Section 4
Identification of Alternative Nonstructural Control Measures

4.1 Land Use Controls

Impervious cover directly influences urban streams by dramatically increasing surface runoff during storm events. The conversion of farmland, forests, and meadows to rooftops, roads, parking lots, and driveways creates a layer of impervious surface in the urban landscape. Impervious cover is a very useful indicator with which to measure the impacts of land development on aquatic systems. The Nine Mile Run (NMR) watershed comprises an area of 4,283 acres of which 65% is developed. Analysis of data from the Geographical Information System (GIS) database indicates that 26% of the entire watershed is impervious cover and 37% of the urbanized portions of the NMR watershed is impervious cover. A map showing the impervious area in NMR is shown in Figure 4.1.1.

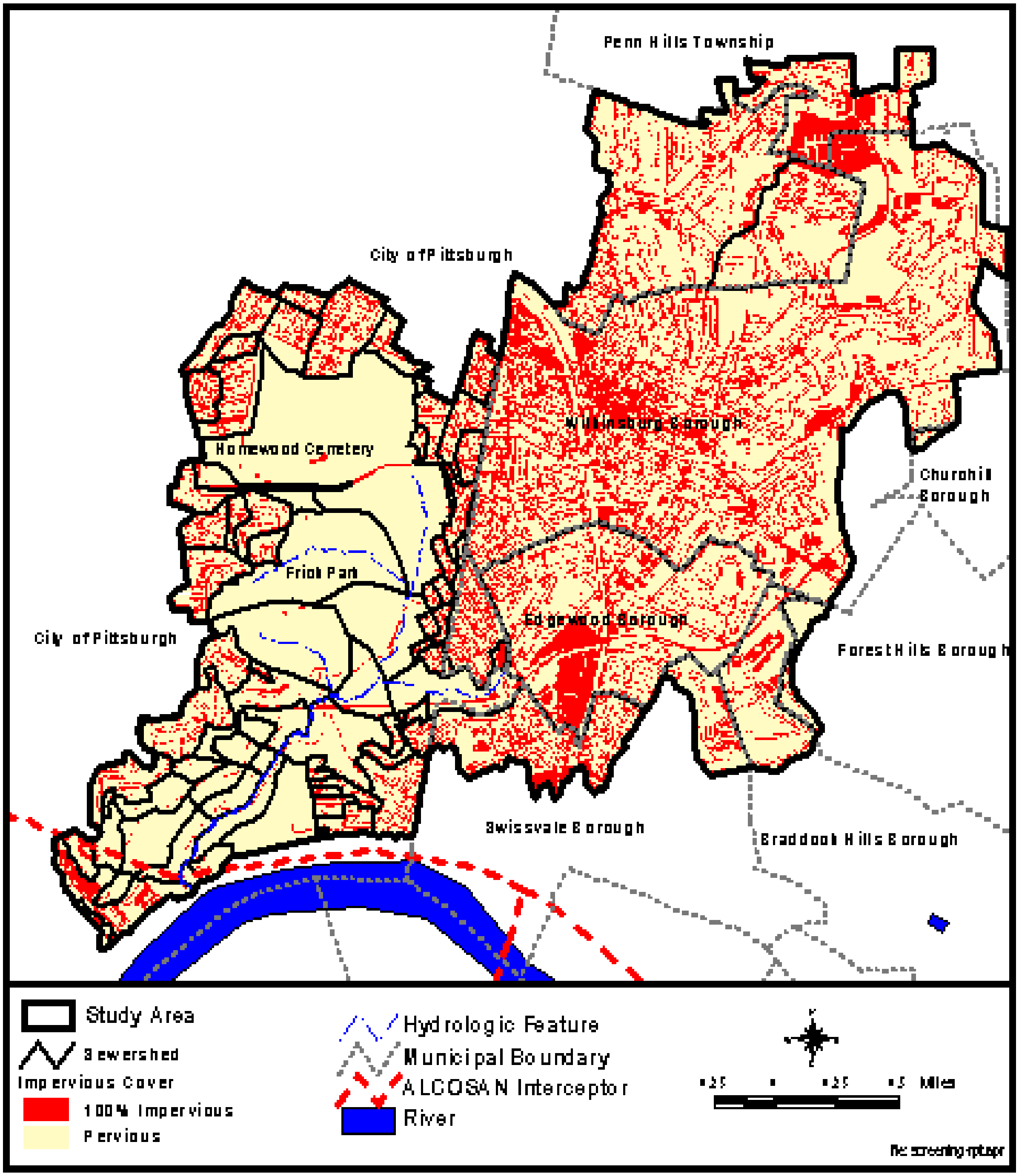
Since impervious cover has such a strong influence on watershed quality, a watershed management plan should critically analyze the degree and location of future development and redevelopment that is expected to occur within a watershed. The basic goal is to apply land use planning techniques to redirect development, preserve sensitive areas, and maintain or reduce the impervious cover within a given subwatershed. This goal can be addressed by applying the following land use controls:

- Direct Regulatory Approaches for New Development
- Indirect Regulatory Approaches for New Development
- Regulatory Approaches for Restorative Redevelopment
- Land Acquisition to Maintain Open Areas and Buffer Zones
- Runoff Control Programs for Industrial and Commercial Sites
- Improvements to Current Site Plan Review Process

This section of the watershed management plan lists and explains potential land use control measures that *could* be considered for the NMR watershed. It is important to note that not all of the alternative management measures documented in this section have equal applicability to the specific conditions within the NMR watershed. The alternative measures have differing implementation costs and differing effectiveness in improving water and habitat quality. The alternative measures that are listed in this section are evaluated and screened in Section 6.1.

For example, much of the developable land within the watershed has already been built out and there are limited opportunities for new development. As a result, there are limitations associated with using land use controls to improve water and habitat quality in the NMR watershed. These limitations are discussed in Section 6.1.

Figure 4.1.1: Impervious Areas in the NMR Watershed



4.1.1 Direct Regulatory Approaches for New Development

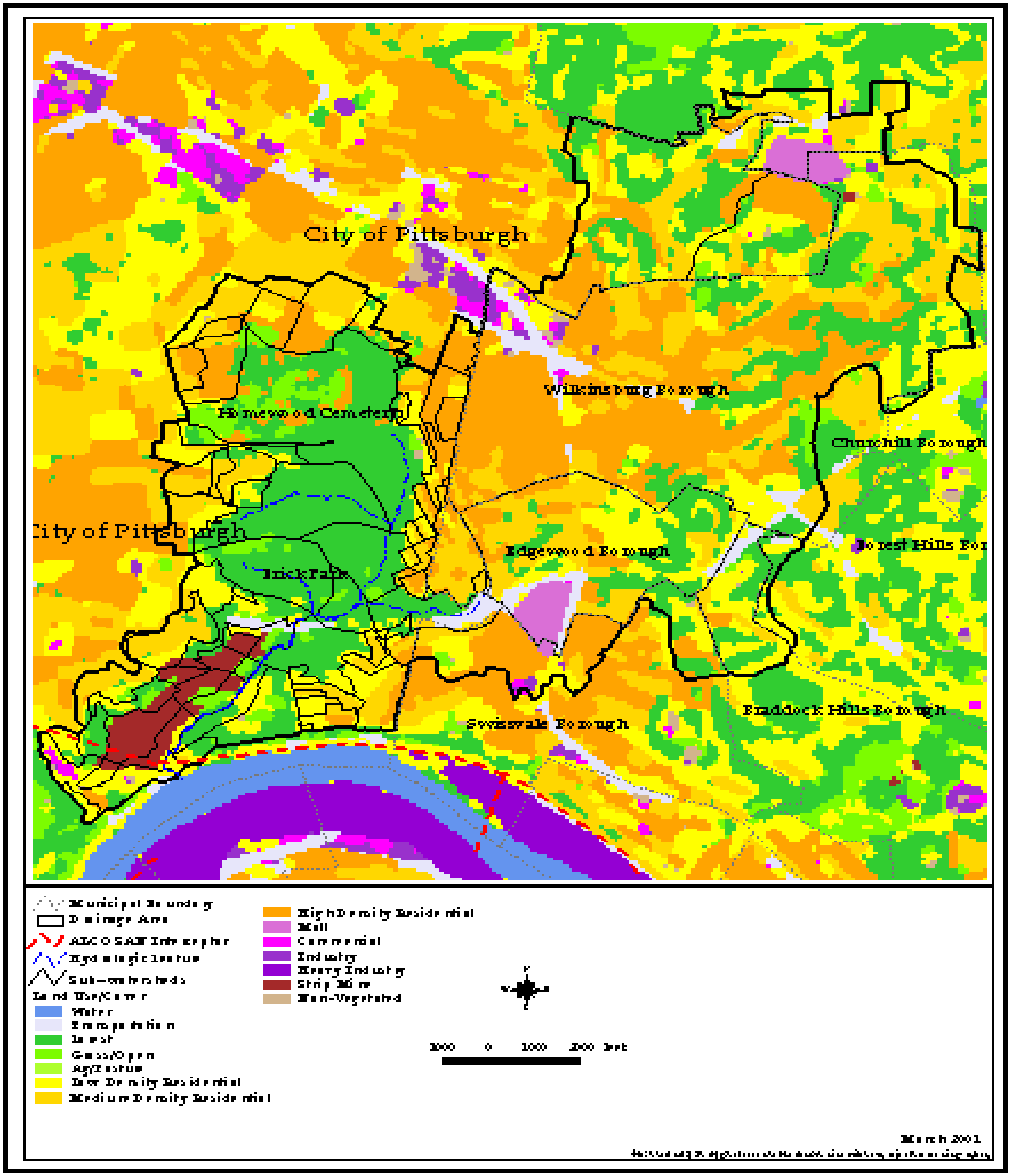
Planning for new development is best conducted at the subwatershed scale, where it is recognized that stream quality is related to land use and consequently impervious cover. One of the goals of watershed planning is to shift development toward subwatersheds that can support a particular type of land use and/or density.

Most of the NMR watershed consists of urbanized, residential and commercial areas. At present, approximately 34 percent of the NMR watershed area is undeveloped open space. The majority of this open space consists of Frick Park, Homewood Cemetery, and a large portion of the Duquesne slag disposal area. Other areas of open space consist of smaller parks, highway rights-of-way, or properties that are unlikely to be developed because of steep grades or other site-specific constraints. A land use map of the NMR watershed is shown in Figure 4.1.2.

For the most part, the possibility for new development in NMR is minimal. However, the City of Pittsburgh, in conjunction with the Urban Redevelopment Authority, is currently in the process of constructing several hundred additional units of mixed-income housing on the Duquesne slag pile as part of a development plan called "Summerset". The City's master plan includes a 100-acre greenway extension of Frick Park through the slag valley to the Monongahela River. Storm water discharges into NMR from the new housing development are a factor that will affect the stream channel and riparian greenway. In the later stages of the project, several access roads and bridges will be constructed along NMR.

Another development possibility affecting the restoration of NMR is the construction of the Mon-Fayette Expressway by the Pennsylvania Turnpike Commission. At present, the expressway is expected to cross the mouth of NMR. This could impact pollutant discharges into the stream from storm water runoff.

Figure 4.1.2: Land Use Map of the NMR Watershed



Regulatory approaches are needed to control pollutant discharges in storm water runoff from new development projects using zoning, erosion and sedimentation control, and grading and filling ordinances. These approaches are briefly described below.

Zoning

A wide variety of techniques can be used to manage land use and impervious cover in subwatersheds. These techniques have been employed in a wide variety of watershed applications by many local governments across the country. Some of these techniques include the following:

- Watershed Based Zoning
- Overlay Zoning
- Urban Growth Boundaries
- Large Lot Zoning

Watershed-Based Zoning: This specialized technique is the foundation of a land use planning process using subwatershed boundaries as the basis for future land use decisions. Watershed based zoning involves defining existing watershed conditions, measuring current and potential future impervious cover, classifying subwatersheds based on the amount of future imperviousness, and most importantly modifying master plans and zoning to shift the location and density of future development to the appropriate subwatershed management categories. Watershed based zoning can employ a mixture of land use and zoning options to achieve desired results.

Overlay Zoning: This land use management technique consists of superimposing additional regulatory standards, specifying permitted uses that are otherwise restricted, or applying specific development criteria onto existing zoning provisions. Overlay zones are mapped districts that place special restrictions or specific development criteria without changing the base zoning. The advantage is that specific criteria can be applied to isolated areas without a threat of being considered spot zoning. An overlay zone may take up only a part of an underlying zone or may even encompass several underlying zones. Often the utilization of an overlay zone is optional. A developer can choose to develop a property according to the underlying zone provisions. However, in order to develop certain uses or densities, the overlay provisions kick-in. Overlay zones can also be created to protect particular resources such as wetlands, forests, or historic sites. Here the provisions of the overlay zone incorporate mandatory requirements that restrict development in some way to restrict development in some way to reach the desired end.

Urban Growth Boundaries: This planning technique establishes a dividing line between areas appropriate for urban and suburban development, and areas appropriate for agriculture, rural and resource protection. Boundaries are typically set up for a 10 or 20-year period and should be maintained during the life of the planning period. Boundaries may be examined at planning period renewal intervals to assess whether conditions have changed since they were established. Boundaries should rarely be changed between planning cycles to ensure a consistent playing field for both the marketplace and citizens.

Large Lot Zoning: This land use planning technique is perhaps the most widely used to try to mitigate the impacts of development on receiving water quality. This technique involves zoning land at very low densities to disperse impervious cover over large areas. From the standpoint of watershed protection, large lot zoning is most effective when lots are extremely large (5 to 20 acres). While large lot zoning does tend to reduce the impervious cover and therefore the amount of storm water runoff at a particular location, it also spreads development over large areas. The road networks required to connect these large lots can actually increase the amount of imperviousness created for each dwelling unit. In addition, large lot zoning contributes to regional sprawl. Sprawl-like development increases the expense of providing community services such as fire protection, water and sewer systems, and school transportation.

The use of zoning as a watershed management tool would have a minimal impact on the NMR watershed. With the exception of the Summerset development, the possibility for new development within the watershed is minimal. There is minimal development pressure for the existing greenway belt along the NMR stream channel.

<u>Erosion and Sedimentation Controls</u>

Every community needs to have an effective erosion and sediment control (E&SC) program to reduce the potentially severe impacts generated by the construction process. The watershed management plan helps define which specific E&SC practices need to be applied within the watershed to best protect sensitive aquatic communities, reduce sediment loads, and maintain the boundaries of conservation areas and buffers.

Perhaps the most critical stage at a construction site is when soils are exposed both during and after construction. Erosion of these exposed soils can be sharply reduced by stabilizing the soil surface and erosion controls. For many contractors, erosion control is just shorthand for hydroseeding. However, a wide range of erosion control options are available that include mulching, blankets, plastic sheeting, and sodding among others.

Erosion controls have benefits beyond controlling erosion. First, they can improve the performance of sediment controls. Controlling erosion reduces the volume of sediment going to a sediment control device. Consequently, less treatment volume is reduced by sedimentation and "clean out" frequencies are lower. In addition, many erosion controls can lower surface runoff velocities and volumes, preventing damage of perimeter controls.

Erosion controls can actually preserve topsoil, and reduce the need for re-grading at the site because of rill and gully formation. Furthermore, erosion control reduces landscaping costs by limiting the need to import topsoil.

There will be limited impacts of erosion and sedimentation from construction activities within the NMR watershed due to the limited opportunities for new development. However, it is important to note that each municipality within the NMR watershed already has E&SC ordinances in place based upon the Allegheny County E&SC ordinances.

Erosion and sedimentation, however, is a significant issue regarding the NMR stream. Sporadic high velocity storm flows have been responsible for significant stream bank erosion and subsequent deposition of sediments within the open channel section of the stream (see Figure 4.1.3). These sporadic high velocity flows and erosion have lead to the destruction of the native wildlife and plant habitat.

Figure 4.1.3: Channel Erosion of NMR Stream

A detailed fluvial geomorphology study and assessment was conducted by Biohabitats, Inc., in April 2000, as part of the *ACOE Section 206 Environmental Restoration Report*. The Biohabitats study concluded that the NMR stream channel is not stable and that the natural recovery process would not correct the current channel condition. The stream is actively adjusting as evidenced by accelerated bank erosion, channel incision, and lateral scour including meander migration. Therefore, stream restoration, using fluvial geomorphological principles, was recommended to stabilize the channel, provide adequate sinuosity, reconnect the channel to the floodplain, and improve both aquatic and terrestrial habitat.

Clearing and Grading Ordinances

Perhaps the single most destructive stage in the development process involves the clearing of vegetative cover and the subsequent grading of the site to achieve a more buildable landscape. The potential impacts to a stream and its watershed in this stage are numerous and profound. Trees and topsoil are removed, and soils are exposed to erosion. Heavy equipment compacts underlying soils, reducing their capability to infiltrate rainfall. Steep slopes are cut, and the natural topography and drainage of the site is altered. The existence of buffers and environmentally sensitive areas are at risk from clearing or erosion.

Clearing and grading should only be performed within the context of the overall stream protection strategy. Some portions of the development site should never be cleared and graded, or clearing in these areas should at least be sharply restricted. These areas include the following:

- Stream Buffers
- Forest Conservation Areas
- Wetlands, Springs, and Slopes
- Highly Erodible Soils
- Steep Slopes
- Environmental Features
- Storm water Infiltration Areas

A site designer should go even further and analyze the entire site to find other open spaces where clearing and/or grading can be avoided. Ideally, only those areas actually needed to build structures and provide access should be cleared. This technique, known as fingerprinting, can sharply reduce earthwork and E&SC control costs, and is critical for forest conservation. All “protected” areas should be delineated on construction drawings and shown as “limits of disturbance” or LOD. The LOD must be clearly visible in the field, and posted by signage, staking, flagging, or most preferably, fences (i.e. silt fence or temporary safety/snow fence). The limits and the purpose of the LOD should be clearly conveyed to site personnel and the construction foreman at pre-construction meetings. In addition, paving and other subcontractors that will be working on the site during the later stage of construction should also be routinely notified about the LOD as they arrive.

