R. Pitt
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Lincoln, Nebraska, Retrofit Stormwater Management Options
- Performance and Relative Costs –
Prepared for Wright Waters Engineers, EA Assoc. and the City of Lincoln

Contents

Introduction

This report describes the expected performance of many alternative stormwater control programs that were evaluated in nine land use categories based on Antelope Creek study area site surveys. The earlier report (R. Pitt. *Lincoln, Nebraska, Standard Land Use Characteristics and Pollutant Sources*, Prepared for Wright Water Engineers, Inc., Denver, CO. April 22, 2011) described these land use areas, the expected stormwater characteristics, and pollutant sources. The discussion of pollutant sources helped to frame the stormwater control program alternatives to examine. This report contains the following main sections that supplement the earlier calibration, characterization, and sources report:

- Introduction
- Descriptions of stormwater control practices (including discussions of factors affecting the use of different controls, combinations of practices, plus variability and uncertainty of predicted outcomes)
- Analysis results (including selecting the most suitable stormwater control program)
- An appendix containing detailed modeling results for all constituents and land uses

Land Uses

This current report is a continuation of the prior report and focusses on stormwater control programs that can be used in the Antelope Creek watershed. The land uses identified in the Antelope Creek study area were examined with more than 25 alternative stormwater control programs in each. Calculated performance attributes are presented and evaluated for each of the following nine land use categories:

- Commercial areas:
  - Strip malls
  - Shopping center
- Light Industrial areas
- Institutional areas:
  - Schools
  - Churches
  - Hospitals
- Residential areas:
  - Low density
  - Medium density, constructed before 1960
  - Medium density, constructed between 1960 and 1980

Stormwater Controls Examined

The stormwater controls examined in the Antelope Creek study area varied somewhat for the different land uses (based on available space and other compatibility issues mostly, plus from the earlier source analyses). The controls examined included the following:

- Roof runoff controls: rain gardens, disconnections, rain barrels and larger water tanks
- Pavement controls: disconnections, biofiltration, and porous pavement
- Street side drainage controls: grass swales and curb-cut biofilters
- Public works practices: street cleaning and catchbasin cleaning
- Outfall controls: wet detention ponds

Some of these controls (especially the roof and pavement controls) are at source areas and their maximum benefits are restricted by the fraction of the constituent of concern originating from those areas. As an example, consider stormwater beneficial uses using roof runoff for irrigation of landscaped areas. In some of the land uses, roof runoff contributes less than 20% of the total runoff, so the controls are restricted to that somewhat low maximum benefit for the whole area. The drainage system and outfall controls (swales, curb-cut biofilters, and wet detention ponds) can basically treat all of the runoff from the land use and are not restricted by source contributions. If land is available, they can therefore have larger theoretical benefits. The range of difficulties and land requirements varies, mostly depending on available opportunities. In some communities, extensive retro-fitting is occurring including installation of curb-cut biofilters. These can also be installed during scheduled repaving and sidewalk repairs that usually occur in many areas every few decades. Rain gardens are usually installed by the home owners with no cost to the city. The public works practices usually get the most attention, especially street cleaning, as they can be used with no change to the land. Redevelopment and new construction times are the most suitable for installation of many of these controls in order to have the least interferences with current residents and for the least costs and optimal locations.

The designs of the individual control practices are described in this report, along with the WinSLAMM unit process calculation procedures. Calculated runoff, TSS, and *E. coli* conditions for each scenario, and also the estimated costs (capital costs, land costs, maintenance costs, total annual costs, and total present value cost) and the unit removal costs for runoff (dollars per cubic feet removed, compared to the base conditions) and for TSS (dollars per pound removed, compared to the base conditions) are summarized. Scatterplots relating the calculated percent removals of these three stormwater constituents vs. the total annual costs (dollars per 100 acres per year) are also shown. The most suitable stormwater control programs meeting the removal objectives at the least cost can be identified from these figures (also considering other factors affecting the selection process as described earlier, such as groundwater contamination potential, maintenance requirements, suitability for retrofitting, etc.). Detailed information for all constituents examined (runoff volume, Rv, TSS, TDS, total and filterable phosphorus, nitrates, total and filterable TKN, total and filterable COD, total and filterable copper, total and filterable lead, total and filterable zinc, fecal coliform bacteria, and *E. coli* bacteria) is presented for each land use and soil combinations for each set of stormwater controls in the appendix.

Selection of Most Appropriate Stormwater Control Program

For runoff volume controls, each land use group had similar most cost-effective controls, as shown on the following list for the controls having at least 25% levels of runoff volume reduction potential in areas having clay load soils in the infiltration areas. Other control options have similar potential levels of control, but the others are likely more costly. These are listed in order with the first control having the lowest level of maximum control, but the highest unit cost-effectiveness; and the last control listed having the highest level of maximum control, but the lowest unit cost-effectiveness. Therefore, if low to moderate levels of control are suitable, the first control option may be best, but if maximum control levels are needed, then the last control option listed would be needed:

- Strip mall and shopping center areas:
  - Porous pavement (in half of the parking areas)
  - Curb-cut biofilters (along 80% of the curbs) for strip malls or biofilters in parking areas (10 percent of the source area) for shopping centers
  - Biofilters in parking areas (10 percent of the source area) and curb-cut biofilters (along 40% of the curbs)

- Light industrial areas:
  - Curb-cut biofilters (along 40% of the curbs)
  - Roofs and parking areas half disconnected
  - Roofs and parking areas all disconnected

• School, church, and hospital institutional areas:
  - Small rain tank (0.10 ft^3 storage per ft^2 of roof area) for schools and churches; rain tank (0.25 ft^3 storage per ft^2 of roof area) for hospitals
  - Roofs and parking areas half disconnected
  - Roofs and parking areas all disconnected

• Low and medium density residential areas:
  - Curb-cut biofilters (along 20% of the curbs)
  - Curb-cut biofilters (along 40% of the curbs)
  - Curb-cut biofilters (along 80% of the curbs)

For suspended solids, all areas show that wet detention ponds are the most cost-effective control option, irrespective of the conditions. Obviously, other factors may influence the selection of the “best” stormwater control program for an area, beyond least cost for the level of control needed. As an example, wet detention ponds, while being the most cost-effective, are likely very difficult to retrofit into existing areas. However, these analyses indicate that these controls should not be rejected without careful evaluations and searching for potential locations.

There are many attributes and characteristics associated with a stormwater management plan that need to be considered during the selection process. An example decision analysis process is shown for the Lincoln, NE, medium residential area (1960-1980) that represents the largest fraction of the Antelope Creek study area. Some of the characteristics of concern include: *E. coli* discharge reductions, nutrient discharge reductions, costs (initial and maintenance costs, plus total annual costs), land requirements, runoff volume discharge reductions, and TSS discharge reductions. As described in this report, WinSLAMM can calculate these attributes for a broad selection of alternative stormwater programs.

In the simplest case, the selection of the most suitable control can be based on examining the calculated outcomes and filtering them according to set objectives, and then choosing the least costly alternative. As an example, if the runoff reduction objectives were expressed in expected biological conditions of “good” and the required particulate solids (TSS) mass discharge reductions needed were at least 75%, seven of the 29 control programs for this land use would be satisfactory. The least costly alternative involves the use of curb-cut biofilters along at least 20 percent of the total curb length. If this control program meets other objectives (mainly approval of the residents living in the area, and design specifics to overcome possible problems associated with snowmelt and clogging can be developed), this would be a good choice, and is being more frequently used in many US communities.

Formal decision analysis methods can be used when conflicting and complex attributes and objectives make the simpler filtering method described above impractical. Good decision analysis methods are a powerful tool that can be used to compare the rankings of alternative stormwater management programs for different groups of stakeholders. In many cases, final rankings may be similar amongst the interested parties, although their specific reasons vary. This tool also completely documents the decision making process, enabling full disclosure. In this example, the top ranked alternatives are generally similar for each hypothetical stakeholder group, even with very different trade-off values. The municipal governments and local resident’s trade-offs are quite similar, but are quite different from the regulatory agency’s trade-off values. The overall top ranked alternative is the curb-cut biofilters at 40% of the curb line. This alternative ranked first for the municipal government and local resident stakeholder groups and second for the regulatory agency. The top ranked alternative for the regulatory agency (the curb-cut biofilters at 80% of the curb line) ranked much lower for the other two stakeholder groups due to its much higher costs. The small wet pond plus the curb-cut biofilters at 40% of the curb line ranked second for the municipal government stakeholders and third for the regulatory agency and the local government stakeholder groups.

Other Considerations Affecting Selection and Use of Stormwater Controls

Certain site conditions may restrict the applicability of some of the controls and need to be considered during the selection process. Some of these examined in the report are summarized below:

- The sodium adsorption ratio (SAR) can radically degrade the performance of an infiltration device, especially when clays are present in the infiltration layers of a device, and snowmelt containing deicing salts enters the device. Soils with an excess of sodium ions, compared to calcium and magnesium ions, remain in a dispersed condition, and are almost impermeable to rain or applied water. A "dispersed" soil is extremely sticky when wet, tends to crust, and becomes very hard and cloddy when dry. Water infiltration is therefore severely restricted. SAR has been documented to be causing premature failures of biofiltration devices in northern communities. These failures occur when snowmelt water is allowed to enter a biofilter that has clay in the soil mixture. In order to minimize this failure, do not allow snowmelt water to enter a biofilter unit. As an example, roof runoff likely has little salt and SAR problems seldom occur for roof runoff rain gardens. The largest problem is associated with curb-cut biofilters or parking lot biofilters in areas with snowmelt entering these devices, especially if clay is present in the engineered backfill soil. The biofilter fill soil should not have any clay. It appears that even a few percent clay can cause a problem, but little information is currently available on the tolerable clay content of biofilter soils. The most robust engineered soil mixtures used in biofilters should be mixtures of sand and an organic material (such as compost if nutrient leaching is not an issue, or Canadian peat for a more stable material having little nutrient leaching potential).

- The designs of infiltration devices need to be checked based on their clogging potential. As an example, a relatively small and efficient biofilter (in an area having a high native infiltrating rate) may capture a large amount of sediment. Having a small surface area, this sediment would accumulate rapidly over the area, possibly reaching a critical clogging load early in its design lifetime. Infiltration and bioretention devices may show significantly reduced infiltration rates after about 2 to 5 lb/ft^2 (10 to 25 kg/m^2) of particulate solids have been loaded.

- The potential for infiltrating stormwaters to contaminate groundwaters is dependent on the concentrations of the contaminants in the infiltrating stormwater and how effective those contaminants may travel thru the soils and vadose zone to the groundwater. Source stormwaters from residential areas are not likely to be contaminated with compounds having significant groundwater contaminating potential (with the exception of high salinity snowmelt waters). In contrast, commercial and industrial areas are likely to have greater concentrations of contaminants of concern that may affect the groundwater adversely. Therefore, pretreatment of the stormwater before infiltration may be necessary, or the use of specially selected media in the biofilter can be used.

- Most of the control options examined in this report are intended for retrofitting in existing urban areas. Therefore, their increased costs and availability of land will be detrimental in developing highly effective control programs. The range of difficulties and land requirements varies, mostly depending on available opportunities. In some communities (especially those with combined sewer overflows), extensive retro-fitting is occurring, including installation of curb-cut biofilters.

Modeling Approach

WinSLAMM version 9.5 was previously used to analyze the water quality (stormwater pollution loading) and runoff volume for the land uses found in the Antelope Creek study area (R. Pitt. *Lincoln, Nebraska, Standard Land Use Characteristics and Pollutant Sources*, Prepared for Wright Water Engineers, Inc., Denver, CO. April 22, 2011). This current report is a continuation of that prior report and focusses on stormwater control programs that can be used in the Antelope Creek watershed. The nine land uses identified in the Antelope Creek study area were examined with more than 25 alternative stormwater control programs in each. Calculated performance attributes are then presented and evaluated for each of the nine land use categories. Relative cost data (focusing on expected total annual costs), along with discharge volume and load reductions are also summarized. The following is a brief discussion of the WinSLAMM model and how it was used in these calculations.

WinSLAMM Background Information

WinSLAMM was developed to evaluate stormwater runoff volume and pollutant loadings in urban areas using small storm hydrology. The model determines the runoff based on local rain records and calculates runoff volumes and pollutant loadings from each individual source area within each land use category for each rain. Examples of source areas include: roofs, streets, small landscaped areas, large landscaped areas, sidewalks, and parking lots.

The model can use any length of rainfall record as determined by the user, from single rainfall events to several decades of rains. The rainfall file used in these calculations for Lincoln, NE, was developed from hourly data obtained from EarthInfo CDROMs, using the four years from 1996 through 1999. The model applied a series of stormwater control practices, including rain barrels and water tanks for stormwater irrigation, pavement and roof disconnections, roof rain gardens, infiltration/biofiltration in parking lots and as curb-cut biofilters, street cleaning, wet detention ponds, grass swales, porous pavement, catchbasins, and selected combinations of these practices. The model evaluates the practices through engineering calculations of the unit processes based on the actual designs and sizes of the controls specified and determines how effectively these practices remove runoff volume and pollutants.

WinSLAMM does not use a percent imperviousness or a curve number to general runoff volume or pollutant loadings. The model applies runoff coefficients to each “source area” within a land use category. Each source area has a different runoff coefficient equation based on factors such as: slope, type and condition of surface, soil properties, etc., and calculates the runoff expected for each rain. The runoff coefficients were developed using monitoring data from typical examples of each site type under a broad range of conditions. The runoff coefficients are continuously updated as new research data becomes available.

Each source area also has a unique pollutant concentration (event mean concentrations - EMCs - and a probability distribution) assigned to it. The EMCs for a specific source area vary depending on the rain depth. The source area’s EMCs are based on extensive monitoring conducted in North America by the USGS, Wisconsin DNR, University of Alabama, and other groups. These monitoring efforts isolated source areas (roofs, lawns, streets, etc.) for different land uses and examined long term data on the runoff quality. The pollutant concentrations are also continuously updated as new research data become available.

For each rainfall in a data set, WinSLAMM calculates the runoff volume and pollutant load (EMC x runoff volume) for each source area. The model then sums the loads from the source areas to generate a land use or drainage basin subtotal load. The model continues this process for the entire rain series described in the rain file. It is important to note that WinSLAMM does not apply a “unit load” to a land use. Each rainfall produces a unique load from a modeled area based on the specific source areas in that modeled area.

The model was used to predict stormwater management practice effectiveness as presented in this project report. The model replicates the physical processes occurring within the practice. For example, for a wet detention pond, the model incorporates the following information for each rain event:

1. Runoff hydrograph, pollution load, and sediment particle size distribution from the drainage basin to the pond,
2. Pond geometry (depth, area),
3. Hydraulics of the outlet structure,
4. Particle settling time and velocity within the pond based on retention time

Stokes Law and Newton's settling equations are used in conjunction with conventional surface overflow rate calculations and modified Puls-storage indication hydraulic routing methods to determine the sediment amounts and characteristics that are trapped in the pond. Again, it is important to note that the model does not apply "default" percent efficiency values to a control practice. Each rainfall is analyzed and the pollutant control effectiveness will vary based on each rainfall and the pond's antecedent condition. This report describes how each stormwater control practice examined in Antelope Creek is evaluated in WinSLAMM.

The model's output is comprehensive and customizable, and typically includes:

1. Runoff volume, pollutant loadings and EMCs for a period of record and/or for each event.
2. The above data pre- and post- for each stormwater management practice.
3. Removal by particle size from stormwater management practices applying particle settling.
4. Other results can be selected related to flow-duration relationships for the study area, impervious cover model expected biological receiving water conditions, and life-cycle costs of the controls.

A full explanation of the model's capabilities, calibration, functions, and applications can be found at www.winslamm.com. For this project, the parameter files were calibrated using the local Lincoln MS4 monitoring data, supplemented by additional information from regional data from the National Stormwater Quality Database (NSQD), available at: http://www.unix.eng.ua.edu/~rpitt/Research/ms4/mainms4.shtml

Calibration of WinSLAMM to Simulate Local Observed Stormwater Conditions

All models need to be calibrated to result in the most effective information. WinSLAMM calibrations for Lincoln were based on a multi-step process. Much source area monitoring data are available from different locations (mainly from California, Alabama, Ontario, and Wisconsin). These data are summarized in a series of peer-reviewed chapters in modeling monographs:

- Pitt, R., R. Bannerman, S. Clark, and D. Williamson. "Sources of pollutants in urban areas (Part 1) – Older monitoring projects." In: Effective Modeling of Urban Water Systems, Monograph 13. (edited by W. James, K.N. Irvine, E.A. McBean, and R.E. Pitt). CHI. Guelph, Ontario, pp. 465 – 484 and 507 – 530. 2005.
- Pitt, R., R. Bannerman, S. Clark, and D. Williamson. "Sources of pollutants in urban areas (Part 2) – Recent sheetflow monitoring results." In: Effective Modeling of Urban Water Systems, Monograph 13. (edited by W. James, K.N. Irvine, E.A. McBean, and R.E. Pitt). CHI. Guelph, Ontario, pp. 485 – 530. 2005.
- Pitt, R., D. Williamson, and J. Voorhees. "Review of historical street dust and dirt accumulation and washoff data." Effective Modeling of Urban Water Systems, Monograph 13. (edited by W. James, K.N. Irvine, E.A. McBean, and R.E. Pitt). CHI. Guelph, Ontario, pp 203 – 246. 2005.

These data have been used to create calibrated WinSLAMM models in several locations that have since been verified using outfall data. The most extensive data are from the Birmingham, AL area and from the state of Wisconsin. Land use (and stormwater) data from throughout the nation are also available from many research reports. These data were separated into several regional groups. The Lincoln area is included in the Central US area and was originally based on the Wisconsin calibration and verification model sets. The Central model files were then modified based on outfall data from the Central US region as contained in the NSQD. Finally, these Central US files were further modified using the events monitored in Lincoln as part of their MS4 monitoring program, as described in the earlier Antelope Creek stormwater source report.

The Lincoln rain file was used to calculate long-term stormwater conditions. The four year period from 1996 through 1999 was used. A longer period was not possible due to missing observations. Winter conditions were also defined as being from December 20 to February 10 of each year. During these winter periods, no stormwater calculations were made.

During the Lincoln calibration process, the calculated long-term averaged modeled concentrations were compared to the monitored concentrations for each site. Factors were applied uniformly to each land use in the Lincoln pollutant and particulate solids parameter files to adjust the long-term modeled concentrations to best match the monitored/observed values. The runoff parameter file was not modified as it has been shown to compare well to observed conditions under a wide range of situations, and no local runoff quantity data were available for the local monitoring locations.

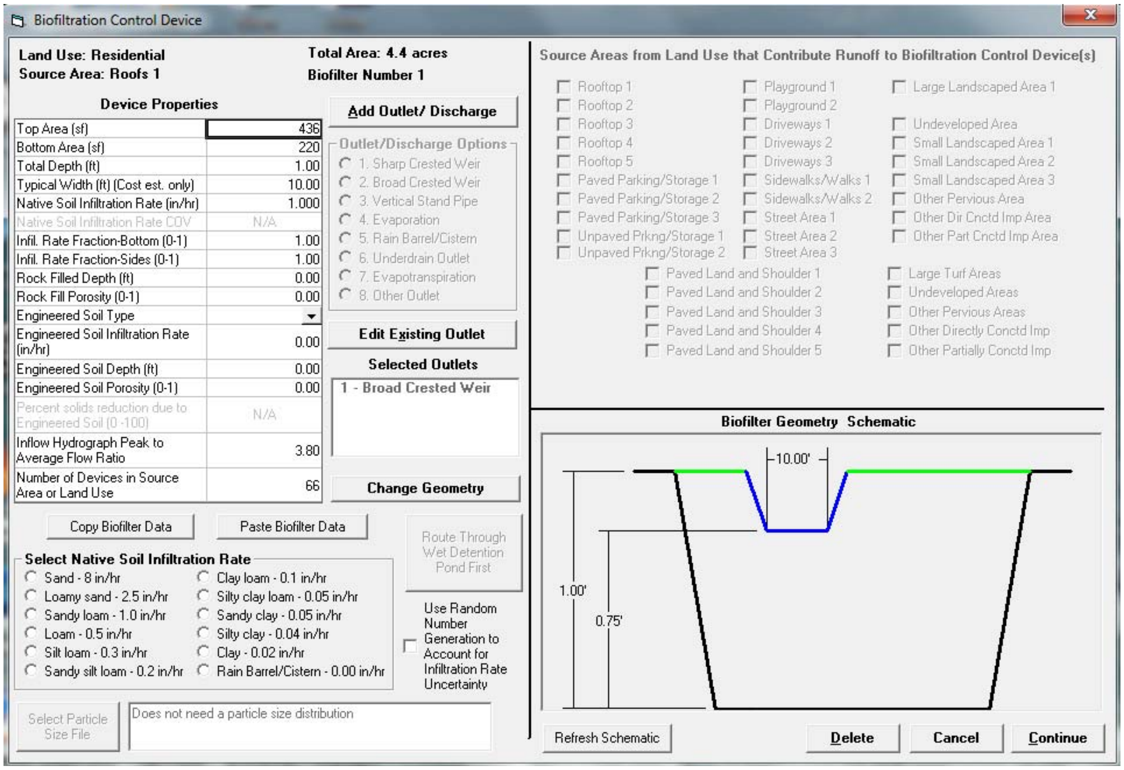
Description of Control Practices

The following subsections describe how WinSLAMM models the performance of the various stormwater control practices considered in this evaluation, plus some individual control production functions. These production functions were used to help determine the range of designs to apply to each land use category to represent the likely best performing sizes and combinations of control practices. As indicated, WinSLAMM calculates the expected performance of the controls based on the unit processes available in the control and the specific designs applied to site specific conditions.

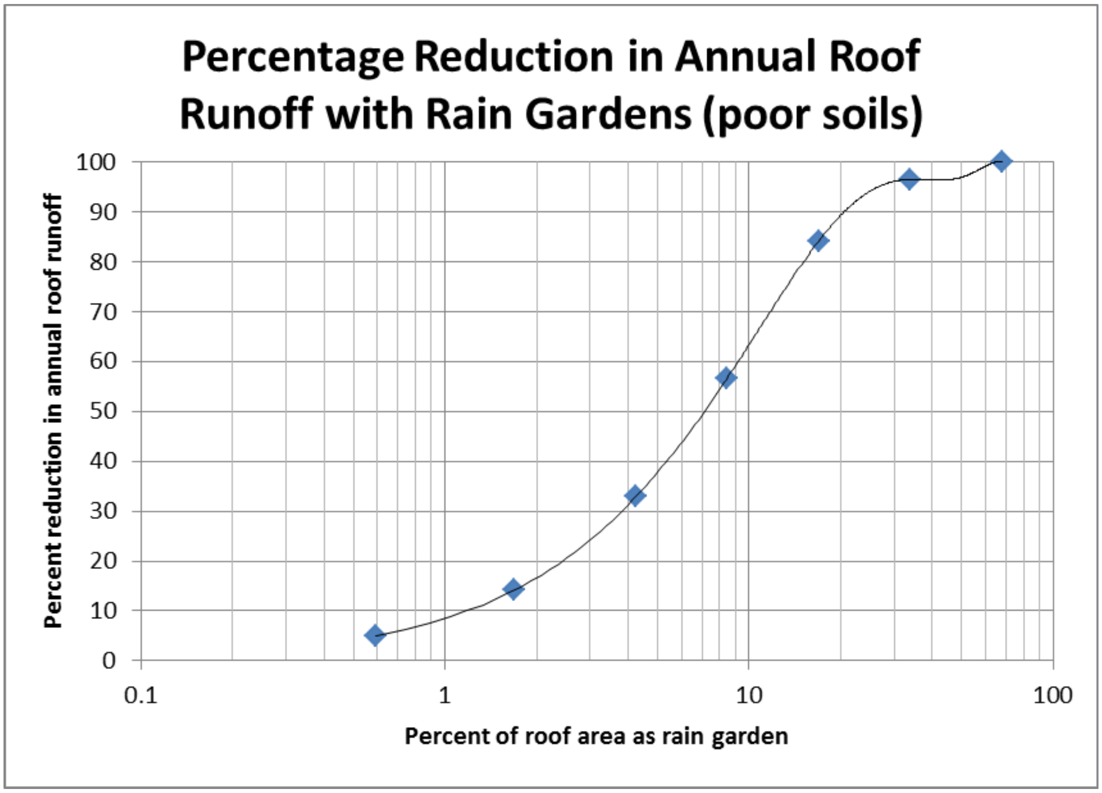
Roof Runoff Controls

Rain Gardens

Rain gardens are simple bioretention devices located adjacent to roofs. The following screen dump from the biofilter information screen in WinSLAMM describes one of the rain gardens used in these analyses. Each rain garden has a top surface area of 436 ft^2, corresponding to 1% of one acre. The number of rain gardens was changed for each scenario corresponding to the size of the rain garden compared to the roof area. In this example, this relatively large rain garden is about 20 by 22 ft in area; however, the performance is directly dependent on the total areas of all the rain gardens being considered in the area. The rain gardens are only excavated to an overall depth of 1 ft, with no fill soil (and no underdrains). In many cases, amendments are tilled into rain garden excavations, usually to improve the tilth and organic content in order to better support the plants and to improve infiltration. The surface 1 ft is left open to provide surface storage 9 inches deep (several inches act as on overflow). Clay loam soils having 0.1 in/hr and sandy loam soils having 1.0 in/hr infiltration rates were examined for each scenario to represent a likely range of urban soil conditions. The only outlet used (besides the natural infiltration) is a surface overflow along one edge of the rain garden that is 3 inches lower than the other edges.



The following figure is a plot of the performance of rain gardens as a percentage of the roof area, based on long-term continuous modeling. This figure was used to select rain gardens having total surface areas of 3 and 15% of the total roof areas in each land use. Even though these are more cost-effective if treating runoff from directly connected roofs, the modeling scenarios examined all roofs in each area (both directly connected roofs draining to the drainage system and roofs already draining to adjacent landscaped areas) in order to maximize the potential control of the roof runoff by rain gardens. The 3% rain gardens are expected to reduce the annual roof runoff volumes by about 25%, while the large rain gardens that are 15% of the roof areas are expected to reduce the annual roof runoff volumes by about 75%.



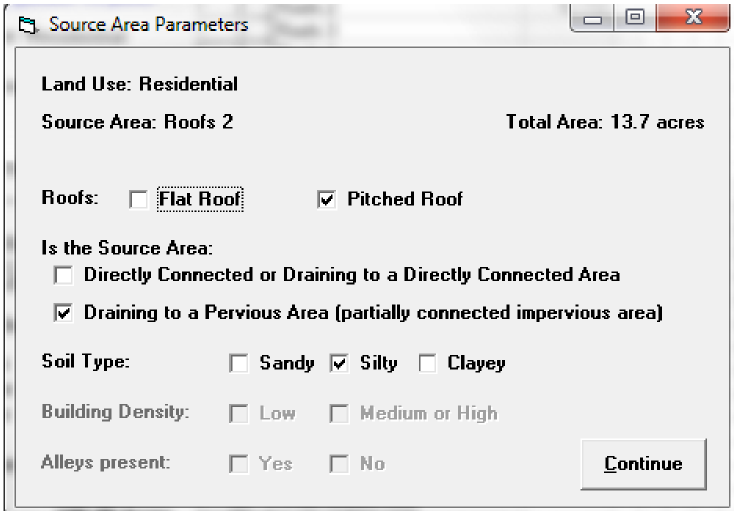
Rain gardens can be very effective in reducing runoff discharges from roofs, but they need to be relatively large, especially in areas having poor soils. Care is also necessary in their construction to prevent compaction and sealing the soils. In many cases, incorporating compost or peat into the top soil layers can enhance their performance. Many references are also available describing plant choices for rain gardens. These are typically constructed and maintained by the individual property owners and are located on private property. Biofilters, described later under pavement controls, are more sophisticated versions of rain gardens.

