New Castle County's Clearwater Disconnection Pilot Program

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ABSTRACT

A clearwater connection permits storm water (inflow) or groundwater (infiltration) to enter the sanitary sewer system via cross connected sump pumps, french/foundation drains, punctured floor drains, leaking building drains, driveway drains, basement stairwell drains, window well drains, and roof drains. These connections, often illegal, contribute to sewage backups into basements, overflows into the environment, and increased wastewater collection and treatment costs. When properly addressed, residential clearwater flow should discharge into a nearby stream, stormwater conveyance system, or onto the property owner's yard. Often times, the general public is unaware of the existence or the illegal nature of these clearwater connections.

The objective of this paper is to share the knowledge gained from the implementation of a residential Clearwater disconnection pilot program by outlining the approach, results, and lessons learned.

KEYWORDS: Private Property Issues, Illegal Connections, Infiltration & Inflow (I/I), Sanitary Sewers

BACKGROUND

New Castle County (NCC) owns, operates, and maintains more than 1,600 miles of sanitary sewers in northern Delaware. In 2001, NCC proactively developed a sewer rehabilitation program to address infiltration and inflow (I/I) and reduce peak wet weather flows in the oldest and most densely populated portion of the County, referred to as the "Brandywine Hundred." Although this work began proactively by NCC, it is now being conducted under a State of Delaware Department of Natural Resources and Environmental Control Secretary's Order. Overall, the goals of the Brandywine Hundred Sewer Rehabilitation Program are:

- To remove enough rainfall derived I/I to eliminate two structured overflows.
- Eliminate basement backups.
- Recover enough conveyance capacity in the existing sewer system that, combined with related capacity increase efforts, the current wet weather issues can be resolved.

In an effort to define the scope of the I/I problem, NCC and Malcolm Pirnie performed a hydraulic condition assessment of the Brandywine Hundred, which included basement inspections. Inspections revealed that 15% of the homes (~3,600 homes) have internal clearwater connections (either illegal sump pumps or punctured floor drains/foundation drains). Initial projections indicated that removal of these connections would yield the greatest amount of I/I removed per dollar spent; however NCC initiated a Clearwater Disconnection Pilot Program (Pilot Program) to verify the projected costs, benefits, risks, and other issues associated with a comprehensive clearwater removal program.

APPROACH

The Pilot Program included the following steps:

1. Solicit homeowners within Brandywine Hundred to volunteer to participate in a no cost (t them) Pilot Program that includes Amnesty.
2. Review existing information, select targeted properties, and mail participation letters to the targeted properties.
3. Perform property inspections to identify illegal connections and to design disconnection solutions. Inspection included completing an inspection checklist and photo documentation of existing conditions.
4. Research information on sump pumps and battery backup systems.
5. Prepare draft legal disconnection agreements and figures for NCC review.
6. Prepare final disconnection legal agreements and figures for execution by property owner and NCC, and file at Recorder of Deeds.
7. Develop an agreement tracking status table and track the status of all agreements.
8. Schedule the work with property owners and subcontractors.
9. Inspect the disconnection work and interface with property owners. Inspection included photo documentation of the completed work.
10. Receive calls from residents and address a variety of issues and complaints with follow-up inspections, agreements, and additional work.

Selection of Target Areas

The target areas for the Pilot Program were selected for the following reasons:

- Sub-basin NA2 and neighborhood of Ramblewood: Known to have a significant number of illegal sump pumps based on prior inspections. NA2 was also an area of known basement backups during storm events and a priority for reducing peak flows.
- Northcrest and Afton: Suspected to have leaking building drains (LBDs), based on anecdotal information. An LBD is a sanitary drain pipe (lateral) under the basement floor slab that is punctured or with separated joints near the building foundation wall to let groundwater drain into the pipe.
- Fairfax: Suspected to have punctured floor drains (PFDs) based on prior inspections. A PFD is a basement floor drain that was punctured in order to let groundwater drain into the pipe.

