer system and how it reacts and functions during wet weather events. It has hydraulically modeled the combined trunk sewers, the largest sewers in the system, where flow from many smaller branch sewers is collected and conveyed. As part of the expanded modeling effort in the flood prone areas, the Department is adding many more sewer segments into the model. This is labor intensive but necessary to better understand the system in individual blocks. A Geographic Information System (GIS) which catalogs all the infrastructure of the Water Department in a digital form was completed in the fall of 2005. This system is currently being used by the hydraulic modeling unit to facilitate the building of the computerized sewer network that is the foundation for the modeling effort.

In order for the hydraulic modeling results to be valid the model must be calibrated to ensure that the results reflect how the system is truly functioning. Building the computerized model of the sewer system and calibrating it is time consuming. Calibration quite often requires flow monitors to be installed in the sewers at key locations. These monitors will provide actual data of sewer flows and depths during wet weather events. This data will in turn be utilized in the hydraulic model to ensure that the model reflects the actual response of the sewer system to rainfall and that flood relief alternatives can indeed be effective.

The Water Department has installed temporary flow monitors in the sewer system at 26 key locations in order to obtain flow data during rain events. These monitors were installed in specific locations that would provide the most beneficial information to the modelers. In order for the information to be relevant, the monitors must be in place for several rain events, typically several months. The information gathered is then used in conjunction with the hydraulic model to calibrate and/or verify that the model reflects what is actually taking place in the sewer system.

The modeling effort is well under way for the following trunk sewer systems:

- Lombard Street sewershed east of Broad Street
- Passyunk Ave & Shunk Street sewersheds west of Broad Street
- Tasker Street sewershed east of Broad Street
- Snyder/McKean Street sewershed east of Broad Street

To date, the computerized hydraulic model for the above drainage sheds has been constructed and calibrated. These hydraulic models can now be used to evaluate these systems and start the process of identifying possible solutions.

The modeling effort has begun for the following trunk sewer systems:

- Shackamaxon St sewershed (Northern Liberties/Olde Kensington)
- Allen St. sewershedc(Northern Liberties/Olde Kensington)

As the modeling effort continues the hydraulic modeling will be expanded to include additional known flood prone drainage sheds in the city in a similar fashion.

d. Government and Regulatory Initiatives

The Water Department is pursuing several related initiatives, which would have a positive impact on flood prone areas. They are as follows:

Stormwater Regulations –PWD adopted new stormwater management regulations requiring modern stormwater management practices to be implemented in development and redevelopment projects. These new regulations were adopted and became effective on January 1, 2006. These provisions will prevent worsening of the flooding problem and contribute greatly to their reduction over time as the City redevelops.

Backwater Valves - PWD has convened a backwater valve task force to examine the legal and practical issues of initiating a program to install backwater valves in new developments or redevelopments with below grade space in affected areas of the city. PWD will produce a summary of code changes and resources needed to implement such a program and review them with the plumbing board.

e. Sewer System Modifications

The Water Department currently has an active capital project on Snyder Avenue from Swanson Street to Dilworth Street under construction, which was initiated several years ago. The project involves reconstruction of approximately 800 feet of the existing trunk sewer with an enlarged box sewer. This project will have a positive impact on the sewer system's wet weather flow capacity and will thereby improve the flooding situation in the Snyder Ave. & McKean Street drainage sheds upstream of the project. In addition the project involves approximately 2000 feet of water main replacement. The total cost of this project is \$4.895 Million and is scheduled to be completed in the Fall of 2006.

The Water Department has also increased its capital budget line item for storm flood relief projects from \$4 Million to \$10 Million annually. These funds will be used to construct flood relief projects as the analysis identifies specific system modifications/improvements that will mitigate the flooding situation.

III. Conclusion:

The Water Department understands the hardship of basement flooding. The existing sewer system was built on average 89 years ago. It was designed to handle sewage flow and the vast majority of rain events. However it cannot handle all severe rain events. Basement flooding has been brought to the highest priority for the Water Department. This is a complex problem without a quick fix, and will require a considerable amount of time and resources to analyze the problem, determine possible alternatives, and finally implement chosen solutions.

Rebuilding the entire sewer system would take many years and is neither practical nor affordable to the ratepayers. Creative solutions must be found to deal with this problem. The solutions may be many and may vary from neighborhood to neighborhood and even from block to block.

The Water Department is committed to analyzing the problem, and searching for and implementing solutions. Information regarding flooding is critical to understanding the problem and finding the appropriate solution. Anyone experiencing flooding should contact the Water Department during or as soon after the flooding incident as possible. This information is used to better understand the sewer system and how it responds to wet weather events. Flood prone areas will be modeled, analyzed, and flood management solutions/alternatives will be identified.

Homeowners experiencing basement backups should evaluate whether basement fixtures can be elevated, plugged, or eliminated. Homeowners can also have a licensed engineer or registered plumber evaluate the feasibility of installing a backwater valve.

Further updates will be issued, as new information becomes available.