Disconnections of Roof Downspouts

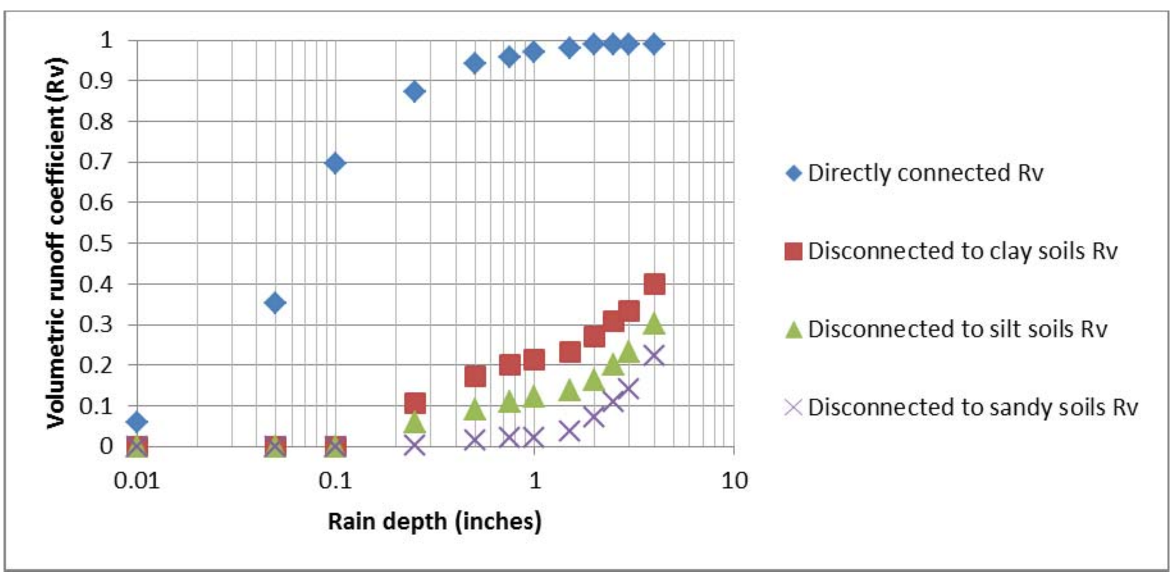
Another option for the control of runoff from directly connected roofs is to disconnect the roof drain downspouts that are currently directed towards pavement that in turn are directly connect to the drainage system. When disconnecting downspouts, the water needs to be redirected over pervious ground, most commonly regular turf grass located adjacent to the downspouts. This is most effective if the water is discharged to relatively flat lawns in good conditions that have flow path lengths of at least 10 feet for small residential roofs. If the soils have poor infiltration characteristics (such as for the clay loam soil conditions), the amount of water that can be infiltrated may be relatively high if the roofs comprise small fractions of the pervious areas. In this case, the available flow paths are also relatively long, increasing the infiltration potential.

WinSLAMM version 9.5 was used to make a preliminary analysis of the benefits of disconnecting the directly connected roofs to allow the runoff to flow across the pervious areas. The new version 10 being completed will be able to more directly calculate these benefits through grass filtering processes. These results can be roughly compared to the benefits associated with rain gardens and rain barrels/tanks, the other roof runoff control options being considered in these analyses. For clay loam soils, disconnecting the roof downspouts in most residential areas (having suitable flow paths) is expected to result in annual reductions of the roof runoff by about 80%. This would increase to about 90% and 95% for areas having silty and sandy soils, respectively.

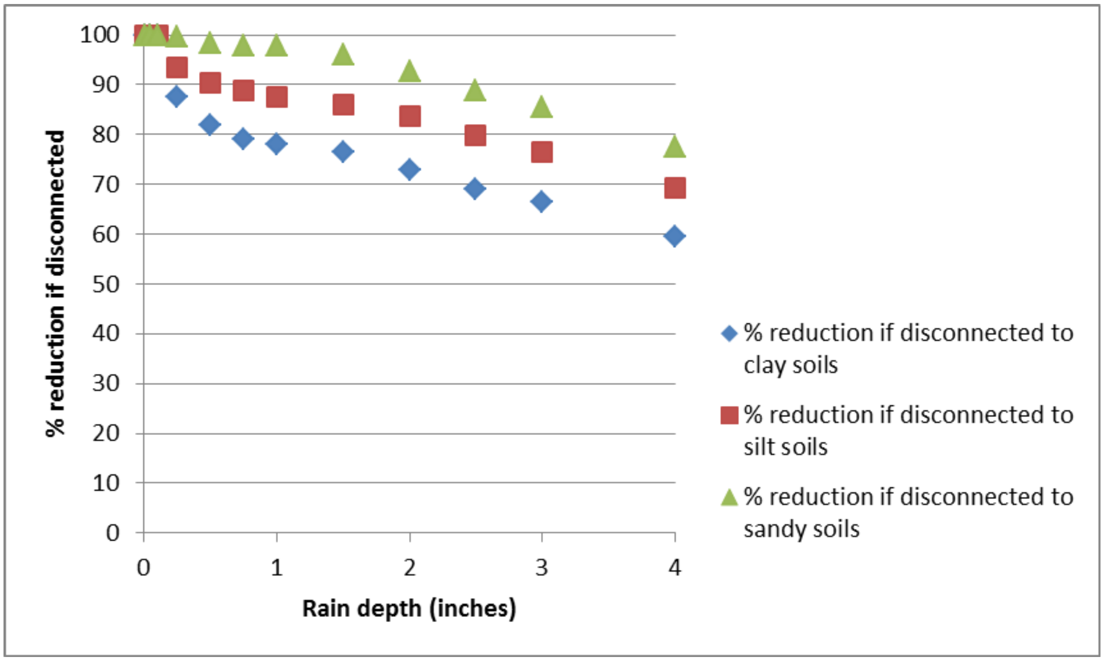
The following is the WinSLAMM entry screen showing how the roof areas are disconnected during a model analysis:



The following plots illustrate the expected benefits of these disconnection practices for different individual rains, up to 4 inches in depth, for residential areas. The volumetric runoff coefficient (Rv), the ratio of runoff volume to rainfall volume falling on an area, is seen to increase with increasing rain depths. For directly connected pitched roofs, the Rv is about 0.7 for 0.1 inch rains, and is quite close to 1.0 for rains larger than about 2 inches in depth. When disconnected to clayey soils, runoff is not expected until the rain depth is greater than about 0.1 inches and the Rv starts to climb steeply with rains larger than several inches in depth. It is expected to be very large for very large and unusual rains that can cause severe flooding, irrespective if they are disconnected or not. However, the benefits for small and intermediate rains are large.



The following graph illustrates the percentage reductions associated with disconnecting the directly connected roofs for the three main soil categories in residential areas. The percentage reduction is about 75% for 1.5 inch rains, being greater for smaller rains. These levels of control can also be achieved using rain gardens in relatively small areas, or by using water tanks and irrigating the landscaped areas with the captured water, if the available landscaped area is relatively large. However, these other controls should only be retrofitted at homes that currently have directly connected roof drains and if disconnecting is not feasible due to poor flow paths or limited space.

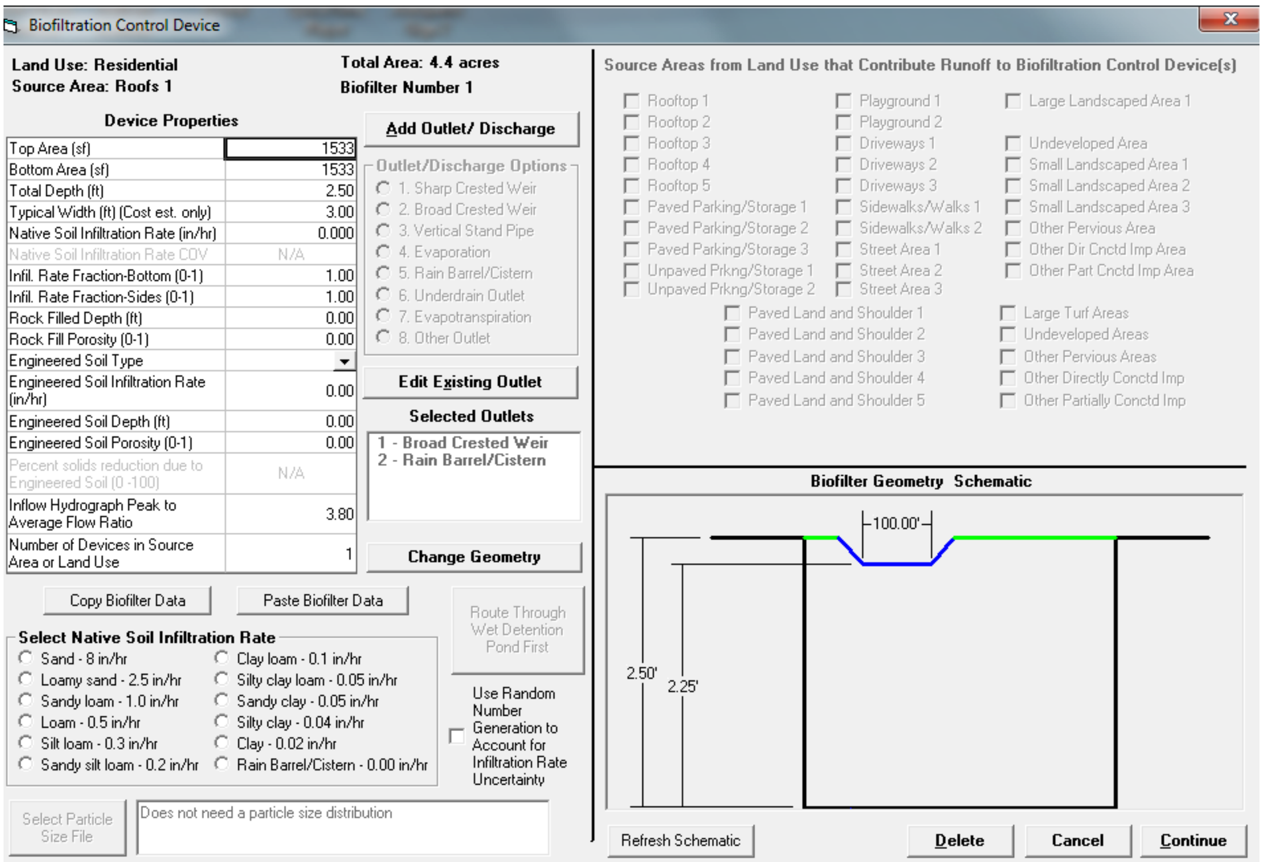


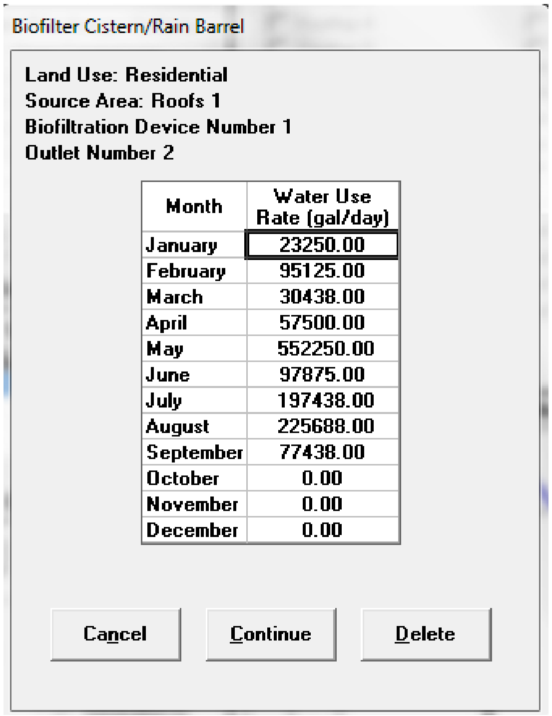
Rain Barrels and Water Tanks for Irrigation using Roof Runoff

Rain barrels are a very simple method for collecting roof runoff for beneficial uses. In these analyses, irrigation of turf grass landscaping around the buildings is the use provided. In some cases, especially for new construction, in-house beneficial uses of stormwater may also be available (such as for toilet flushing). The irrigation opportunity that can be met by the use of stored stormwater is the additional water needed to supplement the long-term monthly average rainfall infiltration in order to match the evapotranspiration requirements for the area. As will be shown in these analyses, small rain barrels provide limited direct benefits, so larger water tanks are also considered in these analyses. Also, in order to be most beneficial, these calculations assume that the irrigation rates are controlled by soil moisture conditions in order to match the ET requirements closely. This level of control is usually most effectively achieved with a single large storage tank connected to an automatic irrigation system. Numerous smaller rain barrels are more difficult to optimally control.

The water harvesting potential for the retrofitted rain barrels and water tanks was calculated based on supplemental irrigation requirements for the basic landscaped areas. The irrigation needs were determined to be the amount of water needed to satisfy the evapotranspiration needs of typical turf grasses, after the normal amounts of infiltration of rainfall added moisture to the soil.

The following is the form used for rain barrel or cistern/water tanks in WinSLAMM version 9.5 (version 10 currently being completed has a more stream-lined water beneficial use/water barrels input screen (but the calculations and data needs are the same). This is the same form used for the biofilters, but conditions relevant to rain barrels and water beneficial use are selected (top and bottom area the same, no native soil infiltration and no fill material needed. The two discharges include the required overflow (just the tank upper rim) and the monthly water use requirements (the irrigation demands to match ET deficits after considering the rain water infiltration).





Biofilter Cistern/Rain Barrel

Land Use: Residential
Source Area: Roofs 1
Biofiltration Device Number 1
Outlet Number 2

Month	Water Use Rate (gal/day)
January	23250.00
February	95125.00
March	30438.00
April	57500.00
May	552250.00
June	97875.00
July	197438.00
August	225688.00
September	77438.00
October	0.00
November	0.00
December	0.00

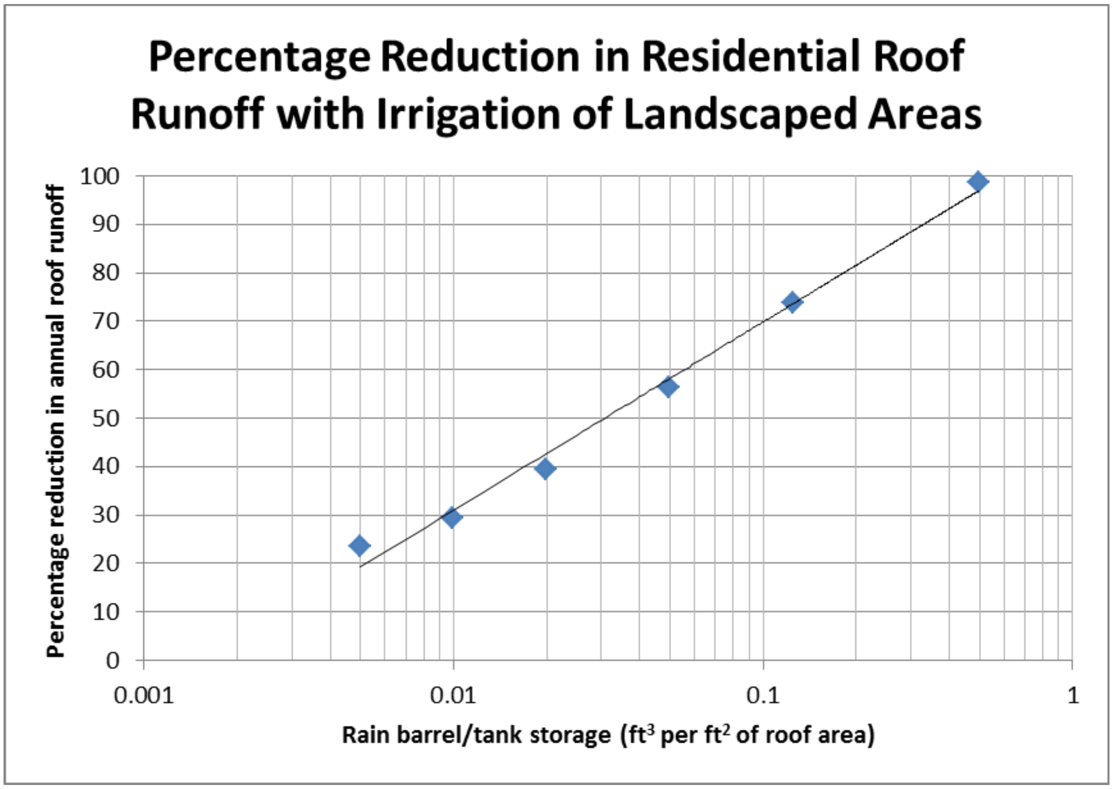
Cancel Continue Delete

The following tables show the calculations for the maximum water demands, by month, for the nine different land uses examined for these analyses. The water demand was calculated based on long-term modeling of Lincoln, NE, rainfall conditions and calculating the amount of infiltrating rainwater that was available to partially meet the ET requirements for the turf grass landscaped areas. This water demand is the balance of the ET not being met by the rainfall contributions. For each land use, the maximum irrigable land for 100 acres of the land use area was used to calculate the monthly water demand, as shown on the following tables:

month	Water demand to meet local ET for Lincoln, NE (gal/day/acre of landscaped area)	total irrig use (gal/day) for 14 acres of irrigated land per 100 acres of strip malls	total irrig use (gal/day) for 12 acres of irrigated land per 100 acres of shopping centers	total irrig use (gal/day) for 15 acres of irrigated land per 100 acres of light industrial areas	total irrig use (gal/day) for 48 acres of irrigated land per 100 acres of schools
Jan	372	5,208	4,352	5,692	17,670
Feb	1522	21,308	17,807	23,287	72,295
Mar	487	6,818	5,698	7,451	23,133
Apr	920	12,880	10,764	14,076	43,700
May	8836	123,704	103,381	135,191	419,710
Jun	1566	21,924	18,322	23,960	74,385
Jly	3159	44,226	36,960	48,333	150,053
Aug	3611	50,554	42,249	55,248	171,523
Sep	1239	17,346	14,496	18,957	58,853
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0

month	total irrig use (gal/day) for 44 acres of irrigated land per 100 acres of churches	total irrig use (gal/day) for 33 acres of irrigated land per 100 acres of hospitals	total irrig use (gal/day) for 66 acres of irrigated land per 100 acres of low density residential areas	total irrig use (gal/day) for 58 acres of irrigated land per 100 acres of medium density residential areas (before 1960)	total irrig use (gal/day) for 63 acres of irrigated land per 100 acres of medium density residential areas (1960 to 1980)
Jan	16,182	12,239	24,589	21,725	23,250
Feb	66,207	50,074	100,604	88,885	95,125
Mar	21,185	16,022	32,191	28,441	30,438
Apr	40,020	30,268	60,812	53,728	57,500
May	384,366	290,704	584,060	516,022	552,250
Jun	68,121	51,521	103,513	91,454	97,875
Jly	137,417	103,931	208,810	184,486	197,438
Aug	157,079	118,802	238,687	210,882	225,688
Sep	53,897	40,763	81,898	72,358	77,438
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	0	0	0	0	0

The following figure summarizes the calculated benefits of storage and irrigation use of the runoff collected from directly connected residential roofs in the area. As an example, the use of a single rain barrel is expected to provide about a 24% reduction in runoff through irrigation to match ET. However, more than 25 would be needed to reduce the roof’s contributions by 90%. In order to match the benefits of disconnection of the connected downspouts (about 78% reductions), about 25 rain barrels would be needed. Twenty-five rain barrels correspond to a total storage quantity about equal to 0.12 ft (1.4 inches). Six different water tankage scenarios were examined for each land use, as the ratio of roof area to landscaped area varied. The resulting storage volumes and numbers of 35 gallon rain barrels and 6 ft tall by 6 ft diameter water tanks that were used in the modeling are shown on these tables for each land use.



The number of rain barrels or water tanks per acre of roof and landscaped area is the same for each land use, but because the roof areas varied by lands use, the number of each storage container varied. The wide range of storage volumes was considered because the irrigation potential varied for each land use.

25 acres of roof area in 100 acres of strip mall area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	931	3	26
rain barrel (at 0.02 ft^3/ft^2)	186	1862	5	51
many rain barrels (at 0.05 ft^3/ft^2)	465	4655	13	128
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	107
rain tank (at 0.25 ft^3/ft^2)			64	267
large rain tank (0.75 ft^3/ft^2)			192	801

27 acres of roof area in 100 acres of shopping center area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	1009	3	28
rain barrel (at 0.02 ft^3/ft^2)	186	2018	5	56
many rain barrels (at 0.05 ft^3/ft^2)	465	5046	13	139
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	116
rain tank (at 0.25 ft^3/ft^2)			64	289
large rain tank (0.75 ft^3/ft^2)			192	868

5.6 acres of roof area in 100 acres of light industrial area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	209	3	6
rain barrel (at 0.02 ft^3/ft^2)	186	417	5	11
many rain barrels (at 0.05 ft^3/ft^2)	465	1043	13	29
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	24
rain tank (at 0.25 ft^3/ft^2)			64	60
large rain tank (0.75 ft^3/ft^2)			192	179

24 acres of roof area in 100 acres of school area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	894	3	25
rain barrel (at 0.02 ft^3/ft^2)	186	1787	5	49
many rain barrels (at 0.05 ft^3/ft^2)	465	4469	13	123
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	102
rain tank (at 0.25 ft^3/ft^2)			64	256
large rain tank (0.75 ft^3/ft^2)			192	769

24 acres of roof area in 100 acres of church area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	894	3	25
rain barrel (at 0.02 ft^3/ft^2)	186	1787	5	49
many rain barrels (at 0.05 ft^3/ft^2)	465	4469	13	123
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	102
rain tank (at 0.25 ft^3/ft^2)			64	256
large rain tank (0.75 ft^3/ft^2)			192	769

20 acres of roof area in 100 acres of hospital area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	741	3	20
rain barrel (at 0.02 ft^3/ft^2)	186	1482	5	41
many rain barrels (at 0.05 ft^3/ft^2)	465	3705	13	102
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	85
rain tank (at 0.25 ft^3/ft^2)			64	212
large rain tank (0.75 ft^3/ft^2)			192	637

1.8 acres of roof area in 100 acres of low density residential area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	67	3	2
rain barrel (at 0.02 ft^3/ft^2)	186	134	5	4
many rain barrels (at 0.05 ft^3/ft^2)	465	335	13	9
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	8
rain tank (at 0.25 ft^3/ft^2)			64	19
large rain tank (0.75 ft^3/ft^2)			192	58

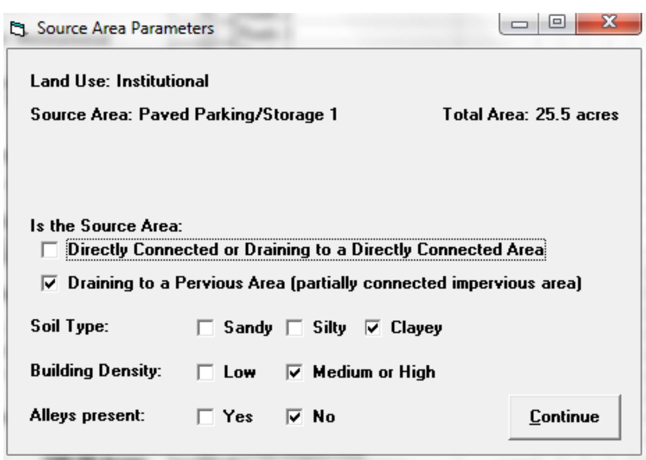
2.8 acres of roof area in 100 acres of pre 1960 medium density residential area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	104	3	3
rain barrel (at 0.02 ft^3/ft^2)	186	209	5	6
many rain barrels (at 0.05 ft^3/ft^2)	465	521	13	14
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	12
rain tank (at 0.25 ft^3/ft^2)			64	30
large rain tank (0.75 ft^3/ft^2)			192	90

4.4 acres of roof area in 100 acres of 1960 to 1980 medium density residential area	number of 35 gal barrels per acre of roof	number of 35 gal barrels per 100 acres of site	number of 6 ft dia 6 ft tall tanks per acre of roof	number of 6 ft dia 6 ft tall tanks per 100 acres of site
2.5 ft tall barrels:				
few rain barrels (at 0.01 ft^3/ft^2)	93	164	3	5
rain barrel (at 0.02 ft^3/ft^2)	186	328	5	9
many rain barrels (at 0.05 ft^3/ft^2)	465	819	13	23
6 ft tall tanks:				
small rain tank (at 0.10 ft^3/ft^2)			26	19
rain tank (at 0.25 ft^3/ft^2)			64	47
large rain tank (0.75 ft^3/ft^2)			192	141

Pavement Controls

Disconnections

Disconnections for roof runoff and for pavements are calculated in similar manners and require similar information in version 9.5. In the upcoming version 10, more direct analyses will be used to calculate the benefits of grass filters. In version 9.5, the results of extensive field monitoring at many locations having varying amounts of disconnected pavement (and roofs) were examined and compared. The model reduces the effective runoff coefficients as a function of land use, the soil type, the building density, and if alleys are present. These factors have all been found to significantly affect the drainage efficiency of an area. The following is the input screen for modifying the pavement connections for an area.