As with land use measures and E&SC controls, the impacts of clearing and grading in the NMR watershed as a result of new development will be minimal. With the exception of the Summerset development, there is little anticipated new development within the watershed.

4.1.2 Indirect Regulatory Approaches for New Development

There are additional indirect regulatory approaches to control and reduce runoff from new development projects such as controlling the use of steep slopes, impervious surfaces, wetland and floodplain disturbance, and tree and vegetation removal during new development. These measures will only be discussed briefly since, as previously mentioned, there are limited possibilities for new development projects in the NMR watershed.

Steep Slopes

One indirect regulatory approach toward new development avoids placing houses and roads on steep slopes. Generally, the steeper the slope, the greater the erosion hazard. This is because the effects of gravity and reduced friction between soil particles on steep slopes means it takes less energy for water to dislodge and transport soil particles. In addition, steep slopes lead to greater areas of soil disturbance in order to accommodate facilities compared to flatter slopes. This is because most development projects generally require extensive grading to create flat areas for such things as roads and buildings.

Impervious Surfaces

Reducing the amount of impervious cover created by subdivision and parking lots for new developments can lead to savings for municipalities and developers. Impervious cover can be minimized by modifying local subdivision codes to allow narrower or shorter roads, smaller parking lots, shorter driveways, and smaller turnarounds. Infrastructure normally constitutes over half of the total cost of subdivision development. Much of the infrastructure creates impervious surfaces. Thus, builders can realize significant cost savings by minimizing impervious areas. These structural tools make both economic and environmental sense and will be discussed in Section 5 as structural control methods. In addition to these direct cost savings, developers will realize indirect savings. For example, costs for storm water treatment and conveyance are a direct function of the amount of impervious cover. Thus, for each unit of impervious cover that is reduced, a developer can expect a proportionately smaller cost for storm water management and control.

Wetland Disturbance and Flood Plain Development

Wetlands and floodplains can be used to control storm water runoff. Wetlands maintain wildlife habitat while decreasing the stream gradient and allowing slow flow areas to store and regulate flow. Ponded water and wetland areas mitigate the effects of storm water flow and its destructive effect on stream habitat. They mitigate the effects of storm water flows by slowing down the water and allowing more time for pollutants associated with storm water to be settled, filtered out, or assimilated by plants. The greater percentage of existing wetlands and floodplains that are preserved and maintained during new development projects, the quicker the system will recover from storm water runoff and reduce its effects on stream habitat and water quality.

Tree and Vegetation Removal

Another indirect regulatory approach toward new development includes preserving existing areas of dense vegetation. Good vegetative cover is an extremely important factor in preventing erosion. Disturbance of areas with a well-established, dense vegetative cover exposes valuable topsoil, making it highly susceptible to erosion. Destruction of such vegetation adds significant expense to the construction budget for clearing and destroys an inherently valuable attribute to the site (mature trees have recognized value in real estate appraisals and market absorption rates for home sales forecasts).

4.1.3 Regulatory Approaches for Restorative Redevelopment

Many of the older properties and older systems of sewage, drainage, transportation, and pavements in NMR have deteriorated and may need to be restored, revitalized, or reconstructed. As redevelopment progresses, buildings will be renovated and reconstructed, driveways will be repaved, patios and sidewalks will be replaced, and storm water and wastewater utilities will be rehabilitated or replaced. The technical key for restoring and revitalizing urban watersheds is to remove storm water from sewers and reintroduce it to the soil and vegetation, and reduce the area of impervious surfaces within the watershed. Regulatory land use approaches can be used to encourage home and business owners to apply the principals of restorative redevelopment whenever existing facilities wear out and need to be replaced or revitalized.

Every rainfall over the NMR watershed brings with it the diverse pollutants associated with urban watersheds; oils, trash, salts, pesticides, fertilizers all end up in the stream. Culverts convey abrupt pulses of peak storm flow, eroding the stream channels. Flows from rooftops and street runoff get into the combined and sanitary sewers, producing overflows that negatively impact environmental quality. When the rain is not falling, the base flow of watershed streams is almost nonexistent, drying up at times because the water has never entered the soils of the watershed.

The soils in NMR are relatively porous and permeable. They have capacities to infiltrate water that comes in contact with them, filter solids particles out of the infiltrating water, and build them into the soil matrix. Microorganisms decompose pollutants and turn them into nutrients. Storage in the soil and the deeper groundwater turns intermittent pulses of rainfall into a perennial moisture supply discharging slowly, almost steadily, months after the rain falls, to the streams and wetlands where aquatic organisms can survive over dry summers. Even after a soil has been churned and compacted by construction, nature tends to restore these kinds of processes wherever it is allowed to work freely.

Taking advantage of natural processes to store and treat storm water brings additional benefits as well. Recharging the groundwater supports riparian vegetation, providing wildlife habitat and opportunities for human interaction with the natural world. Reductions in impervious surfaces and tree planting help moderate urban temperatures, increasing human comfort. Porous pavements can be designed to improve pedestrian access to desirable places. Re-vegetation of landscapes beautifies neighborhoods.

A variety of techniques are available for removing storm water from sewers, reducing the quantity of impervious surfaces, and restoring beneficial natural processes. Land use regulations are watershed management measures that can encourage the use of these techniques. These strategies include:

- **Capturing Roof Runoff** in tanks or cisterns for irrigation or indoor graywater use
- **Disconnecting Pavement and Roof Drainage** from sewer lines and directing it to adjacent vegetated soil or to infiltration basins
- **On-lot Infiltration Basins** – install “water gardens”, dry wells, and subsurface recharge beds - to collect runoff and percolate it into the soil
- **Planting Trees** to intercept a portion of rainwater
- **Rehabilitating Soils** to increase infiltration rates and pollutant - neutralizing microbial activity
- **Reconfiguring Driveways, and Parking Areas** to turn more of a site to pervious, vegetated soil
- **Using Porous Pavements for Driveways and Parking Areas** – special varieties of asphalt, concrete, masonry, and other materials with open pores that allow water to pass through
- **Routing Runoff Through Vegetated Surface Channels** – “swales” – to slow its velocity, remove pollutants, and infiltrate it into the soil

Urban retrofit and redevelopment projects can disconnect storm water drainage from combined and sanitary sewers, and reconnect it with the vegetation and soil. A range of measures can use natural processes to reuse, infiltrate, treat, and detain rainwater with individual sites and neighborhoods.

The informed, creative retrofit and redevelopment of urban places can solve watershed problems at the source, while revitalizing older communities. It can reduce impervious cover, disconnect storm drains from sewers, build storage and treatment features into the fabric of urban places, educate the residents about where they live, and allow natural processes to operate again.

Existing land use controls can be revised so that future retrofit and redevelopment projects are encouraged to implement restorative redevelopment management measures. The following patterns of site-specific restorative redevelopment should be encouraged to restore watershed processes while revitalizing specific urban sites:

- Make components multi-functional
- Use every square inch
- Use freely available natural processes
- Use disconnections and reconnections
- Find out what is possible
- Engage the community

Make Components Multi-Functional

Everything that is done in a retrofit or redevelopment project should produce multiple, mutually reinforcing benefits. When a component is multi-functional, it attracts advocates promoting each of its several functions, and attracts a broad community and political support. Land use controls are a regulatory watershed management tool that can encourage this principal.

For instance, storm water has traditionally been moved off city roofs and streets through a single-purpose system of underground pipes. Instead, if it was kept on the surface, recreating a creek that was lost or recharging the groundwater and nourishing vegetation could be accomplished. In either case, it provides ecosystem benefits in terms of habitat for wildlife, human benefits in experiencing the beauty and wonder of natural systems, and financial benefits in reduced municipal costs of maintaining a hidden infrastructure.

Whenever an important storm water management component of a project has a cost that may be deemed undesirable by a developer or homeowner, it is important to point out the additional desirable benefits resulting from that storm water management component. The project budget is thereby enlarged as the cost for the storm water management becomes absorbed into the provision of other functions deemed more "necessary" by the developer or homeowner. Multiple functions as various as water quality improvement, employment, housing, separation of storm drainage from sanitary sewers, parking improvements, noise reduction, pedestrian safety, temperature moderation, and social equity can and should be found in the design of every building, street, sidewalk, park, water course, drainage system, residential yard, and institutional landscape.

One of the functions every restorative development should have is the education of people about natural processes and on-site connections to the watershed. Storm water systems should be visible and a tangible part of the urban framework of the watershed. Creating and implementing public education programs for watershed protection is discussed later in Section 4.2 of the plan.

Use Every Square Inch

Urbanized areas can be crowded places. Successful restoration and revitalization depends on utilizing every square inch of a retrofit or redevelopment project for positive, multiple functions. Every component is in the midst of community life, and must have a positive community benefit in addition to technical function.

As older cities and urban communities were built, the cumulative impacts of transforming the landscape mounted, and municipalities had to replace natural systems with cost-intensive infrastructure. Now, when much of the older infrastructure fails to perform to today's standards, an opportunity is made available to reconsider the form and function of the urban landscape – and ultimately integrate each site into a seamlessly operating whole.

The redevelopment of every site can contribute incrementally to the restoration of watershed process. For example, retrofitting of a single house with separation of roof drainage from sanitary sewers contributes only a small amount to the reduction of sewer overflows – but the impact is both immediate and maintainable over generations. The solution to a watershed-wide problem requires the contribution of many similar projects throughout the watershed. The cumulative public benefits are enormous. There must be a constant search for restoration and revitalization opportunities on additional sites. Once started, the endeavor must be maintained with purpose over many human generations. Existing land use controls can be revised to encourage the implementation of this management principal.

Use Freely Available Natural Processes

Freely available natural processes are capable of working for the greater benefit of watershed restoration. Vegetated soils absorb rainwater, and the chemical and microbial processes of the soil capture and degrade most pollutants that may be present. The infiltrated water recharges groundwater tables and restores flows to streams. These processes reduce peak flows and erosion, reduce sewer overflows, prevent and mitigate pollution, and sustain watershed ecosystems.

The regenerative capacity of soils and ecosystems is strong everywhere in the Pittsburgh region. Natural processes are waiting to perform essential services. Taking advantage of them enacts a new concept of storm water infrastructure to include the capacities of soil and vegetation to absorb water and filter pollutants. This is a "smarter", "cheaper" approach to infrastructure because it puts nature to work, and reduces the work humans must do, in contrast to the more active systems of pipes and facilities for conveyance and mechanically-dependant treatment.

Use Disconnections and Reconnections

Sewer overflows are usually the biggest pollutant sources in the watersheds where they exist, such as NMR. To the degree storm water is diverted out of sewers, downstream overflows and sewage pollution are reduced. Separating storm water drainage from sanitary sewage conveyance is a basic and essential task for restoration of old urban watersheds.

In particular, the drainage from impervious surfaces should be disconnected from combined sewers at every opportunity, even for small areas. In urban areas like NMR, the drainage from impervious surfaces is the great bulk of runoff, and it carries significant amounts of urban pollutants. In combined sewer systems, such as those serving the City of Pittsburgh portions of the NMR watershed, connections between roof leaders, area drains, foundation drains, and the sewer system are legal. In separate sewer systems, such as those in Edgewood, Swissvale and Wilkinsburg, these connections are illegal and should promptly be disconnected. This municipal measure is described in Section 4.3.

In some cases, drainage can be disconnected from the combined sewer rather easily. Even though these existing connections are legal, residents may be willing to voluntarily implement the disconnections. However, some disconnections require structural modifications that will be discussed in Section 5. To disconnect rooftop drainage, a downspout can be detached from combined sewers and routed to flat lawn areas, dry wells, water gardens, and cisterns. To disconnect pavement runoff, the drainage from driveways and walkways can be pitched away from street gutters, and onto vegetated soil; parking areas can be broken up with "infiltration islands" or served by underground storage/recharge beds; street drainage inlets can be detached from combined sewers, and their storm water diverted into vegetated swales.

Drainage that is "disconnected" from sewers in these ways is "reconnected" with its natural path in contact with soil and vegetation. The reconnection with its natural processes reduces the volume of surface runoff, filters the pollutants, replenishes the groundwater, and maintains the stream base flows. The volume of storm water, which once seemed a hazard and a nuisance, is turned into a resource and a productive public benefit.

Find Out What is Possible

Diverse, flexible, economical techniques for treating and storing storm water within urban retrofit and redevelopment projects have been proven in applications throughout the United States. Developers, public officials, and citizens need to be aware of the alternatives that are available. This will allow for examination and selection of numerous techniques, old and new, that can be applied in the NMR watershed in ways that are economical, effective, and supportive of economic vitality and quality of life. These techniques also can contribute to progress on local agendas, including ecosystem restoration and community social and economic development.

Engage the Community

Most leaders and professionals recognize that decisions having profound impacts on people and places – infrastructure choices, facility siting, provision of public amenities, policy development, and more – should be made with the full participation of those who will bear the effects of those decisions. Moreover, each city and its respective communities have a unique social and political history, style of governance, method of public discourse, and capacity for action. Local application of potential solutions needs to be carefully defined in order to build cohesive cultural forces for long-term success.

Collaborative, community-based efforts are key to developing sustainable approaches to issues as broad as sewer overflows, ecosystem restoration, and community development. If functions and benefits in these areas are to be coordinated and maximized, the community must be involved in the search for the solutions. Creating and implementing public education programs for watershed protection is discussed later in Section 4.2 of this storm water management plan.

4.1.4 Land Acquisition for Preservation of Open Space and Buffer Zones

A stream buffer is the region immediately beyond the banks of a stream that serves to limit the entrance of sediment, pollutants, and nutrients into the stream. It acts as a "right-of-way" for a stream and functions as an integral part of the stream ecosystem. When forested, a stream buffer promotes bank stability and serves as a major control of water temperature. Stream buffers add to the quality of the stream and the community in many diverse ways as shown in Table 4.1.1. As a result, stream and wetland buffers are an increasingly popular watershed protection technique due to simplicity, low cost, ease of implementation, and capability to protect resource areas. As an alternative watershed management measure, local governments may choose to purchase land to maintain existing open areas and buffer zones to protect valuable resources from the effects of development.

Table 4.1.1: Twenty Benefits of Urban Stream Buffers

1. **Reduces watershed imperviousness by 5%.** An average buffer width of 100 feet protects up to 5% of the watershed area from future development.
2. **Distances areas of imperviousness cover from the stream.** More room is made available for placement of storm water practices. *(f)*
3. **Reduces small drainage problems and complaints.** When properties are located too close to a stream, residents are likely to experience and complain about backyard flooding, standing water, and bank erosion. A buffer reduces complaints.
4**. Stream "right-of-way" allows for lateral movement.** Most stream channels shift or widen over time; a buffer protects both stream and nearby properties.
5. **Effective flood control.** Other, expensive flood controls not necessary if buffer includes 100-yr floodplain.
6. **Protection from streambank erosion.** Tree roots consolidate the soils of floodplain and stream banks, reducing the potential of severe bank erosion. *(f)*
7. **Increase property values.** Homebuyers perceive buffers as attractive amenities to the community. 90% of buffer administrators feel buffers have a neutral or positive impact on the property values. *(f)*
8. **Increased pollutant removal.** Buffers can provide effective pollutant removal for development located within 150 feet of the buffer boundary, when designed properly.
9. **Foundation for present or future greenways.** Linear nature of the buffer provides for connected open space, allowing pedestrians and bikes to move more efficiently through a community. *(f)*
10. **Provides food and habitat for wildlife.** Leaf litter is the base food source for many stream ecosystems; forests also provide woody debris that creates cover and habitat structure for aquatic insects and fish. *(f)*
11. **Mitigates stream warming.** Shading by the forest canopy prevents further upstream warming in urban watersheds. *(f)*
12. **Protection of associated watersheds.** A wide stream buffer can include riverine and palustrine wetlands that are frequently found along the stream corridor.
13. **Prevent disturbance to steep slopes.** Removing construction activity from these areas is the best way to prevent soil erosion. *(f)*
14. **Preserves important terrestrial habitat.** Riparian corridors are important transition zones, rich in species. A mile of stream buffer can provide 25-40 acres of habitat area. *(f)*
15. **Corridors for conservation.** Unbroken stream buffers provide "highways" for migration of plant and animal populations. *(f)*
16. **Essential habitat for amphibians.** Amphibians require both aquatic and terrestrial habitats and are dependant on riparian environments to complete their life cycle. *(f)*
17. **Fewer barriers for fish migration.** Chances for migrating fish are improved when stream crossings are prevented or carefully planned.
18. **Discourages excessive storm drain enclosures/channel hardening.** Can protect headwater streams from extensive modification.
19. **Provides space for storm water ponds.** When properly placed, structural storm water practices within the buffer can be an ideal location for storm water practices that remove pollutants and control flows from urban areas.
20. **Allowance for future restoration.** Even a modest buffer provides space and access for future stream restoration, bank stabilization, or reforestation.
(f) = Benefit by or requires forest cover

In NMR, no private land needs to be acquired to maintain existing open spaces and stream buffers. For the lower portions of the NMR watershed where urbanization is limited, the lands constituting the original stream alignment are owned by the City of Pittsburgh. These include Frick Park and the valley floor and lower slopes along the Duquesne slag disposal area. The floodway of NMR is considered to be the property of the Commonwealth. As a result, no additional land acquisition is necessary for stream buffers as an urban watershed protection strategy.

4.1.5 Runoff Control for Industrial and Commercial Sites

In an urban area like NMR, industrial and commercial facilities can be considered potential "hot spots" as sources of pollutants. While only a small portion of the total watershed area is designated as industrial/commercial land use, routine or accidental discharges from these few industrial or commercial facilities can discharge pollutants such as petroleum hydrocarbons, heavy metals, and toxic organic materials in quantities far beyond the proportion of industrial/commercial land use. For this reason, runoff controls for industrial and commercial sites are an important nonstructural watershed management tool.