November 1, 2006

**Update
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Table of Contents: **Page No.**

I.	Introduction	3
II.	Update on Comprehensive Flooding & Sewer Overflow Mitigation Program	5
	a. Sewer System Inspection and Maintenance.....	5
	b. Property Data Collection.....	6
	c. Sewer System Analysis.....	6
	d. Governmental and Regulatory Initiatives.....	8
	e. Active Capital Projects.....	8
	f. Individual Property Solutions.....	9
III.	Conclusion.....	10

I. Introduction

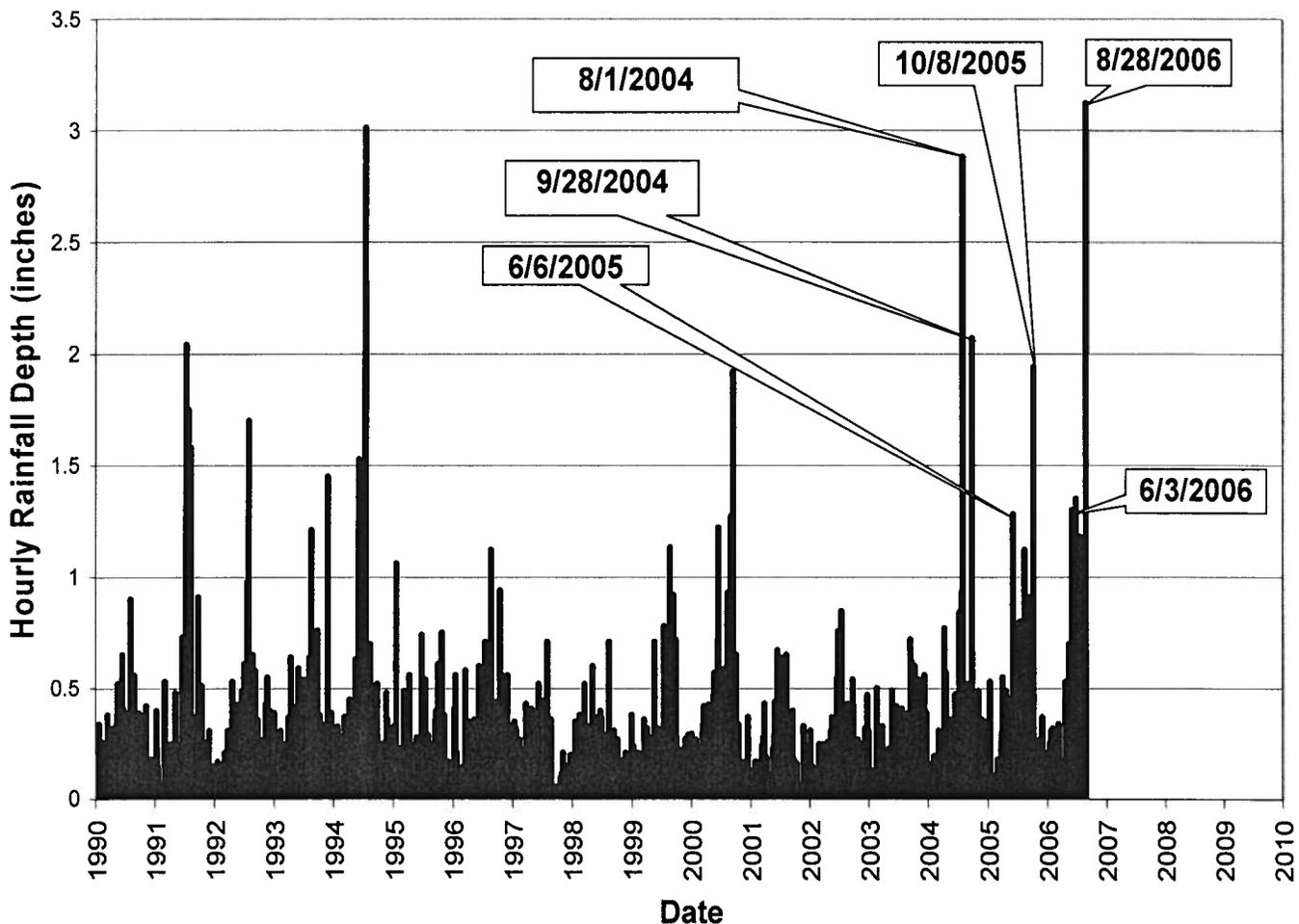
Since the release of the Water Department's "Update to Interim Report on Wet Weather Basement Flooding in Philadelphia" dated March 1, 2006, there have been 2 severe rain events that has caused additional basement flooding in certain blocks within the flood prone areas. The severe rain events occurred on June 3, 2006 & August 28, 2006.

The Philadelphia region has experienced an unusual number of severe rainfall events since 2004 that have caused basement flooding in several neighborhoods. The Water Department received many complaints of basement flooding following these rain events. The rain events of

- August 1, 2004
- September 28, 2004 (Hurricane Ivan)
- June 6, 2005
- October 8, 2005
- June 3, 2006
- August 28, 2006

rank in the top 15 out of over 1,600 rain events in the last 16 years from 1990 to 2006, based on a 1-hour rain intensity. See graph below for data of all rain events between 1990 and 2006, with some of the most recent severe rain events labeled.

**Hourly Rainfall Depths Recorded at PWD Rain Gage #05 (South Philadelphia)
1990 - August 28, 2006**



After evaluating over 1,600 rain events over the last 16 years, the following observations were made:

- The August 28, 2006 storm had the highest 1-hour rain intensity of any storm in the last 16 years, with over 3" of rain falling in a 1 hour period.
- Three of the top 4 storms based on a 1-hour rain intensity occurred in the last 2 years.
- 7 of the 15 most severe rain events in the last 16 years have occurred in the last 2 years.

