Infiltration & Inflow

Sources of extraneous flows are classified as either inflow or infiltration. As shown in Figure 4, inflow is rain water that enters the sewer system from roof leaders, floor drains, sump pumps, manhole covers, or improper connections between drainage and sanitary sewer systems. Infiltration is groundwater that enters the sewer system through leaks in pipelines and/or manholes. Extraneous flows ("clean" water) enter the collection and transmission system and consume capacity that could be allocated for true wastewater disposal. Additionally, these extraneous flows do not require treatment, but unavoidably get treated at the WWTP, leading to undue cost.

All sewer systems have extraneous flows, and it is impossible to eliminate all extraneous flows. Quantification of these extraneous flows and identification of sources are the initial steps in targeting removal. Concord has had an infiltration and inflow (I&I) investigation program in place for several years and has achieved some degree of extraneous flow removal in recent years to recover capacity and minimize undue treatment costs.

Based on review and analysis of flow and rainfall data for Concord, I/I percentages during peak flow periods (springtime) are in the range of 45%. For general comparison, typical communities within the metropolitan Boston area, Massachusetts Water Resources Authority (MWRA) system, experience inflow and infiltration rates between 50% and 55% at peak I/I times. It is important to recognize that peak flow periods with I/I contributions occur most significantly during wet weather events and are relatively infrequent, so they do not relate directly to (and these percentages cannot be applied to) average daily flow. The main reason for consideration of extraneous flows in this evaluation is to target potential removal initiatives and to recognize how removal of these flows impacts the WWTP 12-month rolling average through seasonal ADF reduction, playing a part in freeing up some capacity.

Quantification of I&I using the Town's existing data was performed as part of this Integrated Planning Initiative. This analysis included detailed review of meter data collected by the Town from various points in the sewer system and rainfall/weather data. Analysis of the data is different for infiltration versus inflow, so each is described separately below.

Infiltration Analysis

Infiltration generally affects treatment plant flows during wet seasons when the groundwater levels are high. Generally, New England experiences one wet season per year, which is somewhat balanced out by three drier seasons. Therefore, removal of infiltration sources may have some impact on the Concord WWTP's 12-month rolling average but the impact will most likely be limited on an average basis.

Analysis of the flow data for infiltration consisted of selecting the lowest flow reading occurring during dry weather conditions between the hours of 12:00 a.m. and 6:00 a.m. during Spring 2006 (the high groundwater period). During dry weather, and between these hours, sewer usage is minimal and the flow is assumed to be primarily due to infiltration. Peak infiltration rates were generated based on observation of the average minimum nighttime flows during this high groundwater period. A total of approximately 550,000 gpd of peak infiltration was estimated in the Concord sewer system. This value translates to approximately 3,000 gallons per day per inch-diameter mile (gpdim) for the entire Concord sewer system.

According to the DEP Guidelines for performing I/I analyses, flow isolation programs may be recommended for subareas exhibiting an infiltration rate equal to or greater than 4,000 gpdim. Two of the ten sub-areas in the Concord system exhibited infiltration rates exceeding the 4,000 gpd limit deemed excessive by the DEP Guidelines. The subareas identified have been targeted for continuing infiltra-