Individual properties within these target areas were sent mailings based on a combination of factors including:

- Previously known Clearwater connections.
- Geographic location.
- Calls received by NCC's Clearwater amnesty hotline.

The letters provided the property owner with a description of the Pilot Program and requested that they call and schedule an inspection of their property. Table 1 provides a breakdown of responsiveness to mailings by target area. The difference in degree of responsiveness is partially attributed to the level of effort in pursuing participation from the property owners. In NA2 and Ramblewood, multiple mailings and phones calls were made to solicit participation. In the other areas, the solicitation efforts were less intensive and generally consisted of a single mailing. Also basement backups and overflows in NA2 were occurring in the same area as the Clearwater connections – sometimes the same house.

Table 1. Responsiveness to Pilot Program Mailings.

Target Area	Number of Properties Invited to Participate	Number of Properties Inspected	Responsiveness
NA2 and Ramblewood	51	41	80%
Fairfax	50	18	36%
Northcrest and Afton	61	10	16%
Total	162	69	43%

Property Inspections

Malcolm Pirnie personnel scheduled and attended detailed residential inspections of 69 properties under the Pilot Program. The property owners responding to the notifications called and scheduled inspections during blocks of time that were reserved by Malcolm Pirnie. The inspections fell into two categories: illegal sump pump/PFD inspections and full clearwater inspections. An inspection checklist was developed to assist Malcolm Pirnie staff gather the information necessary to identify the clearwater connection and design the disconnection solution.

Malcolm Pirnie personnel conducted the illegal sump/PFD inspections with two staff members performing between 2 and 5 inspections per day. Approximately 1.5 to 2 hours were allocated for each inspection. The illegal sump/PFD inspection process generally includes the steps below.

Illegal Sump Pump/PFD Inspections

1. Meet with property owner and describe the nature and purpose of the Pilot Program.
2. Inspect for the presence of any sump pump connected to the sewer system or discharging to a basement utility sink.
3. Visually inspect basement floor drains (if present) for PFDs (i.e. holes, punctures, or gaps in the drain pipe).
4. If no Clearwater connections are identified (sump pump or PFD), the inspection ends at this point.

5. Photograph and measure the dimensions of the existing sump pit, piping, and basement. Confirm if a new pit may be required to accommodate a new pump.
6. Note the make, model, and power requirements for the sump pump, and photograph it.
7. Check to see if an outlet is required to properly operate the sump pump. Identify whether a new circuit is needed (and available). Photograph and note the type and amperage of the circuit panel.
8. Photograph and document any significant pre-existing conditions (i.e. cracks, evidence of infiltration, floor patching, or water damage).
9. Photograph and identify the most appropriate locations to install discharge piping and to penetrate the basement/exterior wall.
10. Photograph and diagram the outside of the property. Confirm the location for the exterior wall penetration. Identify the most appropriate location for discharge.
11. Interview property owner about the history of drainage problems and wet basement episodes.
12. Review the findings of the inspections with property owner, and discuss the options for locating the pit, piping, wall penetration, and discharge location.
13. Describe to the property owner the agreement and construction process and schedule. Allow the property owner to ask questions about the process.

Full Clearwater Inspections (additional steps to inspect for LBDs)
The full Clearwater inspections required the services of the plumbing subcontractors to assist with the inspection for LBDs. With the assistance of the plumbing subcontractors, Malcolm Pirnie performed between 2 and 3 inspections each day with approximately 2.5 hours allocated between each inspection. The full inspection procedure included all of the steps for the illegal sump pump/PFD inspections plus the following steps performed by the plumbing subcontractor:

1. Visual and (if possible) hand inspection of the floor drain to identify punctures, cracks or other features intended to allow inflow into the sewer. This sometimes required hand tools to detach the floor drain grate/cover. In some instances the floor drain was not accessible due to corrosion or floor coverings and could not be fully inspected.
2. Camera inspection of the sewer lateral from an accessible sewer cleanout. In several instances, the cleanout was not accessible or bends in the pipe prevented a thorough camera inspection.
3. Hydrostatic inspection of the sewer lateral using an inflatable plumber's ball to plug the line outside the foundation wall. The pipe was filled with water. Once the water level became visible in the floor drain or cleanout, the water was turned off and the drop in water level observed. A rapid drop in water level is indicative of the presence of an LBD. This inspection technique was only used successfully at four residences. In many cases, the plumbing subcontractors were unable to get the plumber's ball past fittings in the piping to a location necessary to perform the hydrostatic test.