This is dramatic evidence that the frequency of intense rain events has increased substantially over the last 2 years as compared to the preceding decade, and the intensities are among some of the highest in the last 16 years.

According to the National Oceanic and Atmospheric Administration's Precipitation Frequency Atlas, a rainfall event with the hourly intensity of August 1, 2004 and September 28, 2006 has the probability of occurring once every hundred years in the Greater Philadelphia Region. In this case it has recurred in just a little over 2 years. Storms of this intensity are unmanageable forces of nature that can overwhelm both home plumbing systems as well as the municipal sewer system.

II. Update of Comprehensive Flooding & Sewer Overflow Mitigation Program

The Water Department has initiated a large-scale project to analyze and reduce property damage from flooding and basement backups. Since we generated the interim report on basement flooding (9/1/05) and the 1st update (3/1/2006), the Water Department has been working hard on multiple fronts to both understand the causes of flooding as well as to start implementation of items that would be helpful to flood prone properties.

The Water Department has embarked upon a huge effort to investigate, evaluate, analyze, and look for solutions to these problems. As part of this effort the Water Department has begun and will continue to:

- inspect sewers in flood prone areas to determine if there are any obstructions and schedule appropriate maintenance where problems are found or schedule capital projects if structural problems are observed
- collect and update data from property owners impacted by flooding
- analyze the sewer system by hydraulically modeling the system to determine how the sewer system responds to storm events
- coordinate with other government entities and enhance the legal framework for managing stormwater
- provide possible remedies/solutions based upon the modeling information, which in turn is based on all of the data collected

The following is updated information on what the Water Department has done regarding this issue.

a. Sewer System Inspection and Maintenance

The Water Department has been and will continue to send maintenance crews to inspect sewers in the blocks that experienced and reported flooding, to look for blockages, obstructions, or other defects that may have contributed to the flooding problem.

To date the Water Department has inspected many sewers and has identified no obstructions or accumulation of debris that would result in such flooding. The small amounts of debris that were observed in a few isolated blocks have been cleaned. As part of this investigation the Water Department has identified 2 blocks that have sewers that are structurally failing. These blocks have been added to the Water Department's sewer reconstruction capital program and given a high priority.

The Department has a large inlet-cleaning program, which cleaned approximately 76,000 inlets in Fiscal Year 2006 (July 1, 2005 to June 30, 2006), removing approximately 9,000 tons of debris.

b. Property Data Collection

As stated in our original interim report and in the 1st update, input from neighborhoods and individual customers is essential in defining the extent and cause of the problem. In order to better understand the extent and severity of backups, PWD has modified its customer complaint system to allow for data to be collected in a more useful way on basement backups. As it is impossible for us to observe conditions in every home, it is critically important that residents work with their civic leaders to accurately record, and communicate information about the date, time, depth and duration of basement backups. It is also important to characterize the type and elevation (height from basement floor) of each basement plumbing fixture from which the backup has been observed. This information is needed to hydraulically model the storm event, evaluate the sewer system response to the rainfall, and to identify measures to resolve backups.

The Water Department has met with several community groups to discuss the flooding issue and attempted to obtain more information from the affected property owners. To facilitate information gathering the Water Department has generated a flooding questionnaire to help standardize the data collection. The information gathered has been vital in helping the Water Department understand the limits of the affected areas as well as in calibrating and verifying the hydraulic modeling of the sewer system in these areas. The questionnaire has been distributed at all community meetings on the subject as well as given to community group leaders for distribution to individuals who may have been unable to attend the public meetings.

c. Sewer System Analysis

The Water Department has made a significant investment in the latest technology in order to understand and analyze this city's infrastructure. The Water Department also has made a large investment in the ability to hydraulically model and analyze the sewer system and how it reacts and functions during wet weather events. In order for the hydraulic modeling results to be valid the model must be calibrated to ensure that the results reflect how the system is truly functioning. Building the computerized model of the sewer system and calibrating it is time consuming. Calibration quite often requires flow monitors to be installed in the sewers at key locations. These monitors will provide actual data of sewer flows and depths during wet weather events. This data will in turn be utilized in the hydraulic model to ensure that the model reflects the actual response of the sewer system to rainfall and that flood relief alternatives can indeed be effective.

The Water Department has installed temporary flow monitors in the sewer system at 26 key locations in order to obtain flow data during rain events. These monitors were installed in specific locations that would provide the most beneficial information to the modelers. In order for the information to be relevant, the monitors must be in place for several rain events, typically several months. The information gathered is then used in conjunction with the hydraulic model to calibrate and/or verify that the model reflects what is actually taking place in the sewer system.

The modeling has been completed for the following trunk sewer systems:

- Snyder/McKean Street sewershed east of Broad Street

The modeling effort in this neighborhood has shown that certain sewer system improvements could significantly improve the basement-flooding situation in the neighborhood served by this sewer system. The improvements, which are needed in addition to the existing Snyder Avenue project between Swanson & Dilworth Sts., are as follows:

- Replace 1500 feet of existing 5'-6" & 6'-0" diameter sewer located in Snyder Ave, from Front St. to Fourth St. with a 4.5'x11' box sewer.
- Replace approximately 300 foot of existing 6'-0" x 9'-0" sewer, upstream of the Delaware River outfall with a 7.5' x 12.5' box sewer, including a new chamber.