Industrial and commercial activities, even small businesses and relatively small facilities, have the potential to be a significant pollutant contributor if the facility operator does not pay attention to routine operations that may discharge pollutants. The "operational practices", or best management practices (BMP), approach to pollution prevention can be especially attractive to smaller facilities and businesses, which may not generate pollutants in large quantities that make hydraulic treatment methods feasible but nevertheless can be occasional sources of significant amounts of pollutants. Further, small businesses may not have the wherewithal to implement extensive structural controls or to develop in-house expertise on specialized environmental issues. The intent of this pollution prevention approach is to achieve a level of on-site pollution control at the point of origin so that storm water need not be treated in an off-site regional hydraulic detention facility or pollutant removal device. The approach is highly practical from a business standpoint because it focuses on industrial/commercial operations and low-cost pollution control practices rather than expensive constructed solutions like new industrial structures or new storm water detention or treatment facilities.

Pollution prevention practices can be divided into three groups (see Table 4.1.2). The first two concentrate heavily on operational practices and nonstructural pollution prevention methods and the third could entail some structural control measures.

The first recommends to all facilities: employee training, customer awareness, spill prevention, and eliminating non-storm water discharges. The second includes pollution prevention practices that may be conducted at a typical facility (e.g. methods of handling wastes, pollution prevention for outdoor equipment, and proper methods of building and grounds maintenance, vehicle maintenance, shipping and receiving, and equipment washing). The third group may entail some structural modifications to facilities to enhance pollution prevention: design features of loading dock areas, vehicle fueling and maintenance areas, and access roads and rail facilities on the site.

Table 4.1.2: Industrial/Commercial Storm Water Practices

A. Storm water pollution prevention practices recommended for all facilities ▪ Training and education for employees and customers ▪ Eliminating improper discharges to storm drains ▪ Spill prevention, control, and cleanup
B. Categories for industrial/commercial activity for which pollution prevention practices may be adequate for storm water control ▪ Outdoor process equipment operations and maintenance ▪ Outdoor materials handling and storage ▪ Waste handling and disposal ▪ Vehicle and equipment washing and stream cleaning ▪ Trucking and shipping/receiving ▪ Fleet vehicle maintenance ▪ Fueling fleet vehicles and equipment ▪ Building and grounds maintenance ▪ Building repair, remodeling, and construction
C. More extensive practices that may be needed for some industrial/commercial activities ▪ Loading dock design features ▪ Equipment yard design features ▪ Fleet or equipment fueling area design features ▪ Controls and design features for access roads and rail corridors

While only a small portion of the total NMR watershed area is designated as industrial/commercial land use, discharges from industrial or commercial facilities located within the NMR watershed can contribute to storm water pollution. Even small businesses and relatively small facilities have the potential to be significant pollutant contributors. Industries implementing the nonstructural management and control practices described above can reduce storm water pollution and avoid the need for expensive constructed solutions (i.e. detention/treatment facilities).

4.1.6 Better Site Design

Individual development and redevelopment projects can be designed to reduce the amount of impervious cover they create, and increase the natural areas they conserve. Many innovative site-planning techniques have been shown to sharply reduce the impact of development. Designers, however, are often not allowed to use these techniques in many communities because of outdated local zoning and/or subdivision codes.

The better site design watershed protection tool is a nonstructural management measure that seeks to foster better site designs that can afford greater protection to a watershed. Four better design strategies that have special merit for watershed protection include:

- Open space residential subdivisions
- Green parking lots
- Headwater streets
- Rooftop runoff management

Open Space or Cluster Residential Subdivisions

Cluster development designs minimize lot sizes within a compact developed portion of a property while leaving the remaining portion open. Housing can still be detached single-family homes as well as multi-family housing or a mix of both. Clustered development creates protected open space that provides many environmental as well as market benefits. Cluster or open space development design typically keeps 30 to 80% of the total site area in permanent community open space with much of the open space managed as natural area.

The key benefit of open space or cluster development is that it can reduce the amount of impervious cover created by residential subdivision by 10 to 50% (CWP, 1998b; DEREC, 1997; Dreher and Price, 1994; Maurer, 1996; SCCCL, 1995). Clustering can also provide many community and environmental benefits. It can eliminate the need to clear and grade 35 to 60% of total site area and can reserve up to 15% of the site for active or passive recreation. When carefully designed, the recreation space can promote better pedestrian movement, a stronger sense of community space, and a park-like setting. Open space designs provide developers some “compensation” for lots that would otherwise have been lost due to wetland, floodplain, or other requirements. This, in turn, reduces the pressure on buffers and other natural areas. In addition, the ample open spaces within a cluster development provide a greater range of locations for more cost-effective storm water runoff practices. These same development concepts can be applied to new homes and businesses constructed on individual lots as well as entire subdivisions. Better site design can significantly reduce the quantity of new impervious area constructed on the lot, direct storm water runoff to vegetated areas, and maximize green space.

Green Parking Lots

When viewed from the air, parking lots are usually the largest feature of a commercial area, at least in terms of surface area. Over time, local parking codes have evolved to ensure that all workers, customers, and residents have convenient and plentiful parking. In this respect, local parking codes have been a great success. One by-product, however, has been the creation of large expanses of often-needless impervious cover.

A key strategy to reduce impervious cover involves the construction of green parking lots. Green parking refers to an approach that downsizes parking areas while still providing convenient access for the motorist. Green parking can be achieved through careful design and a comprehensive revision of local parking codes. The common theme in green parking lots is minimization of impervious area at every stage of parking lot planning and design. The concept of green parking lots can also be applied to existing parking lots when they are refurbished.

Headwater Streets

Since streets are one of the biggest components of impervious cover created by car transport needs, headwater streets are built or restored on a revised classification system where street widths decline with decreasing average daily trips (much like headwater streams which decrease in size with decreasing drainage area). This is essential, since streets are a key source area for storm water pollutants and do not allow the natural infiltration of water into the ground. By revisiting and changing some local subdivision codes, many of the traditionally accepted standards can be addressed to change this issue.

Rooftop Runoff Management

Re-directing rooftop runoff over pervious surfaces before it reaches paved surfaces can decrease the annual volume runoff from a site by as much as 50% for medium to low density residential land uses (Pitt, 1987). This can significantly reduce the annual pollutant load and runoff volume being delivered to receiving waters and therefore can have a substantial benefit in reducing downstream impacts.

It is important to note that the three proposed development phases for the Summerset plan are to be built on the Duquesne slag disposal area (Figure 4.1.4). The first development phase is currently under construction. The slag was deposited by area steel mills during the 1920's through 1970's. Storm water and groundwater percolate through the slag disposal areas and produce a leachate discharge that raises the pH of the stream. As a result, the aquatic habitat is degraded and unable to support aquatic organism species. Because of this, the site design watershed tools described above should not be applied for this specific development project. Applying measures to increase the infiltration of water into the ground would increase the slag leachate entering the stream and lead to further degradation.

Figure 4.1.4: Duquesne Slag Disposal Area

For the most part, the possibility for new development in NMR is minimal. The NMR watershed comprises an area of 4,283 acres of which 65% is developed, with a large portion of the undeveloped areas consisting of municipal parklands and the Duquesne slag disposal area. The key toward revitalizing the NMR watershed will lie with restorative redevelopment. The ideas will be to solve problems of sewer overflows, storm water runoff, and urban revitalization at the source. Future retrofit and redevelopment projects, in both the private and public sectors, will improve the value and livability of the watershed while effectively restoring natural processes and functions. The following sections will discuss both non-structural and structural measures that can be used to restore and protect the NMR watershed.

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4.2 Public Education and Volunteer Programs

Nine Mile Run (NMR) is an urban headwater stream. It is important to note that even if the sewage and slag leachate problems were to be controlled and aquatic habitat improved, the stream would continue to be subjected to the wide variety of problems typically related to urban runoff. These include water quality degradation due to runoff contaminated with pet wastes, lawn care chemicals, petroleum products from automobiles, and volumes of trash among others. All of these pollutants can be linked to individual behavior and watershed ethic.

The public does not always practice good watershed ethic, and continues to engage in many behaviors that are linked to water quality problems. Watershed education is the primary tool for changing these behaviors and is an important watershed management element. Some communities have attempted to craft education programs in recent years to influence watershed behaviors. These initial efforts have gone by an assortment of names such as public outreach, source control, watershed awareness, pollution prevention, citizen involvement, and stewardship, but they all have a common theme: educating residents on how to live within their watershed.

It is imperative that the public is properly educated as to the potential impairment to public safety and water quality resulting from poor watershed ethics. For the NMR watershed, the following potentially polluting behaviors can be linked to the observed water quality problems and will be discussed as alternative public education program elements:

- Littering
- Illegal Dumping
- Landscaping and Lawn Care
- Automobile Maintenance
- Car Washing
- Animal Waste Collection
- Vegetation Controls and Tree Planting

This section of the watershed management plan lists and explains potential public education programs that *could* be considered for the NMR watershed. It is important to note that not all of the alternative management measures documented in this section have equal applicability to the specific conditions within the NMR watershed. The alternative measures have differing implementation costs and differing effectiveness in educating residents on how to live within their watershed. The alternative measures that are listed in this section are evaluated and screened in Section 6.2.

The first step in crafting better watershed educational programs is to compile some baseline information on local awareness, behaviors, and media preferences. The following are some of the key questions that should be considered for the NMR watershed management plan:

- Is the typical individual aware of water quality issues in the NMR watershed?
- Is the individual or household behavior directly linked to water quality problems?
- Is the behavior widely prevalent in the NMR watershed population?
- Do specific alternative(s) to the behavior exist that might reduce pollution?
- What is the most clear and direct message about these alternatives?
- What outreach methods are most effective in getting the message out?
- How much individual behavior change can be expected from these outreach techniques?

The best way to elicit this information is to conduct a market survey within the watershed. If funding for a market survey is not available, a watershed manager can consult other residential surveys from similar areas.

The next step in developing alternative measures for a watershed education program is to consider the alternative outreach techniques. Several communities have recently undertaken before and after surveys to measure how well the public responded to their watershed protection programs. From this research, two outreach techniques showed promise in actually changing behavior: media campaigns and intensive training.

Media campaigns typically use a mix of radio, television, direct mail, and signs to broadcast a general watershed message to a large audience. Intensive training uses workshops, consultation, and guidebooks to send a much more complex message about watershed behavior to a smaller and more interested audience. Intensive training requires a substantial time commitment from residents of a few hours or more.

The remainder of this section will present alternative elements of a comprehensive public education program for the NMR watershed. All the alternative education elements will include watershed ethic and how it can improve the quality of an urban watershed. Watershed behaviors, especially the most potentially polluting behaviors associated with NMR, will be discussed in detail. Descriptions of the impacts these behaviors have on a watershed and suggestions on how to educate the public on these behaviors will be discussed as well.

4.2.1 Littering

Littering is a pervasive problem in the United States, as well as in the NMR watershed. Refuse may be blown out of overflowing trash bins or inexcusably tossed by consumers onto streets and into yards. The litter can eventually make its way into receiving streams thus making it a risk to public safety and water quality. Figure 4.2.1 below shows the effects littering has had on the NMR stream.

Figure 4.2.1: Effects of Littering in the NMR Watershed

During a geology study conducted by the United States Army Corp of Engineers (ACOE) in 1999, plastic supermarket carry bags were observed wrapped around nearly every tree limb within the reach of high water during storm events. One ACOE staff member participated in an Ohio Valley Water Sanitation sponsored program to remove these plastic bags and other debris from a 1.9 mile long open length of the stream only to come back a month later to observe stream side vegetation again wrapped with plastic bags and other trash.

Education is the key to changing behavior and attitudes with regards to littering. The key is to successfully educate the public on the problem and its implications. Effective litter prevention programs use practices that educate and involve the community in an effort to eliminate littering.

Some of the alternative prevention strategies that need to be considered and addressed when creating a public litter awareness program include:

- Creating a maintenance plan to keep an area clean
- Addressing problem disposal items
- Conducting comprehensive education campaigns

There are a number of groups that have ongoing efforts to educate the public about litter reduction. On such group, PA CleanWays, concentrates their efforts on changing the behavior of those who are littering our lands and waterways. They offer a variety of educational material explaining the problem of littering, why people intentionally and accidentally litter, and how everyone can be a part of the solution.

The media can be another useful tool to increase public awareness on litter reduction and can send the message that littering will not be tolerated. To maximize their educational role, the media should be involved before, during, and after cleanup projects.

Local litter control and cleanup programs focus on community involvement. The team approach not only provides most, if not all, the resources needed to conduct the cleanups, but, most importantly, it provides the involvement and commitment needed to keep the sites clean. Volunteers provide people power to remove litter that does not require heavy equipment. Often trash is scattered, and removal by equipment would cause undo damage to the environment. Sources of volunteers can include local residents, people with special interests in the area, and local service groups or businesses. Volunteers who live nearby or have a special interest are essential team players in keeping the area clean. Businesses can also provide many resources. Table 4.2.1 below shows a list of businesses and the types of resources they could provide.

Table 4.2.1: Litter-Prevention Resources from Businesses

Business	**Resource(s)**
Waste Industry	Disposal or recycling
Utilities	Equipment, cleanup supplies, deterrents, and re-beautification supplies
Food Vendors	Food and beverages for volunteers
Contractors	Equipment

Government, particularly local government, can assist in trash cleanups as well. They may provide hauling, labor, heavy equipment, and physical deterrents such as guide rails or fill to prevent access to a cleaned site. In addition, enforcement agencies can be essential players and should be encouraged to meet with volunteers and discuss ways they can work together to increase successful prosecution of littering offenders.

Another deterrent to littering is natural beauty. If a land is naturally beautiful and well cared for, it is less likely to be trashed by uncaring people. A number of local volunteer and community service groups have aided in the re-beautification of roads and public lands. One such group, the National Tree Trust, has teamed with PA CleanWays to provide several thousand seedlings during the spring that are potted, nurtured, and then distributed to groups throughout Western Pennsylvania for planting on public lands.

The cost of litter control programs can vary due to economic and social factors, but with creative thinking and community involvement potential costs may be reduced. Funding sources, such as foundations, corporations, and government agencies may provide funds to acquire essential resources not attainable from your community.

4.2.2 Illegal Dumping

Illegal dumping can occur in both urban and rural settings in all geographic regions, including NMR. For the NMR watershed management plan, illegal dumping control is important in preventing contaminated runoff from entering wells and surface water, as well as averting flooding due to blockages of drainage channels for runoff like the Commercial Avenue culvert. Illegal dumping control as a management practice involves using public education to familiarize residents and businesses with how improperly disposed materials can affect storm water. Locating and correcting these practices through educational measures can prevent the many risks of public safety and water quality associated with these actions.

Several types of illegal dumping can occur. The first is the illegal dumping (also known as “open dumping,” fly dumping,” or “midnight dumping”) of litter that occurs at abandoned industrial, commercial, or residential buildings; vacant lots; and poorly lit areas such as rural roads and railway lines. This dumping primarily happens to avoid disposal fees or the time and effort required for proper disposal at landfills or recycling facilities. These items include auto batteries, refrigerators and other scrap appliances, and even Christmas tress. Figure 4.2.2 shows the impact dumping that illegal dumping up in the watershed has along the NMR stream.

During a geology study conducted by the ACOE, the illegally dumped products observed in and along the NMR stream ranged from a church welcome mat to hypodermic needles and motorcycles. The migration of two motorcycles partially buried in the course substrate of the lower reaches of the stream during this study illustrates the violence of storm runoff events that can occur along NMR, and the high mobility of its bedload.

Figure 4.2.2: Example of Illegal Dumping along NMR

A second type is the illegal dumping of water that has been exposed to industrial activities and then released to the storm drainage system, including pollutants into storm water runoff. A third type is the illegal pouring of pollutants such as used motor oil, engine antifreeze, paint thinner, pesticides, or other household hazardous wastes (HHWs) into storm drains.

Illegal dumping control programs focus on community involvement and targeted enforcement to eliminate or reduce these acts. The key to successfully using this practice is increasing public awareness of the problem and its implications. Effective illegal dumping control programs use practices that educate and involve the community, local industries, and elected officials in an effort to eliminate the illegal discarding of wastes. Some of the alternative issues that need to be examined and considered when creating a public awareness program include:

- The locations of persistent illegal dumping activity
- The types of waste that are dumped and the profile of dumpers
- Previous education and cleanup efforts that have been used
- Existing sources of funding and additional resources that may be required

Cleanup projects will require coordinated planning efforts to ensure that adequate resources and funding are available. Once a site has been cleaned, signs, lighting, or barriers may be required to discourage future dumping. Landscaping and beautification efforts may also discourage illegal dumping, as well as provide open space and increased property value. Stenciling storm drains may make residents more aware that the pollutants that they illegal pour down storm drains will eventually end up in watershed streams. The Allegheny County Sanitary Authority (ALCOSAN) already has a storm drain stenciling program in place. Stenciling kits, that include stenciling patterns and instructions, are available through their public relations department.

The organization of special cleanup events where communities are provided with the resources to properly dispose of illegally dumped materials increase the understanding among residents of illegal dumping impacts and supplies opportunities to correctly dispose of materials. There are existing volunteer groups within the watershed that could provide labor resources needed to implement cleanup programs. Integration of illegal dumping prevention into community policy programs or use of programs such as Crime Stoppers may also be an effective way to increase enforcement opportunities without the additional cost of hiring new staff. Producing simple messages relating the cost of illegal dumping on local taxes and proper disposal sites will aid in eliminating the problem. Having a hotline where citizens can report illegal activities and educating the public on the connection between the storm drain and water quality will decrease disposal of waste into storm drain inlets.

Implementing a tracking and evaluation tool of the prevention efforts will determine if goals are being met. Using mapping techniques and computer databases allows officials to identify areas where dumping most often occurs, record patterns in occurrence, and calculate the number of citations issued and the responsible parties. This allows for better allocation of resources and more specific targeting of outreach and education efforts for offenders.

The cost of illegal dumping control programs can vary due to economic and social factors, but with creative thinking potential costs may be reduced. Possible sources of labor for dumping site cleanups can include volunteer community and youth groups.