Design, Execution of Agreements, and Scheduling Work
Following the property inspections, Malcolm Pirnie prepared a Clearwater disconnection agreement for each home that had a Clearwater connection. Each agreement contained two parts: a uniform text section with legal language approved by NCC and a customized AutoCAD figure (11"x17") that provided a sketch, notes, and details of the proposed Clearwater disconnection

work. Before any work was scheduled at a property, the agreement was reviewed, approved, executed by both the property owner and NCC, and recorded at the County's Recorder of Deeds office. The agreements were recorded to assure that future property owners would not be eligible for any future financial assistance to disconnect Clearwater connections that had been re-connected following the Pilot Program. Figure 1, on the following page, includes a flow chart that shows the steps for routing and executing the agreements.

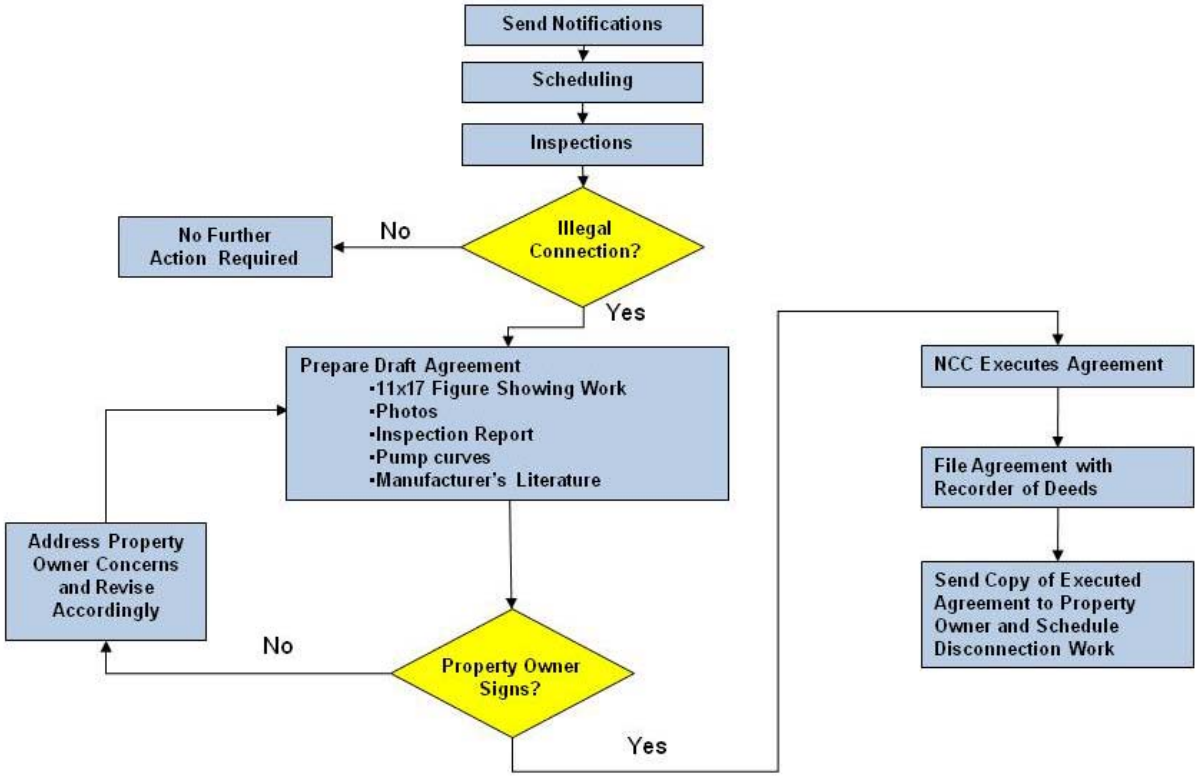

Figure 1. Private Property Approach.