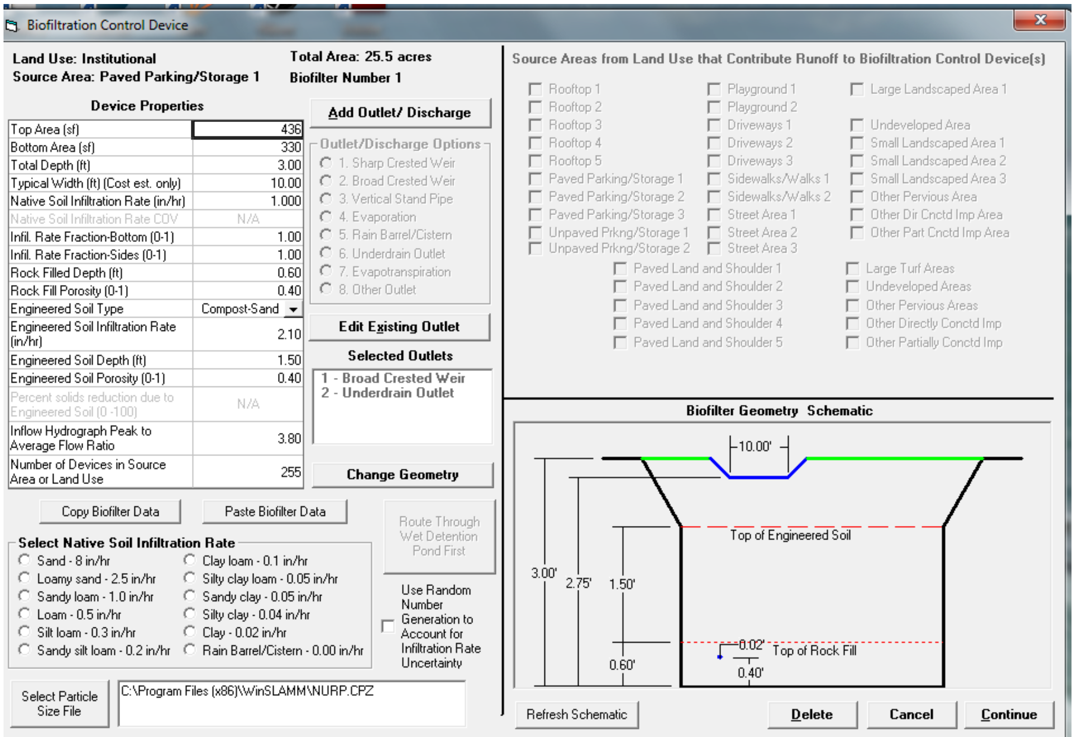


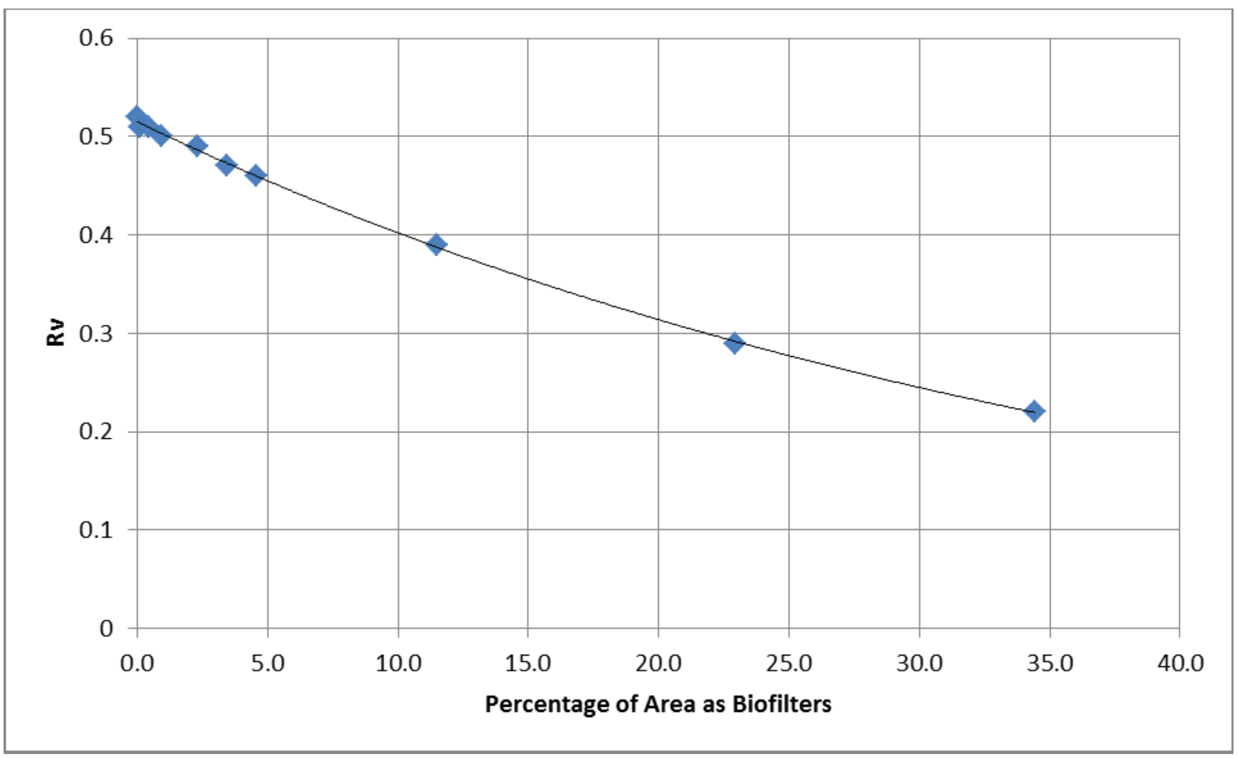
Biofiltration

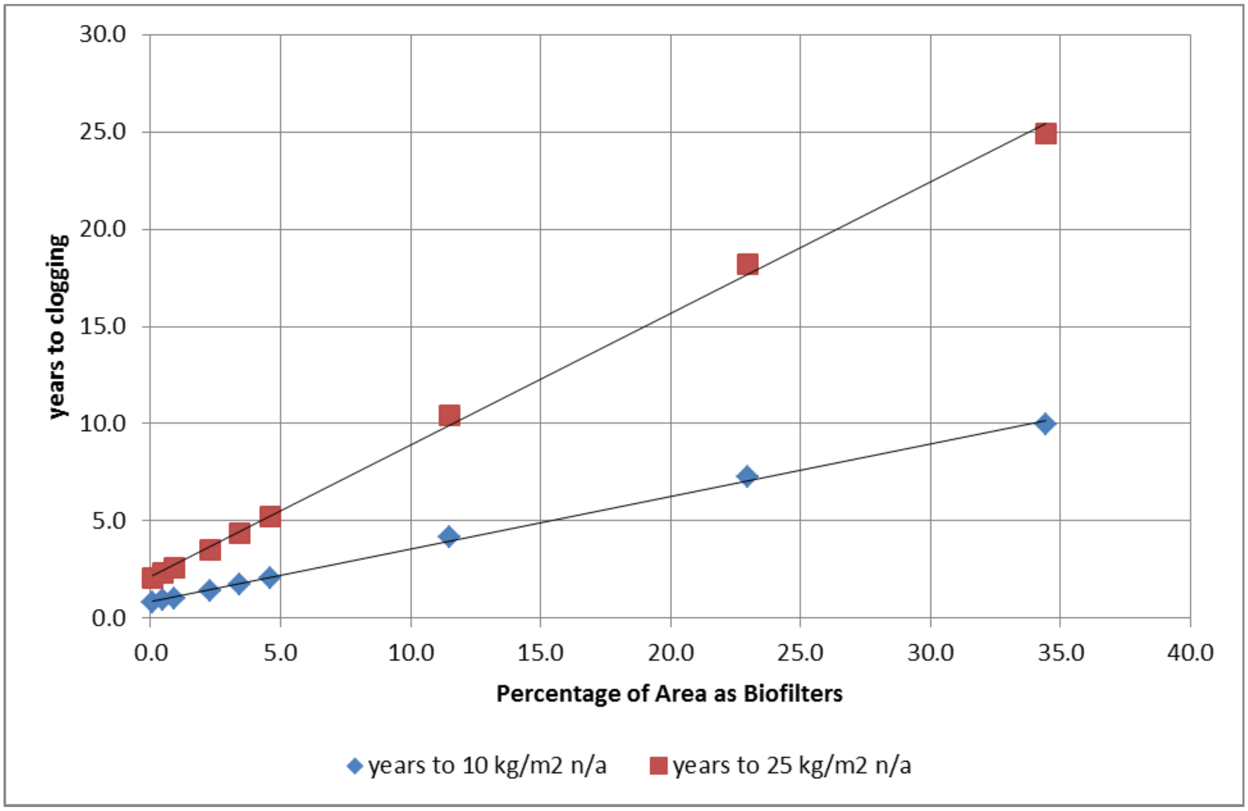
The performance of biofiltration devices is affected by several unit processes that are modeled in WinSLAMM. Modified puls hydraulic routing with surface overflow calculations are the basic processes used in the modeling of these devices. However, several layers in the biofilter are also considered. As runoff enters the device, water infiltrates through the engineered soil or media fill. If the entering rain-runoff cannot all be infiltrated through the surface layer, water will pond. If the ponding becomes deep, it may overflow through a surface outlet. The percolating water moves down through the device until it reaches the bottom and intercepts the native soil. If the native soil infiltration rate is less than the percolation water rate, then there is no subsurface ponding; if the native soil infiltration rate is slower than the percolation water rate, ponding will occur. This ponding may buildup to the surface of the device and add to the surface ponding. If an underdrain is present (usually with a subsurface storage layer), the subsurface ponding water will be intercepted by the drain which is then discharged to the surface water, but later in the event and is filtered by the media. With the water percolating through the fill, particulates and particulate-bound pollutants are trapped by the fill through filtering actions. Therefore, the underdrain water usually has a lower particulate solids content than the surface waters entering the device. The calculations are sensitive to the amounts of the different media used as fill and its characteristics (especially its porosity and percolation rate; and if evapotranspiration (ET) is used, the wilting point). The hydraulic routing uses the sum of the void volumes in the device to determine the effluent hydrograph, while the different infiltration/percolation rates affect the internal ponding. The stage-discharge relationships of the outlet devices are all modeled using conventional hydraulic processes. The ET loss calculations are based on the changing water content in the root zone at each time increment, and the ET adjustment factors for the mixture of plants in the device.

Biofilters can be used as control devices in individual source areas, in land uses, as a part of the drainage system or at the outfall. If modeled as an outfall biofilter, the biofiltration control can be used with an upstream wet detention pond for pretreatment. To model biofilters in a source area, as in these examples, the geometry and other characteristics of a typical biofilter are described, then the number of biofilters in the source area is entered. The model divides the total source area runoff flows by the number of biofilters in the source area, creates a complex triangular hydrograph for that representative flow fraction that is then routed through that biofilter, and then multiplies the resulting losses by the number of biofilters for the total source area.

The following is the WinSLAMM input form for the biofilters that were examined. The biofilters described on this form were located in paved parking areas, and contains a SmartDrain. The production functions were prepared by varying the number of these standard sized units. The total area of the devices is the critical measure of application of the biofilters.


Biofiltration Control Device
Land Use: Institutional
Source Area: Paved Parking/Storage 1
Total Area: 25.5 acres
Biofilter Number 1
Device Properties
Top Area (sf) 436
Bottom Area (sf) 330
Total Depth (ft) 3.00
Typical Width (ft) (Cost est. only) 10.00
Native Soil Infiltration Rate (in/hr) 1.000
Native Soil Infiltration Rate COV N/A
Infil. Rate Fraction-Bottom (0-1) 1.00
Infil. Rate Fraction-Sides (0-1) 1.00
Rock Filled Depth (ft) 0.60
Rock Fill Porosity (0-1) 0.40
Engineered Soil Type Compost-Sand
Engineered Soil Infiltration Rate (in/hr) 2.10
Engineered Soil Depth (ft) 1.50
Engineered Soil Porosity (0-1) 0.40
Percent solids reduction due to Engineered Soil (0 -100) N/A
Inflow Hydrograph Peak to Average Flow Ratio 3.80
Number of Devices in Source Area or Land Use 255
Add Outlet/ Discharge
Outlet/Discharge Options
1. Sharp Crested Weir
2. Broad Crested Weir
3. Vertical Stand Pipe
4. Evaporation
5. Rain Barrel/Cistern
6. Underdrain Outlet
7. Evapotranspiration
8. Other Outlet
Edit Existing Outlet
Selected Outlets
1 - Broad Crested Weir
2 - Underdrain Outlet
Change Geometry
Copy Biofilter Data
Paste Biofilter Data
Route Through Wet Detention Pond First
Select Native Soil Infiltration Rate
Sand - 8 in/hr
Loamy sand - 2.5 in/hr
Sandy loam - 1.0 in/hr
Loam - 0.5 in/hr
Silt loam - 0.3 in/hr
Sandy silt loam - 0.2 in/hr
Clay loam - 0.1 in/hr
Silty clay loam - 0.05 in/hr
Sandy clay - 0.05 in/hr
Silty clay - 0.04 in/hr
Clay - 0.02 in/hr
Rain Barrel/Cistern - 0.00 in/hr
Use Random Number Generation to Account for Infiltration Rate Uncertainty
Select Particle Size File
C:\Program Files (x86)\WinSLAMM\NURP.CPZ
Source Areas from Land Use that Contribute Runoff to Biofiltration Control Device(s)
Rooftop 1
Rooftop 2
Rooftop 3
Rooftop 4
Rooftop 5
Paved Parking/Storage 1
Paved Parking/Storage 2
Paved Parking/Storage 3
Unpaved Prkng/Storage 1
Unpaved Prkng/Storage 2
Playground 1
Playground 2
Driveways 1
Driveways 2
Driveways 3
Sidewalks/Walks 1
Sidewalks/Walks 2
Street Area 1
Street Area 2
Street Area 3
Large Landscaped Area 1
Undeveloped Area
Small Landscaped Area 1
Small Landscaped Area 2
Small Landscaped Area 3
Other Pervious Area
Other Dir Cnctd Imp Area
Other Part Cnctd Imp Area
Paved Land and Shoulder 1
Paved Land and Shoulder 2
Paved Land and Shoulder 3
Paved Land and Shoulder 4
Paved Land and Shoulder 5
Large Turf Areas
Undeveloped Areas
Other Pervious Areas
Other Directly Cnctd Imp
Other Partially Cnctd Imp
Biofilter Geometry Schematic
10.00'
Top of Engineered Soil
3.00'
2.75'
1.50'
0.02'
Top of Rock Fill
0.60'
0.40'
Refresh Schematic
Delete
Cancel
Continue


Rv
0.6
0.5
0.4
0.3
0.2
0.1
0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Percentage of Area as Biofilters

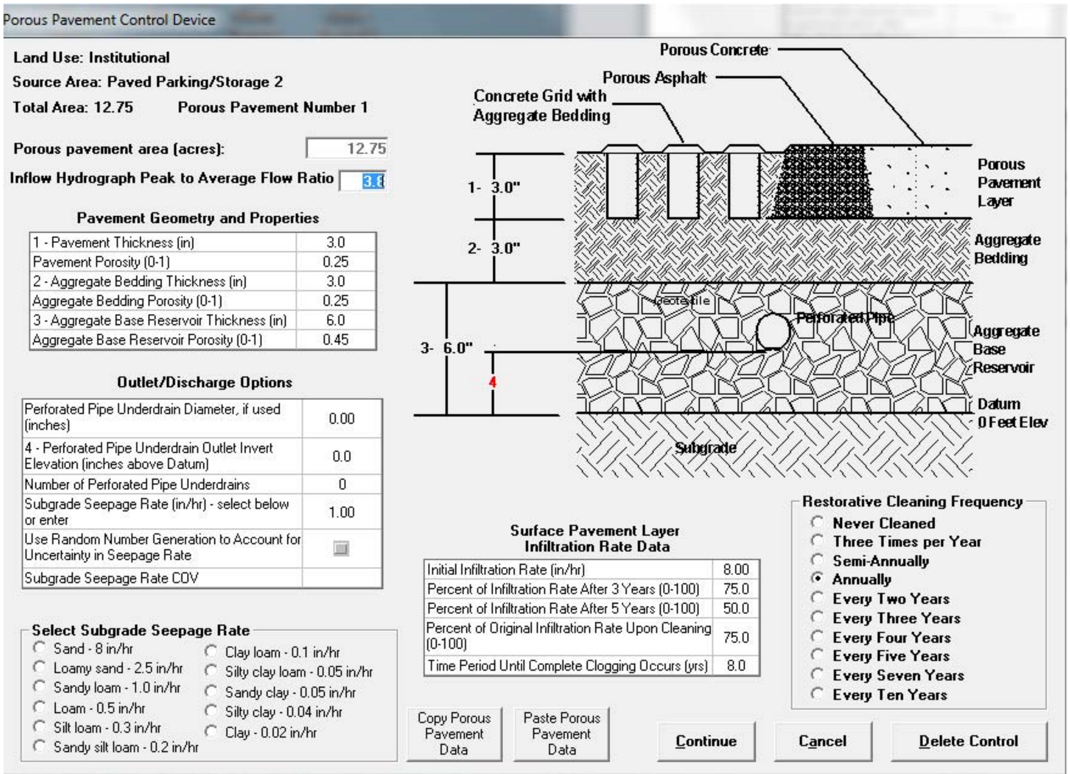


The above production functions were based on typical pavement conditions and relate the area of the paved area dedicated as biofilters to their expected performance. In this example, almost 25% of the paved area would have to be dedicated as biofilters to produce about half the runoff compared to an uncontrolled area, a clearly unworkable option. When examining the clogging potential of biofilters for very dirty paved parking areas, biofilters between about 12 and 34% of the area are needed to prevent clogging loadings (assumed to be between 10 and 25 kg/m^2 within a 10 year period of time). Cleaner sites could have smaller biofilters, while even dirtier sites would need larger biofilters in order to have a ten year service life, assumed to be the goal for these areas. Pretreatment is another option to extend the service life of the biofilters. Pollutant reductions are maximized when the biofilters are about 10% of the area, with no further benefits.

These production functions were used to select the range of biofilters to use for treating paved areas in the different land uses. For clay loam soil conditions, the biofilters examined were 3, 10, and 25% of the paved contributing area, while for sandy soil conditions, the biofilters examined were 3 and 10% of the paved areas.

Porous Pavement

Porous pavement structures can be designed to totally eliminate all runoff from the area covered by the porous pavement. WinSLAMM version 9.5 doesn't allow any run-on to the porous pavement; only rainfall directly onto the porous pavement is considered. Version 10 does allow run-on from adjacent areas. The following screen shows the information entered to analyze porous pavements:



The following is a summary from the porous pavement HELP screens in WinSLAMM: The porous pavement control option uses full routing calculations associated with pond storage in conjunction with other porous pavement features. The “outlet” options for porous pavement include subgrade seepage as well as an optional underdrain, which is modeled as an orifice. The porous pavement control device option also has a surface seepage rate that limits the amount of runoff that can enter the storage system. This surface seepage rate can be reduced to account for clogging over time, and the surface seepage rate can be partially restored with cleaning at a stated cleaning frequency. The porous pavement control device infiltrates water originating from the rainfall hitting the pavement surface area only - it does not accept run-on from other surfaces. The runoff volume reaching the porous pavement surface is therefore equal to the rainfall volume directly falling on the porous pavement. The porous pavement surface area can be any suitable porous pavement material, including paver blocks, porous concrete, porous asphalt, or any other porous surface or just turf reinforcement. Porous pavements are usually installed over a subsurface storage layer that can dramatically increase the infiltration performance of the device.

The porous pavement control option can be used as a control device only in individual source areas. Porous pavements are usually located at paved parking and storage areas, paved playgrounds, paved driveways, or paved walkways. They should be used only in relatively clean areas (walkways or driveways or other surfaces that receive little traffic, for example), to minimize groundwater contamination potential. Porous pavements direct the infiltrating water to subsurface soil layers, usually beneath much or the organic surface soils that tend to sorb many pollutants. Salts used for ice control in northern areas are also problematic when considering infiltrating stormwater. Therefore, only use porous pavements in areas needing minimal salt applications. Consider biofiltration devices to infiltrate water from more contaminated sites, as they can use amended soils to help trap contaminants before infiltration, or use other appropriate pre-treatment before infiltration. No common pretreatment device is suitable for the removal of salts, however, so minimal use is the preferred control option in that case.

Pavement Geometry and Properties:

1. Pavement thickness (inches): Enter the thickness of the surface pavement.

2. Pavement porosity (unit less): Enter the porosity (the ratio of air volume to total volume) of the surface pavement. This ratio can range from zero to one.

3. Aggregate bedding thickness (inches): Enter the thickness of the aggregate bedding layer.

4. Aggregate bedding porosity (unit less): Enter the porosity (the ratio of air volume to total volume) of the aggregate bedding. This ratio can range from zero to one.

5. Aggregate base reservoir thickness (inches): Enter the thickness of the aggregate base reservoir.

6. Aggregate base reservoir thickness porosity (unit less): Enter the porosity (the ratio of air volume to total volume) of the aggregate base reservoir thickness. This ratio can range from zero to one.

Outlet/Discharge Options:

7. Underdrain diameter (inches): Enter the diameter of the underdrain. This is an optional outlet. The model calculates flow through the underdrain as an orifice; it assumes that the discharge flow is not limited by friction through underdrain pipe slots or pipe friction (the water velocity is usually very slow). Any water entering the underdrain is re-directed to surface flows; it is not infiltrated. WinSLAMM adds this runoff volume (and associated pollutants) back to the surface drainage system. An underdrain is usually specified to minimize ponding on the surface of the porous pavement such as when the aggregate grade base reservoir nears capacity.

8. Underdrain outlet invert elevation (inches above datum): Enter the elevation of the invert of the underdrain outlet. The model assumes that all porous pavement surfaces are flat and that the underdrains also have minimal gradient.

9. Number of underdrains. Enter the number of underdrains in the porous pavement control device.

10. Subgrade seepage rate (in/hr): Enter the subgrade seepage rate. Default values for selected soil types are listed in the radio buttons below the data entry table, or you can enter your own values, if known. You can also vary this value stochastically by electing to use the random number generator.

11. Random number generator: Check this box to generate a random subgrade seepage value for each rainfall event. These values are randomly generated based upon a log normal distribution.

12. Subgrade seepage rate COV: Enter the Coefficient of Variation (COV) for the seepage rate you are using if you intend to generate seepage rates stochastically. The COV values are given if you use the radio buttons to select the seepage rate, and are based on numerous field tests. Soil seepage rates can vary greatly over short distances, even for the same soil textures, usually due to compaction, roots, soil animals, etc.

Surface Pavement Layer Infiltration Rate Data:

13. Initial infiltration rate (in/hr): Enter the infiltration rate through the surface layer when the pavement was newly installed. Any rain having intensities greater than this initial infiltration rate will not enter the porous pavement structure, but will run off. The rain intensities are calculated using the complex triangular distribution in WinSLAMM. Initial infiltration rates for porous pavements are usually very large (ranging from 5 to 20, or even more, in/hr, based on the specifications for the material used).

14. Percent of infiltration rate after three years (0-100): Enter the percent of the initial surface infiltration rate you expect the surface to have after three years without cleaning. If you expect it to maintain the initial rate, then enter 100. This, and the next parameter, determines how fast the pavement surface water infiltration rate degrades with time. This value is highly dependent on the type of pavement material Paver blocks may clog more slowly; areas with more traffic clog faster; tracking of mud or other debris also hastens clogging; many site factors affect long-term performance, and this value should be based on regional monitoring for similar conditions and similar porous pavement materials. A suitable value may be about 75%, indicating a 25% reduction over the first three years of porous pavement life.

15. Percent of infiltration rate after five years (0-100): Enter the percent of the initial surface infiltration rate you expect the surface to have after five years without cleaning. If you expect it to maintain the initial rate, then enter 100. This factor is also dependent on site conditions. A suitable factor may be 50% after five years.

16. Percent of original infiltration rate restored upon cleaning (0-100): Enter the percent of the initial surface infiltration rate the surface will have after it is cleaned. If there is more than one cleaning, the surface infiltration rate will return to this percentage of the initial rate after every cleaning. If you expect it to maintain the initial rate, then enter 100. In most cases, typical porous pavement restorative cleaning activities cannot completely restore the initial rate. However, this factor should also be determined locally. A suitable value may be about 85%, but can vary widely.

17. Time period until complete clogging occurs (years): This is the time when complete failure of the surface infiltration rate occurs. It can be regenerated to whatever percent of the initial infiltration rate you entered for the previous variable upon cleaning. This is also dependent on local conditions. With no cleaning, most porous pavements are expected to eventually completely clog. A value of about 10 years may be a suitable value.

18. Restorative cleaning frequency: Enter how often the porous pavement surface will be cleaned. All stormwater controls need maintenance, and porous pavement is no exception. Commercial paved areas may be cleaned quite frequently to remove large debris, but standard pavement cleaning is usually not adequate to maintain an acceptable infiltration rate. Special cleaning operations are needed, but may be much less frequent. Consult the manufacture of the porous pavement for proper cleaning techniques and frequencies. Once a year may be a suitable value, but will depend on local conditions.

The storage provided by the pore space in the pavement (asphalt, concrete, block, or turf reinforcement grids) plus in the bedding and in the storage rock reservoir easily exceeds the depth of rain for even the most severe rains in an area. The reservoir volume than needs to drain through the underlying natural soils before the next rain, or the storage volume is reduced. In these calculations, all porous pavements are 3 inches thick with a 3 inch bedding layer and a 6 inch storage layer. They were used for half of the paved parking areas, in the assumed overflow parking areas that receive little parking. Due to groundwater concerns, porous pavement was not considered in areas having heavy traffic or parking. These were assumed to be cleaned yearly. The model used a decreasing rate of infiltration as the porous pavement aged, and good recovery was obtained when cleaned. The largest detriments to porous pavements include:

1) high costs, especially when retrofitting in an existing paved area

2) relatively high efficiency of transport of contaminants to the subsurface areas

3) cleaning is needed to maintain high infiltration rates

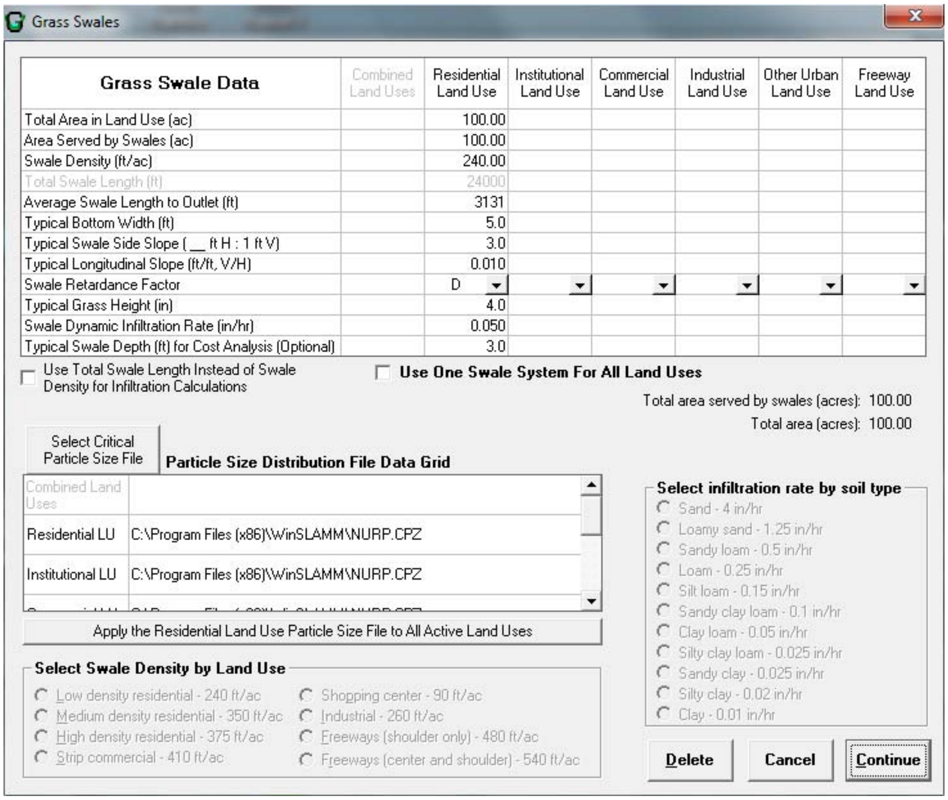
Street Side Drainage Controls

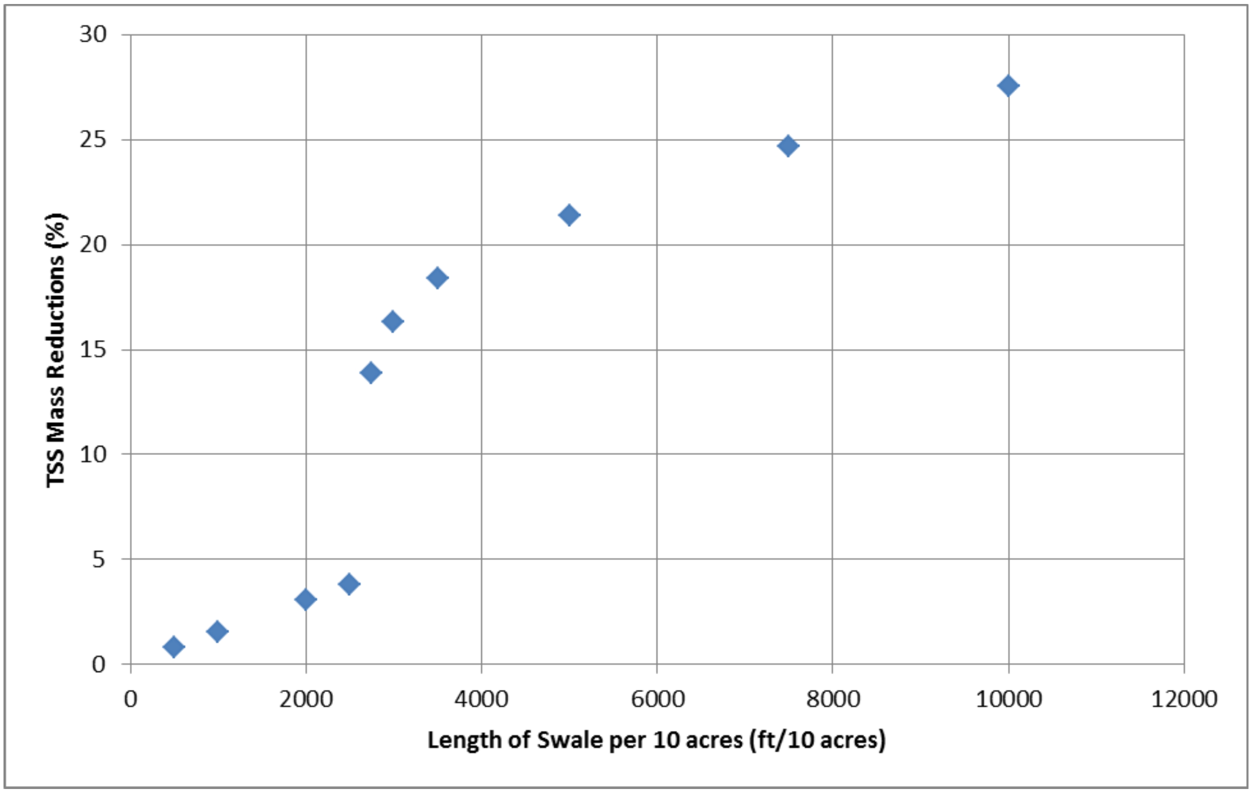
Grass Swales

Grass filters have broad, shallow flows, while grass swales have concentrated flows. Grass filters are modeled as a special case of grass swales in version 9.5 of WinSLAMM. The model calculations are based on extensive pilot-scale and field measurements of grass swales and filters conducted for the Alabama Dept. of Transportation. The algorithms used to determine the Manning's n values used in grass swale hydraulic calculations were developed from the master's thesis work by Jason Kirby (Kirby, J.T., S.R. Durrans, R. Pitt, and P.D. Johnson. "Hydraulic resistance in grass swales designed for small flow conveyance." Journal of Hydraulic Engineering, Vol. 131, No. 1, Jan. 2005.) as part of a WERF-supported research project: Johnson, P.D., R. Pitt, S.R. Durrans, M. Uremia, and S. Clark. Metals Removal Technologies for Urban Stormwater. Water Environment Research Foundation. WERF 97-IRM-2. ISBN: 1-94339-682-3. Alexandria, VA. 701 pgs. Oct. 2003. The particle trapping algorithms were based on the master's thesis research conducted by Yukio Nara (Nara, Y., R. Pitt, S.R. Durrans, and J. Kirby. "Sediment transport in grass swales." In: Stormwater and Urban Water Systems Modeling. Monograph 14. edited by W. James, K.N. Irvine, E.A. McLean, and R.E. Pitt. CHI. Guelph, Ontario, pp. 379 402. 2006.), supported by the University Transportation Center for Alabama: "Alabama Highway Drainage Conservation Design Practices - Particulate Transport in Grass Swales and Grass Filters", by Yukio Nara and Robert Pitt, University Transportation Center for Alabama, University of Alabama, Tuscaloosa, Alabama, November, 2005.