4.2.3 Landscaping and Lawn Care

Lawn care and landscaping are important topics to consider when developing alternative elements for a comprehensive public education program for the NMR watershed. Landscaping and lawn care are a big business and it has been estimated that there are 25 to 30 million acres of turf and lawn in the United States. To put this statistic in perspective, consider that if lawns were classified as a crop, they would rank as the fifth largest one in the country on the basis of area (USDA, 1992). In terms of fertilizer inputs, nutrients are applied to lawns at about the same application rates as those used for row crops (Barth, 1995). The urban lawn is estimated to receive an annual input of five to seven pounds of pesticides per acre (Schueler, 1995).

Not many residents understand that lawn fertilizer can cause water quality problems – overall less than one-fourth of residents rated it as a water quality concern (Syferd, 1995 and Roberts, 1989 and Lawn and Landscape Institute, 1999). Unlike farmers, suburban and rural landowners are often ignorant of the actual nutrient needs of their lawns. According to surveys, only 10 to 20% of lawn owners take the trouble to take soil tests to determine whether fertilization is even needed (CWP, 1999b). The majority of landowners are not aware of the phosphorus or nitrogen content of the fertilizer they apply or that mulching grass clippings into lawns can reduce or eliminate the need to fertilize. Informing residents and lawn care professionals on methods to reduce fertilizer and pesticide application, limit water use, and avoid land disturbance can help alleviate the potential impacts of a major contributor of nonpoint source pollution in residential communities.

Because landscaping and lawn care are such common practices, education programs for both residents and lawn care professionals on reducing storm water impacts of these practices are an excellent way to improve local water quality. Education programs that seek to change the impacts of fertilizer, pesticide, and herbicide use on receiving water quality should first consider creating training programs for those involved in the lawn care industry. Nationally, lawn care companies are used by 7 to 50% of consumers, depending on household income and lot size. Lawn care companies can exercise considerable authority over which practices are applied to the lawns they tend, as long as they still produce a sharp looking lawn. For example, 94% of lawn care companies reported that they had authority to change practices, and about 60% of their customers were "somewhat receptive to the new idea" according to a Florida study (Israel et al, 1995). It is important to make residents aware of the environmental options within lawn care services so they can insist that lawn care professionals use them.

Training for employees of lawn and garden centers is another important tool in spreading the message regarding lawn care and pollution control. Study after study indicated that product labels and store attendants are the primary and almost exclusive source of lawn care information for the average consumer who takes care of his or her own lawn. Often the key strategy to implementing a program like this is to substitute watershed friendly products for those that are not, and to offer training for the store attendants to pass on to consumers at the point of sale on how to use, and perhaps more importantly, how not to abuse or overuse such products.

The overriding public desire for green lawns is probably the biggest impediment to limiting pollution from this source. For example, when residents were asked their opinions on over thirty statements about lawns in a Michigan survey, the most favorable overall response was to the statement "a green attractive lawn is an important asset in a neighborhood" (De Young, 1997). Nationally, homeowners spend about 27 billion dollars each year to maintain their own yard or pay someone else to do it (PLCAA, 1999). Convincing residents that a nice green lawn can be achieved without using large amounts of chemicals and fertilizers is difficult when conventional lawn care techniques are often seen as more effective, less-time consuming, and more convenient.

A recent CWP survey of 50 nutrient education programs provides a number of tips to program managers on making outreach programs more effective. Table 4.2.2 provides some of these tips that appear to work best at relaying pollution prevention messages and could be applied to the NMR watershed.

Table 4.2.2: Tips for Creating More Effective Lawn Care Outreach Programs

Tip 1*: Develop a stronger connection between the yard, the street, the storm, and the stream*
Outreach techniques should continually stress the link between lawn care and undesirable water quality it helps to create (e.g. algae blooms, sedimentation)
Tip 2: *Form regional media campaigns*
Since most communities operate on small budgets, they should consider pooling together to develop regional media campaigns that can use the outreach techniques that are proven to reach and influence residents. In particular, watershed-based campaigns allow communities to hire the professionals needed to create and deliver a strong message through the media, such as radio, television, and print, to reach a wider segment of the population. It is important to keep in mind that since no single outreach technique will be recalled by more than 30% of the population at large, several different outreach techniques will be needed in an effective media campaign.
Tip 3: *Use television wisely*
Television is the most influential medium for influencing the public, but careful choices need to be made on the form of television that is used. The CWP survey found that community cable access channels are much less effective than commercial or public television channels. Program managers should consider using cable network channels targeted for specific audiences, and develop thematic shows that capture the interest of the home, garden, and lawn crowd (e.g., shows along the lines of “Gardening by the Yard”). Well-produced public service announcements on commercial television are also a sensible investment.
Tip 4: *Keep messages simple and funny*
Watershed education should not be preachy, complex, or depressing. Indeed, the most effective outreach techniques combine a simple and direct message with a dash of humor.
Tip 5: *Make information packets small, slick, and durable*
Educators continually struggle about how to impart the detailed information to residents on how to practice good lawn care behavior, without losing their interest. The trick is to avoid a ponderous and boring handbook that looks great to a bureaucrat but ends up lining a birdcage. One solution is to create small, colorful, and durable packets that contain the key essentials about lawn care behaviors, and direct contact information to get better advice. These packets can be stuck on the refrigerator, the kitchen drawer or the workbench for handy reference when the impulse for better lawn care behavior strikes.
Tip 6: *Understand the demographics of your watershed*
Knowing the unique demographics of a watershed allows a program manager to determine what outreach techniques are likely to work for that particular area. Watershed managers should consider more direct channels to send watershed messages to reach particular groups such as through church leaders or ethnic specific newspapers and television channels.

The effectiveness of pollution prevention programs designed to educate residents on lawn care and landscaping practices have not been well documented to date. However, the need for such programs is evident. Source area monitoring in Marquette, Michigan found that nitrogen and phosphorus concentrations in residential lawn runoff were 5 to 10 times higher than any other source area (CWP, 1999b). This confirms that earlier Wisconsin research findings that residential lawns yielded the highest phosphorus concentrations of twelve urban pollutant sources examined (Bannerman et al, 1993).

The cost of creating and maintaining a program that addresses lawn care and landscaping practices and water quality varies depending on the intensity of the effort and what outreach techniques are selected. Media campaigns often require a greater amount of money to create, but are also more likely to reach the largest portion of the community. Intensive training campaigns may not require as large a creation cost, but often require more staff time. Production costs for materials such as flyers and brochures is often inexpensive ($0.10 to $0.50 per brochure), and soil kits and testing may be done through a local university to reduce expense. Many cooperative extension offices have already produced materials on lawn care and landscaping techniques to protect water quality and program managers may save money by utilizing these available resources.

4.2.4 Automobile Maintenance

The automotive repair industry is the leader in number of generators and the amount of total waste produced for small quantity generators of hazardous waste in the United States (US EPA, 1985). Therefore, it is important to consider the topic of automotive maintenance in a comprehensive public education program for the NMR watershed. Common activities at maintenance shops that generate this waste include the cleaning of parts, changing of vehicle fluids, and replacement and repair of equipment. These activities are also performed by residents at home in their driveway in the course of normal vehicle care. Since the use of automobiles is not limited by geographic or climatic conditions, maintenance facilities are present nationwide, including the NMR watershed.

Dumping automotive fluids down storm drains can be a major water quality problem, since only a few quarts of oil or a few gallons of antifreeze can have a major impact on streams and wetlands during low flow conditions. Historically, the major culprit has been the backyard mechanic who changes his or her oil own automotive fluids. The number of backyard mechanics who change the oil and antifreeze in their cars, however, has been dropping steadily in recent decades. With the advent of the $20 oil change special, it is reported that only about 30% of car owners change their own oil or antifreeze anymore (CWP, 1999b).

Automotive maintenance facilities are considered to be storm water "hotspots" where significant loads of hydrocarbons, trace metals, and other pollutants can be produced that can affect the quality of storm water runoff. Some of the types of waste generated at automobile maintenance facilities and by residents performing their own car maintenance at home include:

- Solvents (paints and paint thinners)
- Brake fluid and brake lining
- Batteries
- Motor oils
- Fuels (gasoline, diesel, kerosene)
- Lubricating grease

The most effective way to minimize the impacts of automotive maintenance generated waste is by avoiding its production in the first place. Pollution prevention programs seeking to reduce liquid discharges to sewer and storm drains from automotive maintenance should stress techniques that allow facilities to run a dry shop. Among the suggestions for creating a dry operation:

- Do not use water for clean up whenever possible and clean up spills immediately
- Seal floor drains that are connected to the sanitary sewer
- Hire a solvent service to supply parts cleaning materials, and to collect the spent solvent

Other methods are available to help prevent or reduce the discharge of pollutants from vehicle maintenance. Table 4.2.3 lists some of the common suggestions that can help reduce vehicle maintenance and repair impacts. Many of these practices apply both to business owners and to residents who maintain their own vehicles.

Table 4.2.3: Recommendations for Reducing the Storm Water Impacts of Automotive Maintenance

Method	**Suggested Activities**
Water Reduction	▪ The number of solvents used should be kept to a minimum to make recycling easier and to reduce hazardous waste cost ▪ Do all liquid cleaning at a centralized station to ensure solvents and residues stay in one area ▪ Locate drip pans and draining boards to direct solvents back into solvent sinks or holding tanks for reuse
Using Safer Alternatives	▪ Use non-hazardous cleaners when possible ▪ Replace chlorinated organic solvents with non-chlorinated ones like kerosene or mineral spirits ▪ Recycled products such as engine oil, transmission fluid, antifreeze, and hydraulic fluid can be purchased if available to support the market of recycled products
Spill Clean Up	▪ Use as little water as possible to clean spills, leaks, and drips ▪ Rags should be used to clean small spills, dry absorbent material for larger spills, and mop for general cleanup
Good Housekeeping	▪ Employee training and public outreach are necessary to reinforce proper disposal practices ▪ Conduct maintenance work such as fluid changes indoors ▪ Update facility schematics to accurately reflect all plumbing connections ▪ Parked vehicles should be monitored closely for leaks and pans placed under any leaks to collect the fluids for proper ▪ Promptly transfer used fluids to recycling drums or hazardous waste containers ▪ Do not pour liquid waste down floor drains, sinks, or outdoor storm drain inlets ▪ Obtain and use drain mats to cover drains in the event of a spill ▪ Store cracked batteries in leakproof secondary containers
Parts Cleaning	▪ Use detergent based or water based cleaning systems instead of organic solvent degreasers ▪ Stream cleaning and pressure washing may be used instead of solvent parts cleaning ▪ Wastewater generated from stream cleaning should be discharged to a pretreatment structure

4.2.5 Car Washing

Car washing is a common routine for residents and a popular way for organizations such as scout troops, schools, and sports teams to raise funds. This activity is not limited by geographic region, but its impact on water quality is greatest in more urban areas such as NMR. Currently, only a few pollution prevention programs incorporate proper car washing practices as part of the overall message to residents on ways to reduce nonpoint source pollution. Therefore, it is important to consider car washing in a comprehensive public education program for the NMR watershed. This pollution management measure involves educating the general public on the water quality impacts of the outdoor washing of automobiles and how to avoid allowing polluted runoff to enter the storm drain system.

Outdoor car washing has potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions, as the detergent-rich water used to wash automobiles flows down the street and into storm drains. Storm drain stenciling programs emphasize the connection between the storm drain and runoff and help reinforce that car washing activities can have an effect on local water quality. The development of a prevention program to reduce the impact of car wash runoff includes outreach on management practices to reduce discharges to storm drains. Some of these management practices include:

- Using a commercial carwash
- Washing your car on gravel, grass or other permeable surfaces
- Blocking off storm drains during charity car wash events or using an insert to catch wash water
- Pumping soapy water from car washes into sanitary sewer drains
- If pumping into a drain is not feasible, pumping car wash water onto grass or landscaping to provide filtration
- Using hoses with nozzles that automatically turn off when left unattended
- Using only biodegradable soaps

In the Pacific Northwest, outreach programs provide materials to charity car wash organizers to prevent car wash water from entering storm drains. These “water friendly” car wash kits are provided free of charge to charity organizers along with draining and educational videos on planning an environmentally friendly car wash. Two types of equipment are available for charity organizations to borrow: a catch-basin insert with a sump pump or a vacuum / boom device known as a Bubble Buster (Kitsap County, 1999). Both devices capture wash water runoff, allowing it to be pumped to either a sanitary sewer or a vegetative area for treatment.

For businesses, good housekeeping practices can minimize the risk of contamination from wash water discharges. Table 4.2.4 gives some general best management practices that those businesses that have their own vehicle washing facilities can incorporate to control the water quality impacts of wash water discharges.

Table 4.2.4: Storm Water Management Practices for Car Washing Facilities

▪ Have all vehicle washing done in areas designed to collect and hold the wash and rinse water or effluent generated. Recycle, collect, or treat wash water effluent prior to discharge to the sanitary sewer system.
▪ Pressure cleaning and stream cleaning should be done off-site to avoid generating runoff with high pollutant concentrations. If done on-site, no pressure cleaning and stream cleaning should be done in areas designated as wellhead protection areas for public water safety.
▪ Map on-site storm drain locations to avoid discharges to the storm drain system.
▪ Immediately contain and treat spills

The biggest limitation to implementing residential car wash best management practices may be the lack of knowledge regarding the impacts of polluted runoff. Many people do not associate the effects of their vehicle washing activities with local water quality, and may be unaware that discharges that enter storm drains are not treated at plants before being discharged into local waters.

The effectiveness of car washing best management practices at reducing nonpoint source pollutant loads has yet to be measured accurately. It is often difficult to determine the exact impact of a particular pollution prevention measure at reducing pollutant loading. While not much is known about the water quality of car wash water, it is very clear that car washing is a common watershed behavior. Three surveys have asked residents where and how frequently they wash their vehicles (Table 4.2.5).

Residents are typically unaware of the water quality consequences of car washing, and do not understand the chemical content of the soaps and detergents they use. Car washing is a difficult watershed behavior to change since it is often hard to define a better alternative. However, as with all pollution prevention measures, the reduction of pollutant loads from outdoor car washing activities are bound to have a positive effect on storm water quality

Table 4.2.5: Summary of Car Washing Surveys

Study	Car Washing Behavior
Smith, 1996 Maryland	60% washed car more than once a month
Pellegrin, 1998 California	73% washed their own cars 73% report that wash water drains to pavement
Hardwick, 1997 Washington	56% washed their own cars 44% used commercial car wash 91% report that wash water drains to pavement 56% washed car more than once a month 50% would shift if given discounts or free commercial car washes

Most car washing best management practices are inexpensive, and rely on more good housekeeping practices (where vehicles are washed, planning for collection of wash water) than on expensive technology. However, the construction of a specialized area for vehicle washing can be expensive for businesses. Also, for facilities that cannot recycle their wash water, the cost of pretreating wash water through either structural practices or planning for collection and hauling of contaminated water to sewage treatment plants can represent a cost limitation.

Staffing and materials represent the largest expenditure for local governments seeking to administer a nonpoint source education program. Car wash outreach programs are relatively inexpensive to staff and often require only a limited outlay for materials (brochures, training videos, etc.). For Kitsap County, Washington, the Sound Car Wash program requires roughly ten to fifteen hours per week of staff time over a twenty-five week period from April to September. Cost for materials and equipment replacement is estimated to be between $1,500 and $3,000 for the same twenty-five week period (Kitsap County, 1999). The Clean Bay Car Wash kits program in Tacoma, Washington uses only the catch basin insert option and estimates that it spends no more than $2,000 per year and two weeks of staff time per year to handle requests for its program (City of Tacoma Storm water Utility, 1999).

4.2.6 Animal Waste Collection

Animal waste collection as a pollution control source involves using a combination of educational outreach and enforcement to encourage residents to clean up after their pets. Municipal enforcement for pet waste cleanup will be discussed in Section 4.3. The presence of pet waste in storm water runoff has a number of implications for urban stream water quality with perhaps the greatest impact from fecal bacteria. According to recent research, non-human waste represents a significant source of bacterial contamination in urban watersheds. The bacteria can pose health risks to humans and other animals, and result in the spread of disease. Public education on animal waste collection as a pollution control source is necessary in the NMR watershed. In addition to hiking and bird watching, a popular use of the lower portion of Frick Park is dog walking. Residents need to be educated on the implications of their pet's waste on the stream water quality.

Residents seem to be of two minds when it comes to dog waste. While a large majority agrees that dog waste can be a water quality problem, they generally rank it as the least important local water quality problem. This finding strongly suggests the need to dramatically improve watershed education efforts to increase public recognition about the water quality and health consequences of dog waste.

Public education programs are a way to encourage pet waste removal. Often pet waste messages are incorporated into a larger non-point source message relaying the effects of pollution on local water quality. Brochures and public service announcements describe proper pet waste disposal techniques and try to create a storm drain water quality link between pet waste and runoff. Signs in public parks and the provision of receptacles for pet waste also encourage cleanup.

Another option for pet waste management is the use of specifically designated dog parks where pets are allowed off-leash. These parks typically include signs reminding pet owners to remove waste, as well as other disposal options for pet owners. The following management options have been used in Australian dog parks and could be incorporated for dog parks in NMR:

Doggy loos: These disposal units are installed in the ground and decomposition occurs within the unit. Minimal maintenance is required (no refuse collection).

Pooch patch: A pole is placed in the park surrounded by a light scattering of sand. Owners are encouraged to introduce their dog to the pole on entry to the park. Dogs then return to the patch to defecate and special bins are provided in which owners then place the deposit.

The "Long Grass Principle": Dogs are attracted to long grass for defecating and areas that are mowed less frequently can be provided for feces to disintegrate naturally. A height of around 10 cm is appropriate.

The reluctance of many residents to handle dog waste is the biggest limitation to controlling pet waste. According to a Chesapeake Bay survey, 44% of dog walkers who do not pick up indicated they would still refuse to pick up, even if confronted by complaints from neighbors, threatened with fines, or provided more sanitary and convenient options for retrieving and disposing of dog waste. Table 4.2.6 provides factors that compel residents to pick up after their dog, along with some rationalizations for not doing so.