The design process for Clearwater disconnections was broken down into two distinct aspects of the work: interior design work and exterior design work. Although these two aspects of the design process interrelate in terms of selecting the ideal location for new penetrations for discharge piping, they were considered largely independent. Figure 2 describes the basic steps in determining the appropriate scope of work for the interior of the basement. Figure 3 describes the basic steps for determining the appropriate scope of work for the exterior of the property. Effort was made to reasonably accommodate property owner requests and limitations as long as they were feasible and did not add excessive cost.

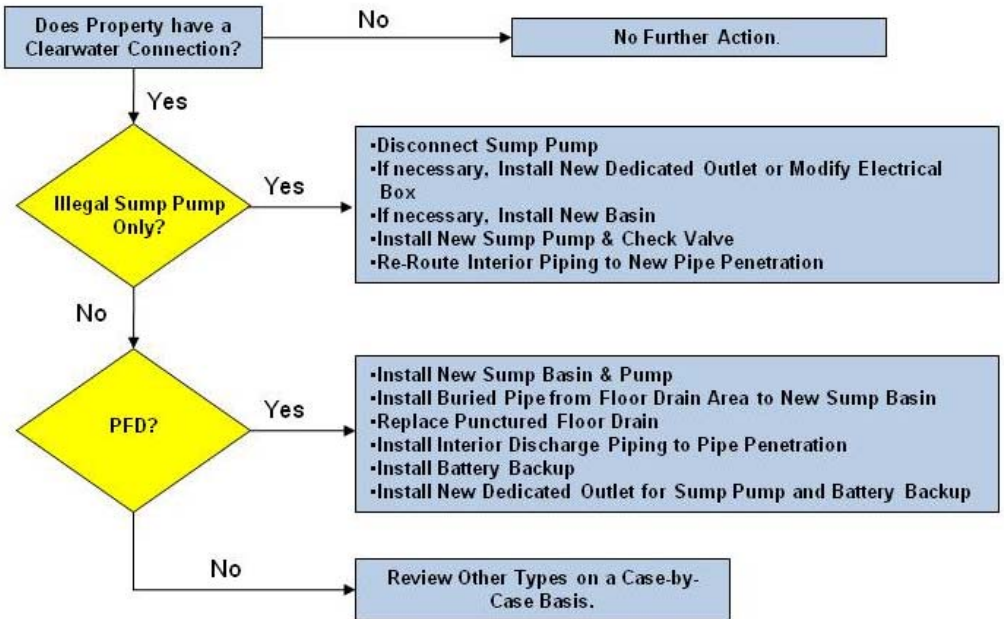

Figure 2. Interior Work.