The estimated construction cost for these sewer system improvements are approximately \$ 5 million. The Water Department has placed this project in its capital program.

- Lombard Street sewershed east of Broad Street

The modeling effort in this neighborhood has shown that certain sewer system improvements could significantly improve the basement-flooding situation in the neighborhood served by this sewer system. The improvements that are needed are as follows:

- Construction of 2820 feet of 5 foot diameter sewer in Pine St. from Broad St. to 8th St.
- Construction of 1325 feet of 6 foot diameter sewer in Pine St. from 8th St. to 5th St.
- Construction of 1900 feet of 8' x 7' box sewer in Pine St. from 5th St to Front St.

The estimated construction costs for these sewer system improvements are approximately \$ 8-10 million. The Water Department has placed this project in its capital program.

These projects are large and complicated and will take several years to design and construct. Our hydraulic model indicates that these sewer system improvements greatly reduce the number of events that caused flooding and the severity, but may not be able to handle all possible rain events.

The Water Department continues to be committed to hydraulically modeling the sewer system and looking for system improvements that will help mitigate the basement flooding in various neighborhoods. To that end the Water Department is continuing its system analysis in the following sewer sheds.

The modeling effort is well under way for the following trunk sewer systems:

- Passyunk Ave & Shunk Street sewersheds west of Broad Street
- Tasker Street sewershed east of Broad Street
- Shackamaxon St sewershed (Northern Liberties/Olde Kensington)
- Allen St. sewershed (Northern Liberties/Olde Kensington)

The hydraulic modeling of these existing sewer sheds is complete and the work of evaluating various possible solutions is currently under way. As viable solutions present themselves they will be incorporated into the Water Department's Capital Program and will be included in future updates.

The Water Department has also increased its capital budget line item for storm flood relief projects from \$4 Million to \$10 Million annually and will be proposing even larger increases in future years. These funds will be used to construct flood relief projects as the analysis identifies specific system modifications/improvements that will mitigate the flooding situation.

d. Government and Regulatory Initiatives

The Water Department is pursuing several related initiatives, which would have a positive impact on flood prone areas. They are as follows:

Stormwater Regulations –PWD adopted new stormwater management regulations requiring modern stormwater management practices to be implemented in development and redevelopment projects. These new regulations were adopted and became effective on January 1, 2006. These provisions will prevent worsening of the flooding problem and contribute greatly to their reduction over time as the City redevelops.

e. Active Sewer Projects

The Water Department currently has an active capital project on Snyder Avenue from Swanson Street to Dilworth Street under construction, which was initiated several years ago. The project involves reconstruction of approximately 800 feet of the existing trunk sewer with an enlarged box sewer. This project will have a positive impact on the sewer system's wet weather flow capacity and will thereby improve the flooding situation in the Snyder Ave. & McKean Street drainage sheds upstream of the project. In addition, the project involves approximately 2000 feet of water main replacement. The total cost of this project is \$4.895 Million and is scheduled to be completed in early 2007.

f. Individual Property Solutions:

Homeowners experiencing frequent basement flooding emanating from plumbing fixtures should evaluate whether individual property backwater prevention and/or an ejector pump is a feasible interim solution for their property. This solution may be particularly valuable for properties that were originally designed with a sub-grade kitchen or other living space. Backwater Valves are permitted to be used in the property's main house drain as described in the plumbing code and should be considered by homeowners in cases where basement flooding has occurred. A backwater prevention approach must be specifically engineered for each home, in order to take into consideration the specific plumbing configuration of that property. Homeowners interested in pursuing such a solution should contact a registered plumber to determine the scope of work at their property. Of particular concern is the location and configuration of roof rainwater conductors and yard drains. They should be connected to the main house drain downstream of the backwater valve. It is important for homeowners to understand that backwater valves require regular maintenance in order to keep them clean and functioning properly. Homeowners experiencing basement backups should evaluate whether basement fixtures can be elevated, plugged, individually retrofitted with a backwater valve, or eliminated. Homeowners can also have a licensed engineer or registered plumber evaluate the feasibility of installing a backwater valve and or ejector pump.

PWD has convened a backwater valve task force to examine the legal and practical issues of initiating a program to install backwater valves in affected areas of the city. The Water Department is researching the feasibility of providing some assistance to homeowners regarding private property plumbing improvements to alleviate backups.

III. Conclusion:

The Water Department understands the hardship of basement flooding. Basement flooding has been brought to the highest priority for the Water Department. This is a complex problem without a quick fix, and will require a considerable amount of time and resources to analyze the problem, determine possible alternatives, and finally implement chosen solutions.

Rebuilding the entire sewer system would take many years and is neither practical nor affordable to the ratepayers. Creative solutions must be found to deal with this problem. The solutions may be many and may vary from neighborhood to neighborhood and even from block to block.

The Water Department is committed to analyzing the problem, and searching for and implementing solutions. Information regarding flooding is critical to understanding the problem and finding the appropriate solution. Anyone experiencing flooding should contact the Water Department during or as soon after the flooding incident as possible. This information is used to better understand the sewer system and how it responds to wet weather events. Flood prone areas will be modeled, analyzed, and flood management solutions/alternatives will be identified.