Grass swale performance is determined by routing a complex triangular hydrograph through the swales described in the model by the user. Runoff volume reductions are determined by infiltration losses, and particulate losses are determined through particle trapping. Runoff volume is reduced by the dynamic infiltration rate of the swales for each six minute time step of the hydrograph. The flow and the swale geometry are used to determine the Manning's n to iteratively determine the depth of flow in the swale for each time step, using traditional VR-n curves that were extended by Kirby to cover the smaller flows found in typical drainage swales. Using the calculated depth of flow for each time increment, the model calculates the wetted perimeter (based on the swale cross-sectional shape) which is then multiplied by the total swale length to determine the area used to infiltrate the runoff. The settling frequency and resultant particulate trapping is calculated for each of the thirty-one particle size fractions in the selected particle size distribution file. The resulting particulate concentrations are then combined into one of eight groups of particle sizes, where it is evaluated to determine if it is below the irreducible concentration values for each particle size group. No resulting concentration values are allowed to go below the irreducible concentration values unless the inflow value is already below that level. For grass swales, no particles smaller than 50 µm are trapped due to turbulent resuspensions of the small particles.

The following is the grass swale information screen in WinSLAMM used in these calculations. The swale density (and resulting total swale length) was varied to develop the production function curves that describe swale performance by swale density for the different land uses.

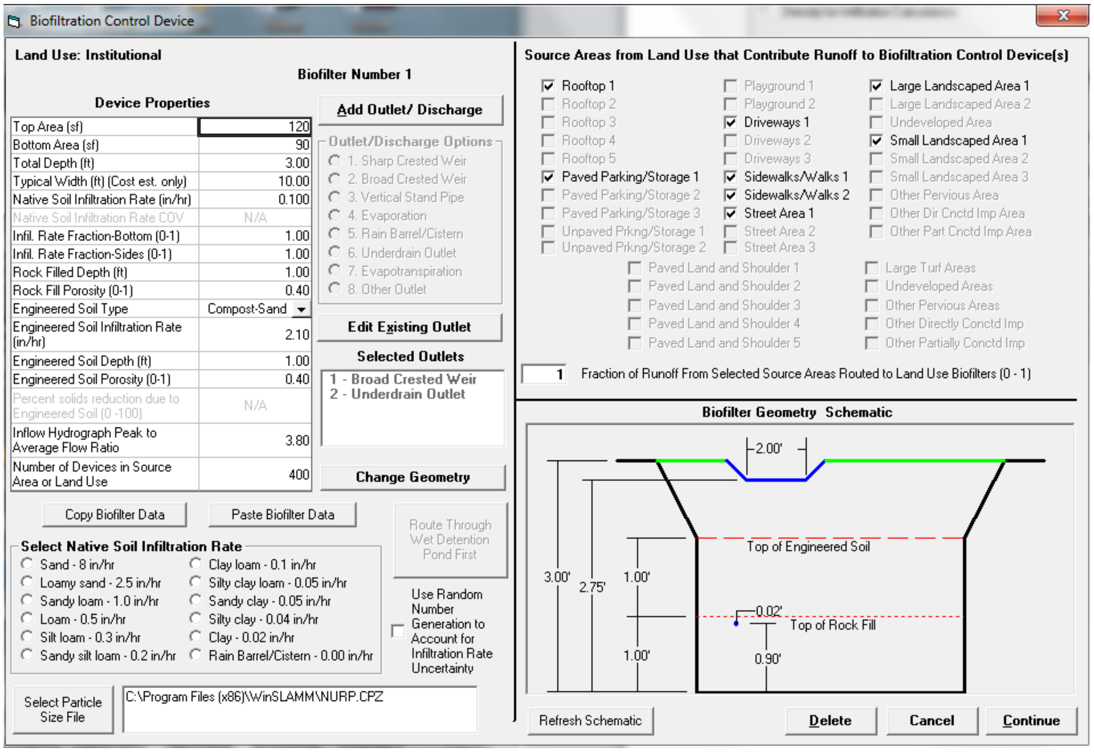




The above production functions show the resulting TSS reductions after treatment in grass swales. The lengths of the swales are shown as length per area (ft per 10 acres). Similar to the biofilters, the benefits of grass swales in reducing runoff volumes is limited because of compacted soils. The plot of TSS mass reductions shows that two mechanisms are responsible for sediment removal. For short swales, the sediment reduction is only associated with the volume reduction of the flowing water. After about 2,800 ft/10 acres, sediment deposition also occurs after sufficient length is available to overcome scour, after about 3,000 ft/10 acres, the sediment reductions change less rapidly.

Curb-cut Biofilters

The mechanisms available for treatment of stormwater in curb-cut biofilters are the same as previously described for parking area biofilters. For these devices, the curb face is cut and the water is allowed to flow into an excavation adjacent to the curb line, usually in an area between the sidewalks and the streets. If this area is too narrow, a curb-extension biofilter may be used. In this case, the excavated area extends out into the street, usually consuming a section of the parking lane. The earlier production functions were examined and sizes of these devices for the Lincoln land uses were determined. Curb-cut biofilters consuming 20, 40, and 80% of the length of the curb length were examined in these calculations, for both clay loam and sandy loam soil conditions in the biofilters, for each land use. The following is the input screen used for these controls:



Public Works Practices

Street Cleaning

The street cleaning control option can be applied to streets and alleys. There are two options for entering in street cleaning dates. 1) Enter Street Cleaning Dates, or 2) Enter a Street Cleaning Frequency. Note that if a street cleaning event occurs on the same day as a rainfall event (such as on April 1 when the 'One Pass Each Spring' option is selected), then the street cleaning event is cancelled for that event.

• Entering a street cleaning frequency. Select the 'Street Cleaning Frequency' check box, and then the desired frequency. This frequency will be applied from the beginning date to the ending date of the model run. The spring pass occurs on the day that the winter season ends during every year in the model run. The fall pass occurs on October 31st of every year of the model run.

· Type of Street Cleaner. Select the type of street cleaner. The program will enter the proper coefficients M and B after you have selected the street cleaner productivity, parking density and parking control option.

· Street cleaning productivity. Select the default productivity by entering the parking density and the parking control status. The parking density options are:

1. None - There is no parking along the street being swept.
2. Light - There is significant spacing between parked cars such that street cleaners can easily get to the curb, between cars, for significant sections of the street.
3. Medium - There is enough spacing between parked cars such that street cleaners can get to the curb for at least some sections of the street.
4. Extensive (short term) - There is not enough space between cars to allow street cleaners to get to the curb for some time during a 24-hour period.

5. Extensive (long term) - There is not enough space between cars to allow street cleaners to get to the curb. This condition persists for most or all of a 24-hour period.

· The parking control status indicates whether parking options such as limited parking hours or alternate side-of-the-street parking have been regulated by the municipality.

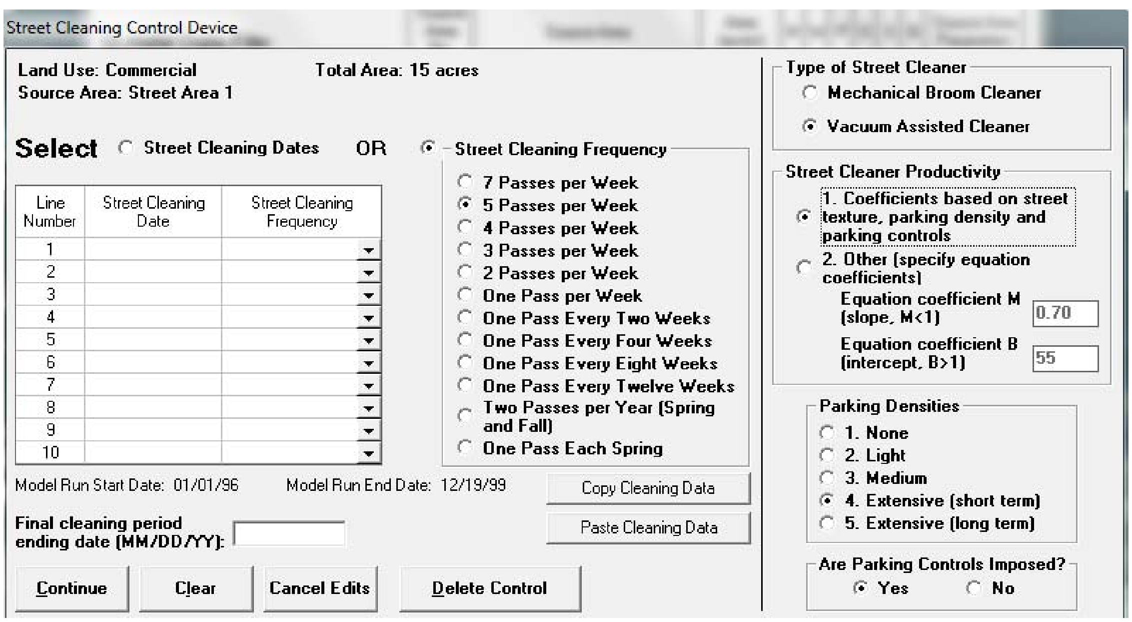
· Street cleaner productivity can also be described by entering the equation coefficients for the linear street cleaning equation, Y = mx + b, where is Y is the residual street dirt loading after street cleaning and x is the before street cleaning load (in lbs/curb-mile). Enter values for:

· m (slope, less than 1)

· b (intercept, greater than or equal to 1)

Where m is the minimum removal fraction, or street cleaning effectiveness, and b is the minimum street dirt loading, after intensive street cleaning.

The following is the street cleaning data entry screen used for these analyses:

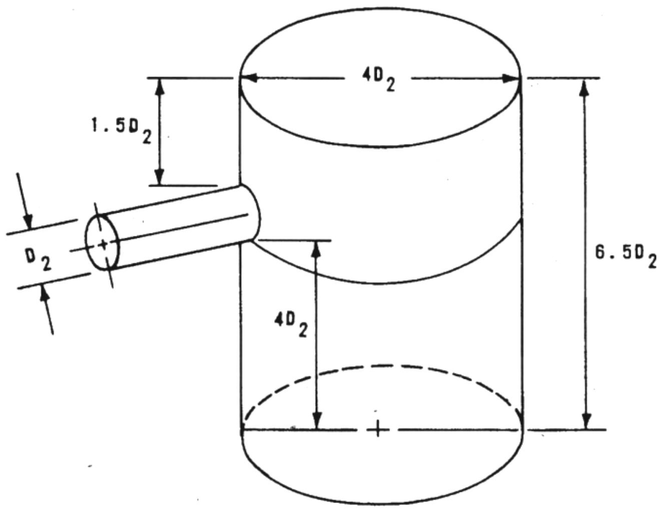


Catchbasin Cleaning

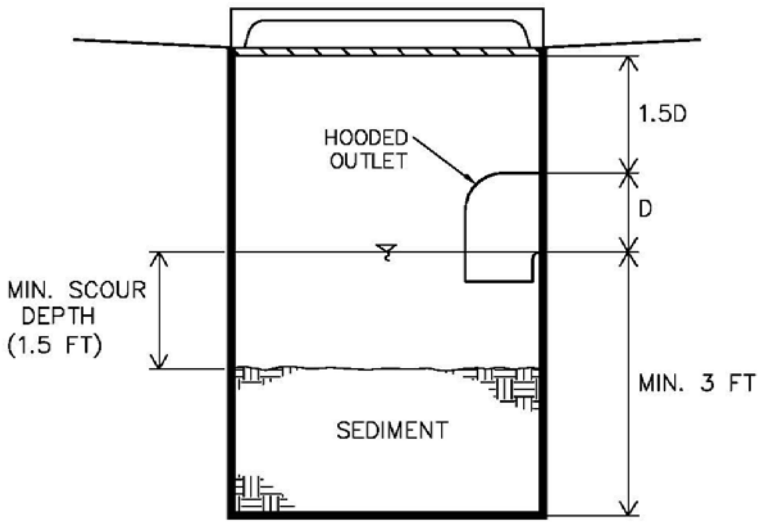
Catchbasins are chambers or sumps installed in a storm sewer, usually at the curb stormwater inlet to the drainage system. Catchbasins have a sump area below the inlet intended to retain captured sediment. By trapping coarse sediment, the catchbasin prevents trapped solids from clogging the sewer or being washed into receiving waters. However, the sumps must be cleaned out periodically to maintain their sediment trapping ability.

Catchbasins with sumps are effective for trapping coarse sediment and large debris and trash. If outfitted with hoods over the outlets, the capture of floatables and other litter can be improved. In addition to reducing sediment loads, catchbasin cleaning may also reduce the load of oxygen demanding substances that reach surface water. However, in the absence of suitable cleaning, they may make water quality worse due to the degradation of captured material.

Catchbasin performance is calculated by assuming flow through a settling area defined by the surface area of the catchbasin. The particulate removal in this settling area is assumed to occur due to ideal settling as described by Stokes Law (for laminar flow), or Newton's law (for turbulent flow). Catchbasin performance has been monitored during many field trials during EPA-sponsored research, and by other international researchers. Metcalf and Eddy (Lager, et al. 1977) developed an idealized catchbasin geometry based on laboratory and field experiments, as shown below:



According to this diagram, if the outlet diameter is 12 inches, the total height of the device should be at least 6.5 feet, the diameter of the manhole would be 48 inches, and the bottom edge of the outlet pipe would be located 48 inches above the device bottom and 18 inches below the top. In almost all full-scale field investigations, this design has been shown to withstand extreme flows with little scouring losses, no significant differences between supernatant water quality and runoff quality, and minimal insect problems. It will trap the bed-load from the stormwater (especially important in areas using sand for traction control) and will trap a low to moderate amount of suspended solids (about 30 to 45% of the annual loadings). The largest size fractions of the sediment in the flowing stormwater will be trapped (typically larger than 50 µm), in preference to the finer material that has greater amounts of associated pollutants. Their hydraulic capacities are designed using conventional procedures (grating and outlet dimensions), while the sump is designed based on the desired cleaning frequency. Pitt and Khambhammettu reviewed the performance of catchbasins from many sources, and recommended a basic catchbasin configuration having an appropriately sized sump with a hooded outlet. The following is the basic recommended configuration showing the hooded outlet for enhanced floatable control:

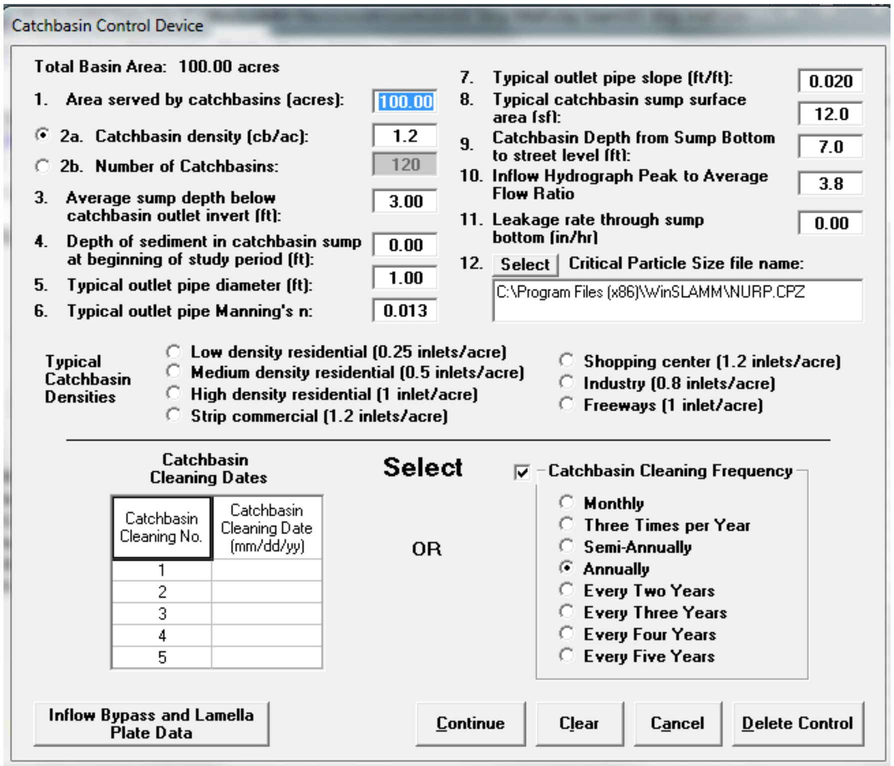


If the water velocity through the catchbasin is slow, slowly falling particles can be retained. If the water velocity is fast, then only the heaviest (fastest falling) particles are likely to be retained. The critical particle settling velocity is equal to the ratio of the discharge water rate to the surface area of the catchbasin. Particles having settling velocities greater than this ratio will be removed. Only increasing the surface area or decreasing the outflow rate will increase settling efficiency. Increasing the catchbasin sump depth does lessen the possibility of bottom scour and increases the estimated time between sump cleanings. Since the settling velocity increases as particle size increases (using Stokes or Newton's law and appropriate shape factors, specific gravity and viscosity values), the catchbasin water quality performance (or percent removal) is determined from the particle size distribution of the solids in the runoff entering the catchbasin. This is done by determining the settling velocity and then calculating the particle size associated with that settling velocity, which is referred to as the critical particle size. The percent of the particles that will settle is then determined from the particle size distribution of the total suspended solids (TSS) concentration of the sediment in the stormwater runoff.

Field test results indicate that the performance of catchbasins is strongly related to the inflowing water rate. The standard surface-overflow-rate (SOR) approach used in water and wastewater treatment facilities, and in sedimentation controls in WinSLAMM, normalizes the inflowing water rate with the surface area of the catchbasin. Detailed scour tests (computational fluid dynamics modeling and full-scale tests) were conducted to verify this approach and to measure critical scour conditions (Avila, H., R. Pitt, and S.E. Clark).

The model assumes that catchbasins with sumps are located at inlets or with minimal flow-through capability. Sumps that are constructed in series would have increasingly larger flow rates in each device, which is not what the program would be modeling. This condition may be evaluated by creating a series of .dat files for the catchbasin series. Each catchbasin would include separate source areas for the upstream drainage areas and the contributing drainage areas. To evaluate flow but not loading in each file, the upstream source areas should have the other control practice activated with 100% control of solids, only. This will allow the program to evaluate each catchbasin with the appropriate flow, from all source areas, while accounting for the loading only from the immediately contributing area.

The following is the data entry form for catchbasins in WinSLAMM:



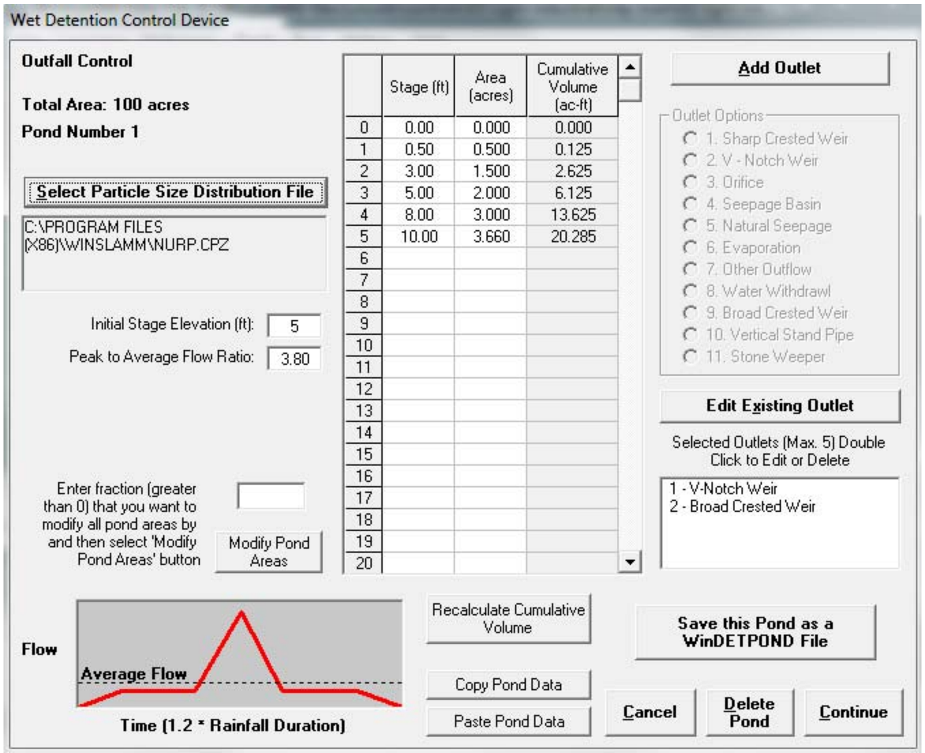
Outfall Controls

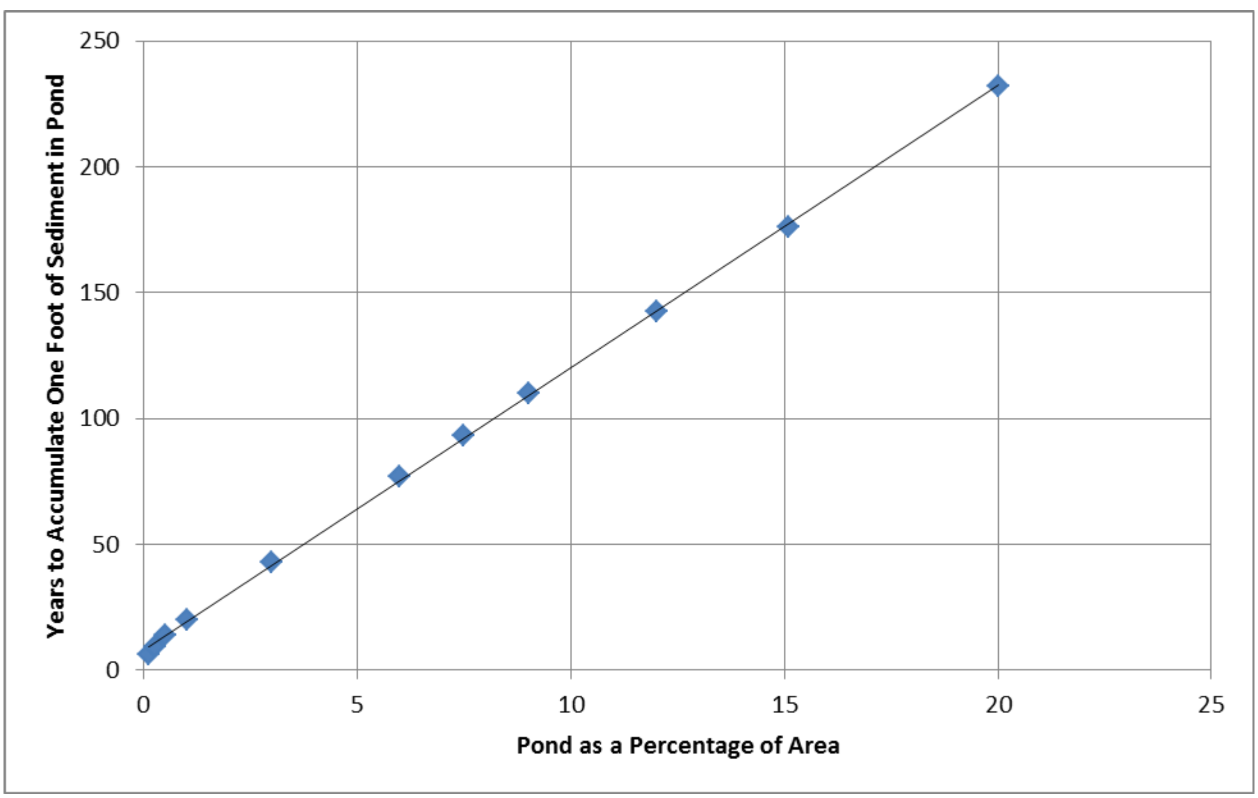
Wet Detention Ponds

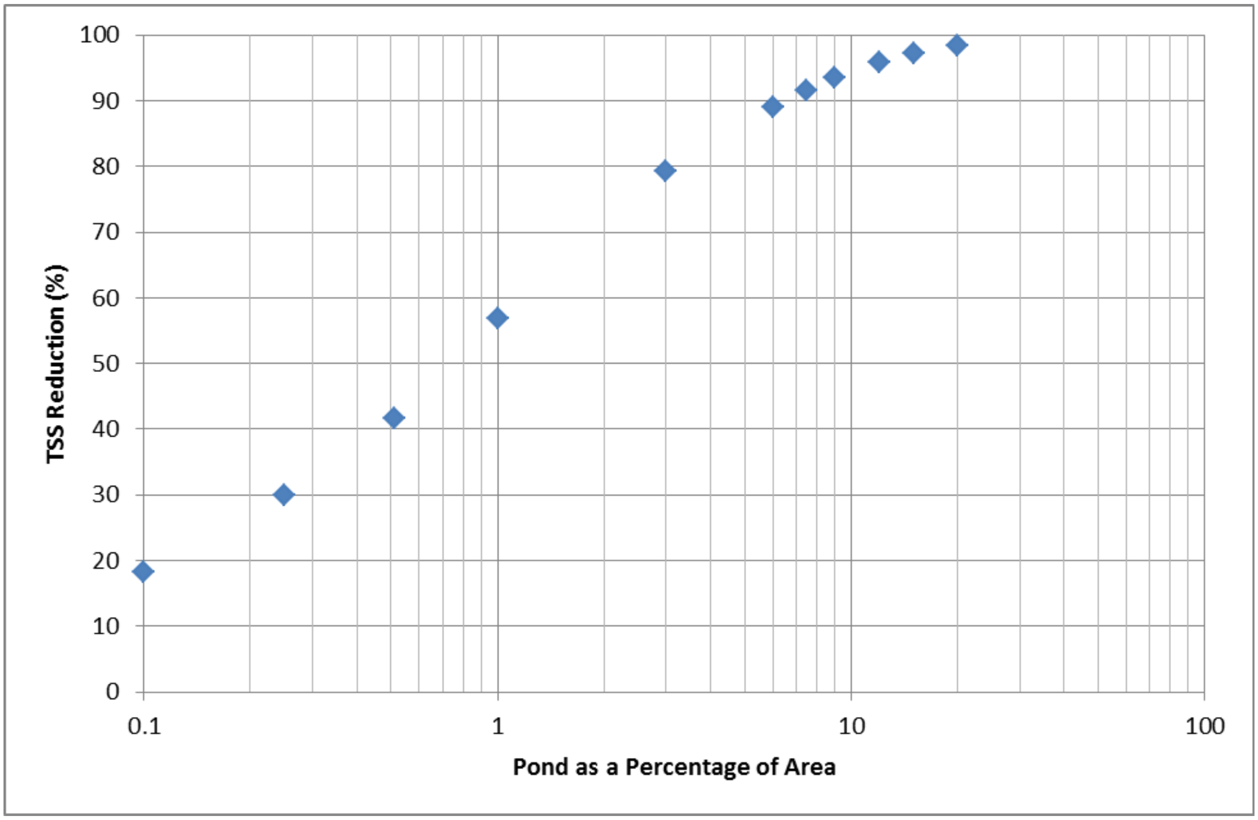
Wet detention ponds are probably the most common management practice for the control of stormwater runoff quality. If properly designed, constructed, and maintained, they can be very effective in controlling a wide range of pollutants and peak runoff flow rates. There is probably more information concerning the design and performance of detention ponds in the literature than for any other stormwater control device. Wet detention ponds are a very robust method for reducing stormwater pollutants. They typically show significant pollutant reductions as long as a few design-related attributes are met. Many details are available to enhance performance, and safety, that should be followed. Many processes are responsible for the pollutant removals observed in wet detention ponds. Physical sedimentation is the most significant removal mechanism.