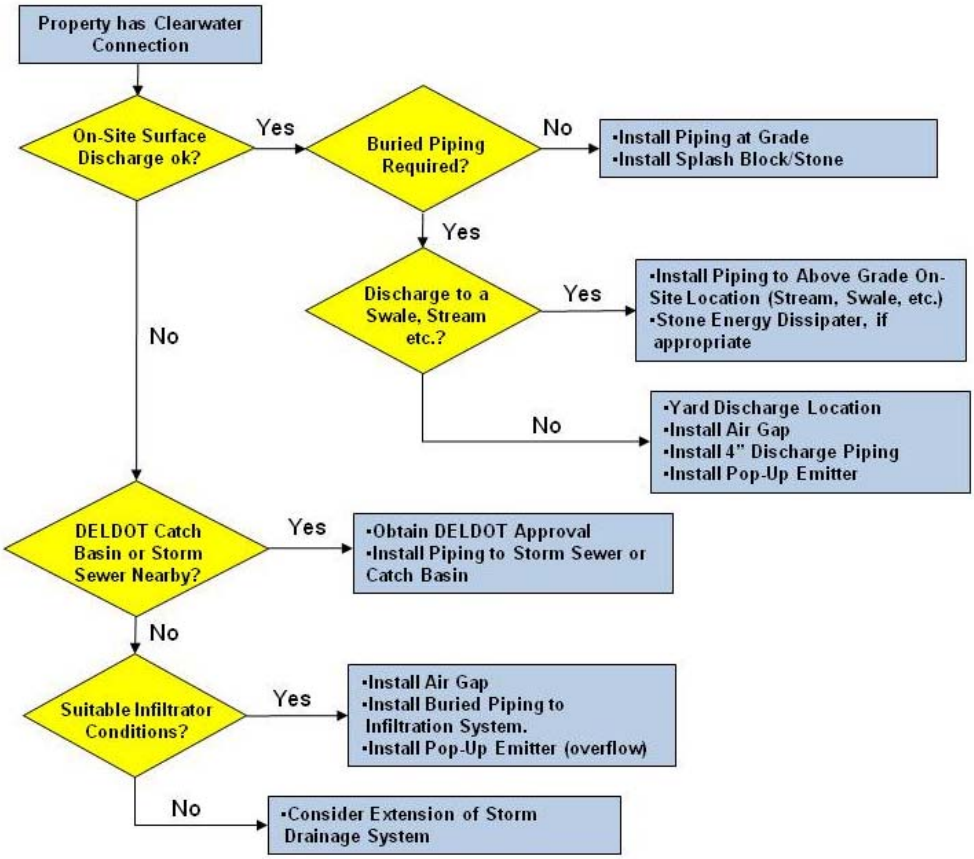

Figure 3. Exterior Work.

The design goal when providing a new pump and piping system was to meet or exceed the existing pump capacity without exceeding the existing pumps's power requirement. When necessary to power higher capacity pumps or battery backup systems, or to correct an existing safety concern, a new outlet and circuit breaker was included in the design. When a PFD was repaired, the resulting legal sump pump was always provided with a battery back-up system to provide continued protection during power outages.

RESULTS

Two types of Clearwater connections were identified and successfully disconnected as part of the Pilot Program: illegal sump pumps and PFDs. A summary of the Clearwater disconnections performed is provided below in Table 2.

Table 2. Summary of Clearwater Disconnections

Type	Quantity	
	Found	**Disconnected**
Illegal Sump Pump	37	33
Punctured Floor Drain	17	15
Leaking Building Drain	0	0
Total	54[1]	48[2]

[1] Does not include initial phase conducted by NCC.
[2] NCC disconnected an additional 11 illegal sumps and 2 punctured floor drains for a total of 61.

Costs

There were several factors that influenced the cost of the Pilot Program and the cost of each disconnection, including the type of Clearwater connection, site conditions, and homeowner-specific issues. Figure 4 shows the range of disconnection costs for the major categories of disconnections.