Table 4.2.6: Dog Owners' Rationale for Picking Up or Not Picking Up After Their Dog (HGIC, 1996)

Reasons for not picking it up:	Reasons for picking up:
• Because it eventually goes away	• It's the law
• Just because	• Environmental reasons
• Too much work	• Hygiene/health reasons
• On edge of my property	• Neighborhood courtesy
• It's in my yard	• It should be done
• It's in the woods	• Keep the yard clean
• Not prepared	
• No reason	
• Small dogs, small waste	
• Use as fertilizer	
• Sanitary reasons	
• Own a cat or other kind of pet	

The cost of animal waste collection programs will vary depending on the intensity of the effort and the paths chosen to control pet waste. The most popular way is through an ordinance, but managers must consider the cost of the enforcement, including staff and equipment requirements. The type of materials produced and the method of distribution selected determine public education program costs. Signs in parks may initially have a higher cost than printed materials, but can last for many years. Signs may also be more effective, since they act as on-site reminders to dog owners to clean up in parks.

4.2.7 Restorative Redevelopment

The concept of restorative redevelopment as an alternative land use control measure was discussed in detail in Section 4.1.3 of the watershed management plan. Here the management practice will be summarized briefly as an important element of a comprehensive public education program. Many of the older residential, commercial, and industrial properties in the NMR watershed have deteriorated and may need to be restored, revitalized, or reconstructed. As redevelopment progresses, buildings will be renovated and reconstructed, driveways and parking areas will be repaved, and patios and sidewalks will be replaced. The technical key for restoring and revitalizing urban watersheds is to remove storm water from sewers and reintroduce it to the soil and vegetation, and reduce the area of impervious surfaces within the watershed. Public education programs can be used to encourage home and business owners to apply the principals of restorative redevelopment whenever existing facilities wear out and need to be replaced or revitalized. These principals and alternative applications for the NMR watershed were previously described in detail in Section 4.1.3.

Urban retrofit and redevelopment projects can disconnect storm water drainage from combined and sanitary sewers, and reconnect it with the vegetation and soil. A range of measures can use natural processes to reuse, infiltrate, treat, and detain rainwater with individual sites and neighborhoods. The informed, creative retrofit and redevelopment of urban places can solve watershed problems at the source, while revitalizing older communities. It can reduce impervious cover, disconnect storm drains from sewers, build storage and treatment features into the fabric of urban places, educate the residents about where they live, and allow natural processes to operate again.

4.2.8 Vegetation Controls and Tree Planting

Vegetation control typically involves a combination of chemical (herbicide) application and mechanical methods. Mechanical methods are discussed herein, vegetation control by herbicides were addressed previously (Landscaping and Lawn Care). Public education of mechanical vegetation control includes properly collecting and disposing of clippings, cutting techniques, leaving existing vegetation, and planting new trees and vegetation.

Clippings and cuttings are the primary waste produced by mowing and trimming. Clippings and cuttings are almost exclusively leaf and woody materials. However, in some cases, litter may be intermingled with the clippings. Clippings/cuttings carried into the storm water system and receiving streams can degrade water quality in several ways. Suspended solids will increase causing turbidity problems. Since most of the constituents are organic, the biological oxygen demand will increase causing a lowering of the available oxygen to plant and aquatic animal life. In areas like NMR where litter and other solid waste pollution exists, toxic materials may be released into receiving streams with a resulting degradation of water quality. For the most part, the solution to this problem involves behavior modification through education. Awareness of the problem is the first step toward the solution.

Once vegetative waste is generated, the main concern is to avoid transport of clippings/cuttings to receiving water bodies. Often, people will discover that clippings/cuttings can easily be disposed of by dumping them down a nearby ravine or on the slope of a creek or drainage channel. This practice introduces a large quantity of decaying organic matter into the storm water collection system that is subsequently carried to receiving streams during the next rainfall event. Disposing of cuttings/clippings in and around catch basins should also be avoided by using either bagging equipment or manually picking up the material.

Mowing should only be performed at optimal times. Mowing should not be performed if significant rain events are predicted. Also, the use of mulching mowers may be recommended for certain areas. Mulching mowers should be encouraged for homeowners in flat areas. Mulching mowers have the added benefit of reducing fertilizer demand through reuse of organic material.

Other techniques are available to supplement existing biodiversity and density as well. One approach is through maintaining existing vegetation and the planting new vegetation. This can be accomplished from the education of homeowners and the formation of citizen volunteer groups.

Firstly, the easiest and least expensive measure is to leave existing vegetation in place. Native vegetation typically requires much less maintenance than introduced vegetation. However, introducing new vegetation is a watershed priority as trees, shrubs, and grasses transpire rainfall through their leaves, consume carbon dioxide, release oxygen, and moderate urban temperatures. Many ground covers can thrive where grass does not. These ground covers provide aesthetically pleasing, innovative landscapes that are adaptable to the environment. Alternative ground covers which require little maintenance and are drought tolerant include native woodland species, perennial or self-sowing wildflowers, and deciduous or evergreen shrubs.

Converting managed turf to native vegetation should be a goal in both the public and private sectors of the watershed. For residential yards, a homeowner can encourage a portion of his/her property to seed in with native species, particularly if there is an adjacent wooded or meadow area with desirable vegetation. Over years, many different plants will colonize such an area, becoming even more attractive with time. The natural zone can be supplemented, or even created, with carefully selected plantings including trees, wildflowers, and different warm-season grasses. In addition, the notion that manicured lawns are more attractive than natural landscapes can be altered with education and examples. For example, allowing nature to landscape a portion of a residential yard that is visible from a heavily traveled road is an effective method of demonstrating the attractiveness of a native landscape.

Alternate landscaping and the introduction of new vegetation can be applied to any land use of any size area. Community awareness through programs, seminars, and field trips can be arranged to emphasize the advantages of natural public areas. Citizens will realize the beauty of a natural setting if exposed to one on a regular basis. Encouraging volunteer community groups to plant native vegetation in public areas, such as parklands, can be a workable goal. These natural areas should be adjacent to watercourses in order to act as a storm water filter and the final product is a landscape within floodplain areas with varying color and texture that do not require intensive labor or pesticide input. In addition, new and existing vegetation should be maintained regularly. Undesirable plants such as Japanese knotweed, ragweed, poison ivy, and multiflora rose should be removed to the greatest extent practical.

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4.3 Municipal Measures

The quality of the waters in the NMR watershed is influenced by dry weather sanitary sewage from leaking sewers and illegal sanitary connections to storm drain systems, combined sewer overflow (CSO) discharges in wet weather, storm water runoff, deicing salts, and other impacts of watershed urbanization. As was discussed previously in Section 4.2, public education on the risks of public safety and water quality resulting from poor watershed ethic is a vital element for successful watershed protection. Municipal coordination and enforcement are another alternative ingredients for successful watershed management and protection.

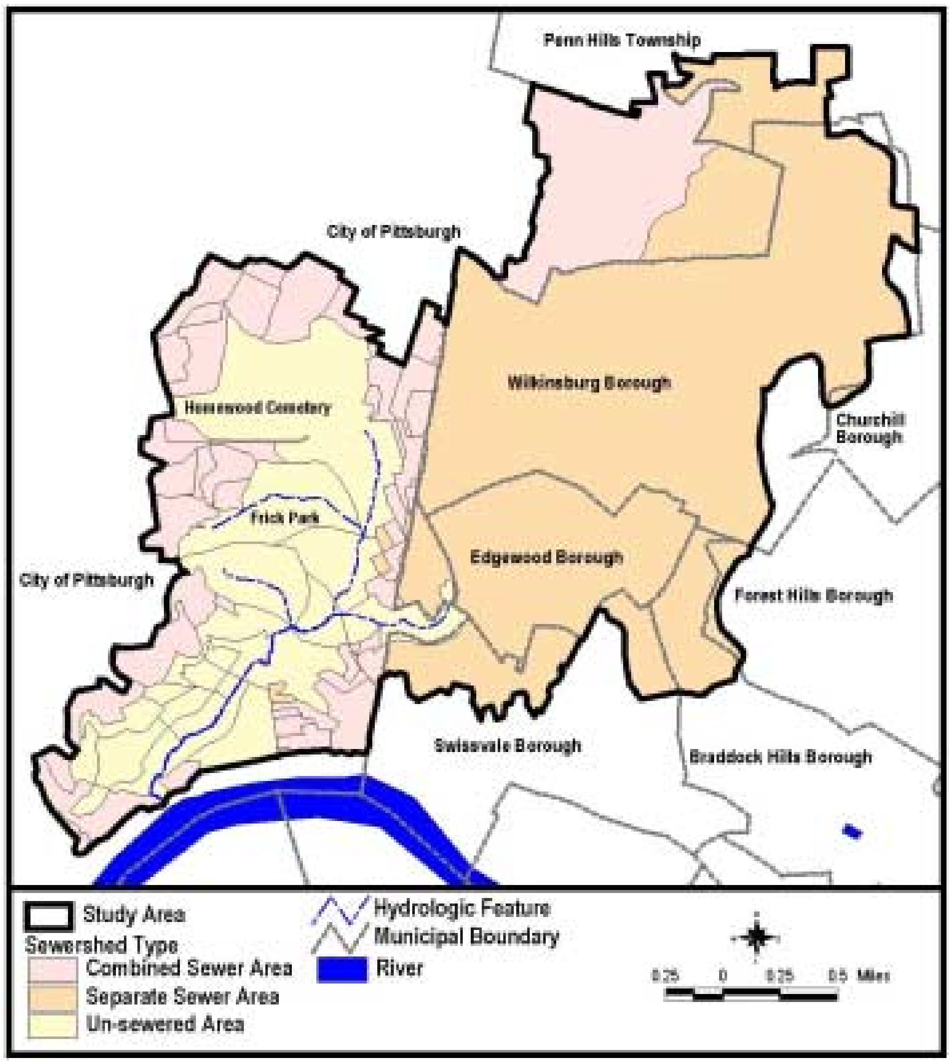
Municipalities have many tools at their disposal to address environmental degradation in urban areas. In NMR, the stream will continue to be subject to the wide variety of problems typically related to urban runoff if action is not taken on the municipal level. In order to manage and control these problems related to urban runoff, municipal management programs should be considered in the following areas:

- Combined Sewer Overflow Reduction
- Catch Basin and Storm Inlet Maintenance
- Sewer Inspection and Cleaning Program
- Sanitary Sewer Overflow Elimination
- Street Sweeping
- Pet Waste Ordinances and Leash Laws
- Household Hazardous Waste Collection
- Pest Control (control of fertilizers, pesticides, and herbicides used on public land)
- Bridge and Roadway Maintenance
- Vegetation Controls

4.3.1 Combined Sewer Overflow Reduction

In many cities throughout the United States, storm water runoff and sanitary wastewater are collected in the same network of sewer pipes, which are called combined sewer systems. There are portions of the NMR watershed that are served by combined sewers. Figure 4.3.1 shows these sewershed areas where homes and businesses are served by combined sewers.

Figure 4.3.1: Areas Served by Combined Sewer Systems



The flow through combined sewer systems is controlled by regulator structures called diversion chambers that determine whether the flow is treated or discharged into the stream. In dry weather conditions, flow through the combined sewers is minimal and all flows are diverted by the regulator structures and conveyed to the ALCOSAN wastewater treatment plant (WWTP). In wet-weather, combined sewer systems fill up with storm water and the hydraulic capacity of the diversion chambers can be exceeded. When this occurs, only a portion of the commingled sanitary-wastewater flow is directed toward the treatment plant. The balance is discharged as combined sewer overflows (CSOs) into receiving waters. The Pittsburgh Water and Sewer Authority (PWSA), and the Allegheny County Sanitary Authority (ALCOSAN) operate and maintain diversion chambers that can release CSO discharges to the NMR watershed. The CSO outfalls and associated diversion chambers that are located within the watershed are listed in Table 4.3.1 below and shown on Figure 4.3.2.

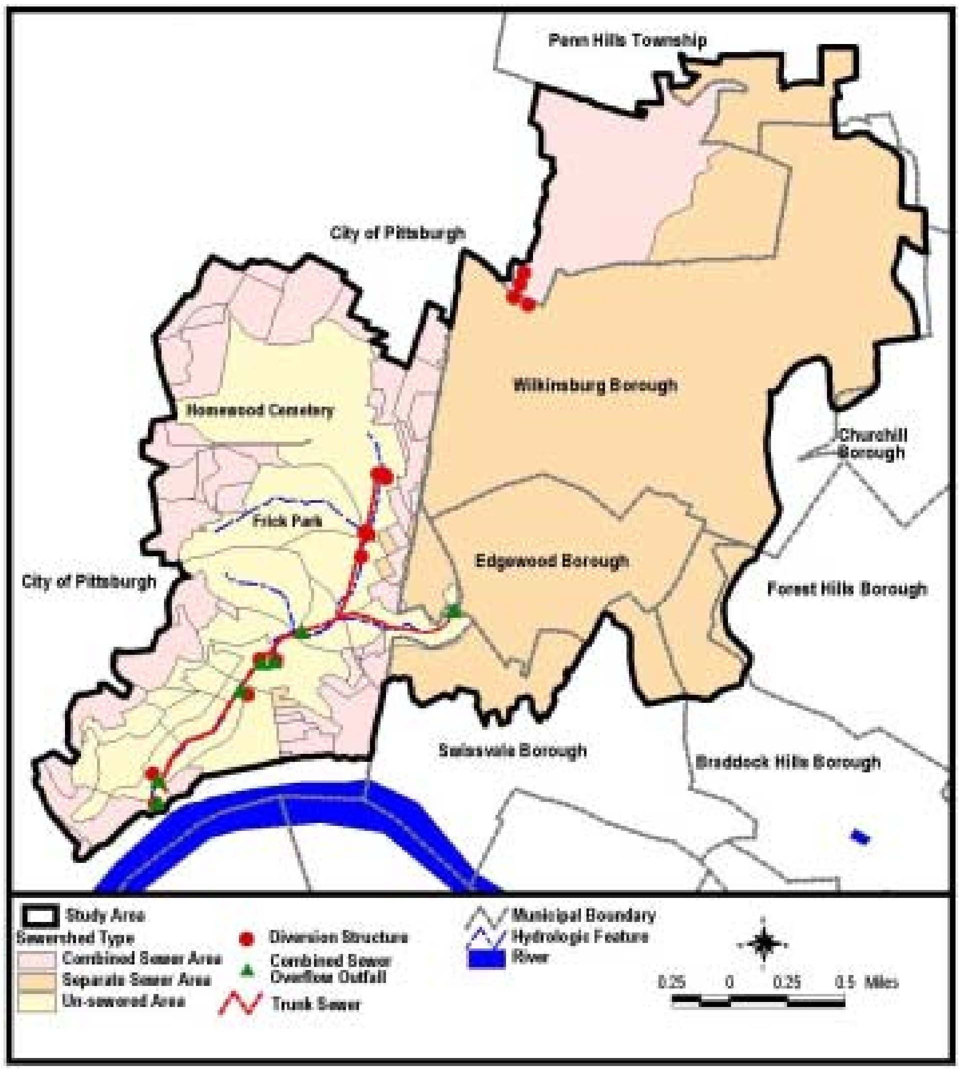
Table 4.3.1: Combined Sewer Overflow Outfalls to Nine Mile Run

PWSA Outfall ID Number	Outfall and Diversion Chamber Description	Pipe Size
CSO 088M001	Beechwood Blvd. Outfall (DC 088M001)	36”
CSO 088S001	Browns Hill Road Outfall (DC 088S001)	24”
CSO 129B001	Love Street Outfall (DC 129B001)	24”
CSO 128P001	Forward Avenue Outfall (DC 128P001)	36”
CSO 128R001	Commercial Street (DC 128R001)	24”
CSO 128R002	Fern Hollow Box Culvert (DC 128D003, 128D002, 128D001, 176J003, and 176J002)	96”x56”
CSO 177K001	Wilkinsburg Culvert (drains storm water from Wilkinsburg, Edgewood, and Swissvale and replaces channel for natural flow of NMR)	96” Arch Culvert
CSO 129N M47	Nine Mile Run Trunk Sewer (ADC 129M M47)	54”
Note: CSO=PWSA Combined Sewer Overflow; DC= PWSA Diversion Chamber ADC=ALCOSAN Diversion Chamber		

A continuous simulation rainfall-runoff model was created for the PWSA and was used to characterize and quantify CSO discharges in the NMR sewershed. Based upon the model, it was estimated that during an average year, approximately 72% of the wet weather flow that is generated within the portion of the NMR watershed that is served by combined sewer systems is captured for conveyance and treatment by ALCOSAN. A total annual volume of approximately 130 million gallons of commingled wastewater and storm water is discharged from combined sewer systems situated within the NMR watershed. Of this total, approximately 117 million gallons is discharged into the Monongahela River from the ALCOSAN regulator chamber that is located near the mouth of Nine Mile Run. Approximately 13 million gallons is discharged into Nine Mile Run from PWSA diversion chambers.

The existing percentage of wet weather capture is good when compared with similar older combined sewer systems, but further reduction in CSO discharges is needed to reduce the concentrations of fecal coliform bacteria and other pollutant substances associated with sanitary sewage and urban storm water runoff from entering watershed streams. Structural measures that can be used to reduce CSO discharges are described in Section 5.2 of this watershed management plan. Alternative nonstructural management measures that can be used to reduce CSO discharges are described below.

Figure 4.3.2: Locations of CSO Outfalls and Diversion Chambers in NMR



The PWSA has several alternative nonstructural tools at its disposal to reduce the frequency, duration, and volume of CSO discharges to the NMR watershed. These management tools include the following.