WinSLAMM uses conventional procedures to calculate hydraulic conditions (pond storage-indication routing) and the behavior of particulates in stormwater as it passes through a detention pond (surface overflow rates described by the Hazen equation and quiescent settling using Stoke’s and Newton’s laws). WinSLAMM was specifically developed for continuous long-term evaluations using lengthy rain series. Whereas most computer-based pond models require time increment direction from the user and frequently crash due to unstable algorithms, WinSLAMM predicts reasonable calculation increments based on the duration of each rain and interevent period. If the calculation appears to approach unstable conditions, it automatically starts over with a smaller calculation increment. In addition, if the pond design is too small or if the outfall is inadequate, causing catastrophic overflow conditions, the program doesn’t crash, but continues using the last known outfall or surface area value, and notes that the pond overflowed. The tabular output of the model can also be easily imported into spreadsheets and graphing programs to produce statistical summaries of the pond performance.

The following screens are used to enter information pertaining to a wet detention pond for analysis with WinSLAMM. The following production functions were prepared by varying the surface area of the pond for different analysis trials.







The wet detention pond is the most effective control for particulate pollutants, as it is usually able to reduce the sediment down to much smaller particle sizes than either biofilters or swales. Wet detention ponds, however, do not provide any volume reductions. It would take about 50 years to accumulate a foot of sediment (average depth) in a pond that is about 3% of the drainage area (a typical size for an industrial area) for typical conditions. With the dirtier sites, the sediment accumulation rate would be much greater. The percentage TSS reductions are much greater for wet detention ponds than for the swales or biofilters. A pond that is 3% of the drainage area would result in about 80% TSS reductions, while about 6.5% of the site would be needed for the pond if the TSS reduction was 90%.

Combinations of Stormwater Control Practices

Combinations of stormwater controls can usually be more effective than individual practices. For biofilters, swales, and wet detention ponds, the increased benefit over the use of ponds alone in minor. However, the other controls can be effective pre-treatment to minimize maintenance in the pond. Again, in this example, the accumulation rate of sediment in the pond is relatively low, so this pre-treatment benefit may not be necessary.

Small wet ponds were used in up to five combinations of stormwater controls:

1) small wet detention ponds and curb-cut biofilters along 40% of the curbs
2) small wet detention ponds and biofilters that are 10% of the paved parking areas (or rain gardens that area 15% of the roof areas in residential areas)
3) small wet detention ponds and medium sized rain tanks to irrigate landscaped areas
4) small wet detention ponds and grass swales

5) small wet detention ponds, curb-cut biofilters along 40% of the curbs, and parking lot biofilters 10% of the paved parking area, or roof gardens that are 15% of the roof areas

As noted, small and moderate-sized controls were examined in combination with each. These are usually the most cost-effective.

Variability and Uncertainty

WinSLAMM contains various Monte Carlo components that enable uncertainly to be evaluated during the model runs. These are available for the infiltration rates for the various infiltration and biofiltration devices, and for the pollutant concentrations. During field investigations, these model parameters have been recognized as having the greatest variabilities that are not explained by the model. The Monte Carlo elements are described by probability distributions, with average and coefficient of variability values (COV) provided, and assumes log-normal distributions of the actual values. If these uncertainty options are selected, the model randomly selects a value of the parameter from this distribution for each rain event. The long-term simulations therefore result in calculated concentrations and loadings of the constituents and the runoff volumes that vary in a similar manner as observed during monitoring. For the calculations in this report, when different options are being compared, the Monte Carlo option was not used as that may affect the average ordering of the different options. However, several different scenarios were repeatedly analyzed and the different concentrations and loads were examined to estimate the likely variability in the model outcomes.

The following table summarizes these results by showing the groups of constituents associated with different ranges of variability and uncertainty. As an example, WinSLAMM is able to predict the runoff volumes and particulate solids loads more accurately than the other constituents. With COV values (the relative standard deviations compared to the average values) of about 5% of the average values, the 95% confidence range of these constituents would be within about 10% of the average (for normal distributions, about 95% of the data is obtained within ± 2 times the standard deviation values). However, for zinc concentrations, the 95% confidence interval is about ± 20 to 30% of the average values. The bacteria data has an even wider range for the confidence interval, as expected (± 60 to 70% for *E. coli* and even wider for fecal coliforms). Therefore, when comparing the ranked sets of control programs that are sorted by expected *E. coli* reductions, control programs that are within about 30% of each other may be difficult to distinguish in practice. In contrast, runoff volume and TSS mass load reduction predictions are expected to be much more precise and it may be possible to distinguish control programs that are much closer.

COV (standard deviation as a percentage of average concentration)	
<5%	runoff volume Rv total and filterable TKN TSS
5 to 10%	total and filterable copper total and filterable lead nitrates
10 to 15%	total and filterable zinc total and filterable COD TDS
30 to 35%	*E. coli* bacteria total and filterable phosphorus
65%	fecal coliform bacteria

Analysis Results

The following subsections contain figures and tables summarizing the performance of the various control programs for each land use and for two soil conditions. The tables are ranked according to the control practice abilities in removing *E. coli*, which has a large coefficient of variability. Runoff volume reductions and TSS reductions are also plotted showing relative unit removal costs. This section shows these plots and summary tables by land use and for clay loam and sandy loam soil conditions at the infiltration devices. The general area soil conditions are all in the silt category, so the only differences based on the sandy loam or clay loam soil are for infiltration or biofiltration devices (not for disconnections, or any of the other practices). The land uses examined were from the land use surveys conducted in the watershed area and were described in the previous stormwater pollutant source report. The land uses include:

- Commercial areas:
  - Strip malls
  - Shopping center
- Light Industrial areas
- Institutional areas:
  - Schools
  - Churches
  - Hospitals
- Residential areas:
  - Low density
  - Medium density, constructed before 1960
  - Medium density, constructed between 1960 and 1980

As noted above, each of these nine land use areas were examined for clay loam (0.1 in/hr) and sandy loam (1 inch/hr) conditions in the infiltration/biofiltration devices. The designs were similar (as described previously), but the infiltration rates were changed to correspond to the soil conditions in the control devices themselves.

The following tables show the calculated runoff, TSS, and *E. coli* conditions for each scenario, and also the estimated costs (capital costs, land costs, maintenance costs, total annual costs, and total present value cost) and the unit removal costs for runoff (dollars per cubic feet removed, compared to the base conditions) and for TSS (dollars per pound removed, compared to the base conditions). The figures are scatterplots relating the calculated percent removals of these three stormwater constituents vs. the total annual costs (dollars per 100 acres per year). The most suitable stormwater control programs meeting the removal objectives at the least cost can be identified from these figures (also considering other factors affecting the selection process as described later such as groundwater contamination potential, maintenance requirements, suitability for retrofitting, etc.). As an example, the volume reduction plot for strip mall commercial areas having clay loam soils at the infiltration/biofiltration control locations indicates that several stormwater control programs are more cost-effective than others at similar levels of volume reductions. If the desired volume reduction was 25%, six of the stormwater control programs could meet this level of control, at least, as summarized in the following table:

Control Program for Commercial Strip Mall Land Use	Volume Reduction (% reduction compared to base conditions for clay loam conditions in the biofilters)	Volume Reduction (% reduction compared to base conditions for sandy loam conditions in the biofilters)	Total Annual Costs ($/100 acres/yr)
Porous pavement (in half of the parking areas)	25%	25%	$180,400
Curb-cut biofilters (along 80% of the curbs)	29	67	$166,500
Biofilters in parking areas (10 percent of the source area)	29	47	$314,000
Small wet pond plus biofilters in parking areas (10 percent of the source area)	29	47	$341,800
Biofilters in parking areas (25 percent of the source area)	40	not analyzed for sandy loam conditions	$785,000
Small wet pond plus biofilters in parking areas (10 percent of the source area) and curb-cut biofilters (along 40% of the curbs)	43	80	$424,600

The least costly option having at least 25% runoff reductions is shown to be the curb-cut biofilters along 80% of the curbs. This option is expected to result in about 29% runoff volume reductions with clay loam soil conditions, so theoretically, the application of this control could be reduced somewhat with some further cost savings (to about 70% of the curbs and $143,500). In this example, the use of porous pavement on half of the parking areas would result in about 25% runoff volume reductions (right at the removal goal), but at about 25% increased costs. This larger cost may be justified if other factors are important. It would be very challenging to install this many curb-cut biofilters, for example; however, the biofilters could be more easily maintained and retrofitted in an existing area and offer some additional protection to the groundwater. The other controls are all likely to be substantially more costly. Using parking lot island biofilters (that are about 10 percent of the paved area in size) would cost almost twice compared to the curb-cut biofilters. Adding a small wet pond adds costs but would not provide any additional runoff volume reductions (but would provide additional sediment reductions). Increasing the size of the parking lot island biofilters to 25% of the paved parking drainage areas (very large) would result in substantially greater runoff volume controls (up to about 40%), but at 2.5 times the cost of the smaller (or fewer) parking lot biofilters. Adding a small wet pond to the fewer parking lot biofilters, plus using some curb-cut biofilters results in the largest runoff volume reductions expected for the alternatives examined. If only runoff volume (and filterable pollutants) were of consideration, but at a higher control level, it would be worthwhile to also examine this last option without the pond (this would provide the same 43% calculated reductions, but the annual costs would be reduced to slightly less than $400,000 per 100 acres per year, or about 2.8 times the least cost option for 25% control, with an associated increase in performance of about 1.7 times. The declining unit cost returns with increasing removals are obvious on the plots. However, if the larger removal rates are needed, the more costly control options would likely be needed.

As noted on the further plots, the same size of controls in a sandy loam area has the same annual costs for the same stormwater control programs as for clay soil conditions, but the performance is substantially greater for programs using infiltration or biofiltration devices. The porous pavement benefits do not change as the clay loam soil is sufficient to remove the same amount of runoff due to the storage volume provided. The large 25%

biofilter areas were not evaluated for sandy soil conditions as they would not likely be used. The runoff volume removal rates for the other control programs are expected to be about double with sandy loam soils compared to clay loam soils for this land use, at the same annual costs.

Detailed information for all constituents examined (runoff volume, Rv, TSS, TDS, total and filterable phosphorus, nitrates, total and filterable TKN, total and filterable COD, total and filterable copper, total and filterable lead, total and filterable zinc, fecal coliform bacteria, and *E. coli* bacteria) is presented for each land use and soil combinations for each set of stormwater controls in the appendix.

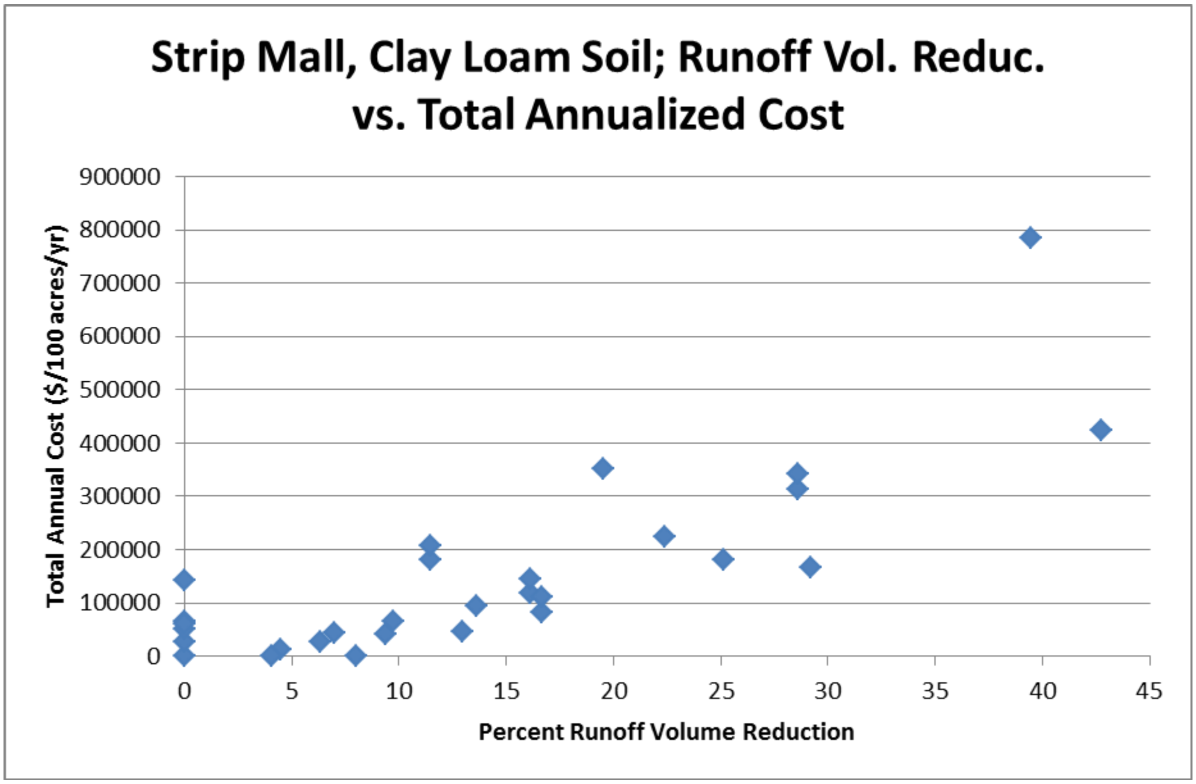
Each appendix table lists the amounts and concentrations expected for a homogeneous 100 acre site for four years of rains. The total amounts therefore represent these conditions. As an example, on the first appendix table, the first line shows the information for the base condition (from the land use land cover survey) for the strip mall commercial areas. The total runoff volume shown is 25,715,040 ft^3 (it was not possible to show many of these total yield values with an appropriate number of significant figures in these tables). The 25.7 million cubic feet of runoff represents the total amount of runoff expected for a 100 acre site exposed to all of the rains occurring in the 4 year test period of rainfall. The sum or yield values therefore need to be reduced by 1/400 to obtain the annual runoff or discharge amounts from one acre for one year. The annual unit acre runoff quantity for this condition is therefore about 64,300 ft^3/acre/year. This is shown to represent about 64% of the total rainfall quantity that fell on this site. The concentration values shown on these appendix tables are not affected by the size of the area or the length of the rain record, but the long records result in more reasonable flow-weighted average values with smaller effects from extreme events that may occur. As an example, the base condition is expected to have a total suspended solids (TSS) concentration of about 410 mg/L, with a total discharge of about 660,000 lbs of TSS for 100 acres over 4 years (or 1,640 lbs/ac/yr). During the 4 year study period, a total of 107.41 inches of rain fell during 340 separate rain events. The largest single rain was 2.63 inches in depth, and the average rain was 0.32 inches.

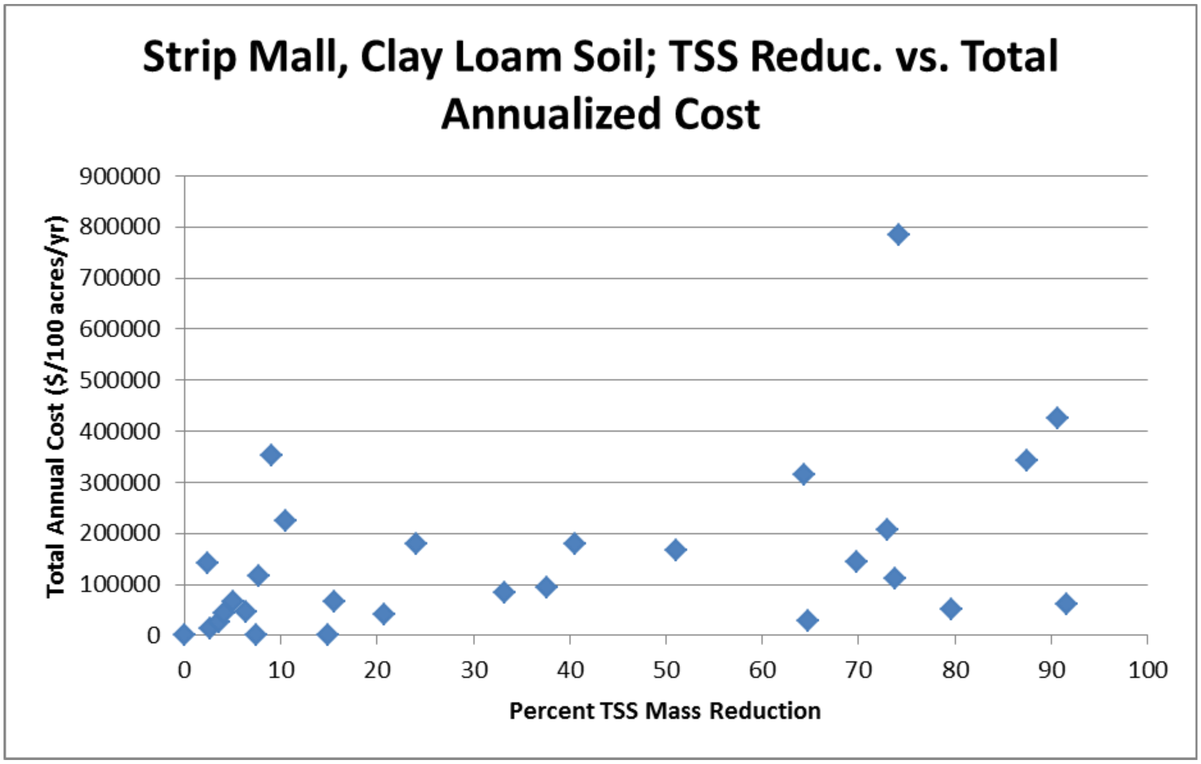
In most cases, total and filterable forms of each pollutant are shown. The control practices were previously described, along with the combinations examined. Also, clay loam and sandy loam soil conditions are examined for each case. The performance of the alternative control programs can be assessed by examining the resulting loadings and concentrations. The filterable forms of the contaminants are reduced through volume reducing infiltration practices (biofilters at parking areas, curb-cut biofilters, disconnected impervious areas, porous pavement, rain gardens, grass swales), plus the beneficial use practices (rain barrels and rain tanks), and combinations of these practices. The particulate-bound pollutants are removed by these same practices, plus the sedimentation practices (wet detention ponds), and the catchbasin and street cleaning public works practices. The removal of the specific pollutants is therefore highly dependent on how the pollutant partitions between the particulate-bound phase and the filterable phase. The bacteria, even though traditionally captured on a small aperture filter, are treated as filterable constituents for these analyses. Some of the bacteria are bound to small particulates and tend to migrate with those materials. Therefore, the calculated bacteria conditions are conservative, with somewhat additional reductions expected.

When examining the performance options, it is seen that the mass discharges always decrease, unless a control program option is very inefficient, or for filterable pollutant concentrations for an option that only affect particulate-bound pollutants (such as street cleaning). However, the resulting concentrations after control by some options may actually be seen to increase. An example is for a roof runoff volume reducing control (such as rain gardens) for a pollutant that has low concentrations in roof runoff compared to other source areas. As that cleaner water is infiltrated (always a good idea to minimize groundwater contamination issues), the remaining load of that constituent from all areas is transported with less water, resulting in a higher concentration, even if the water volume reduction is large. However, the load reduction should still decrease, corresponding to the pollutant content of the infiltrating roof runoff.

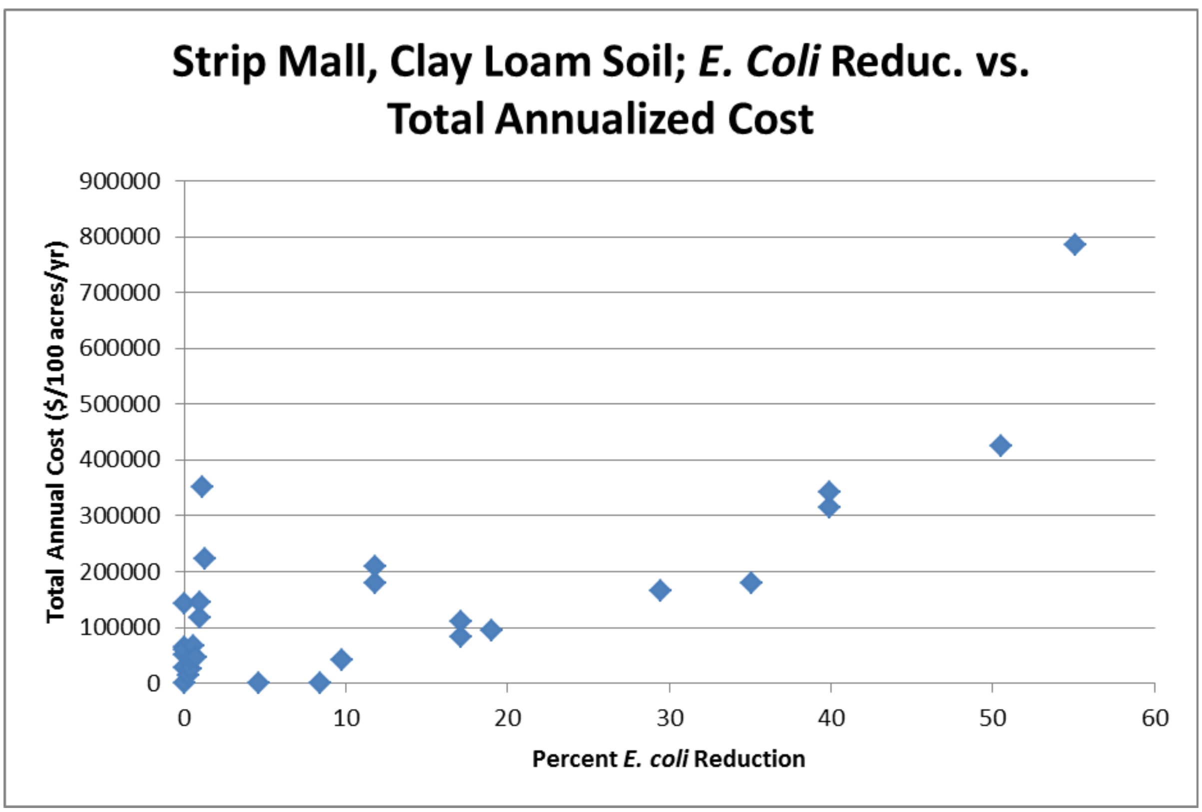
Commercial: Strip Mall Land Use

Clay Loam Soil Conditions





Strip Mall, Clay Loam Soil; TSS Reduc. vs. Total Annualized Cost
Total Annual Cost ($/100 acres/yr)
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0
10
20
30
40
50
60
70
80
90
100
Percent TSS Mass Reduction



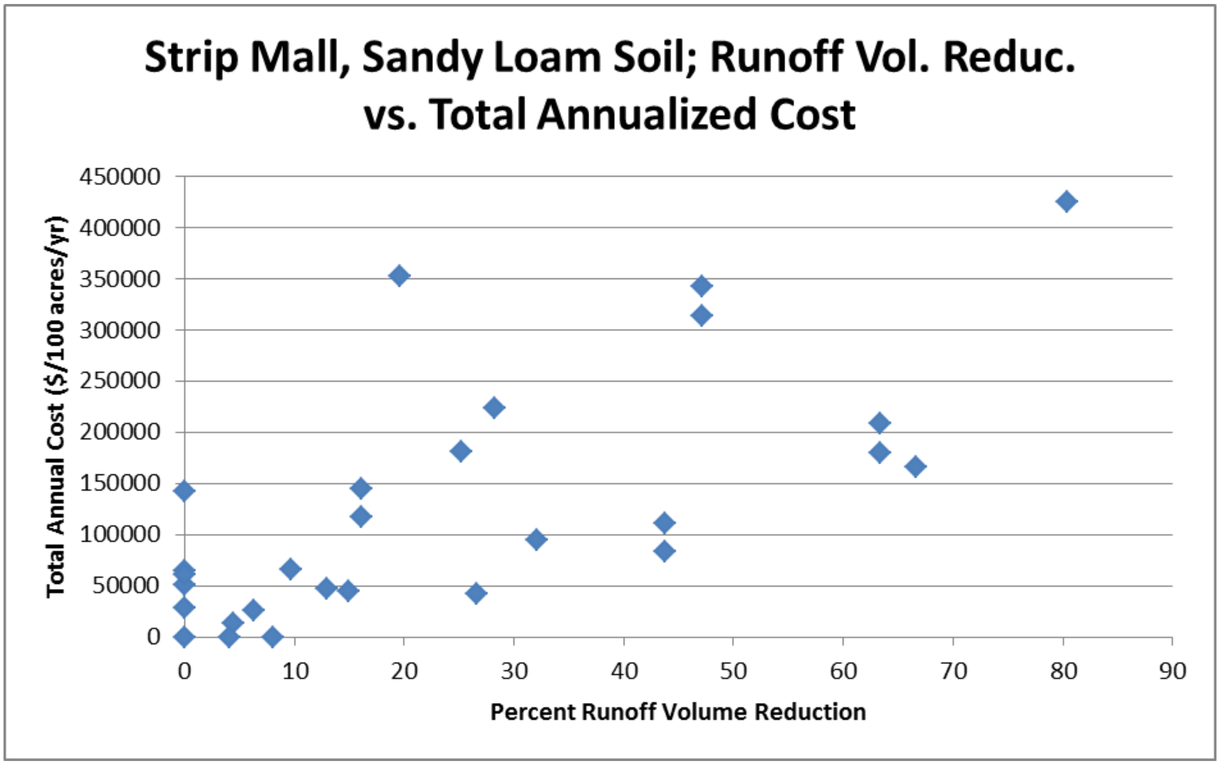
Strip Mall, Clay Loam Soil; E. Coli Reduc. vs. Total Annualized Cost
Total Annual Cost ($/100 acres/yr)
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0
10
20
30
40
50
60
Percent E. coli Reduction

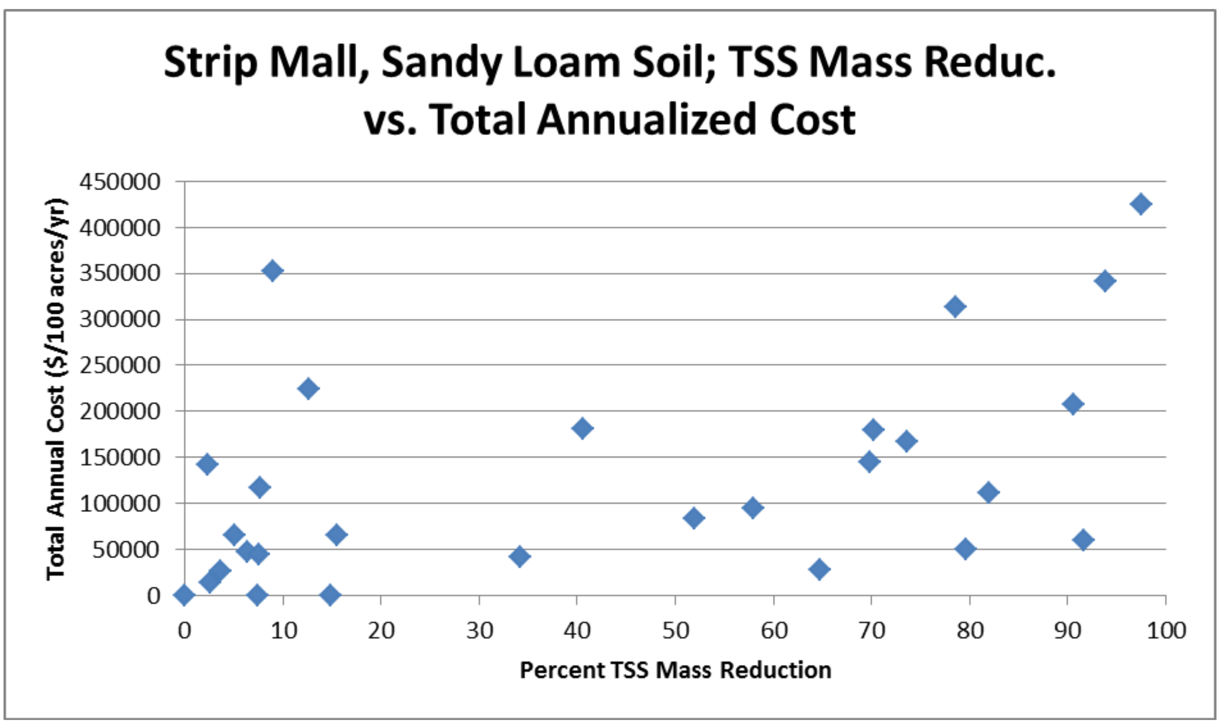
Commercial Strip Mall Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