Homeowners experiencing basement backups should evaluate whether basement fixtures can be elevated, plugged, or eliminated. Homeowners can also have a licensed engineer or registered plumber evaluate the feasibility of installing a backwater valve.

Further updates will be issued, as new information becomes available.

March 15, 2008

**Final Report
on
Wet Weather Basement Flood Relief
in
Philadelphia**

**Prepared by:
Philadelphia Water Department**

Table of Contents:

Page No.

I.	Introduction	3
II.	Update on Comprehensive Flooding & Sewer Overflow Mitigation Program	5
	a. Sewer System Inspection and Maintenance.....	5
	b. Property Data Collection.....	6
	c. Sewer System Analysis.....	6
	d. Governmental and Regulatory Initiatives.....	7
	e. Active Capital Projects.....	8
	f. Individual Property Solutions.....	8
III.	Conclusion.....	9

Appendix A – Storm Flood Relief Projects

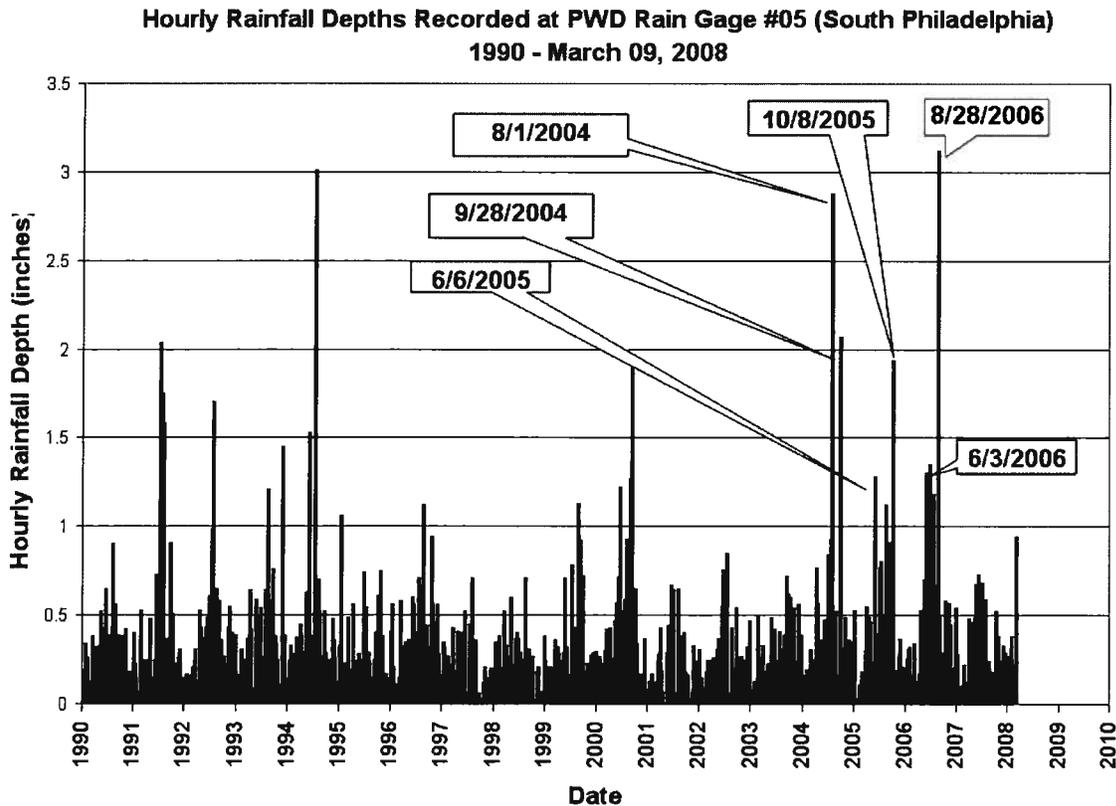
I. Introduction

Since the release of the Water Department's last update, dated November 1, 2006, there have been no severe rain events that have caused additional basement flooding within the flood prone areas.

The Philadelphia region experienced an unusual number of severe rainfall events since 2004 that caused basement flooding in several neighborhoods. The Water Department received many complaints of basement flooding following these rain events. The rain events of

- August 1, 2004
- September 28, 2004 (Hurricane Ivan)
- June 6, 2005
- October 8, 2005
- June 3, 2006
- August 28, 2006

rank in the top 15 out of over 1,800 rain events in the last 18 years from 1990 to 2007, based upon a 1-hour rain intensity. See graph below for data of all rain events between 1990 and 2007, with some of the most recent severe rain events labeled.



After evaluating over 1,800 rain events over the last 18 years, the following observations were made:

- The August 28, 2006 storm had the highest 1-hour rain intensity of any storm in the last 18 years, with over 3" of rain falling in a 1 hour period.
- Three of the top 4 storms based on a 1-hour rain intensity occurred in the last 4 years.
- 7 of the 15 most severe rain events in the last 18 years have occurred in the last 4 years.

This is dramatic evidence that the frequency of intense rain events has increased substantially over the last several years as compared to the preceding decade, and the intensities are among some of the highest in the last 18 years.