- Proper operation, inspection, and maintenance of diversion chambers
- Implement simple revisions to the diversion chambers to increase the capture of wet weather flow
- Proper inspection and maintenance of catch basins, and collector sewers

- Disconnect roof leaders and pavement runoff from combined sewers and redirect the flow to flat vegetated surfaces

Diversion Chambers

The proper operation, inspection, and maintenance of diversion chambers are important nonstructural municipal management tools. There are 11 diversion chambers (also called regulator structures) located within the NMR watershed. One is owned and operated by ALCOSAN and the others are owned and operated by PWSA. They are listed in Table 4.3.1 and were shown on Figure 4.3.2. To insure that these diversion chambers operate properly, they need to be inspected and maintained on a regular basis. After every significant storm, maintenance workers should open the manhole cover and inspect the inside of the diversion structure to see if solids or debris flushed by the storm surge have gotten caught in the chamber. Once or twice a year, preventive maintenance should be performed on the flow control devices within the chambers to keep them functioning properly.

Simple modifications to the flow control devices within the diversion chambers can be implemented to increase the capture of wet weather flow and decrease CSO discharges in the watershed. Within the PWSA chambers, dry and wet weather flow is diverted by a low brick dam that extends across the combined sewer pipe. Figure 4.3.3 is a photograph of the inside of a typical PWSA diversion chamber and shows the diversion dam. Sometimes another course or two of brick can be added to increase the height of the diversion dam and increase the capture of wet weather flow through the combined sewer system. These alternative nonstructural management measures can maximize wet weather flow to the ALCOSAN treatment plant and minimize CSO discharges within the NMR watershed.

Figure 4.3.3: Typical PWSA Diversion Chamber with Static Diversion Dam

Catch Basins and Collector Sewers

The proper inspection and maintenance of catch basins and collector sewers are also important municipal management measures that can improve water quality within the watershed. The combined sewer system catch basins and collector sewers within the NMR watershed are owned and maintained by the PWSA. Detailed descriptions of proper inspection and maintenance of catch basins are provided in Section 4.3.2. Detailed descriptions of alternative inspection and maintenance measures for collector sewers are documented in Section 4.3.3.

Roof Leaders and Pavement Runoff

In combined sewer systems, roof leaders and area drains are allowed to be directly connected to sewers. Property owners cannot be forced to remove these connections, but they can be encouraged and enticed to do so voluntarily. In urban areas like NMR, the drainage from roofs, patios, driveways, and parking areas can be a significant portion of the storm water runoff, and can carry a significant amount of pollutants. To disconnect rooftop drainage, downspouts can be detached from combined sewers and routed to flat lawn areas, dry wells, water gardens, or rain barrels. However, care must be taken to insure adjacent property is not flooded. To disconnect pavement runoff, the drainage from driveways and walkways can be pitched away from street gutters, and onto vegetated soils. Parking areas can be broken up with “infiltration islands”. Drainage that is “disconnected” from sewers in these ways is “reconnected” with its natural path in contact with soil and vegetation. The reconnection with natural processes reduces the volume of surface runoff, filters the pollutants, replenishes the groundwater, and maintains stream base flows.

In some cases, runoff from roofs, driveways and parking areas can be disconnected from the combined sewer rather easily and are considered non-structural management measures. However, some disconnections are more complex and require structural modifications. Alternative structural management measures will be presented and documented in Section 5.

4.3.2 Catch Basin and Storm Inlet Maintenance

Implementing a comprehensive inspection and maintenance program for catch basins and storm inlets can be an effective nonstructural management measure. Catch basins and storm inlets are the points of input to the municipal storm drain system. They typically include a grate or curb inlet where storm water enters and they may include a sump to capture sediment, debris and associated pollutants. The performance of these devices at removing sediment and other pollutants depends on routine maintenance to retain the storage available in the sump to capture sediment. Storm drains can be categorized into two types: combined and separate.

Separate drains, or storm inlets, exist where storm water and sanitary sewage are separate and flow in different pipes to different locations. Edgewood, Swissvale, and Wilkinsburg have separate storm drainage systems with storm inlets. Storm inlets do not contain litter traps. An example of a typical storm inlet in NMR is shown in Figure 4.3.4.

Catch basins, on the other hand, are found in combined sewer areas like the City of Pittsburgh portion of NMR. Catch basins contain sewer hoods whose primary intent are to trap odors but also can capture floatable materials and settle some solids. Catch basins can act as pretreatment for other treatment practices by capturing large sediments. An example of a catch basin in NMR is shown in Figure 4.3.5.

Catch basins and storm inlets have three major limitations in their potential to improve water quality in the NMR watershed, including:

- Even carefully operated and maintained and catch basins and storm inlets cannot remove pollutants as well as other alternative storm water treatment practices such as wet ponds, sand filters, and storm water wetlands.
- Unless frequently maintained, catch basins and storm inlets can become a source of pollutants through re-suspension.
- Catch basins and storm inlets cannot effectively remove soluble pollutants or fine particles.
- If sewer hoods within catch basins are not maintained or are removed when they deteriorate and fail, street litter is not trapped and is transported to streams during storm events.

Figure 4.3.4 Typical Storm Inlet in NMR

Figure 4.3.5 Typical Catch Basin in NMR

Inspection and maintenance of storm inlets includes checking the quantities of trapped gravel and sediment and removal of sediment using a vacuum truck. Inspection and maintenance of catch basins in combined systems includes the above plus checking the sewer hood to verify that it is functioning properly and includes removal of trash and debris that is captured by the sewer hood. Operators need to be properly trained in catch basin and storm inlet maintenance. Maintenance should include keeping a log of the amount of sediment and / or trash collected, and the date of removal. Some cities have incorporated the use of Geographic Information Systems (GIS) to track sediment collection, and to optimize future catch basin cleaning efforts.

At a minimum, catch basins and storm inlets should be cleaned once or twice per year (Aronson *et al*, 1983). Two studies suggest that increasing the frequency of maintenance can improve the performance of catch basins and storm inlets, particularly in industrial or commercial areas. One study of sixty catch basins in Alameda County, California, found that increasing the maintenance frequency from once per year to twice per year could increase the total sediment removed by catch basins on an annual basis (Mineart and Singh, 1994). Annual sediment removed per inlet was 54 pounds for annual cleaning, 70 pounds for semi-annual and quarterly cleaning, and 160 pounds for monthly cleaning. For catch basins draining industrial facilities, monthly cleaning increased total annual sediment collected to six times the amount collected by annual cleaning (180 lbs. versus 30 lbs.). These results suggest that, at least for industrial areas, more frequent cleaning of catch basins and storm inlets may improve removal efficiency. However, the cost of increased operation and maintenance costs needs to be weighed against the improved pollutant removal and industrial land use areas are minimal in the NMR watershed.

A typical pre-cast catch basin costs approximately between $2,000 and $3,000. The true pollutant removal cost associated with catch basins, however, is the long-term maintenance cost. A vactor truck, the most common method of catch basin cleaning, costs between $125,000 and $150,000. This initial cost may be high for smaller communities, however, it may be possible to pool resources and share a vactor truck with another community. Typical vactor trucks can store between 10 and 15 cubic yards of material, which is enough storage for between three and five catch basins. Assuming semi-annual cleaning, and that the vactor truck could be filled and material disposed of twice in one day, one truck would be sufficient to clean between 750 and 1,000 catch basins. Another maintenance cost is the staff time needed to operate the truck. Depending on the rules within a community, disposal costs of the sediment captured in catch basins may be significant.

4.3.3 Sewer Inspection and Cleaning Programs

Implementing a comprehensive inspection and cleaning program for combined and separate sewers can be an effective municipal management measure. Hydraulic conditions can deteriorate over time as solids build up in the sewer system, pipes become corroded or cracked, and tree roots intrude into open pipe joints. Dirty or rot intruded sewers are less efficient and lose their optimal carrying capacity. Sewers need regular inspection and cleaning to identify and locate potential problem areas, prevent stoppages, and restore optimal hydraulic conditions. Cleaning removes obstruction to flow, such as accumulated sand, slime, grit, grease, roots, and mineral deposits from the sewers. Sewer systems tend to be large, and management decisions need to be made regarding the frequency at which inspection and cleaning and root removal activities are conducted.

The PWSA and watershed municipalities currently are in the process of conducting a comprehensive field investigation and inspection program in the sewer collection systems within and discharging to the NMR watershed. Starting in the fall of 1999, PWSA performed cleaning and television inspections, dye testing activities, and an assessment of the physical condition of the sewer system. The purpose of the sewer cleaning was to remove accumulation of sediment and debris blockages to permit a thorough and complete examination of the system. The closed circuit television inspection assisted in evaluating the structural integrity and identifying sources of infiltration. The total of combined and separate sewer lines televised within the City portion of the NMR watershed was approximately 11 miles. An image from the TV inspection is shown in Figure 4.3.6 and shows root intrusion of a pipe segment in the NMR trunk sewer. Municipal consulting engineers have assisted Edgewood, Swissvale, and Wilkinsburg in similar sewer cleaning and investigation studies.

Implementing a sewer cleaning program cannot change flat pipe grades, increase pipe diameters, or fix pipe defects but does help sewers to flow at their optimal capacity. Regular cleaning and root removal removes resistance to wastewater flow. Regular inspections generate repair work orders, which in turn have a positive impact on system performance.

Figure 4.3.6: Root Intrusion in NMR Trunk Sewer

All sewers should be cleaned periodically, but how often is a question of balance. Sewer cleaning needs are not equal for every pipe segment in the sewer system. Combined sewer pipes have a greater tendency to be flushed during storms while separate sewers do not. Combined sewers, however, receive gravel and street solids while separate sewers do not. Cleaning frequency should be based on pipe condition and slope. Good, problem free sewer mains and collector sewers with relatively steep slopes may need cleaning on a 3-year cycle. More frequent cleaning is unnecessary. Problem sewers with minimal slopes should be cleaned as often as necessary; annual, semiannual, or quarterly cleaning may be required to prevent stoppages. Lines increase in importance according to the volume of wastewater they carry. Critically important collector sewers should be cleaned as often as necessary to prevent the possibility of stoppages. Based on the findings of the current television inspections that are underway, frequent cleaning should be performed on the majority of the collection system within and discharging to the NMR watershed.

Sewers are cleaned by increasing the water velocity, increasing water volume, or moving mechanical tools through the pipe that dislodge the debris. Line cleaning methods are divided into two categories, hydraulic and mechanical, as shown in Table 4.3.2. Figure 4.3.7 shows a jet vac truck cleaning a sewer. It is important to note, however, that these sewer cleaning methods are ineffective if the debris is not trapped and removed with a vactor truck. Applying sewer cleaning techniques without proper removal of the debris just pushes the sediment down the pipe and creates potential blockages downstream.

Table 4.3.2: Sewer Line Cleaning Methods

Cleaning Method	Water Use	Forces Used
Jetting	High pressure, low water volume	Hydraulic
Flushing	Low pressure, high water volume	Hydraulic
Balling	Low pressure	Hydraulic
Rodding	No water needed	Mechanical
Bucketing	No water needed	Mechanical

Figure 4.3.7: Jet Vac Truck Cleaning a Sewer

Manhole inspection and rehabilitation are essential management elements of maintaining a wastewater collection system. To field verify and document its condition, it is imperative to inspect manholes periodically. A 3-to-5 year interval is suggested for manholes serving small-diameter (8-to-12 inch) sewer mains. Collector sewers and outfalls should be inspected biannually. Trunks and interceptor sewers should be inspected annually. Frequent inspection provides valuable up-to-date information about the condition of the system as a whole. Old, deteriorated manholes should be rehabilitated so that they are structurally sound and watertight. Manhole rehabilitation methods and procedures are structural management measures and will be discussed in Section 5.

Manholes should be inspected in an orderly fashion. A checklist inspection form makes field inspection quick and easy, and the form should match a computerized database in the office to make data entry easier. The following items are what should be looked for during a typical manhole inspection.

- Buried manholes
- Accessibility
- Frame and cover setting
- Mineral deposits, infiltration, or inflow
- Roots
- Structural problems
- Deterioration of manholes or pipes
- How the manhole invert and bench affect the flow
- Strong or unusual odors
- Rough or turbulent water surface

In addition to routine manhole inspections, closed-circuit video inspection (CCTV) is a powerful information gathering and diagnostic tool. Information about structural conditions, flow characteristics, and defects are gathered with CCTV. CCTV provides detailed, site-specific data needed to analyze line maintenance and rehabilitation needs. CCTV inspection equipment gear has many uses, including:

- Verify line-cleaning operations
- Pinpoint roots and document root severity
- Locate and identify defects

- Answer service call questions
- Document rate of pipe deterioration and corrosion
- Provide data for line evaluation, rating, and analysis
- Guide specialized line rehabilitation tools and robotics
- Assess road reconstruction damage to a sewer
- Inspect new construction
- Conduct infiltration / inflow studies
- Conduct capacity, flow, and hydraulic studies

CCTV consists of a waterproof video camera, powerful lights, camera transport mechanism, video processing, and camera control equipment. The video signal is carried through the cable that connects the camera to the van and is usually recorded on a VCR tape for future reference.

Historically, sewer cleaning and inspection information was archived, not managed. Computerization helps manage this information. Computerization is a suite of tools that can enhance to performance of a sewer cleaning and inspection program. Computers help focus maintenance and rehabilitation efforts where they are needed most. Applications range from simple word-processed lists to advanced Geographical Information Systems (GIS). Computers are ideal for managing data about wastewater infrastructure, defect analysis, generating work orders and reports, and evaluating system conditions. A computerized information management system is a vital tool for an effective sewer cleaning and inspection program.

A proactive sewer maintenance program is also necessary for municipal water pollution control. CSOs and backwater intrusions can be caused by malfunctioning regulators, improper diversion settings, and partially blocked interceptors. The resulting pollution abatement is a dual benefit of required system maintenance. Various municipalities have adopted this approach and have gained high CSO control cost benefits.

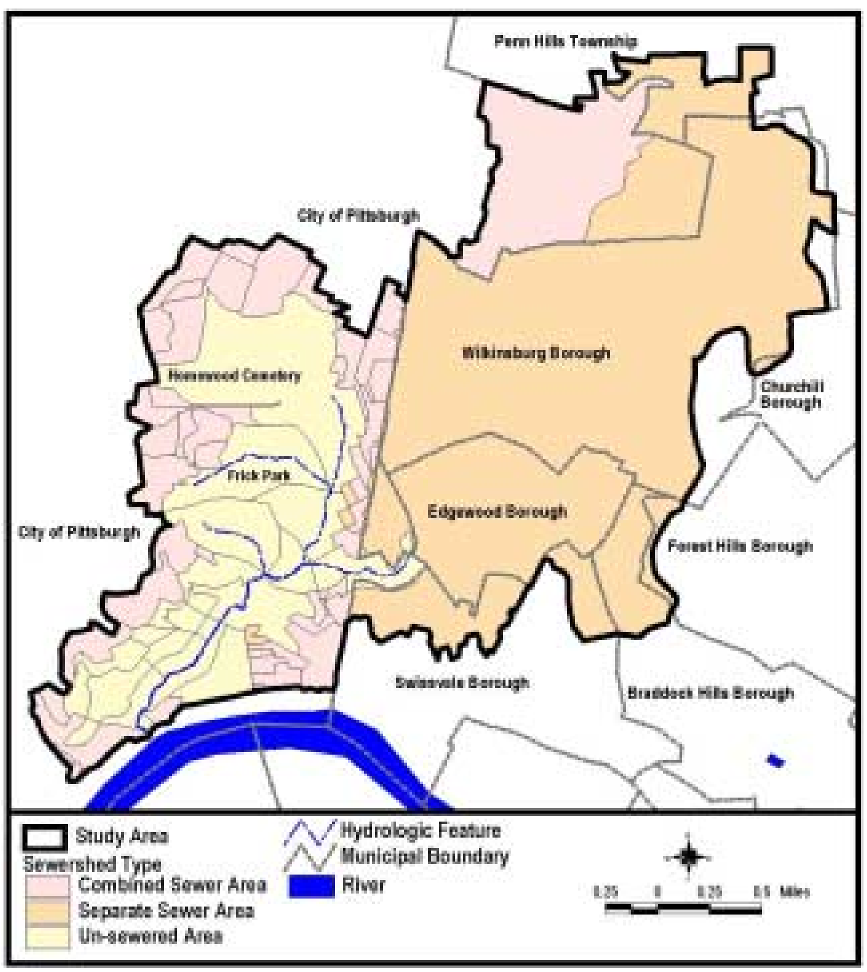
4.3.4 Sanitary Sewer Overflows

A comprehensive illicit storm water connection inspection and removal program can be an effective municipal management tool to reduce the frequency, duration, and volume of sanitary sewer overflow (SSO) discharges in the NMR watershed. In combined sewer systems, roof leaders and area drains are allowed to be directly connected to sewers and property owners cannot be forced to remove these connections. However, in separate sewer systems like those in Edgewood, Swissvale and Wilkinsburg, these connections are illegal and property owners are required to make the necessary corrections. Figure 4.3.8 shows the sewershed areas within the NMR watershed that are served by separate sanitary sewer and storm drain systems.

In separate sewer systems, illicit connections to sanitary sewers contribute significant quantities of extraneous sewer flow from ground water and surface runoff. The quantity of extraneous flow from the illicit connections can eclipse the design capacity of the sanitary sewers and cause them to surcharge. These surcharge conditions can result in sewer back-ups into basements, or cause street or yard flooding by sewage.

To prevent these surcharge conditions during storms, municipal maintenance workers sometimes modify certain manholes by constructing overflow pipes through manhole walls that allow sanitary wastewater to overflow into adjacent streams or storm drains. These sewer discharges and any associated modified manholes are called SSOs and are illegal. Figure 4.3.9 shows a sanitary sewer overflow that was caused by surcharge conditions along a sanitary sewer. Several modified manholes that allow SSO discharges into streams and storm drains are known to exist within the NMR watershed.

Figure 4.3.8: Areas Served by Separate Sanitary Sewers



To develop a municipal management program that successfully identifies and corrects illicit storm water connections to sanitary sewers, several questions need to be asked and answered.

- Who will be authorized to conduct inspections?
- Who will be authorized to make any required corrections and how will the "disconnection" be verified?
- At what time and how often will illicit connection inspections be conducted?