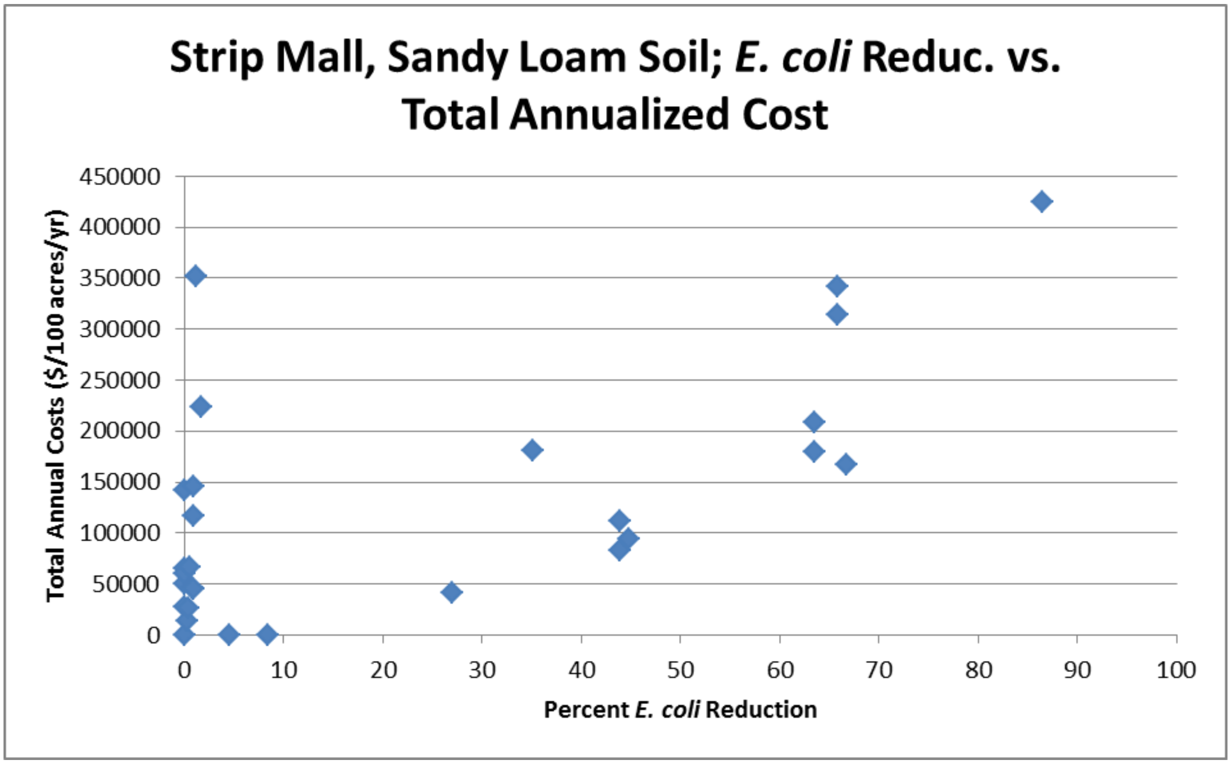
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
01 strip mall Linc base	0.64	Poor	n/a	n/a	n/a	410	n/a	n/a	n/a	n/a	n/a	n/a	n/a
01 strip mall Linc CB	0.64	Poor	0	16	0	346	566,626	0	19,620	65,088	811,134	-	2.52
01 strip mall Linc pond 085 perct	0.64	Poor	0	65	0	145	251,151	9,938	6,907	27,857	347,165	-	0.26
01 strip mall Linc pond 17 perct	0.64	Poor	0	80	0	83	463,123	19,875	11,783	50,540	629,841	-	0.38
01 strip mall Linc pond 34 perct	0.64	Poor	0	92	0	34	535,234	39,750	14,170	60,308	751,573	-	0.40
01 strip mall Linc street cleaning daily	0.64	Poor	0	2	0	400	26,560	0	139,412	141,543	1,763,935	-	35.42
01 strip mall Linc rain barrels few	0.61	Poor	5	3	0	418	88,474	10,000	5,270	13,172	164,154	0.05	2.99
01 strip mall Linc rain barrels	0.60	Poor	6	4	0	422	176,948	20,000	10,541	26,344	328,308	0.06	4.39
01 strip mall Linc roof rain garden 3 perct clay loam	0.60	Poor	7	4	0	422	266,024	75,069	17,432	44,802	558,331	0.10	6.59
01 strip mall Linc rain barrels many	0.58	Poor	10	5	1	430	442,371	50,000	26,352	65,861	820,770	0.10	7.75
01 strip mall Linc rain tanks small	0.56	Poor	13	6	1	440	294,581	41,667	19,942	46,923	584,766	0.06	4.39
01 strip mall Linc rain tanks	0.54	Poor	16	8	1	451	736,452	104,167	49,854	117,308	1,461,915	0.11	9.18
01 strip mall Linc sml pnd and rain tanks	0.54	Poor	16	70	1	148	987,603	114,104	56,761	145,165	1,809,080	0.14	1.25
01 strip mall Linc rain tanks large	0.52	Poor	20	9	1	463	2,209,356	312,500	149,563	351,924	4,385,745	0.28	23.60
01 strip mall Linc roof rain garden 15 perct clay loam	0.50	Poor	22	11	1	472	1,330,119	375,344	87,159	224,010	2,791,656	0.15	12.82
01 strip mall Linc half disconnected	0.61	Poor	4	8	5	395	0	0	0	0	0	0.00	0.00
01 strip mall Linc disconnected	0.59	Poor	8	15	8	379	0	0	0	0	0	0.00	0.00
01 strip mall Linc curb biofilters 20 clay loam	0.58	Poor	9	21	10	358	283,417	3,444	18,601	41,619	518,670	0.07	1.21
01 strip mall Linc swale clay loam	0.57	Poor	11	24	12	351	1,613,577	0	50,678	180,156	2,245,143	0.24	4.51
01 strip mall Linc sml pond	0.57	Poor	11	73	12	125	1,864,728	9,938	57,586	208,014	2,592,308	0.28	1.72

and swale clay loam													
01 strip mall Linc curb biofilters 40 clay loam	0.53	Poor	17	33	17	328	566,833	6,887	37,202	83,239	1,037,339	0.08	1.51
01 strip mall Linc sml pnd and curb biofilters 40 clay loam	0.53	Poor	17	74	17	129	817,984	16,825	44,109	111,096	1,384,504	0.10	0.91
01 strip mall Linc biofilt parking 3 perct clay loam	0.55	Poor	14	38	19	295	572,422	137,126	37,181	94,117	1,172,910	0.11	1.51
01 strip mall Linc curb biofilters 80 clay loam	0.45	Poor	29	51	30	283	1,133,666	13,774	74,404	166,478	2,074,678	0.09	1.96
01 strip mall Linc porous pvt parking half clay loam	0.48	Poor	25	41	35	325	2,158,148	0	7,223	180,398	2,248,161	0.11	2.68
01 strip mall Linc biofilt parking 10 perct clay loam	0.46	Poor	29	64	40	204	1,909,465	457,420	124,029	313,954	3,912,554	0.17	2.94
01 strip mall Linc sml pnd and biofilt parking 10 perct clay loam	0.46	Poor	29	87	40	72	2,160,616	467,357	130,936	341,811	4,259,720	0.18	2.36
01 strip mall Linc sml pnd and park biofilt 10 perc and curb biofilters 40 clay loam	0.37	Poor	43	91	51	67	2,721,929	474,244	168,138	424,607	5,291,539	0.15	2.82
01 strip mall Linc biofilt parking 25 perct clay loam	0.39	Poor	40	74	55	175	4,771,573	1,143,049	309,936	784,540	9,777,105	0.31	6.38

Sandy Loam Soil Conditions






Strip Mall, Sandy Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
100
Percent E. coli Reduction

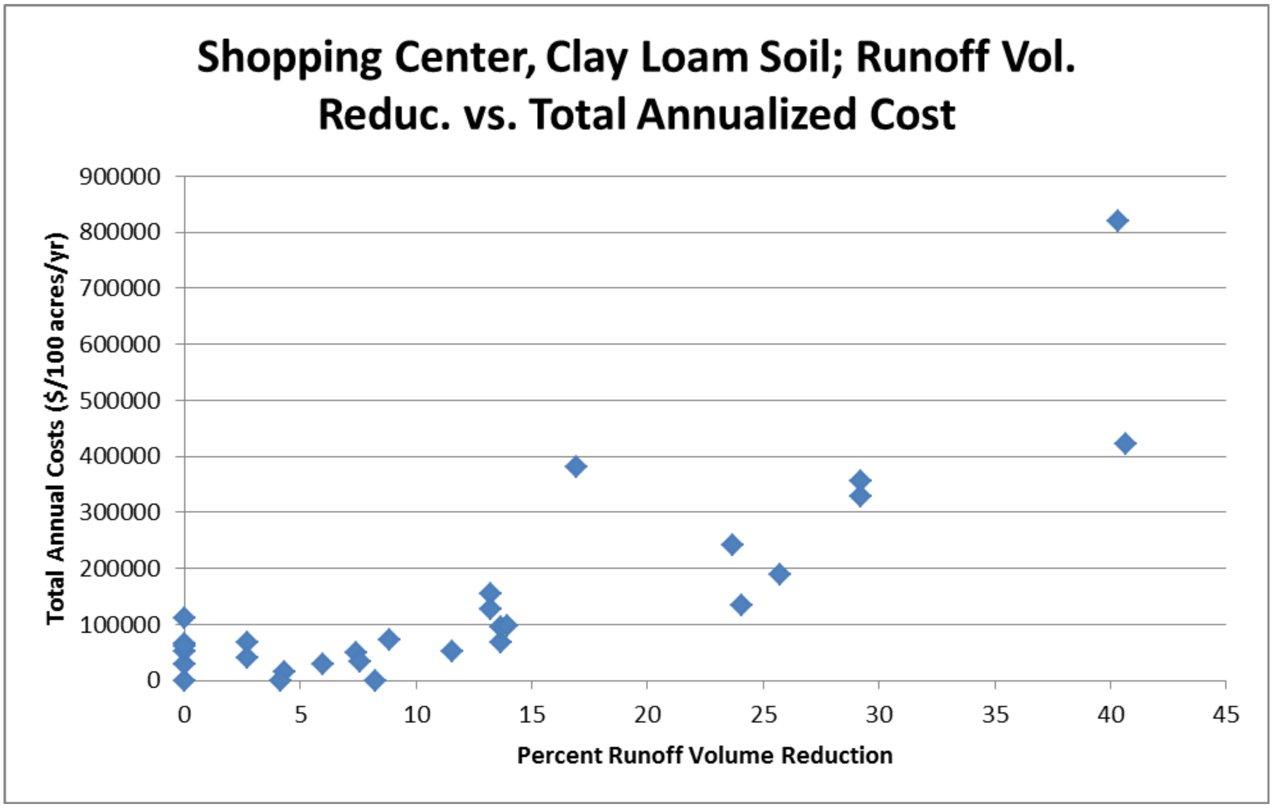
Commercial Strip Mall Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

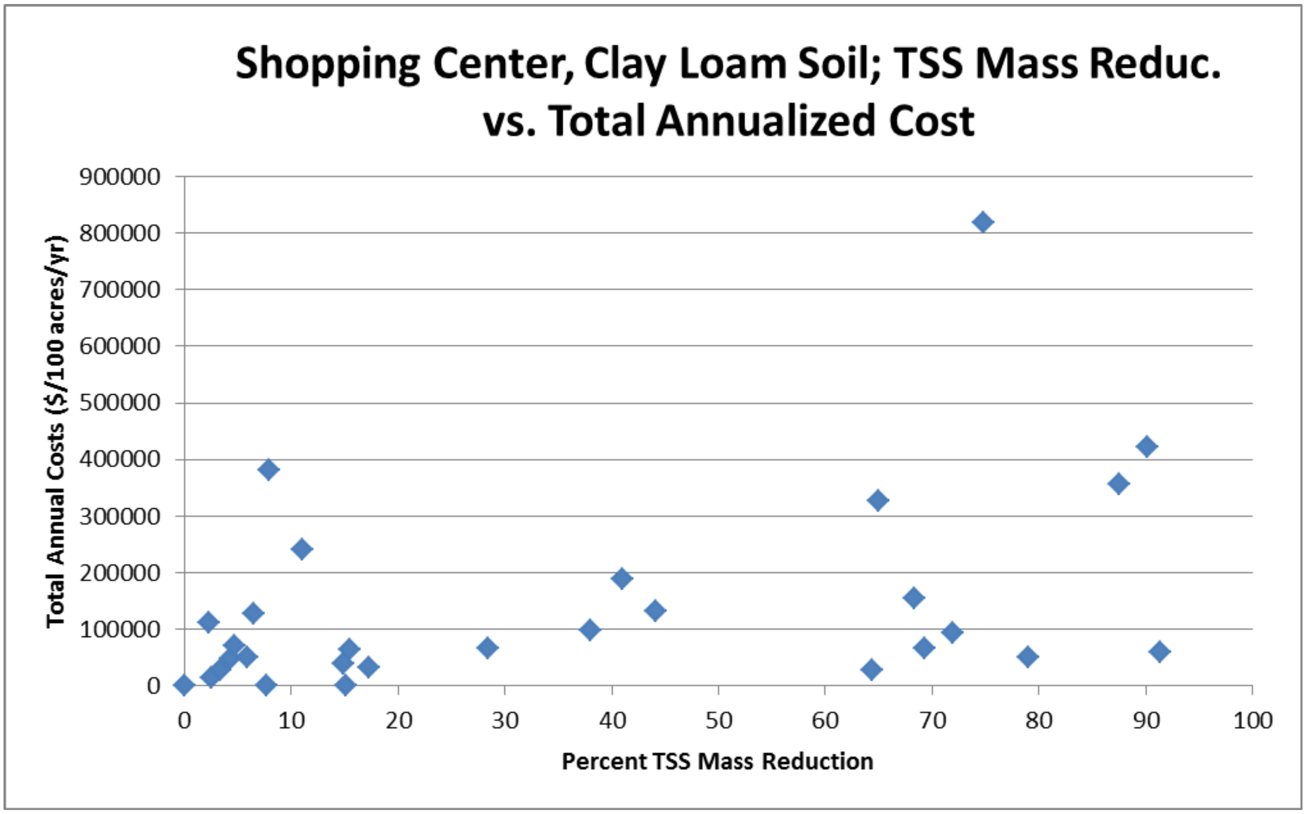
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
01 strip mall Linc base	0.64	Poor	n/a	n/a	n/a	410	n/a	n/a	n/a	n/a	n/a	n/a	n/a
01 strip mall Linc CB	0.64	Poor	0	16	0	346	566,626	0	19,620	65,088	811,134	-	2.52
01 strip mall Linc pond 085 perct	0.64	Poor	0	65	0	145	251,151	9,938	6,907	27,857	347,165	-	0.26
01 strip mall Linc pond 17 perct	0.64	Poor	0	80	0	83	463,123	19,875	11,783	50,540	629,841	-	0.38
01 strip mall Linc pond 34 perct	0.64	Poor	0	92	0	34	535,234	39,750	14,170	60,308	751,573	-	0.40
01 strip mall Linc street cleaning daily	0.64	Poor	0	2	0	400	26,560	0	139,412	141,543	1,763,935	-	35.42
01 strip mall Linc rain barrels few	0.61	Poor	5	3	0	418	88,474	10,000	5,270	13,172	164,154	0.05	2.99
01 strip mall Linc rain barrels	0.60	Poor	6	4	0	422	176,948	20,000	10,541	26,344	328,308	0.06	4.39
01 strip mall Linc rain barrels many	0.58	Poor	10	5	1	430	442,371	50,000	26,352	65,861	820,770	0.10	7.75
01 strip mall Linc rain tanks small	0.56	Poor	13	6	1	440	294,581	41,667	19,942	46,923	584,766	0.06	4.39
01 strip mall Linc roof rain garden 3 perct sandy loam	0.54	Poor	15	8	1	445	266,024	75,069	17,432	44,802	558,331	0.05	3.58
01 strip mall Linc rain tanks	0.54	Poor	16	8	1	451	736,452	104,167	49,854	117,308	1,461,915	0.11	9.18
01 strip mall Linc sml pnd and rain tanks	0.54	Poor	16	70	1	148	987,603	114,104	56,761	145,165	1,809,080	0.14	1.25
01 strip mall Linc rain tanks large	0.52	Poor	20	9	1	463	2,209,356	312,500	149,563	351,924	4,385,745	0.28	23.60
01 strip mall Linc roof rain garden 15 perct sandy loam	0.46	Poor	28	13	2	498	1,330,119	375,344	87,159	224,010	2,791,656	0.12	10.64
01 strip mall Linc half disconnected	0.61	Poor	4	8	5	395	0	0	0	0	0	0.00	0.00
01 strip mall Linc disconnected	0.59	Poor	8	15	8	379	0	0	0	0	0	0.00	0.00
01 strip mall Linc curb biofilters 20 sandy loam	0.47	Poor	27	34	27	367	283,417	3,444	18,601	41,619	518,670	0.02	0.73
01 strip mall Linc porous pvt parking half sandy loam	0.48	Poor	25	41	35	325	2,158,148	0	7,223	180,398	2,248,161	0.11	2.68

01 strip mall Linc curb biofilters 40 sandy loam	0.36	Poor	44	52	44	350	566,833	6,887	37,202	83,239	1,037,339	0.03	0.97
01 strip mall Linc sml pnd and curb biofilters 40 sandy loam	0.36	Poor	44	82	44	131	817,984	16,825	44,109	111,096	1,384,504	0.04	0.82
01 strip mall Linc biofilt parking 3 perct sandy loam	0.44	Poor	32	58	45	253	572,422	137,126	37,181	94,117	1,172,910	0.05	0.98
01 strip mall Linc sml pnd and swale sandy loam	0.24	Poor	63	91	63	105	1,864,728	9,938	57,586	208,014	2,592,308	0.05	1.38
01 strip mall Linc swale sandy loam	0.24	Poor	63	70	63	332	1,613,577	0	50,678	180,156	2,245,143	0.04	1.55
01 strip mall Linc biofilt parking 10 perct sandy loam	0.34	Poor	47	79	66	166	1,909,465	457,420	124,029	313,954	3,912,554	0.10	2.41
01 strip mall Linc sml pnd and biofilt parking 10 perct sandy loam	0.34	Poor	47	94	66	48	2,160,616	467,357	130,936	341,811	4,259,720	0.11	2.20
01 strip mall Linc curb biofilters 80 sandy loam	0.21	Poor	67	74	67	323	1,133,666	13,774	74,404	166,478	2,074,678	0.04	1.36
01 strip mall Linc sml pnd and park biofilt 10 perc and curb biofilters 40 sandy loam	0.13	Good	80	98	86	51	2,721,929	474,244	168,138	424,607	5,291,539	0.08	2.62

Commercial: Shopping Center Land Use

Clay Loam Soil Conditions




Shopping Center, Clay Loam Soil; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
900000
800000
700000
600000
500000
400000
300000
200000
100000
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0
10
20
30
40
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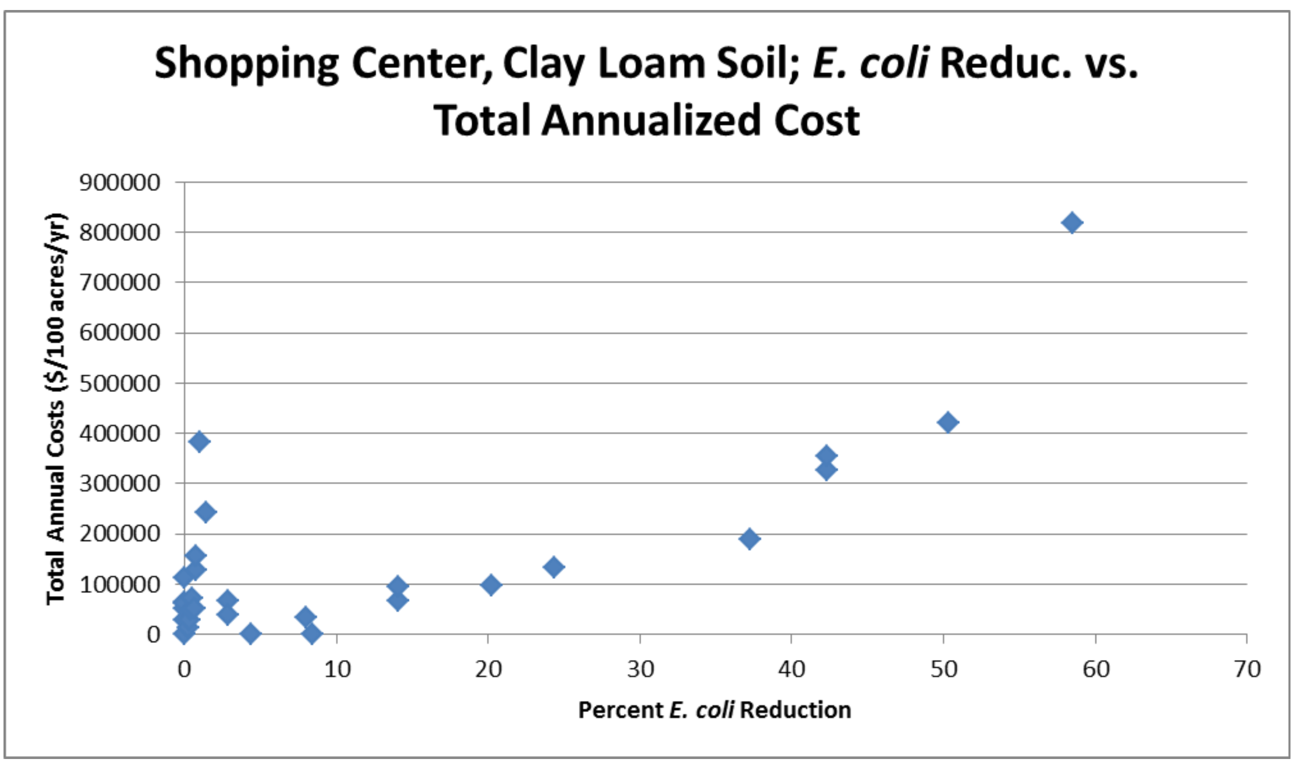
60
70
80
90
100
Percent TSS Mass Reduction

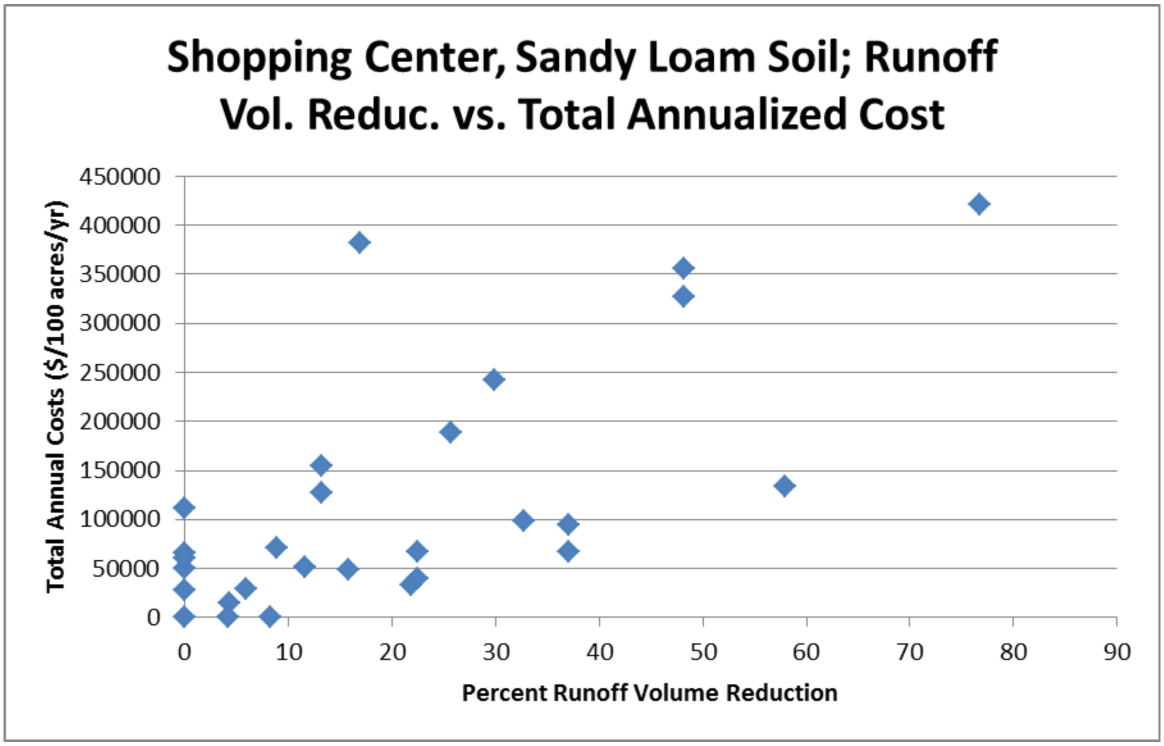

Shopping Center, Clay Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0
10
20
30
40
50
60
70
Percent E. coli Reduction

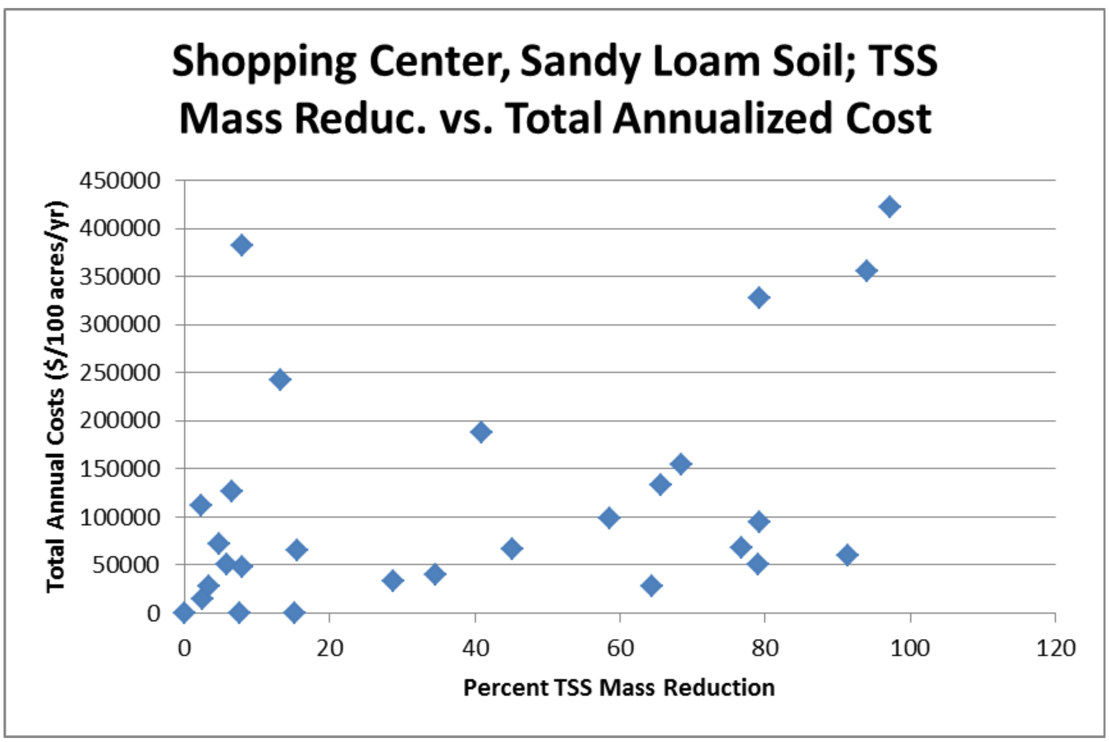
Commercial Shopping Center Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