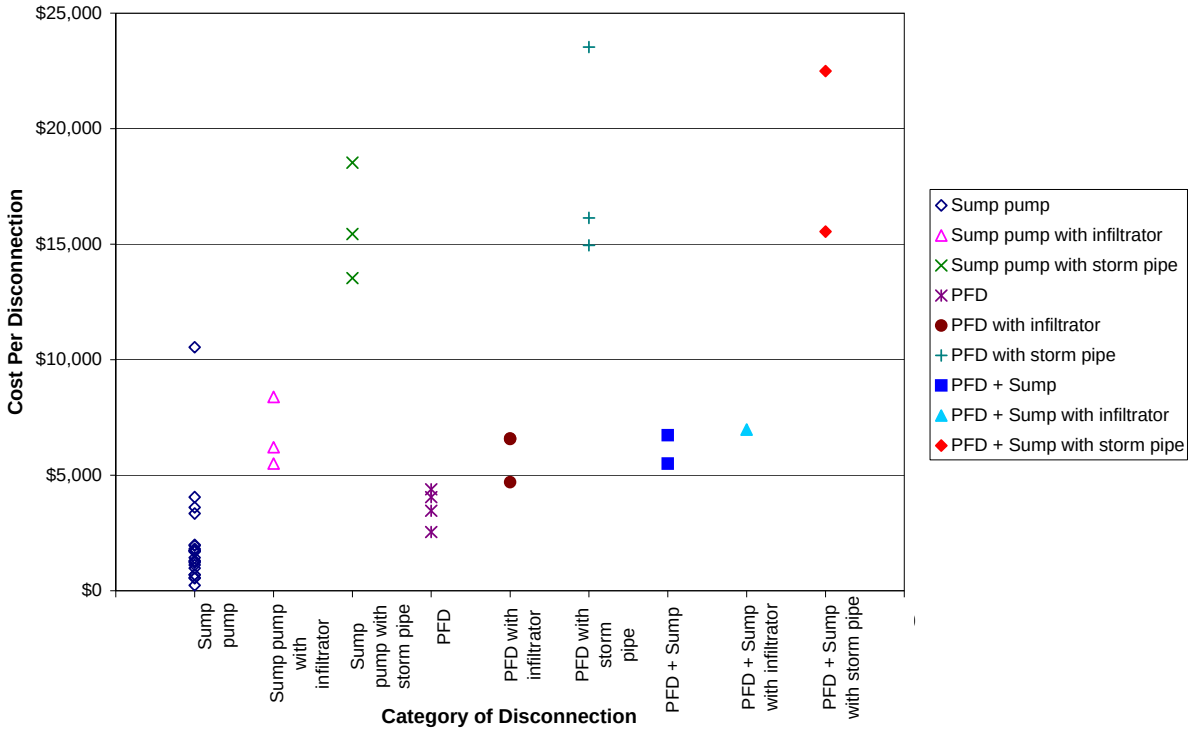

Figure 4. Range of Clearwater Disconnection Costs.

The average cost per property for the disconnection and addressing outside drainage improvements was $2,400 and $3,400, respectively. The relatively large average outside drainage costs were associated with the need to install storm drain piping and buried infiltration units at approximately 1/3 of the properties in order to manage the discharge from the Clearwater sources in a manner satisfactory to property owners.

There are a number of issues that impacted the overall cost of the work. These are discussed below.

- New sump pumps: Due to the modifications to the sump pump systems, a new sump pump was provided at each disconnection location regardless of the condition of the existing sump pump. This added to the time and cost of each disconnection. The primary cost drivers for simple disconnections are the cost of the pump, the work to install new piping, and the time and effort to core drill and seal the exterior wall penetration. The average cost of a simple sump pump only disconnection without significant excavation or basement work was $1,800, which includes oversight costs. The standard model sump pump specified for the Pilot Program was the Zoeller M53 cast iron submersible pump; however, if the previous pump was a pedestal type pump, a Zoeller 72 or 76 plastic casing pump was specified to match the lower power requirements of a typical pedestal pump. One unexpected cost implication of specifying these pedestal pumps was the added shipping costs to purchase them. While the submersible was generally in stock and available immediately, the pedestal models were not typically in stock and had to be

special ordered. If, due to scheduling or material substitutions, the specified pump was needed on short order, the shipping and handling costs added nearly $50.00 in order to obtain the pedestal pump within a day or two. These costs can be avoided if the contractor/supplier pre-orders a supply of these pumps or is given ample time to have them shipped. Bulk purchasing of sump pumps may also provide a cost benefit not realized in the Pilot Program.