Figure 4.3.9: Sanitary Sewer Overflow in NMR

Who Conducts the Inspections

To locate and identify illicit storm water connections to the sanitary sewer system, a comprehensive inspection program is needed. The inspections either can be conducted by a municipal representative such as the building inspector or zoning officer, or the inspections could be conducted by a licensed plumber. To check for illegal downspout connections, the municipal inspector or registered plumber would add a mixture of colored dye and water to any downspout that extends underground and does not daylight onto the ground surface. If the dye is observed in the street gutter or the storm drain system, the downspout "passes" the test. If the dye is observed in the sanitary sewer, the downspout "fails" and the property owner is issued a notice of violation that requires the disconnection of the roof leader. To disconnect illegal rooftop drainage, downspouts can be detached from separate sewers and routed to flat lawn areas, dry wells, water gardens, or rain barrels. Care must be taken to insure adjacent property is not flooded.

Similar dye tests would be conducted to determine if illicit connections from driveway or area drains exist. Inspectors would also check to see if a sump pump exists in the basement. If so, a sufficient quantity of dye and water is added to the sump to activate the pump. If dye is observed in the sanitary sewer, the sump pump fails and the owner is required to redirect the pump outfall. To disconnect illegal ground water drainage from sump pumps, the discharge pipes can be detached from separate sewers and routed to flat lawn areas, street curbs, or directly to the municipal storm drain system.

Who Makes Corrections

Redirecting an illicit downspout connection to a flat vegetated area can be a simple and inexpensive task that can be performed by the property owner. However, some illicit connections can be complicated and expensive to mitigate and would require a licensed professional to implement. After the correction is made, and the illegal connection is removed, the property either will need to be re-inspected, or documented evidence of the remedial action would need to be submitted.

Generally, there are two methods for the disconnection of downspouts from sanitary sewers. The simplest method is to cut the downspout just above where it runs into the ground, plug the underground pipe with concrete, extend the downspout away from the house, and allow the water to flow onto a concrete or plastic splash block to prevent erosion. Figure 4.3.10 shows a disconnected downspout with a splash block. This permits the water to flow directly onto the ground to be absorbed by the soil, and is the best method in most situations. The storm drainage system then has to be repaired so that the holes left by the disconnected non-storm water sewer entrances do not become a location for dirt and groundwater to enter.

In some cases, where releasing the water onto the ground is not feasible, a covered gravel trench can be used. The downspout is cut just after it enters the ground. A trench or pit is excavated, lined to prevent sediment movement, filled with gravel, and then covered with soil to match the surrounding landscaping. The cut downspout is extended underground so that the water from the roof flows into the gravel to be absorbed by the soil.

Figure 4.3.10: Disconnected Downspout with Splash Block

When are the Inspections Conducted

Many municipalities have sewer ordinances that require testing for illicit sewer connections when a property is sold and ownership is transferred. Community opposition to these illicit connection inspections tends to be minimal since other property inspections are already required and property owners are already accustomed to paying for these inspections. A more aggressive and proactive management alternative would require all properties in the watershed to be inspected.

Disconnecting residential roof downspouts is an important control measure toward reducing water pollution. Numerous opportunities exist within the NMR watershed to disconnect roof downspouts and allow the rooftop runoff to flow onto the ground and be absorbed by the soil. The communities of Edgewood, Swissvale, and Wilkinsburg are currently under an order from the Pennsylvania Department of Environmental Protection (PA-DEP) to identify and remove illegal sanitary connections to the Braddock Avenue storm culvert.

4.3.5 Street Sweeping

Implementing a street sweeping program can be an effective municipal management measure to improve water quality in the NMR watershed. Street sweeping often is practiced in most urban areas, including NMR, as an aesthetic practice to remove sediment buildup, debris, and litter from curb gutters. In colder climates, street sweeping is used during the spring snowmelt to reduce pollutant loads from road salt and to reduce sand export to receiving waters. Seventy percent of cold climate storm water experts recommend street sweeping during the spring snowmelt as a pollution prevention measure (Caraco and Claytor, 1997). The frequency and intensity of rainfall for a region are key variables in determining how streets need to be swept to obtain a desired removal efficiency. Other factors that affect a street sweeper's ability to reduce nonpoint pollution include the condition of the street, its geographical location, the operator's skill, the presence of parked cars, and the amount of impervious area devoted to roadways.

Street cleaning practices are designed to remove sediment, debris, litter, and other pollutants from road and parking lot surfaces that are a potential source of pollution impacting urban waterways (Bannerman, 1999). Although older performance monitoring studies for the Nationwide Urban Runoff Program (NURP) indicted that street sweeping was not very effective in reducing pollutant loads (US EPA, 1983), recent improvements in street sweeper technology have enhanced the ability of present day machines to pick up the fine grained sediment particles that carry a substantial portion of the storm water pollutant load. Many of today's sweepers can now significantly reduce the amount of street dirt entering streams and rivers, some by significant amounts (Runoff Report, 1998).

Arguably the most essential factor in using street sweeping as a pollutant removal practice is to be sure to use the most sophisticated sweepers available. Today, communities have a choice in three basic sweeping technologies to clean their urban streets:

- Traditional mechanical sweepers that utilize a broom and mechanical belt (see Figure 4.3.11)
- Vacuum-assisted sweepers
- Regenerative-air sweepers

Innovations in sweeper technology have improved the performance of these machines. The vacuum-assisted dry sweeper has the ability to pick up a very high percentage of even the finest sediment particles under dry pavement conditions and, unlike other sweepers, may work effectively in wet or frozen conditions. Regenerative air sweepers blast air onto the pavement surface to loosen particles and quickly vacuum them into a hopper. By using the most sophisticated sweepers in areas with the highest pollutant loads, greater reductions in sediment and accompanied pollutants can be realized.

A benefit of high-efficiency street sweeping is that by capturing pollutants *before* they are made soluble by rainwater, the need for storm water treatment practices may be reduced. Storm water treatment practices, such as filtering systems, can be very costly when compared to collecting pollutants before they become soluble. Street sweepers that can show a significant level of sediment removal efficiency may prove to be more cost-effective than certain storm water treatment practices, especially in more urbanized areas with higher areas of paving.

Figure 4.3.11: Traditional Mechanical Street Sweeper

The frequency of and location of street sweeping is another consideration for any program. How often and what roads to sweep are determined by the program budget and the level of pollutant removal the program wishes to achieve. Computer modeling in the Pacific Northwest suggest that from the standpoint of pollutant removal, the optimum sweeping frequency appears to be once every week or two (Claytor, 1999). More frequent sweeping operations yielded only a small increment in additional removal. The model also suggests that somewhat higher removal could be obtained on residential streets as opposed to more heavily traveled arterial roads.

Another important aspect of street sweeping programs is the ability to regulate parking. The ability to impose parking regulations in densely populated areas and on heavily traveled roads is essential.

Sweeping of parking lots may also be employed at commercial and industrial sites. This sweeping involves using brooms to remove small quantities of dry chemicals and solids from areas that are exposed to rainfall or storm water runoff. While the effectiveness of this practice at pollutant removal is unknown, the sweeping and proper disposal of materials is a reasonably inexpensive method of pollution prevention that requires no special training or equipment.

The largest expenditures for street sweeping programs are in staffing and equipment. The capital cost for a conventional street sweeper is between $60,000 and $120,000. The cost for newer technologies is higher than that, with prices approaching $180,000. The average useful life of a conventional sweeper is about four years, and programs must budget for equipment replacement. Sweeping frequencies will determine equipment life, so programs that sweep more often should expect to have a higher cost of replacement. The potential inability to restrict parking in urban areas may present another limitation. Additional possible limitations include the need for training for sweeper operators; the inability of current sweeper technology to remove oil and grease; and the lack of solid evidence regarding the level of pollutant removal that can be expected. Proper disposal of swept materials may also be a limitation in some instances.

Within the NMR watershed, each municipality performs their own street sweeping. Greater efficiency can be achieved by increasing sweeping frequencies and utilizing the improved innovations available in sweeping technology. Greater efficiency could also be achieved if the municipalities within the NMR watershed (City of Pittsburgh, Edgewood, Wilkinsburg, and Swissvale) pooled their resources and worked together to remove pollutant loads and sediment from the streets within the watershed.

4.3.6 Pet Waste Ordinances

Animal waste collection ordinances can be an effective pollutant source control management tool. The alternative involves using a combination of educational outreach and enforcement to encourage residents to clean up after their pets (public education on animal waste collection was discussed in Section 4.2.6). The presence of pet waste in storm water runoff has a number of implications for urban stream water quality with perhaps the greatest impact from fecal bacteria. The bacteria can pose health risks to humans and other animals, and result in the spread of disease. In addition to hiking and bird watching, a popular use of the lower portion of Frick Park is dog walking. Pet waste ordinances need to be implemented, posted, and enforced to reduce (if not eliminate) pet waste from affecting the stream water quality.

The reluctance of dog owners to handing dog wastes is the biggest limitation to controlling pet waste. This strong resistance to handling dog wastes suggests that an alternative message may be necessary.

Animal waste collection programs use awareness and education, signs, and pet waste control ordinances to alert residences to the proper disposal techniques for pet droppings. Implementing programs to control pet waste typically use “pooper-scooper” ordinances to regulate pet waste cleanup. These ordinances require the removal and proper disposal of pet waste from public areas and other people’s property before the dog owner leaves the immediate area. Often a fine is associated with failure to perform this act as a way to encourage compliance. Some ordinances also include a requirement that pet owners remove pet waste from their own property within a prescribed time frame.

In some parts of the country, the concept of parks or portions of parks established specifically for urban dog owners has gained in popularity. With provisions for proper disposal techniques for dog feces, these parks may represent another option for protecting local water quality. Another option might be to enforce the practice of rudimentary manure management by training dogs to use areas that are not hydraulically connected to the stream. Enforcing leash laws can help in preventing dogs from using areas that are not hydraulically connected to the stream.

The pollutant removal of abilities of pet waste collection programs has never been quantified although there is ample evidence that programs such as these are necessary. For example, in the Four Mile Run watershed in Northern Virginia, a dog population of 11,400 is estimated to contribute about 5,000 pounds of solid waste every day and has been identified as a major contributor of bacteria to the stream. Approximately 500 fecal coliform samples have been taken from Four Mile Run and its tributaries since 1990, and about 50% of these samples have been over Virginia water quality standards for fecal coliform bacteria (NVPDC, 1998).

The cost of animal waste collection programs will vary depending on the intensity of the effort and the paths chosen to control pet waste. The most popular is through an ordinance, but managers must consider the cost of enforcement, including staff and equipment requirements.

4.3.7 Household Hazardous Waste Collection

A Household Hazardous Waste (HHW) collection program was considered as an alternative municipal management measure for the NMR watershed. Household hazardous wastes are those wastes produced in households that are hazardous in nature, but are not regulated as hazardous waste, under federal and state laws. Studies have shown that each person in Pennsylvania produces an average of four pounds of HHW each year. For residents and small business owners located within the NMR watershed, this estimate would equate to over 75 tons per year. Such consumer waste products, if carelessly managed can, and frequently do, create environmental and public health hazards. Improper disposal of HHW in NMR can affect stream water quality as wastes may be improperly discarded into municipal storm inlets and catch basins or dumped down sewer drains during storm events.

The best method of managing HHW is to prevent its generation in the first place. This involves encouraging residents to select the least toxic item "to do the job" and to buy only the minimum amounts necessary. Buying in large quantities is not a bargain if half of it has to be discarded. If the material is still useable (i.e. has not been damaged / shelf life expired, etc.) residents should be encouraged to check with friends and neighbors to see if they might be able to use it. Also, community groups such as Little League, Habitat for Humanity, etc. should be checked with to see if they are able to use the product.

If the material is not useable and/or if such "outlets" are not available, it should be taken to a community HHW Collection Program. Such programs ensure that the HHW is recycled or, otherwise, managed, in an environmentally preferable way, under the hazardous waste provisions of the law. In addition, used motor oils can be taken to a used oil collection site. Also, spent lead acid (automotive) batteries can be returned to sellers. In Pennsylvania, dealers are required to take old batteries when new ones are purchased.

The Pennsylvania Department of Environmental Protection (PaDEP) encourages local governments and private organizations to sponsor collection events for HHW. Financial and technical assistance are available for programs that register with DEP. These programs provide sites for residents to drop off their HHW. The materials at these sites are then reused, recycled, and, when necessary, disposed of at a permitted hazardous waste facilities.

Chapter 2 of Act 190 of 1996 (The Small Business and Household Pollution Act) established the Small Business and Household Hazardous Waste Prevention Program. Both Act 190 and DEP's hazardous waste management regulations allow local HHW collection programs to accept hazardous waste from:

- Small quantity generators (SQG)-small business hazardous waste generators that generate between 100 and 1,000 Kg of hazardous waste each month
- Conditionally exempt small quantity generators (CESQG)-small business hazardous waste generators that generate less than 100 Kg of hazardous waste each month
- Households

The following special restrictions, however, apply to all SQG participants:

- Waste can be accepted only on the day the operator/contractor is at the site
- Waste cannot be co-mingled with other collected waste
- Each SQG retains its status as the generator of the hazardous waste

Act 155 of 1994 authorized a one-time transfer of $3 million from the Resource Recovery Development Fund (Act 198 of 1974) to the Pennsylvania Recycling Fund (Act 101 of 1988). This funding is used to reimburse up to 50 percent of eligible HHW program costs, not to exceed $100,000 per county per fiscal year.

Act 190 of 1996 provides grants to reimburse up to 50 percent of the costs of developing and operating household and small business hazardous waste collection programs. Under this Act, as much as $2 million annually may be transferred from the Pennsylvania Recycling Fund and Hazardous Sites Cleanup Fund (Act 108 of 1998) to underwrite such collection programs. Act 190 also authorizes the department to provide grants under Section 901 of Act 101 of 1988 to reimburse counties for up to 80 percent of approved costs of HHW education programs or for providing technical assistance to small businesses.

There are thousands of consumer chemical products that may qualify for inclusion in a collection event. However, in order to reduce operational costs and maximize the effectiveness of collection events, a waste targeting protocol is recommended. It is also recommended that all participants be pre-registered, at which time the nature of their waste can be discussed and a decision made on which items should not be brought to the collection event. The following HHW categories should be targeted for collection.

Corrosive Materials (drain cleaners, rust removers, muriatic acid, and oven cleaners)

Highly Flammable Materials (gasoline, gasoline/oil mixtures, kerosene, fuel oil, lighter fluids, oil-based paints, and paint thinners)

Highly Toxic Materials (carbon tetrachloride, benzene, cyanide compounds, lead arsenate, thallium sulfate, strychnine, parathion, and mirex/kepone)

Strong Oxidizers (chlorinated pool chemicals, sodium hypochlorite, and various peroxides)

Air/Water Quality Hazards (rechargeable nickel cadmium household batteries, mercury-containing batteries, thermostats, thermometers, and lead acid batteries)

Wildlife Hazards (old chlorinated pesticides such as DDT, chlordane, dieldrin, heptachlor, etc. and compounds containing heavy metals)

Unknowns (unidentified materials such as those with no ingredient information or signal words on the label that could present a potential threat to human health and the environment)

The following are tips to help make the facilitation of a community collection event an efficient and successful one:

- Educate the public as to the scope of a collection event. Many chemicals that show up at a collection event are the result of the public's lack of knowledge about the wise purchase and use of them.

- Contact other programs. There is no substitute for first hand experience. The experience of similar programs in nearby areas may help in making more accurate estimates regarding the amount of waste to be expected.

- Anticipate high costs with these programs. The major costs will be for contracted services involving the classification, packing, transportation, and management of the collected hazardous waste materials. Generally costs average 30 to 80 cents per pound of hazardous waste but may run as high as $1.00 per pound.

- Take advantage of the available funding. Contractors will be reluctant to prepare bid responses for sponsoring agencies that do not appear to be on sound financial footing.
- Provide special packaging and transportation instructions to all participants to ensure the safe transportation of all materials to the collection site.
- Expect to receive more participants and waste than may be initially anticipated.
- Take steps to reduce the amount of collected HHW requiring disposal. Waste motor oil, if collected, should always be recycled. Organizations such as little leagues, boy / girl scouts, and other community groups often collect old paint. Restrict the materials that truly need to be disposed of as a hazardous waste. Materials that do not qualify as hazardous may not need to be collected in the first place and, if collected, may possibly be disposed of as municipal waste.

4.3.8 Pest Control - Control of Pesticides and Herbicides Used on Public Land

Another alternative watershed management measure would be to implement a municipal program to control the use and misuse of pesticides and herbicides. The major sources of pesticides in urban streams are applications of products designed to kill insects and weeds in the lawn and garden. It has been estimated that an average acre of a well-maintained urban lawn receives an annual input of five to seven pounds of pesticides (Schueler, 1995). Pesticide prevention programs try to limit the adverse impacts of insecticides and herbicides by providing information on alternative pest control techniques other than chemicals or explaining how to determine the correct dosages needed to manage pests. The use of products designed to kill insects and weeds in the lawn and garden cannot be enforced on private property. However, control over the use of these products can be regulated in public areas under municipal maintenance (e.g. parks) and schools.

There are two parallel elements to a municipal pest control program. The first element involves educating residents and businesses on alternatives to pesticide use and this topic was previously discussed in Section 4.2 of the watershed management plan. The second element involves implementing proper application and storage techniques for municipal parklands and public schools. The presence of pesticides in storm water runoff has a direct impact on the health of aquatic organisms and can present a threat to humans through contamination of drinking water supplies. The pesticides of greatest concern are insecticides, such as diazinon and chloropyrifos, (CWP, 1999 and Schueler, 1995) that can be harmful to aquatic life even at very low levels.