Figure 4

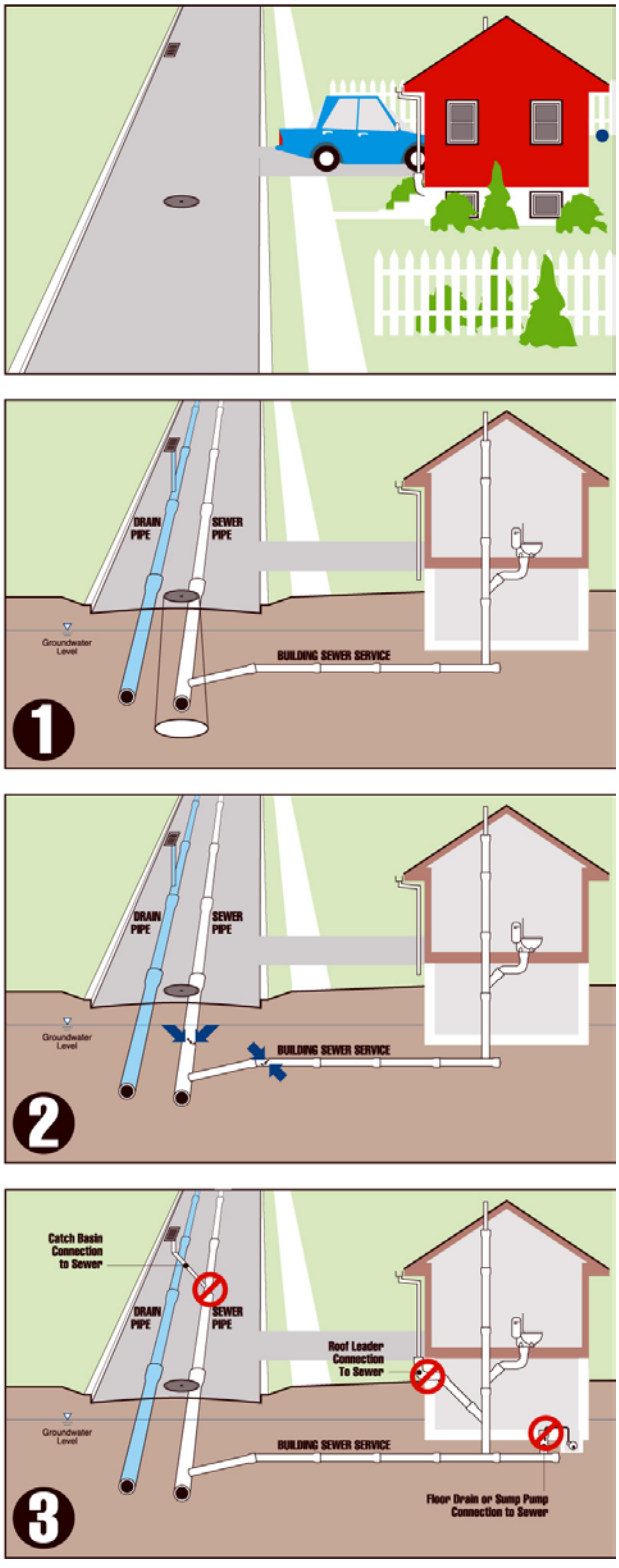
Infiltration and Inflow

Figure 1
Typically, there are two pipes that carry water away. Drain pipes carry rain water to local receiving waters, and sewer pipes carry dirty water (wastewater) from homes and take it to a treatment plant.

Infiltration and inflow are names we give to clean water that enters the sewer pipe instead of the drain pipe. This clean water is needlessly treated and takes up space in the sewer – sometimes causing flooding.

Figure 2
Infiltration is clean water from below the ground (known as groundwater) that enters sewer pipes through cracks.

Figure 3
Inflow is rain water that enters sewer pipes through a mistake in the piping or from homes that direct rain water to the sewer pipe instead of the drain pipe.



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tion investigation and removal as part of the Town's ongoing I&I program.

Inflow Analysis

Rainfall data collected in Concord was used to determine the dates of storm events and rainfall intensity (inches per hour) during each event for inflow analysis. Metered sewer flow data was used to compare variations in sewer flow rates to rainfall intensity, total volume, and duration per event, for the purpose of identifying the impact of inflow on the sewer system. Inflow measurements were calculated by comparing the difference between dry day metered flow and wet day metered flow. Flow from tributary meters was subtracted from downstream subareas to obtain infiltration rates for individual subareas.

The results from the monitoring period were reviewed to develop the inflow quantity corresponding to particular storm events and to obtain several data points for use in developing a linear regression analysis. The analysis was then used to determine the peak design inflow relative to the rainfall intensity. The peak rainfall intensity used was the one-year, six-hour storm event with an intensity of 0.87 inches/hour. A total of approximately 1.89 mgd of instantaneous peak inflow was estimated in the Concord system. This value can only be used to consider the hydraulic capacity required in the sewer system to transmit this instantaneous peak flow from its sources to the wastewater treatment plant. Even in that analysis, it is a conservative number, because not all flow will pass through the same point in the sewer system at once.

Inflow generally affects treatment plant flows during wet weather. While Concord does experience inflow during wet weather events, removal of inflow sources will not likely significantly impact the Concord WWTP's 12-month rolling average because the intermittent high flows get balanced out by lower dry weather flows that occur much more consistently. When considering the total rainfall typical for New England of 42-inches per year, the inflow observed translates to approximately 10,395 gpd of average daily flow.

I/I Removal Potential

I/I removal opportunities are dependent on the ability to locate and identify sources. Generally on the order of 5% to 10% of total inflow and infiltration can be cost-effectively removed. Applying this general factor to the estimated values presented above results in an approximate 28,500 to 57,000 gpd of estimated peak infiltration that may be able to be eliminated from the existing system. This translates to 21,000 to 43,000 gpd of average daily flow when spread over the entire year, assuming a factor of 0.75 to convert peak I/I to annual average daily flow. Similarly, taking 5% to 10% of the average daily inflow values results in 520 to 1,040 gpd of average daily flow that can be realistically removed from the system.