- Installation of a new sump and basement subsurface conditions: Anytime excavation work occurred in the basement, it added time and cost. In most cases, the excavation work was related to the installation of a new sump, which was constructed to conform to the pump manufacturer's recommendations. Many of the existing sumps were 11" by 11" by 21" deep and could not accommodate a new, larger submersible pump. Installing a new sump includes breaking away the concrete and removing and hauling away the concrete and dirt in 5 gallon buckets (usually 10 or more) and bringing gravel in (also by buckets) to backfill around the sump. In most cases, the workers would haul the material up stairs and through fully finished sections of the homes. The contractors took great care to lay matting or protective plastic and paper down to protect the carpets, etc. In several instances, new sumps had to be adjusted in size and depth when hidden (buried) basement pipes, building footers, or bedrock were encountered. In addition to time delays to obtain a different sump size, further delays and cost were incurred if the work included a standard battery backup pump, which would not fit in the small, shallow sump. Consequently these sites required larger, more expensive UPS back-up power supplies to operate the larger sump pump.
- PFD disconnections: PFD disconnections always included excavation work in the basement to repair or replace the floor drain. In most cases, a new sump was also required. Consequently, the complexity and cost for PFD disconnections was higher than for typical sump installations. The same labor intensive work required for new sump installations was also required for PFD disconnections. In a few locations, the work was slowed because of the constant flow of groundwater into the excavation. PFD disconnections also required the installation of an under floor drain pipe from the former PFD directly to the sump.
- Excavation Work: When exterior excavation work was required, there was often a significant amount of rock encountered. Even without rock excavation, it typically added 4 hours of labor to a simple disconnection. When rock was encountered, it could greatly impact the cost and difficulty of the work. In one instance, it added a full day for a 2-man crew digging with the aid of a Ditch Witch trenching machine. These types of conflicts with rock are exacerbated if the exterior wall penetration was placed below grade (i.e., as opposed to above grade with an air gap) because the exterior pipe in such instances is installed deeper to minimize freezing potential. In many cases, the prevalence of rock (above 6" diameter) negated the efficiency and cost savings anticipated with the use of a power trench digger.
- Installation of Infiltrators: At several locations, a suitable surface discharge location could not be agreed upon with the property owner. If a storm drain was not accessible from the property, an infiltrator was specified. Nine infiltrators were installed, three of which were added to respond to homeowner complaints after the initial disconnection work was completed. Five of the infiltrators were put in where sump only disconnections were made. Four infiltrators were installed where PFD disconnections were completed.

Infiltrators added significant costs to each disconnection. The work to install an infiltrator typically includes the use of a machine operator, mini excavator, and a dump truck and trailer. The addition of an infiltrator typically added a full day to the work required for a simple disconnection. The cost of a typical disconnection with an infiltrator unit was approximately $9,000.

- Unsafe Existing Electrical Conditions: In some cases, a long extension cord was draped across a basement to provide power to an existing sump pump. Because NCC was modifying the system and installing a new pump, a new electrical outlet was installed near the sump pump, which added to project costs. Also, as recommended by the manufacturers of the battery back-up systems, the battery back-up, and the main sump pumps were connected to separate circuits. If a new outlet and/or circuit was added, the electrician needed to call to have it inspected by a certified inspection agency.

Effectiveness

In order to assess the impact of Clearwater disconnections on the sanitary sewer flows, pre-disconnection and post-disconnection flow metering was conducted in two of the target areas: Fairfax and NA2. Using a control basin methodology, the peak flow rate and total volume during and following rainfall events were evaluated.

Fairfax

Analysis of the flow meter data for Fairfax showed a 55% reduction in wet weather peak flow rates and 27% reduction in wet weather total storm volumes following the Clearwater disconnections. This clearly illustrates the importance of addressing Clearwater sources when looking to significantly reduce the infiltration and inflow sources in a sanitary sewer system.

NA2

Analysis of the available data for NA2 showed an 18% reduction in wet weather peak flow rates and a 5% reduction in wet weather total storm volumes following the Clearwater disconnections. However, post-disconnection data was limited for this area because the flow meter surcharged during critical, large storms. The presence of unknown volumes of pre and post SSO's during large rain events further complicated the assessment.

Based on observation of the amount of clearwater being discharged from the new sump pumps where clearwater connections were eliminated, it is conservative to estimate that at least 200 gpm (0.3 mgd) was removed from peak wet weather flow rates. At one NA2 residence in particular, the peak flow rate from the sump pump during storms is estimated to be in excess of 50 gpm. Qualitatively, the NA2 pilot was a tremendous success as the residents reported a very significant decrees in wet weather basement backups and SSO's.