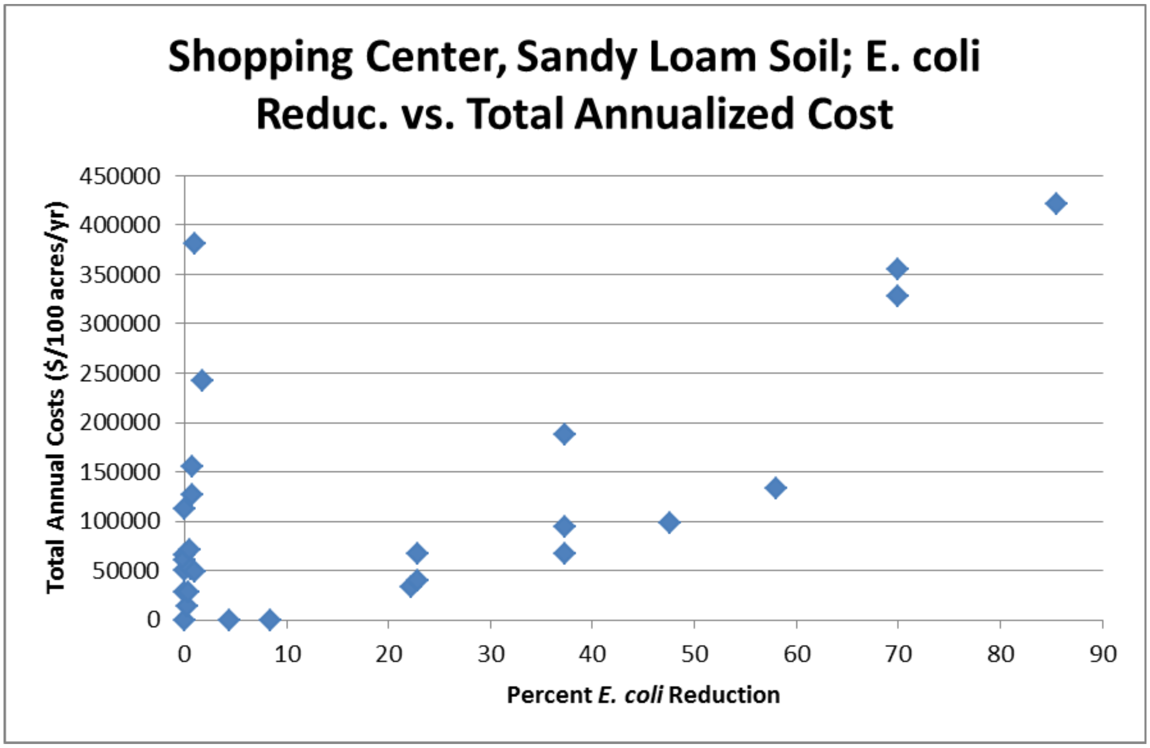
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
02 shop cntr Linc base	0.65	Poor	n/a	n/a	n/a	415	n/a	n/a	n/a	n/a	n/a	n/a	n/a
02 shop cntr Linc CB	0.65	Poor	0	15	0	350	566,626	0	19,620	65,088	811,134	2.46	-
02 shop cntr Linc pond 085 perct	0.65	Poor	0	64	0	148	251,151	9,938	6,907	27,857	347,165	0.25	-
02 shop cntr Linc pond 17 perct	0.65	Poor	0	79	0	87	463,123	19,875	11,783	50,540	629,841	0.37	-
02 shop cntr Linc pond 34 perct	0.65	Poor	0	91	0	36	535,234	39,750	14,170	60,308	751,573	0.39	-
02 shop cntr Linc street cleaning daily	0.65	Poor	0	2	0	405	21,026	0	110,367	112,055	1,396,448	28.81	-
02 shop cntr Linc rain barrels few	0.63	Poor	4	3	0	422	95,908	10,840	5,713	14,279	177,947	3.26	0.05
02 shop cntr Linc rain barrels	0.62	Poor	6	3	0	426	191,816	21,680	11,426	28,558	355,893	4.88	0.07
02 shop cntr Linc roof rain garden 3 perct clay loam	0.61	Poor	7	4	0	429	287,306	81,074	18,826	48,386	602,998	6.58	0.10
02 shop cntr Linc rain barrels many	0.60	Poor	9	5	1	434	479,539	54,201	28,566	71,394	889,733	8.83	0.12
02 shop cntr Linc rain tanks small	0.58	Poor	12	6	1	441	319,332	45,168	21,617	50,866	633,899	5.07	0.07
02 shop cntr Linc rain tanks	0.57	Poor	13	7	1	447	798,322	112,918	54,043	127,163	1,584,732	11.39	0.15
02 shop cntr Linc sml pnd and rain tanks	0.57	Poor	13	68	1	151	1,049,473	122,855	60,950	155,020	1,931,897	1.32	0.18
02 shop cntr Linc rain tanks large	0.54	Poor	17	8	1	460	2,394,950	338,751	162,127	381,486	4,754,164	28.07	0.34
02 shop cntr Linc roof rain garden 15 perct clay loam	0.50	Poor	24	11	1	483	1,436,528	405,372	94,132	241,930	3,014,988	12.79	0.15
02 shop cntr Linc sml pnd and swale clay loam	0.64	Poor	3	69	3	131	605,351	9,938	18,032	67,404	840,001	0.57	0.38
02 shop cntr Linc swale clay loam	0.64	Poor	3	15	3	363	354,200	0	11,125	39,546	492,836	1.55	0.22
02 shop cntr Linc half disconnected	0.63	Poor	4	8	4	400	0	0	0	0	0	0.00	0.00
02 shop cntr Linc curb biofilters 20 clay loam	0.60	Poor	8	17	8	371	226,733	2,755	14,881	33,296	414,936	1.12	0.07
02 shop cntr Linc disconnected	0.60	Poor	8	15	8	383	0	0	0	0	0	0.00	0.00

02 shop cntr Linc curb biofilters 40 clay loam	0.57	Poor	14	28	14	344	453,466	5,510	29,762	66,591	829,871	1.37	0.07
02 shop cntr Linc sml pnd and curb biofilters 40 clay loam	0.57	Poor	14	72	14	135	704,617	15,447	36,669	94,448	1,177,036	0.77	0.10
02 shop cntr Linc biofilt parking 3 perct clay loam	0.56	Poor	14	38	20	298	597,491	143,131	38,810	98,239	1,224,279	1.51	0.11
02 shop cntr Linc curb biofilters 80 clay loam	0.50	Poor	24	44	24	305	906,933	11,019	59,523	133,182	1,659,742	1.76	0.08
02 shop cntr Linc porous pvt parking half clay loam	0.49	Poor	26	41	37	329	2,252,597	0	7,539	188,293	2,346,549	2.68	0.11
02 shop cntr Linc biofilt parking 10 perct clay loam	0.46	Poor	29	65	42	205	1,993,030	477,438	129,457	327,693	4,083,782	2.94	0.17
02 shop cntr Linc sml pnd and biofilt parking 10 perct clay loam	0.46	Poor	29	88	42	73	2,244,181	487,376	136,364	355,551	4,430,947	2.37	0.18
02 shop cntr Linc sml pnd and parking biofilt 10 perc and curb biofilters 40 clay loam	0.39	Poor	41	90	50	69	2,691,886	492,885	166,125	421,679	5,255,057	2.73	0.16
02 shop cntr Linc biofilt parking 25 perct clay loam	0.39	Poor	40	75	59	175	4,980,486	1,193,095	323,506	818,890	10,205,170	6.38	0.31

Sandy Loam Soil Conditions






Shopping Center, Sandy Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
Percent E. coli Reduction

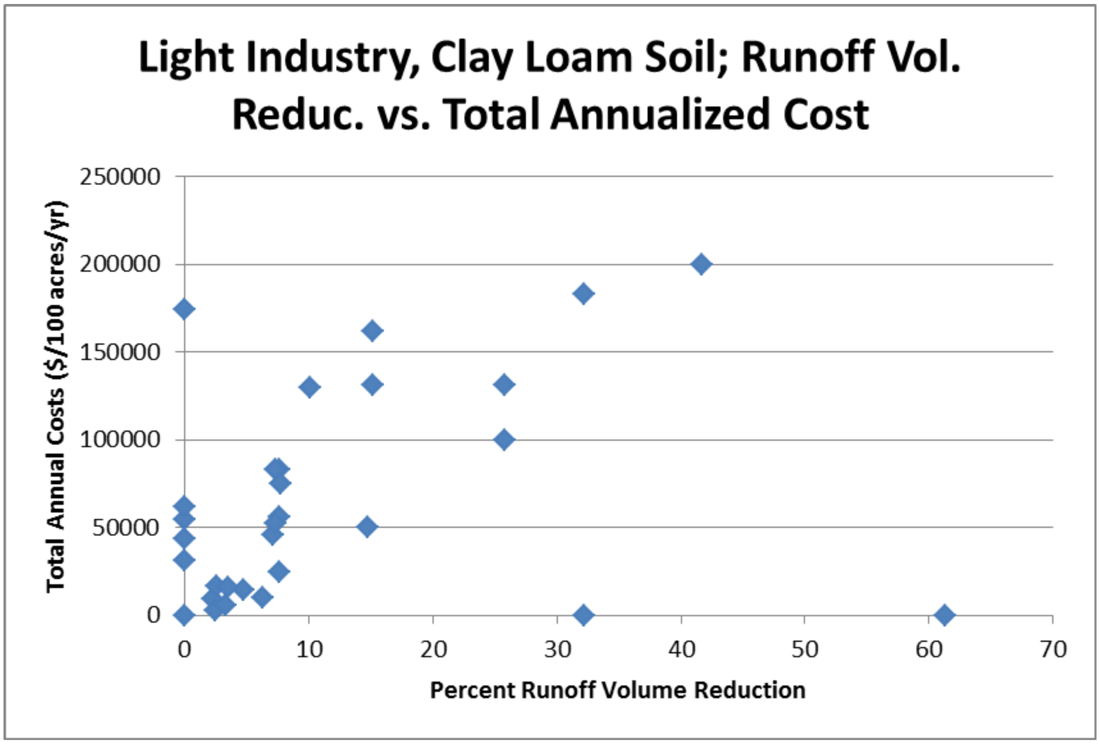
Commercial Shopping Center Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

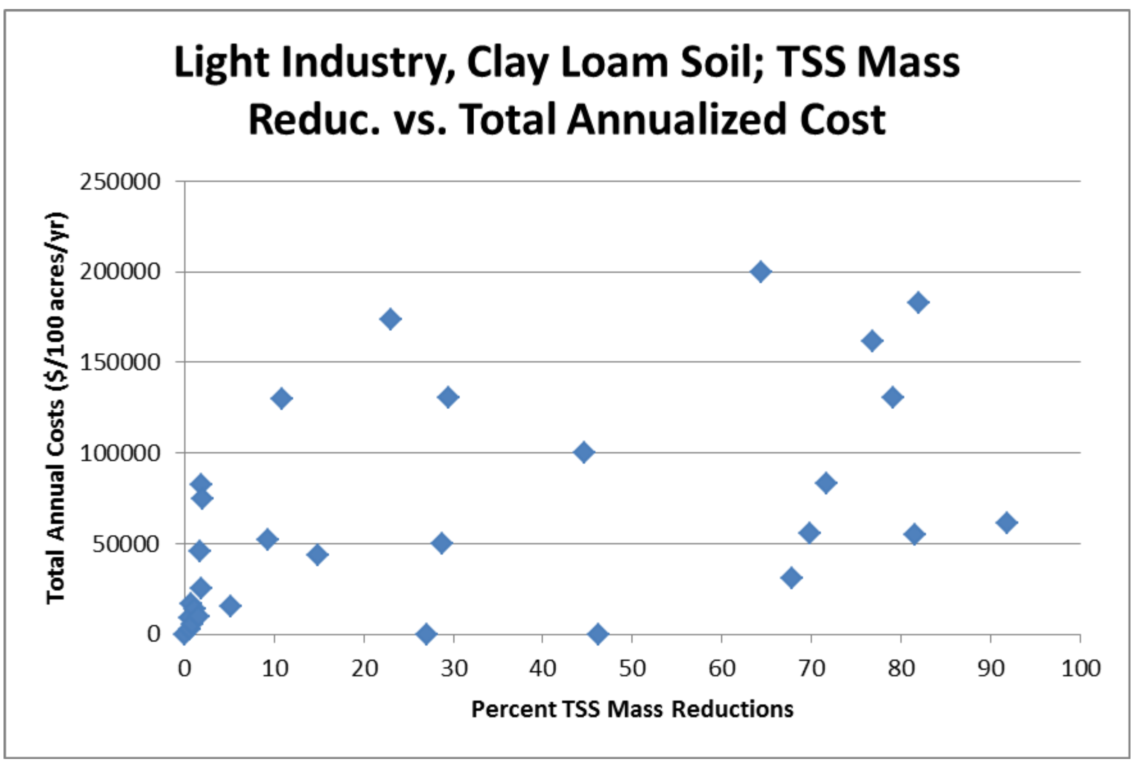
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
02 shop cntr Linc base	0.65	Poor	n/a	n/a	n/a	415	n/a	n/a	n/a	n/a	n/a	n/a	n/a
02 shop cntr Linc CB	0.65	Poor	0	15	0	350	566,626	0	19,620	65,088	811,134	-	2.46
02 shop cntr Linc pond 085 perct	0.65	Poor	0	64	0	148	251,151	9,938	6,907	27,857	347,165	-	0.25
02 shop cntr Linc pond 17 perct	0.65	Poor	0	79	0	87	463,123	19,875	11,783	50,540	629,841	-	0.37
02 shop cntr Linc pond 34 perct	0.65	Poor	0	91	0	36	535,234	39,750	14,170	60,308	751,573	-	0.39
02 shop cntr Linc street cleaning daily	0.65	Poor	0	2	0	405	21,026	0	110,367	112,055	1,396,448	-	28.81
02 shop cntr Linc rain barrels few	0.63	Poor	4	3	0	422	95,908	10,840	5,713	14,279	177,947	0.05	3.26
02 shop cntr Linc rain barrels	0.62	Poor	6	3	0	426	191,816	21,680	11,426	28,558	355,893	0.07	4.88
02 shop cntr Linc rain barrels many	0.60	Poor	9	5	1	434	479,539	54,201	28,566	71,394	889,733	0.12	8.83
02 shop cntr Linc rain tanks small	0.58	Poor	12	6	1	441	319,332	45,168	21,617	50,866	633,899	0.07	5.07
02 shop cntr Linc rain tanks	0.57	Poor	13	7	1	447	798,322	112,918	54,043	127,163	1,584,732	0.15	11.39
02 shop cntr Linc sml pnd and rain tanks	0.57	Poor	13	68	1	151	1,049,473	122,855	60,950	155,020	1,931,897	0.18	1.32
02 shop cntr Linc roof rain garden 3 perct sandy loam	0.55	Poor	16	8	1	454	287,306	81,074	18,826	48,386	602,998	0.05	3.57
02 shop cntr Linc rain tanks large	0.54	Poor	17	8	1	460	2,394,950	338,751	162,127	381,486	4,754,164	0.34	28.07
02 shop cntr Linc roof rain garden 15 perct sandy loam	0.46	Poor	30	13	2	513	1,436,528	405,372	94,132	241,930	3,014,988	0.12	10.61
02 shop cntr Linc half disconnected	0.63	Poor	4	8	4	400	0	0	0	0	0	0.00	0.00
02 shop cntr Linc disconnected	0.60	Poor	8	15	8	383	0	0	0	0	0	0.00	0.00
02 shop cntr Linc curb biofilters 20 sandy loam	0.51	Poor	22	29	22	378	226,733	2,755	14,881	33,296	414,936	0.02	0.67
02 shop cntr Linc sml pnd and swale sandy loam	0.51	Poor	23	77	23	125	605,351	9,938	18,032	67,404	840,001	0.05	0.51
02 shop cntr Linc swale	0.51	Poor	23	35	23	350	354,200	0	11,125	39,546	492,836	0.03	0.67

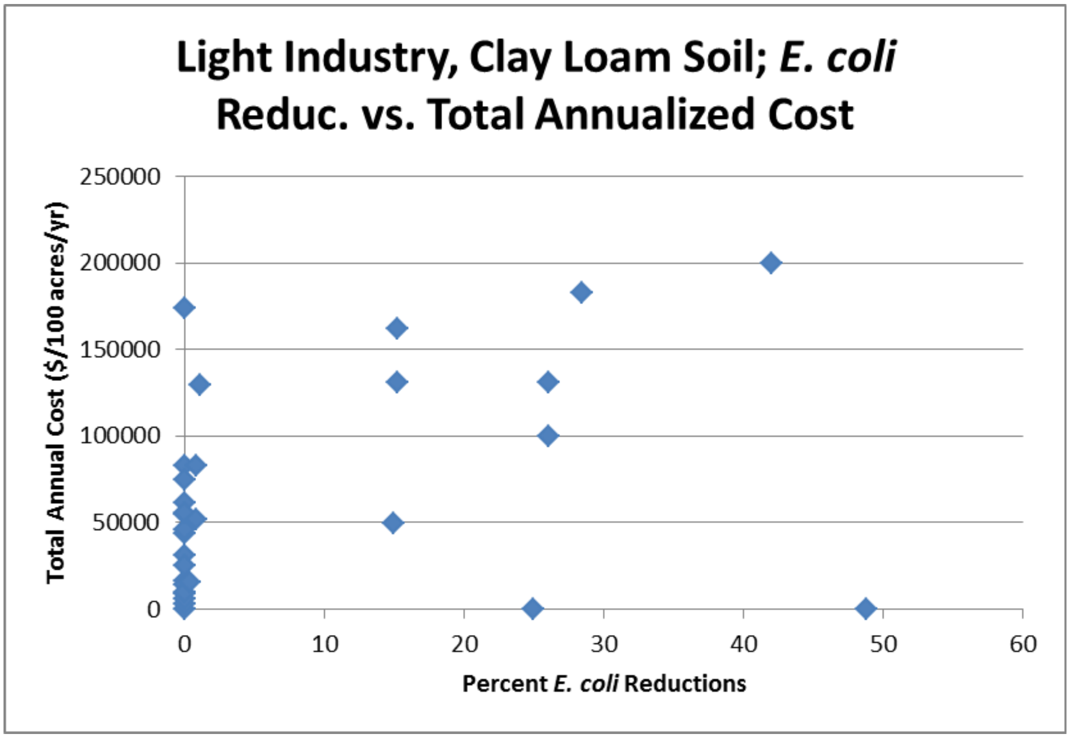
sandy loam													
02 shop cntr Linc porous pvt parking half sandy loam	0.49	Poor	26	41	37	329	2,252,597	0	7,539	188,293	2,346,549	0.11	2.68
02 shop cntr Linc curb biofilters 40 sandy loam	0.41	Poor	37	45	37	361	453,466	5,510	29,762	66,591	829,871	0.03	0.86
02 shop cntr Linc sml pnd and curb biofilters 40 sandy loam	0.41	Poor	37	79	37	137	704,617	15,447	36,669	94,448	1,177,036	0.04	0.70
02 shop cntr Linc biofilt parking 3 perct sandy loam	0.44	Poor	33	59	48	256	597,491	143,131	38,810	98,239	1,224,279	0.05	0.98
02 shop cntr Linc curb biofilters 80 sandy loam	0.28	Poor	58	66	58	338	906,933	11,019	59,523	133,182	1,659,742	0.03	1.18
02 shop cntr Linc biofilt parking 10 perct sandy loam	0.34	Poor	48	79	70	166	1,993,030	477,438	129,457	327,693	4,083,782	0.10	2.41
02 shop cntr Linc sml pnd and biofilt parking 10 perct sandy loam	0.34	Poor	48	94	70	48	2,244,181	487,376	136,364	355,551	4,430,947	0.11	2.20
02 shop cntr Linc sml pnd and parking biofilt 10 perct and curb biofilters 40 sandy loam	0.15	Fair	77	97	86	50	2,691,886	492,885	166,125	421,679	5,255,057	0.08	2.53

Light Industrial Land Use

Clay Loam Soil Conditions





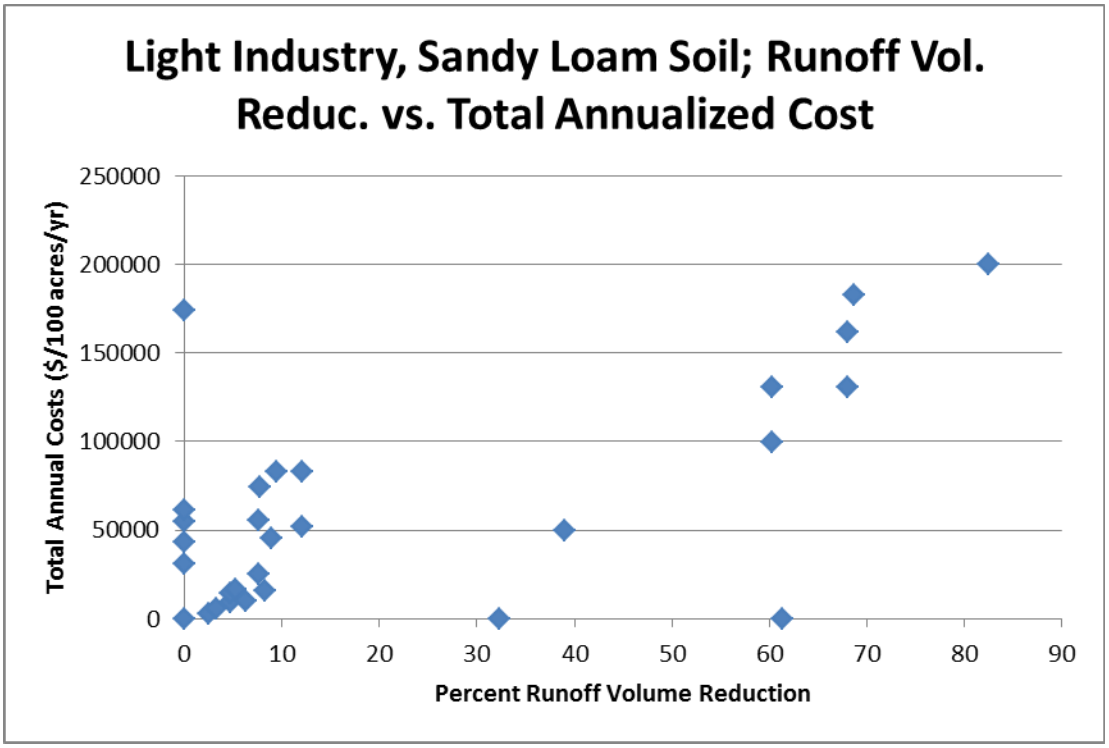

Light Industry, Clay Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Cost ($/100 acres/yr)
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
Percent E. coli Reductions

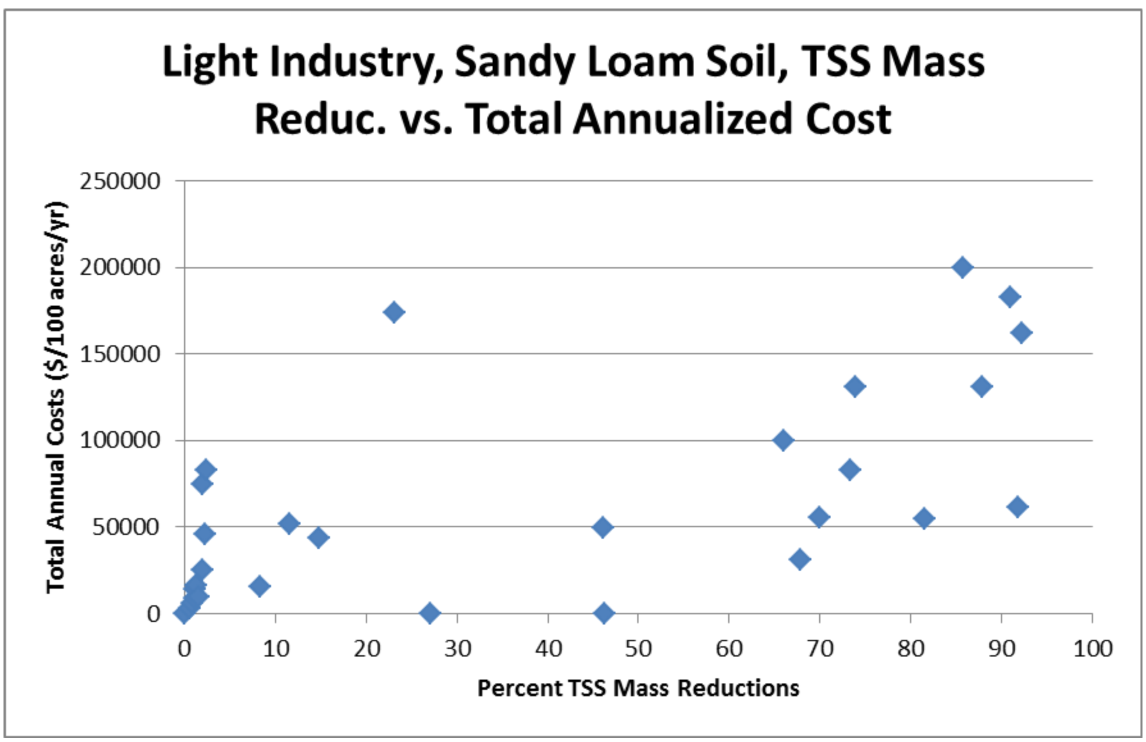
Light Industrial Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