The US EPA estimates that nearly 70 million pounds of active pesticide ingredients are applied to urban lawns each year. Table 4.3.3 compares surveys on residential pesticide use in eleven different areas of the country, broken down by insecticide and herbicide use. At first glance, it appears that pesticide application rates vary greatly, ranging from a low of 17% to a high of 87%. Some patterns do emerge, however. For example, insecticides tend to be applied more widely in warm weather climates where insect control is a year round problem (such as Texas, California, and Florida). Anywhere from 50 to 90% of residents reported that they had applied insecticides in the last year in warm-weather areas. This can be compared to 20 to 50% levels of insecticide use reported in colder regions like NMR where hard winters can help keep insects in check. In contrast, herbicide application rates tend to be higher in cold weather climates to kill the weeds that arrive with the onset of spring (60 to 75% in the Michigan, Wisconsin and Minnesota surveys).

An integrated pest management (IPM) program is a municipal watershed management element that encourages the use of alternatives to chemical pesticides on public land. IPM reflects a holistic approach to pest control that examines the interrelationship between soil, water, air, nutrients, insects, diseases, landscape design, weeds, animals, weather, and cultural practices to select an appropriate pest management plan. The goal of an IPM program is not to eliminate pests but to manage them to an acceptable level while avoiding disruptions to the environment. An IPM program incorporates preventative practices in combination with non-chemical and chemical pest controls to minimize the use of pesticides and promote natural control of pest species. Three different non-chemical pest control practices - biological (good bugs that eat pests), cultural (handpicking of pests, removal of diseased plants, etc) and mechanical (zappers, paper collars, etc) - are used to limit the need for chemicals. In those instances when pesticides are required, programs encourage the use of less toxic products such as insecticidal soaps. The development of higher tolerance levels for certain weed species is a central concept of IPM programs for reducing herbicide use.

The public perception that no effective alternative to pesticide use exists is probably the greatest limitation to this alternative management measure. Surveys tell us that the public has a reasonably good understanding about the potential environmental dangers of pesticides. Several surveys indicate that residents do understand environmental concerns about pesticides, and consistently rank them as the leading cause of pollution in the neighborhood (Elgin DDB, 1996). Even so, pesticide use still remains high in many urban areas. The time required for homeowners to learn more about alternative pest control techniques may also limit program effectiveness. Many residents prefer the ease of just spraying a chemical on their lawns to other pest control techniques they perceive as more time intensive and less reliable.

The IPM practices can be enforced for municipal parklands and schools to limit pollutants washed off the ground during storm events. The parks in NMR tend to be located near surrounding streams causing the potential for pest control pollutants to enter the stream to be great. An example of successful use of IPM is the Grounds Maintenance Program for the City of Eugene, Oregon. This program was started in the early 1980's and includes all the city public parks and recreation areas. The city uses a variety of IPM methods, including water blasting to remove aphids, insecticidal soaps and limited use of pesticides. The city has also adopted higher tolerance levels for certain weed and pest species that reduces the need to apply pesticides and herbicides.

Table 4.3.3: A comparison of Eleven Surveys of Residential Insecticide and Weedkiller Use

Study	**Number of Respondents**	**% Using Insecticides**	**% Using Herbicides**
Chesapeake Bay Swann, 1999	656	21%	- -
Maryland Kroll and Murphy,1994	403	42%	32%
Virginia Aveni, 1998	100	66%	- -
Maryland, Smith *et al.*, 1994	100	23%	n/a
Minnesota, Morris and Traxler, 1997	981	- -	75%
Michigan, De Young, 1997	432	40%	59%
Minnesota, Dindorf, 1992	136	- -	76%
Wisconsin, Kroupa, 1995	204	17%	24% **
Florida, Knox *et al.*, 1995	659	83%	- -
Texas, NSR, 1998	350	87%	- -
California, Scanlin and Cooper, 1997	600	50%	- -
** Note difference in self reported herbicide use and those that use a weed and feed product (herbicide combined with fertilizer)			

Since the programs inception, pesticide usage by the City of Eugene has dropped by more than 75% (Lehner *et al*., 1999). No exact cost savings have been calculated from the use of the IPM program, but the city turf and grounds supervisor is convinced that it saves money and has little citizen opposition. A similar program could be implemented for pest control in the public park and recreation areas of the NMR watershed, such as Frick Park.

The cost of educating residents and parkland grounds supervisors on proper pesticide use varies greatly depending on the intensity of the effort. Like lawn care and landscaping programs, some cities have begun partnerships that include training of retail employees and parkland supervisors on IPM techniques. In addition, promotional materials and displays on safer pesticide alternatives are set up. The cost of staff time for training and production of materials must be included in any cost estimate. Since there are currently a number of good fact sheets on IPM and pesticide use available through cooperative extension programs, the NMR watershed management plan should consider using these existing resources instead of trying to create new ones. Another way to save cost would be to utilize master gardener volunteers to help with training for residents, parkland supervisors, and store employees.

4.3.9 Bridge and Roadway Maintenance

Municipal management of level of pollutants from road and bridge runoff involves incorporating pollution prevention techniques to reduce or eliminate pollutant loads from existing road surfaces as part of routine operation and maintenance. Substantial amounts of sediment and pollutants are generated during daily roadway and bridge use and scheduled repair operations, and these pollutants can impact local water quality by contributing heavy metals, hydrocarbons, sediment and debris to storm water runoff.

Table 4.3.4 below provides a list of the potential pollutants that are often encountered on roadways and bridges, along with their primary sources. These highway pollutants can significantly influence the quality of storm water runoff and watershed streams. The proper performance of general maintenance activities such as street sweeping, vegetation maintenance, and cleaning runoff control structures can help alleviate the impacts of these pollutants. Modifications in roadway resurfacing practices can also help reduce pollutant loads to storm water runoff and protect the quality of receiving waters.

Road and bridge maintenance programs have a number of options for reducing the level of pollutants generated during the maintenance of existing road surfaces. Changes in the methods used for maintaining road surfaces, removing debris and sediment from roadways, and cleaning of runoff control structures can help improve the overall quality of storm water discharges from roads and bridges.

There are four categories of alternative management measures for bridge and roadway maintenance that are being considered for the NMR watershed.

- Alterations to road and bridge resurfacing practices
- Alterations to the ways deicing materials are used and applied
- Alterations to the ways roadside vegetation is controlled
- Alterations to existing bridge scupper drains

Table 4.3.4: Highway Runoff Constituents and their Primary Sources (US EPA, 1993)

Constituent	**Primary Sources**
Particulates	Pavement wear, vehicles, atmosphere
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Tire wear, automobile exhaust
Zinc	Tire wear, motor oil, grease
Iron	Auto body rust, steel highway structures, moving engine parts
Copper	Metal plating, brake lining wear, moving engine parts, bearing and bushing wear, fungicides and insecticides
Cadmium	Tire wear, roadside insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anticake compound used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks, or blow-by of motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate

Resurfacing Activities

Proper planning for road and bridge resurfacing operations is a simple but effective method to control pollution. There are a number of suggestions that can be implemented to control the impacts of this maintenance operation. First, paving operations using concrete, asphalt, or other sealers should be performed only in dry weather situations to prevent contamination of runoff. Second, use proper staging techniques to reduce the spillage of paving materials during the repair of potholes and worn pavement. This can include covering storm drain inlets and manholes during paving operations, using erosion and sediment control measures to decrease runoff from repair sites, and utilizing pollution prevention materials such as drip pans and absorbent material for all paving machines to limit leaks and spills of paving materials and fluids. Finally, resurfacing operations could consider employing porous asphalt for pothole repair and for shoulder areas to reduce the level of storm water runoff from road systems.

Deicing Materials

Proper application of road salt or other deicers is essential for reducing storm water pollution. By routinely calibrating spreaders, a program manager can prevent over-application of deicing materials. In addition to reducing the effects of these materials on the aquatic environment, a cost savings may be realized due to reductions in the purchase of deicing materials. Training for transportation employees in proper deicer application techniques, the timing of deicer application, and what type of deicer to apply will also alleviate impacts to water quality and aquatic habitat.

An understanding of snowpack and snowmelt dynamics is useful to develop effective techniques for treating snowmelt runoff. Different techniques should be employed at each stage of the meltwater sequence, so as to effectively address the constantly changing flows and pollutant concentrations that occur as the melt progresses. A list of some effective techniques is provided in Table 4.3.5.

Most northern states have traditionally employed road salt as a primary chemical deicer and sand as an abrasive (for better traction). Although sodium chloride is an inexpensive and effective choice, concerns are frequently raised about its potential negative impacts on aquatic habitat, highway infrastructure, and vehicles. The potential impacts of road salt are listed in Table 4.3.6.

A number of potential alternatives to sodium chloride exist. Table 4.3.7 lists various deicing materials and their primary components. Calcium chloride applied in pellet or liquid form could be the most attractive deicer for areas where fast melting is a priority. It also causes less corrosion and is only about 10 to 15% more expensive per road mile than road salt. Verglimit contains calcium chloride, but has relatively low deicing ability – a result of its significantly lower concentration of the salt and tendency to absorb water, rendering it largely ineffective at lower temperatures. In regions where the environmental and corrosive effects of deicers are important management issues, calcium magnesium acetate (CMA) may be the preferred choice. However, CMA only works above 23 F, has less deicing ability, and is the most expensive option.

Road salt will probably continue to be an attractive deicing agent because of its high deicing ability, utility at low temperatures, and low cost. The corrosive effects of road salt can and have been reduced through design and material modifications to both road structures and vehicles over the past years. Such developments may make road salt even more attractive as a deicing agent. Consequently, management measures should be taken to minimize runoff containing road salt and other deicing agents into sensitive environmental areas.

Table 4.3.5: Watershed Protection Techniques for Snow and Snowmelt Conditions

- Use of De-icing Compounds
  - Use alternative de-icing compounds such as $CaCl_2$ and calcium magnesium acetate (CMA)
  - Designate "salt-free" areas on roads adjacent to key streams, wetlands, and resource areas
  - Reduce use of de-icing compounds through better driver training, equipment calibration, and careful application
  - Sweep accumulated salt and grit from roads as soon as practical after surface clears
- Storage of De-icing Compounds
  - Store compounds on sheltered, impervious pads
  - Locate at least 100 feet away from streams and floodplains
  - Direct internal flow to collection system and route external flow around shelters
- Dump Snow in Pervious Areas Where It Can Infiltrate
  - Stockpile snow in flat areas at least 100 feet from stream or floodplain
  - Plant stockpile areas with salt-tolerant ground cover species
  - Remove sediments and debris from dump areas each spring
  - Choose areas with some soil-filtering capacity
- Blow Snow from Curbside to Pervious Areas
- Operate Storm water Ponds on a Seasonal Mode
- Use Level Spreaders and Berms to Spread Meltwater Over Vegetated Areas
- Intensive Street Cleaning in Early Spring can Help Remove Particulates on Road Surfaces

Table 4.3.6: Impacts of Road Salt (MDOT, 1993)

- Contamination of drinking water supplies
- Corrosion of automobiles
- Corrosion of bridges and other structures
- Damage to vegetation within 50 ft. of roadside
- Temporary reduction in soil microbes, followed by summer recovery
- Sensitivity of various deciduous trees
- Attraction of deer to salts on roadways, increasing the risk of accidents
- Stratification of small lakes, hindering seasonal turnover
- Secondary components (3-5% of road salt composition) include N, P, and metals in concentrations exceeding those in natural waters

Table 4.3.7: Primary Components and Costs of Selected Deicing Materials (MDOT, 1993)

Deicing Material	Primary Components	Chloride as Fraction of the Total Mass	Material Cost Per Ton
Calcium magnesium acetate (CMA)	Ca, Mg, $C_2H_3O_2$	0%	\$650-675
Calcium chloride	Ca, Cl	>57%	\$200
Calcium chloride (Verglimit)	Ca, Cl	2.2 to 4.8%	\$109-145
Sodium chloride (road salt)	Na, Cl	~58%	\$20-40
Corrosion inhibitor (CG-90 Surface Saver)	Na, Cl	46%	\$185
	Mg, Cl	17%	
Potassium chloride (CMS-B/Motech)	K, Cl	Unknown	\$0.40-0.50/gal
Sand	Si, O	0%	\$5
Ca=calcium; Mg=magnesium; $C_2H_3O_2$=acetate; Cl=chloride; Na=sodium; K=potassium; Si=silicon			

<u>Roadside Vegetation</u>

Maintenance practices for roadside vegetation also determine the storm water quality of road runoff. Restrictions on the use of herbicides and pesticides on roadside vegetation and training to ensure that employees understand the proper handling and application of pesticides and other chemicals can help prevent contamination of runoff. Selection of roadside vegetation with higher salt tolerances will also help to maintain vegetated swales that filter out runoff.

<u>Bridge Runoff</u>

Additional maintenance practices may be needed to eliminate adverse storm water runoff impacts from bridge runoff. In addition to some of the roadway practices listed above, there are practices in bridge siting and design that can help reduce water quality impacts. One alternative is to avoid using bridge scupper drains for any new bridges and to routinely clean existing ones to avoid sediment and debris buildup. Scupper drains can cause direct discharges to surface waters and have been found to carry relatively high concentrations of pollutants (CDM, 1993). An alternative management measure could consider endorsing retrofits of scupper drains with catch basins or redirecting water from these drains to vegetated areas to provide treatment. Other techniques such as using suspended tarps, booms and vacuums to capture pollutants (e.g. paint, solvents, rust and paint scrapings) generated during bridge maintenance will also help reduce impacts to receiving waters. In addition, using deicers such as glycol, urea or CMA reduces the corrosion of metal bridge supports that can occur when salt is used.

Effectiveness

There is limited data available on the actual effectiveness of road and bridge maintenance practices at removing pollutants from storm water runoff. Table 4.3.8 examines the effectiveness and cost of some of the operation and maintenance practices recommended for storm water pollution control.

Table 4.3.8: Road and Bridge Maintenance Management Practices: Cost and Effectiveness (US EPA, 1993)

Practice	**Effectiveness** (% Removal)		**Cost**
Maintaining Roadside Vegetation	Sediment - 90% average Phosphorus and Nitrogen - 40% average COD, Pb, and Zn - 50% average TSS - 60% average		Natural succession allowed to occur Average: $100/acre/year Reported Range: $50 -$200/acre/year
Street Sweeping	Smooth Street Frequent Cleaning: TSS - 20% COD - 5% Pb - 25%	Smooth Street Infrequent Cleaning: TSS - Not applicable COD - Not applicable Pb - 5%	Average: $20/curb mile Reported Range: $10 -$30/curb mile
Litter Control	Not applicable		All are accepted as economical practices to control or prevent storm water impacts
General Maintenance	Not applicable		
Minimizing Deicer Application	Not applicable		

While data may be limited on cost and effectiveness, preventative maintenance and strategic planning are time-proven and cost effective methods to limit contamination of storm water runoff. It can be assumed that the management practices recommended will have a positive effect on storm water quality by working to reduce pollutant loads and the quantity of runoff. Protecting and restoring roadside vegetation, removal of debris and sediment from roads and bridges, and directing runoff to vegetated areas are all effective ways to treat storm water runoff. Other practices such as minimizing deicer application, litter control, and proper handling of fertilizers, pesticides, and other toxic materials work to control some of the sources of storm water pollution. Employing good road and bridge maintenance practices is an efficient and low cost means of eliminating some of the impacts of pollutants associated with road systems on local streams and waterways.

Generally speaking, limitations to instituting pollution prevention practices for road and bridge maintenance involve the cost for additional equipment and training. Since maintenance of roadways and bridges is already required in all communities, staffing is usually in place and alteration of current practices should not require additional staffing or administrative labor. The maintenance of local roads and bridges is already a consideration of most community public works or transportation departments. Therefore, the cost of pollutant reducing management practices will involve the training and equipment required to implement these new practices.

4.3.10 Vegetation Controls

Mechanical vegetation controls include elements such as properly collecting and disposing of clippings, cutting techniques, leaving existing vegetation, etc., and can be implemented as both municipal management measures and public education measures. The public education element of vegetation control previously was discussed in Section 4.2.8. This section will address the municipal side of vegetation management, which would include the practices by which public works and park maintenance crews actively manage and control vegetation on public lands.

Clippings and cuttings are the primary waste produced by mowing and trimming. Clippings and cuttings are almost exclusively leaf and woody materials. However, in some cases, litter may be intermingled with the clippings. Clippings/cuttings carried into the storm water system and receiving streams can degrade water quality in several ways. Suspended solids will increase causing turbidity problems. Since most of the constituents are organic, the biological oxygen demand will increase causing a lowering of the available oxygen to plant and animal life.

A related problem exists with the illegal dumping of clippings/cuttings in or near drainage facilities. Often, park maintenance crews will discover that clippings/cuttings can easily be disposed of by dumping them down a nearby ravine or on the slope of a creek or drainage channel. This practice introduces a large quantity of decaying organic matter into the storm water collection system that is subsequently carried to receiving streams during the next rainfall event.

Once vegetative waste is generated, the main concern is to avoid transport of clippings/cuttings to receiving water bodies. It is necessary to pick up and properly dispose of clippings/cuttings on the slopes and the bottom drainage facilities, including storm water detention/retention facilities. In addition, the presence of clippings/cuttings in and around catch basins should be avoided by either using bagging equipment or manually picking up the material. Materials disposed on flat surfaces are generally not supported by storm water runoff unless the event is particularly intense. Therefore, it is not necessary to pick up or bag clippings/cuttings on flat or nearby flat surfaces. Municipal operators should be trained to use good judgement in determining whether clippings/cuttings should be collected or left in place. Also, mowing should only be performed at optimal times. Mowing should not be performed if significant rain events are predicted.

Municipal anti-dumping ordinances should be enacted or reinforced (if necessary) so that private dumping of vegetative debris is not allowed. It is important that these ordinances be clear and enforceable.

Composting is one of the better alternatives if locally available. Most municipalities either have or are planning yard waste composting facilities as a means of reducing the amount of waste going to landfills. Lawn clippings from municipal maintenance programs as well as private sources would probably be compatible with most composting facilities.

Measures to improve the disposition of clippings/cuttings are relatively simple and inexpensive. Cost considerations include possible upgrading of certain mowing equipment for bagging. Another potential cost is for additional laborers involved in hand cutting and picking up clippings where mechanical cutting and collection is not practical. A third possible cost includes the training of municipal employees on proper vegetation control.

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