According to the National Oceanic and Atmospheric Administration's Precipitation Frequency Atlas, a rainfall event with the hourly intensity of August 1, 2004 and August 28, 2006 has the probability of occurring once every hundred years in the Greater Philadelphia Region. In this case it recurred in just a little over 2 years. Storms of this intensity are unmanageable forces of nature that can overwhelm both home plumbing systems as well as municipal sewer systems.

II. Update of Comprehensive Flooding & Sewer Overflow Mitigation Program

In 2005 the Water Department initiated a large-scale project to analyze and reduce flooding and basement backups. Since we generated the interim report on basement flooding (9/1/05) and the 1st update (3/1/2006), and the 2nd update (11/1/2006), the Water Department has been working hard on multiple fronts to both analyze the causes of flooding as well as to develop plans to provide relief to flood prone areas.

It has been a huge effort to investigate, evaluate, analyze, and seek solutions to these problems. As part of this effort the Water Department has:

- inspected sewers in flood prone areas to determine if there are any obstructions and complete appropriate maintenance where problems are found or schedule capital projects if problems are observed
- collected and updated data from property owners impacted by flooding
- analyzed the sewer system by hydraulically modeling the system to determine how the sewer system responds to storm events
- coordinated with other government entities and enhanced the City's ability to more effectively manage stormwater
- provided possible remedies/solutions based upon the modeling information, which in turn is based on all of the data collected
- initiated a Basement Back-up Protection Program

The following is updated information on what the Water Department has done regarding this issue.

a. Sewer System Inspection and Maintenance

The Water Department has and will continue to send maintenance crews to inspect sewers in the neighborhoods that experience and report flooding to look for obstructions, or other defects that may have contributed to the flooding problem.

To date the Water Department has inspected many sewers and has identified no obstructions that would result in such flooding. The small amounts of debris that were observed in a few isolated blocks have been cleaned. As part of this investigation the Water Department identified 2 blocks that have sewers that are structurally failing and require replacement. These blocks have been added to the Water Department's sewer reconstruction capital program and given a high priority.

b. Property Data Collection

As stated in our previous interim reports, input from neighborhoods and individual customers is essential in defining the extent and cause of the problem. In order to better understand the extent and severity of backups, PWD has improved its customer complaint system to allow for data to be collected in a more useful way on basement backups. As it is impossible for us to observe conditions in every home, it is critically important that residents work with their civic leaders to accurately record, and communicate information about the date, time, depth and duration of basement backups. It is also important to characterize the type and elevation (height from basement floor) of each basement plumbing fixture from which the backup has been observed. This information is needed to hydraulically model the storm event, evaluate the sewer system response to the rainfall, and to identify measures to resolve backups.

The Water Department met with several community groups to discuss the flooding issue and attempted to obtain more information from the affected property owners. To facilitate information gathering the Water Department generated a flooding questionnaire to help standardize the data collection. The information gathered has been vital in helping the Water Department understand the limits of the affected areas as well as in calibrating and verifying the hydraulic modeling of the sewer system in these areas. The questionnaire has been distributed at all community meetings on the subject as well as given to community group leaders for distribution to individuals who may have been unable to attend the public meetings.

c. Sewer System Analysis

Because it is impractical and cost prohibitive to physically monitor every block of sewer in an entire sewershed, calibrated hydraulic models of the sewer system are utilized to estimate storm responses in every pipe, as well as to evaluate possible system improvement scenarios to understand how the system reacts to flooding events. In order for the hydraulic modeling results to be valid the model must be calibrated to ensure that the results reflect how the system is truly functioning. Building the computerized model of the sewer system and calibrating it is time consuming. Calibration requires flow monitoring at key locations. This data is in turn utilized in the hydraulic model to ensure that the model reflects the actual response of the sewer system to rainfall and that flood relief alternatives can indeed be effective.

The Water Department has installed flow monitors in the sewer system at many key locations in order to obtain flow data during rain events. These monitors were installed in specific locations that would provide the most beneficial information. In order for the information to be relevant, the monitors must be in place for several rain events, typically several months or more. The information gathered is then used in conjunction with the hydraulic model to calibrate and/or verify that the model reflects what is actually taking place in the sewer system.

Detailed modeling has been completed for the following trunk sewer systems:

- Lombard Street sewershed east of Broad Street (Washington Square West)
- Laurel Street sewershed (Northern Liberties/Old Kensington)
- Snyder/McKean Street sewersheds (South Philadelphia)
- Tasker & Reed Street sewersheds (South Philadelphia)
- Shunk St., Porter St., Wolf St sewersheds east of Broad Street (South Philadelphia)
- Passyunk Ave & Shunk St. sewersheds west of Broad St. (South Philadelphia)

Many individual projects have subsequently been identified that would increase the capacity of these trunk sewer systems in order to handle these very intense rain events. A detailed list of sewer construction projects in each of these sewersheds is attached in Appendix "A". This list represents approximately \$200 Million in sewer construction costs. These projects are being programmed into the Water Department's capital program. As the Water Department moves these projects forward into design and ultimately into construction, there may be modifications to the size or location of the new sewers based upon new information that will arise from the design process. In addition the Water Department's engineering staff continues to reevaluate these projects to determine if there are better, less disruptive, or more efficient ways of achieving the required results. This list will be modified to reflect these changes as time goes on.