LESSONS LEARNED

Numerous lessons were learned during the inspection, construction, and post-construction periods of the Pilot Program. The lessons learned resulted in improvements in both inspection and design procedures, as well as documenting challenges associated with outside drainage and property owner expectations for utility-performed work. Some of the key lessons learned are summarized in Table 3.

Table 3. Lessons Learned.

Lesson Learned	Problem	Recommendation
Outside area drains	Flooded Basements	Check for outside area drains (e.g., basement stairwell drains, window well drains, or driveway drains) and determine if they are connected to the sump pump or french drain system. If it is, this will greatly increase the size requirements for a new sump pump system.
PFD repairs and conductivity of french drain systems	Wet Basements	Do not assume that existing french drain systems will adequately convey groundwater to a new sump pit, even if the drain pipe is directly connected to the sump. The french drain may be clogged with sediments or contain other obstructions. When sealing a PFD, cut the floor and install a drain pipe to reroute flow from the sealed floor drain area to the new sump.
Outside drainage problems	Wet/muddy/icy conditions	Be prepared to go back to homes to address complaints about wet, muddy, or icy yards following the disconnection work. If new sump pumps will be running frequently during dry weather periods or frequently throughout the winter, take additional measures to convey the water to a stream, storm drain, or on-site infiltrator.
	Low permeability soils and infiltrators	With variability in soil types and volume of water being discharged from each residence, expect some infiltrator installations to be unsuccessful. Consider conducting soil permeability testing.
	Sump pump flows can be hard to predict	Property owner claims about how frequently their existing sump pumps operate have been found generally unreliable. Note frequency of pump operation during inspection.

Lesson Learned	Problem	Recommendation
Testing the Sump and Battery Backup After Installation and Adjustments	Float gets caught or is installed to high to reach the "on" level	Fill the sump basin with a hose and test the operation of the sump pump. It is especially important with models of sump pumps and back-up pumps which have tethered floats.
	Vent hole gets inadvertently covered by a pipe fitting	
Utility-performed work results in greater demand for perfection.	High Costs	Reimbursement or cost sharing program would results in fewer call backs and significantly lower costs to the Utility.
Air Gap Installation	Depth of excavation required to minimize the potential of the discharge pipe freezing and rock excavation	Some of the early clearwater disconnection designs specified for the pipe and pipe penetration through the basement wall to be below grade. In several cases, a significant amount of rock was encountered and added extra time and cost to the work. These conflicts with rock could have been minimized if the pipe were not buried so deep. As the Pilot Program progressed, both the subcontractors and the designers preferred to install above grade penetrations with air gaps. This mitigates the potential for sump pump failure due to a frozen discharge line and allows the pipe to be buried in a shallower trench. Consequently, the subcontractors encountered much less rock during excavation and pipe installation.

CONCLUSIONS

The following conclusions were reached regarding the disconnection of private Clearwater sources:

- It's not easy but it's do-able.
- It can significantly reduce wet weather flows.
- Can be most cost-effective way to manage wet weather flows (versus convey and treat).
- Outside drainage issues are challenging (technically, politically, and public relations).

The costs, effectiveness, reactions, and the lessons learned allowed the development and costing of several alternative approaches for a broadly applied Clearwater program for the entire system. Prior to implementing a full-scale Clearwater disconnection program, NCC is conducting a full scale demonstration project in a single large community having a significant number of sump

pump Clearwater connections. This demonstration project is identifying the sump pump Clearwater connections only, and then requiring the homeowner to perform the disconnect. NCC is offering a rebate upon successful disconnection to offset a portion of the homeowner's cost. Once those disconnections are made and the reductions in storm flows are verified, NCC intends on moving forward with the full-scale program that is planned to include:

- Mandatory inspection program.
- Property owners perform/outsource disconnection work.
- Partial reimbursement by NCC.
- Surcharge on sewer bill if not disconnected.
- Real-estate transaction inspection program.