These projects are large and complicated and will take several years to design and construct. With very conservative assumptions our hydraulic model indicates that these sewer system improvements should greatly reduce the potential for flooding based upon historical storm events. These projects are also quite disruptive to the community adjacent to the construction. The Water Department is sensitive to this fact and will attempt to do what it can to minimize the disruption and stagger the projects to avoid too much disruption at the same time.

d. Government and Regulatory Initiatives

The Water Department is sensitive to the impact stormwater, in particular urban runoff, has on the combined sewer system. New stormwater management regulations requiring modern stormwater management practices to be implemented in development and redevelopment projects were implemented. These new regulations were adopted and became effective on January 1, 2006. These provisions will prevent worsening of the flooding problem and contribute greatly to their reduction over time as the City redevelops.

e. Active Sewer Projects

The Water Department currently is designing sewer projects in the following sewersheds:

- Lombard Street sewershed east of Broad Street (Washington Square West)
- Laurel Street sewershed (Northern Liberties/Old Kensington)
- Snyder/McKean Street sewersheds (South Philadelphia)

The Water Department recently completed construction of a capital project on Snyder Avenue from Swanson Street to Dilworth Street, which was initiated several years ago. The project involved reconstruction of approximately 800 feet of the existing trunk sewer with an enlarged box sewer. This project should have had a positive impact on the sewer system's wet weather flow capacity and will thereby improve drainage in the Snyder Ave. & McKean Street sewersheds upstream of the project. Additionally, the project involved approximately 2000 feet of water main replacement to facilitate the sewer construction. The total cost of this project was \$5.432 Million.

f. Individual Property Solutions:

Homeowners experiencing frequent basement flooding emanating from plumbing fixtures should consider whether individual property backwater prevention and/or an ejector pump is a feasible interim solution for their property. This solution may be particularly valuable for properties that were originally designed with a sub-grade kitchen or other living space. Backwater Valves are permitted to be used in the property's main house drain as described in the plumbing code and should be considered by homeowners in cases where basement flooding has occurred. A backwater prevention approach must be specifically engineered for each home, in order to take into consideration the specific plumbing configuration of that property. Homeowners interested in pursuing such a solution should contact the Water Department at 215-685-6300 to request an evaluation of their system and the scope of work at their property determined. Of particular concern is the location and configuration of roof rainwater conductors and yard drains. They should be connected to the main house drain downstream of the backwater valve. It is important for homeowners to understand that backwater valves require regular maintenance in order to keep them clean and functioning properly. In properties experiencing basement backups, basement fixtures can be elevated, plugged, individually retrofitted with a backwater valve, or eliminated. Homeowners can also have a licensed engineer or registered plumber evaluate the feasibility of installing a backwater valve and or ejector pump.

PWD has budgeted \$3M in FY 2008 to fund a Basement Backup Protection Program. The program provides for backwater valve installations on individual home laterals to protect properties from flooding due to sewer backups.

III. Summary:

The Water Department understands the hardship of basement flooding. Basement flooding is one of the highest priorities for the Water Department. This is a complex problem without a quick fix, and will require a considerable amount of time and resources to implement chosen solutions.

\$3M has been budgeted in FY 2008 for the installation of backwater valves on individual property laterals or other solutions which prevent back-ups.

The Water Department has worked diligently to analyze the sewer systems and identify sewer system improvements, and is now beginning the implementation process. The Department has identified approximately \$200 Million in sewer system improvements in order to improve the system's ability to convey stormwater from intense rain events more efficiently and thereby mitigate the potential for property flooding. The Department's capital budget has been increased to fund these flood relief projects. These projects have been identified (See Appendix "A") and engineering design has commenced on several projects with more to be initiated soon.

It should be noted that these projects are large and disruptive to the community during the construction process. The Water Department will continue to modify the size and location of new sewers based upon information obtained in the design process in order to optimize the solution while minimizing disruption to the community.

APPENDIX A

STORM FLOOD RELIEF PROJECTS

March 15, 2008

Laurel St Sewershed (Northern Liberties)

Street	From	To	Size
Laurel St.	Del. River	Columbus Blvd.	(3) 11' X 11' Box
Laurel St.	Chamber	Chamber	
Laurel St.	Columbus Blvd.	Columbus Blvd.	(1) 11' X 11' Box
Laurel St.	Columbus Blvd.	Germantown Ave.	(1) 10' X 15' Box
Germantown Ave.	Laurel St.	Willey St.	(1) 10' X 15' Box
Germantown Ave.	Willey St.	2nd St.	(1) 10' X 8' Box
Germantown Ave.	2nd St.	Girard	(1) 10' X 8' Box
Germantown Ave.	Thompson St.	Master St.	(1) 9' X 10' Box
Master St.	Germantown Ave.	Randolph St.	(1) 9' X 10' Box

Lombard St. Sewershed East of Broad St. (Washington Square West)

Street	From	To	Size
Pine St.	Front St.	2nd St.	8' X 7' Box
Pine St.	2nd St.	6th St.	78" RCP
Pine St.	6th St.	12th St.	72" RCP
Pine St.	12th St.	13th St.	60" RCP
Pine St.	13th St.	Juniper St.	54" RCP
Pine St.	Juniper St.	Broad St.	48" RCP
3rd St	Delancy St.	Cypress St.	24" RCP

Moore St. Sewershed

Street	From	To	Size
Moore St.	Chamber	Chamber	
Moore St.	Del. River	1000' Upstream	8' X 7' Box

Tasker St. & Reed St. Sewersheds

Street	From	To	Size
Reed St Outfall	River	New Chamber	(1) 7' X 14' Box
Reed St.	Chamber	Chamber	Chamber
Reed St	Chamber	Water St.	(1) 7' X 14' Box
Water St.	Reed St	Dickinson St.	(1) 7' X 14' Box
Dickinson St.	Water St.	8th St.	(1) 7' X 14' Box
Dickinson St.	8th St.	13th St.	(1) 7' X 14' Box
Dickinson St.	13th St.	Broad St.	(1) 5' X 7' Box
9th St	Reed St	40' N. of Reed St.	48" RCP
13th St	Dickinson St.	Reed St.	4' X 8' Box
13th St	Reed St.	Wharton	4' X 6' Box
13th St	Wharton St.	Federal St.	60" RCP
Wharton St.	13th St.	15th St.	60" RCP
15th St.	Wharton St.	Federal St.	48" RCP
Front St.	112' N. of Reed St	Federal St.	42" RCP
Tasker St Gunite	Chamber	Water St.	6" Gunite
Clarion St.	Wharton St.	Federal St.	48" RCP
12th St.	Tasker St.	Morris St.	36" RCP
4th St.	Federal St	130' N. of Federal St.	18" RCP
Federal St.	9th St.	10th St.	36" RCP
13th St	Morris St.	Moore St.	36" RCP
13th St	Dickinson St.	Morris St.	4' X 6' Box
Morris St	13th St.	Broad St.	42" RCP
Tasker St.	Broad St.	15th St.	36" RCP

Snyder/McKean/ Sewersheds

Street	From	To	Size
Weccacoe St.	Snyder Ave.	Wolf St.	6'-0" X 8'-0" Box
Snyder Ave.	Front St.	4th St.	5'-0" X 11'-0" Box
Snyder Ave.	4th St.	5th St.	5'-0" X 11'-0" Box
Snyder Ave.	8th St.	10th St.	5'-0" X 10'-0" Box
3rd St. (Reverse flow)	Snyder Ave.	Jackson St.	36" RCP
3rd St. (Reverse flow)	Wolf St.	Jackson St.	36" RCP
Front St	McKean St.	Mifflin St.	36" RCP
			Chamber

Wolf St. Sewershed

Street	From	To	Size
Oregon Ave	River	Weccacoe St.	6'-6" X 15'-0" Box
Weccacoe St.	Oregon Ave.	Wolf St.	6'-6" X 15'-0" Box
Wolf St.	Weccacoe St.	Vandalia St.	6'-6" X 13'-6" Box
Wolf St.	8th St.	12th St.	6'-0" X 8'-0" Box
Wolf St.	13th St.	Broad St	36" RCP
			Chamber

Oregon Ave./Shunk St./Porter St. Sewershed East of Broad St.

Street	From	To	Size
Oregon Ave.	River	Front St	6' X 20' Box
Oregon Ave.	Front St.	8th St.	6' X 20' Box
8th St	Oregon Ave.	Shunk St.	6' X 20' Box
8th St	Shunk St.	Porter St.	6' X 16' Box
8th St	Porter St.	Wolf St.	6' X 14' Box
8th St	Wolf St.	Snyder Ave.	6' X 6' Box
8th St	Snyder Ave.	McKean St.	5' X 10' Box
Porter St	10th St.	Moyamensing Ave.	5' X 6' Box
Porter St	Moyamensing	13th St.	42" RCP
Porter St	13th ST.	Broad St.	36" RCP
Moyamensing Ave.	Porter St.	Shunk St.	4' X 5' Box
Shunk St.	Moyamensing Ave.	Broad St.	48" RCP
Broad St.	Oregon Ave.	Oregon Ave.	36" RCP
3rd St.	30' S. of Shunk ST.	290' S. of Shunk St.	36" RCP
Oregon Ave.	5th St.	100' E. of 5th St.	36" RCP
5th St.	Shunk St.	Oregon Ave.	36" RCP

Passyunk Ave./Shunk St Sewersheds West of Broad St. (South of Shunk)

Street	From	To	Size
Moyamensing	Junction Chamber	20th St	5'-0" X 12'-0" Box
Penrose Ave.	Pattison Ave.	20th St	5'-0" X 10'-0" Box
20th St.	Moyamensing	Oregon Ave.	5'-0" X 6'-0" Box
Oregon Ave	20th St.	18th St	5'-0" X 6'-0" Box
18th St	Oregon Ave.	Shunk St.	48" RCP
Moyamensing	20th St.	18th St	5'-0" X 7'-0" Box
Shunk St.	18th St.	15th St.	48" RCP
Pollock St.	Moyamensing	17th	66" RCP
17th St.	Pollock St.	Bigler St.	48" RCP
Bigler St.	17th St.	15th St.	48" RCP
Pollock St.	17th St.	Carlisle St.	48" RCP
15th St.	Bigler St.	Moyamensing	36" RCP
18th St	Moyamensing	Stocker St.	36" RCP
Stocker St.	18th St.	17th St.	24" RCP
Barbara St.	18th St.	Moyamensing	24" RCP
16th St.	Moyamensing	Oregon Ave.	30" RCP

The size and/or location of the proposed sewers may change during the design process as more information becomes available or more efficient, less disruptive solutions are identified.