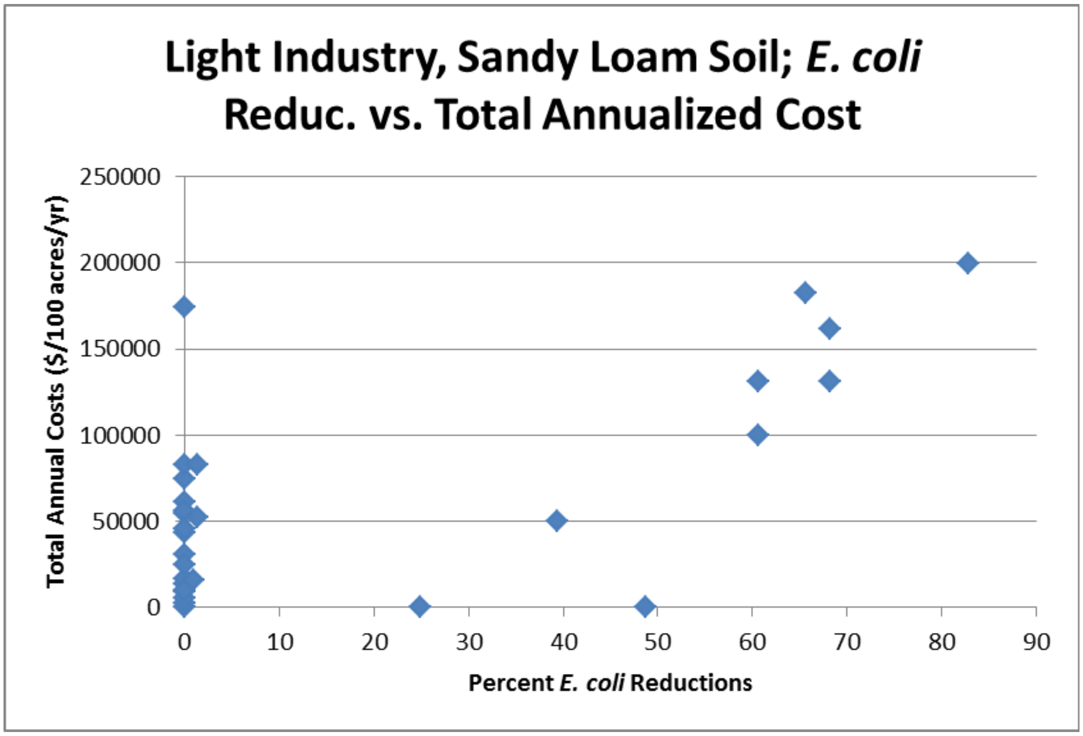
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
03 light indus Linc base	0.45	Poor	n/a	n/a	n/a	91	n/a	n/a	n/a	n/a	n/a	n/a	n/a
03 light indus Linc CB	0.45	Poor	0	15	0	77	377,750	0	13,080	43,392	540,756	-	11.19
03 light indus Linc pond 1 perct	0.45	Poor	0	68	0	29	278,203	13,725	7,450	30,875	384,773	-	1.74
03 light indus Linc pond 2 perct	0.45	Poor	0	82	0	17	497,305	27,450	12,598	54,705	681,749	-	2.57
03 light indus Linc pond 4 perct	0.45	Poor	0	92	0	7	535,234	54,900	14,170	61,524	766,723	-	2.56
03 light indus Linc street cleaning daily	0.45	Poor	0	23	0	70	32,646	0	171,360	173,980	2,168,170	-	28.81
03 light indus Linc connt roof rain garden 3 perct clay loam	0.44	Poor	2	1	0	93	60,299	4,254	3,951	9,131	113,793	0.09	61.89
03 light indus Linc rain barrel few	0.44	Poor	3	1	0	93	19,823	560	1,181	2,816	35,100	0.02	16.95
03 light indus Linc all roof rain garden 3 perct clay loam	0.44	Poor	3	1	0	93	109,957	7,757	7,205	16,651	207,506	0.14	96.19
03 light indus Linc rain barrel	0.44	Poor	3	1	0	93	39,626	1,120	2,361	5,630	70,163	0.04	25.94
03 light indus Linc rain barrel many	0.43	Poor	5	1	0	94	99,097	2,800	5,903	14,080	175,463	0.06	44.34
03 light indus Linc rain tanks small	0.43	Poor	6	2	0	95	65,993	2,334	4,467	9,950	124,000	0.03	24.06
03 light indus Linc connt roof rain garden 15 perct clay loam	0.42	Poor	7	2	0	96	301,494	21,270	19,756	45,655	568,967	0.14	97.36
03 light indus Linc rain tanks	0.42	Poor	8	2	0	97	164,965	5,833	11,167	24,873	309,969	0.07	49.07
03 light indus Linc sml pnd and rain tanks	0.42	Poor	8	70	0	30	443,168	19,558	18,618	55,748	694,742	0.16	3.05
03 light indus Linc all roof rain garden 15 perct clay loam	0.42	Poor	8	2	0	97	546,235	38,535	35,793	82,717	1,030,834	0.23	163.12
03 light indus Linc rain tanks large	0.42	Poor	8	2	0	97	494,896	17,500	33,502	74,618	929,907	0.21	145.63

03 light indus Linc biofilt parking 3 perct clay loam	0.44	Poor	4	5	0	89	104,457	6,256	6,785	15,669	195,268	0.10	11.48
03 light indus Linc biofilt parking 10 perct clay loam	0.42	Poor	7	9	1	89	346,796	20,769	22,526	52,020	648,288	0.15	21.38
03 light indus Linc sml pnd and biofilt parking 10 perct clay loam	0.42	Poor	7	72	1	28	624,999	34,494	29,976	82,895	1,033,061	0.25	4.42
03 light indus Linc biofilt parking 25 perct clay loam	0.41	Poor	10	11	1	90	864,900	51,798	56,179	129,737	1,616,815	0.28	45.60
03 light indus Linc curb biofilters 20 clay loam	0.39	Poor	15	29	15	76	340,100	4,132	22,321	49,943	622,403	0.07	6.65
03 light indus Linc sml pnd and swale clay loam	0.39	Poor	15	77	15	25	1,465,148	13,725	43,045	161,714	2,015,310	0.23	8.05
03 light indus Linc swale clay loam	0.39	Poor	15	29	15	76	1,186,945	0	35,595	130,839	1,630,537	0.19	16.98
03 light indus Linc half disconnected	0.31	Poor	32	27	25	98	0	0	0	0	0	0.00	0.00
03 light indus Linc curb biofilters 4*0 clay lo*am	0.34	Poor	26	45	26	68	680,200	8,264	44,642	99,887	1,244,807	0.08	8.56
03 light indus Linc sml pnd and curb biofilters 40 clay loam	0.34	Poor	26	79	26	25	958,403	21,989	52,092	130,762	1,629,580	0.11	6.32
03 light indus Linc sml pnd and parking biofilt 10 perc and curb biofilters 40 clay loam	0.31	Poor	32	82	28	24	1,304,196	42,759	74,618	182,702	2,276,865	0.12	8.53
03 light indus Linc curb biofilters 80 clay loam	0.27	Poor	42	64	42	56	1,360,399	16,529	89,285	199,773	2,489,613	0.10	11.87
03 light indus Linc disconnected	0.18	Fair	61	46	49	126	0	0	0	0	0	0.00	0.00

Sandy Loam Soil Conditions






Light Industry, Sandy Loam Soil; E. coli
Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
Percent E. coli Reductions

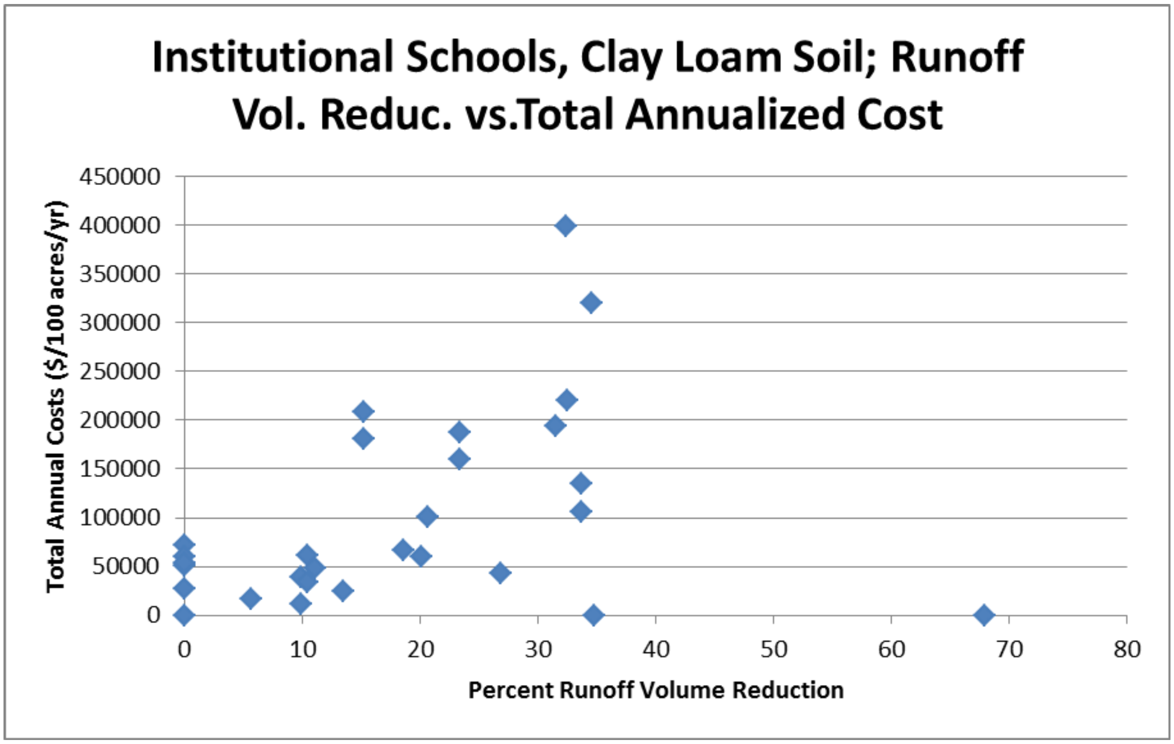
Light Industrial Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

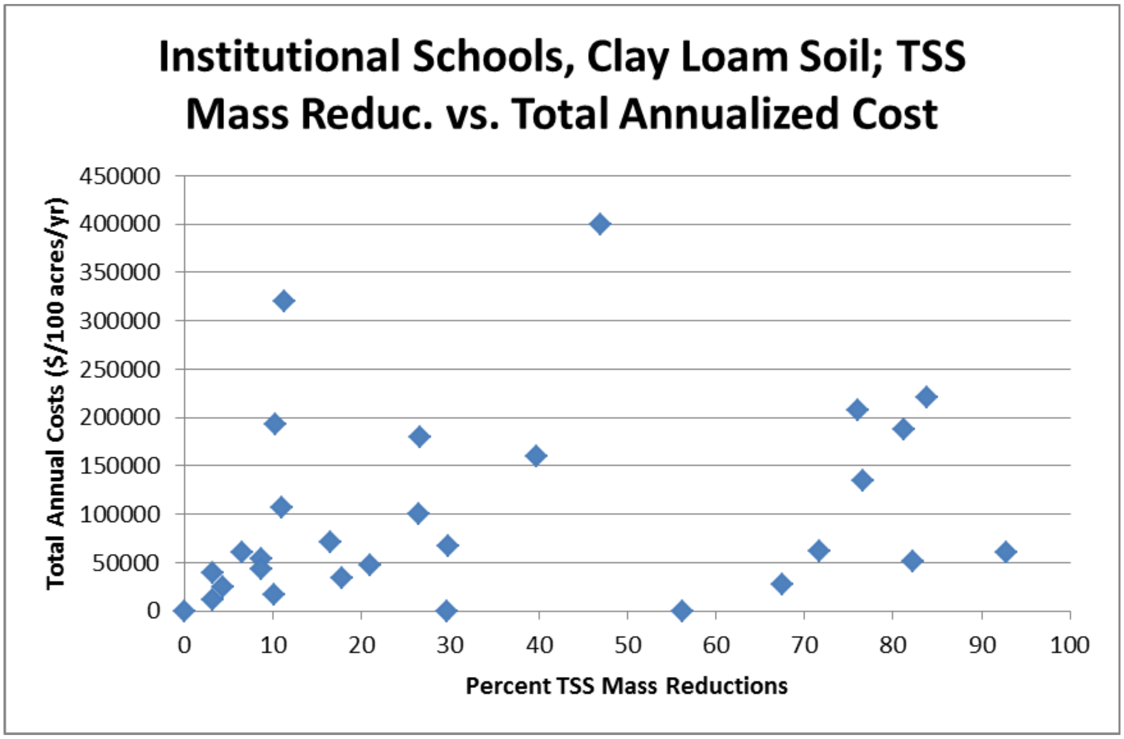
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
03 light indus Linc base	0.45	Poor	n/a	n/a	n/a	91	n/a	n/a	n/a	n/a	n/a	n/a	n/a
03 light indus Linc CB	0.45	Poor	0	15	0	77	377,750	0	13,080	43,392	540,756	-	11.19
03 light indus Linc pond 1 perct	0.45	Poor	0	68	0	29	278,203	13,725	7,450	30,875	384,773	-	1.74
03 light indus Linc pond 2 perct	0.45	Poor	0	82	0	17	497,305	27,450	12,598	54,705	681,749	-	2.57
03 light indus Linc pond 4 perct	0.45	Poor	0	92	0	7	535,234	54,900	14,170	61,524	766,723	-	2.56
03 light indus Linc street cleaning daily	0.45	Poor	0	23	0	70	32,646	0	171,360	173,980	2,168,170	-	28.81
03 light indus Linc rain barrel few	0.44	Poor	3	1	0	93	19,823	560	1,181	2,816	35,100	0.02	16.95
03 light indus Linc rain barrel	0.44	Poor	3	1	0	93	39,626	1,120	2,361	5,630	70,163	0.04	25.94
03 light indus Linc connt roof rain garden 3 perct sandy loam	0.43	Poor	5	1	0	94	60,299	4,254	3,951	9,131	113,793	0.04	28.97
03 light indus Linc rain barrel many	0.43	Poor	5	1	0	94	99,097	2,800	5,903	14,080	175,463	0.06	44.34
03 light indus Linc all roof rain garden 3 perct sandy loam	0.43	Poor	5	1	0	95	109,957	7,757	7,205	16,651	207,506	0.07	47.51
03 light indus Linc rain tanks small	0.43	Poor	6	2	0	95	65,993	2,334	4,467	9,950	124,000	0.03	24.06
03 light indus Linc rain tanks	0.42	Poor	8	2	0	97	164,965	5,833	11,167	24,873	309,969	0.07	49.07
03 light indus Linc sml pnd and rain tanks	0.42	Poor	8	70	0	30	443,168	19,558	18,618	55,748	694,742	0.16	3.05
03 light indus Linc rain tanks large	0.42	Poor	8	2	0	97	494,896	17,500	33,502	74,618	929,907	0.21	145.63
03 light indus Linc connt roof rain garden 15 perct sandy loam	0.41	Poor	9	2	0	98	301,494	21,270	19,756	45,655	568,967	0.11	77.35
03 light indus Linc all roof rain garden 15 perct sandy loam	0.41	Poor	10	2	0	98	546,235	38,535	35,793	82,717	1,030,834	0.19	131.63

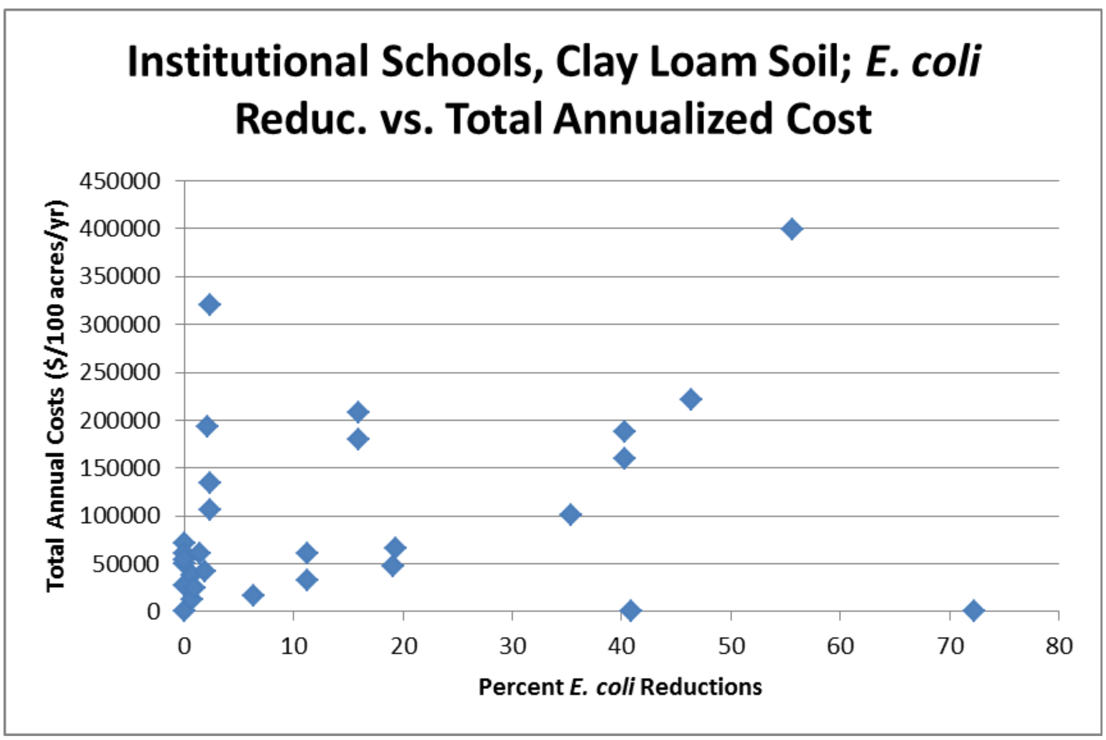
03 light indus Linc biofilt parking 3 perct sandy loam	0.42	Poor	8	8	1	91	104,457	6,256	6,785	15,669	195,268	0.04	7.21
03 light indus Linc biofilt parking 10 perct sandy loam	0.40	Poor	12	12	1	91	346,796	20,769	22,526	52,020	648,288	0.09	17.19
03 light indus Linc sml pnd and biofilt parking 10 perct sandy loam	0.40	Poor	12	73	1	28	624,999	34,494	29,976	82,895	1,033,061	0.15	4.32
03 light indus Linc half disconnected	0.31	Poor	32	27	25	98	0	0	0	0	0	0.00	0.00
03 light indus Linc curb biofilters 20 sandy loam	0.28	Poor	39	46	39	80	340,100	4,132	22,321	49,943	622,403	0.03	4.14
03 light indus Linc disconnected	0.18	Fair	61	46	49	126	0	0	0	0	0	0.00	0.00
03 light indus Linc curb biofilters 40 sandy loam	0.18	Poor	60	66	61	78	680,200	8,264	44,642	99,887	1,244,807	0.04	5.79
03 light indus Linc sml pnd and curb biofilters 40 sandy loam	0.18	Poor	60	88	61	28	958,403	21,989	52,092	130,762	1,629,580	0.05	5.69
03 light indus Linc sml pnd and parking biofilt 10 perct and curb biofilters 40 sandy loam	0.14	Fair	69	91	66	26	1,304,196	42,759	74,618	182,702	2,276,865	0.06	7.68
03 light indus Linc sml pnd and swale sandy loam	0.15	Fair	68	92	68	22	1,465,148	13,725	43,045	161,714	2,015,310	0.05	6.70
03 light indus Linc swale sandy loam	0.15	Fair	68	74	68	74	1,186,945	0	35,595	130,839	1,630,537	0.04	6.77
03 light indus Linc curb biofilters 80 sandy loam	0.08	Good	82	86	83	74	1,360,399	16,529	89,285	199,773	2,489,613	0.05	8.91

Institutional: Schools Land Use

Clay Loam Soil Conditions




Institutional Schools, Clay Loam Soil; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
100
Percent TSS Mass Reductions

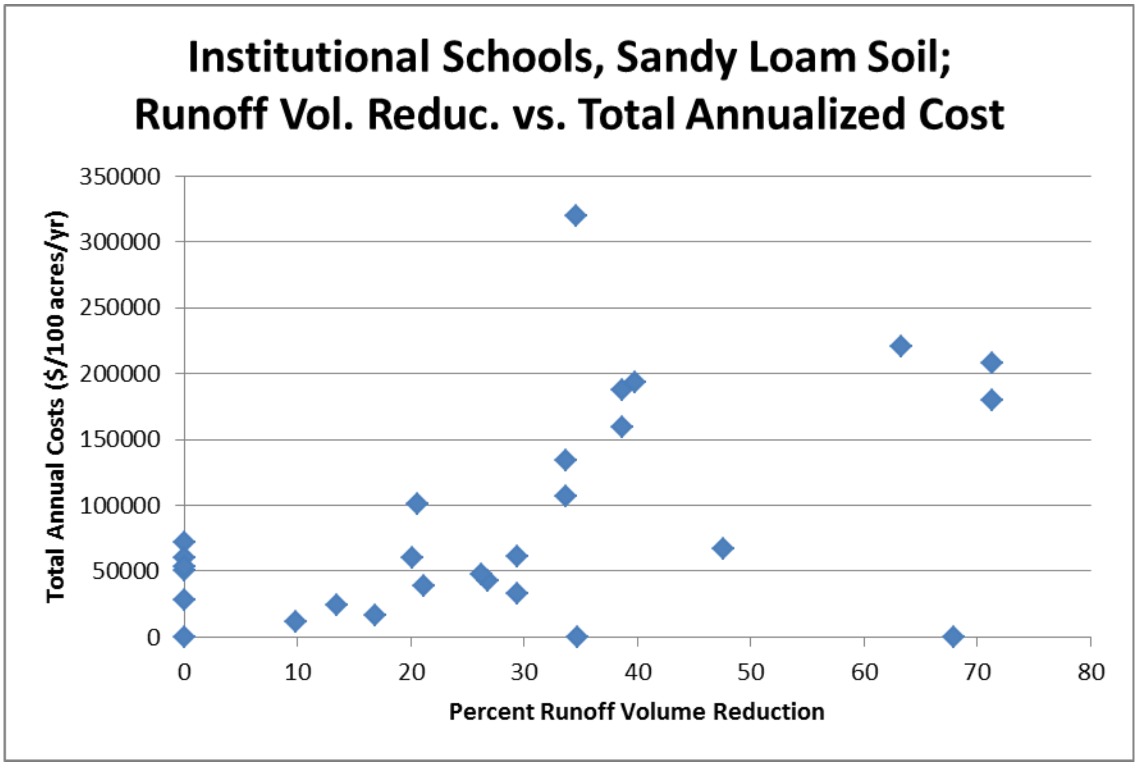

Institutional Schools, Clay Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
Percent E. coli Reductions

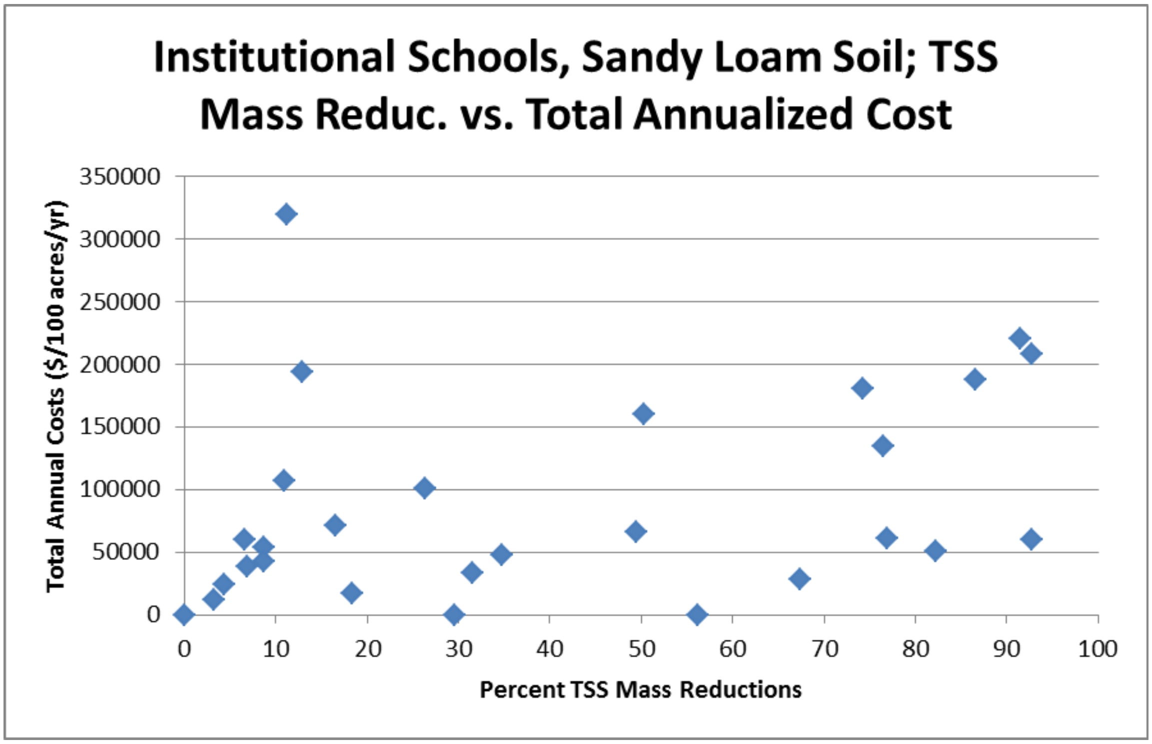
Institutional Schools Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
04 inst school Linc base	0.44	Poor	n/a	n/a	n/a	68	n/a	n/a	n/a	n/a	n/a	n/a	n/a
04 inst school Linc CB	0.44	Poor	0	16	0	57	566,626	0	26,160	71,628	892,637	-	23.23
04 inst school Linc pond 085 perct	0.44	Poor	0	67	0	22	251,151	9,938	6,907	27,857	347,165	-	2.21
04 inst school Linc pond 17 perct	0.44	Poor	0	82	0	12	463,123	19,875	11,783	50,540	629,841	-	3.29
04 inst school Linc pond 34 perct	0.44	Poor	0	93	0	5	535,234	39,750	14,170	60,308	751,573	-	3.47
04 inst school Linc street cleaning daily	0.44	Poor	0	9	0	62	10,056	0	52,784	53,591	667,860	-	33.10
04 inst school Linc roof rain garden 3 perct clay loam	0.39	Poor	10	3	1	73	255,383	18,017	16,735	38,673	481,948	0.09	64.57
04 inst school Linc rain barrels few	0.39	Poor	10	3	1	73	84,940	2,400	5,060	12,068	150,397	0.03	20.14
04 inst school Linc rain barrels	0.38	Poor	13	4	1	75	169,880	4,800	10,120	24,136	300,793	0.04	29.53
04 inst school Linc rain barrels many	0.35	Poor	20	7	1	79	424,680	12,000	25,298	60,338	751,946	0.07	49.33
04 inst school Linc rain tanks small	0.32	Poor	27	9	2	85	282,798	10,000	19,144	42,639	531,375	0.04	26.21
04 inst school Linc roof rain garden 15 perct clay loam	0.30	Poor	32	10	2	89	1,276,914	90,083	83,673	193,364	2,409,741	0.14	101.11
04 inst school Linc rain tanks	0.29	Poor	34	11	2	91	706,994	25,000	47,860	106,597	1,328,438	0.07	52.15
04 inst school Linc sml pnd and rain tanks	0.29	Poor	34	77	2	24	958,144	34,938	54,767	134,455	1,675,603	0.09	9.39
04 inst school Linc rain tanks large	0.29	Poor	35	11	2	92	2,120,981	75,000	143,581	319,792	3,985,315	0.21	152.25
04 inst school Linc curb biofilters 20 clay loam	0.41	Poor	6	10	6	65	113,367	1,377	7,440	16,648	207,468	0.07	8.83
04 inst school Linc curb biofilters 40 clay loam	0.39	Poor	10	18	11	62	226,733	2,755	14,881	33,296	414,936	0.07	9.97
04 inst school Linc sml pnd and curb biofilters 40 clay loam	0.39	Poor	10	72	11	21	477,884	12,692	21,788	61,153	762,101	0.13	4.56
04 inst school Linc sml pnd and swale clay loam	0.37	Poor	15	76	16	19	1,864,728	9,938	57,586	208,014	2,592,308	0.31	14.61

04 inst school Linc swale clay loam	0.37	Poor	15	27	16	59	1,613,577	0	50,678	180,156	2,245,143	0.27	36.10
04 inst school Linc biofilt parking 3 perct clay loam	0.39	Poor	11	21	19	60	317,548	19,017	20,626	47,633	593,613	0.10	12.12
04 inst school Linc curb biofilters 80 clay loam	0.36	Poor	19	30	19	58	453,466	5,510	29,762	66,591	829,871	0.08	11.94
04 inst school Linc porous pvt parking half clay loam	0.35	Poor	21	26	35	63	1,204,218	0	4,030	100,660	1,254,445	0.11	20.38
04 inst school Linc biofilt parking 10 perct clay loam	0.33	Poor	23	40	40	53	1,065,456	63,809	69,206	159,821	1,991,728	0.15	21.45
04 inst school Linc sml pnd and biofilt parking 10 perct clay loam	0.33	Poor	23	81	40	17	1,316,607	73,746	76,113	187,679	2,338,893	0.18	12.34
04 inst school Linc half disconnected	0.29	Poor	35	30	41	73	0	0	0	0	0	0.00	0.00
04 inst school Linc sml pnd and parking biofilt 10 perc and curb biofilters 40 clay loam	0.29	Poor	32	84	46	16	1,540,260	76,501	90,994	220,727	2,750,749	0.15	14.06
04 inst school Linc biofilt parking 25 perct clay loam	0.30	Poor	32	47	56	53	2,661,552	159,396	172,880	399,240	4,975,416	0.28	45.36
04 inst school Linc disconnected	0.14	Good	68	56	72	93	0	0	0	0	0	0.00	0.00

Sandy Loam Soil Conditions




Institutional Schools, Sandy Loam Soil; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
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70
80
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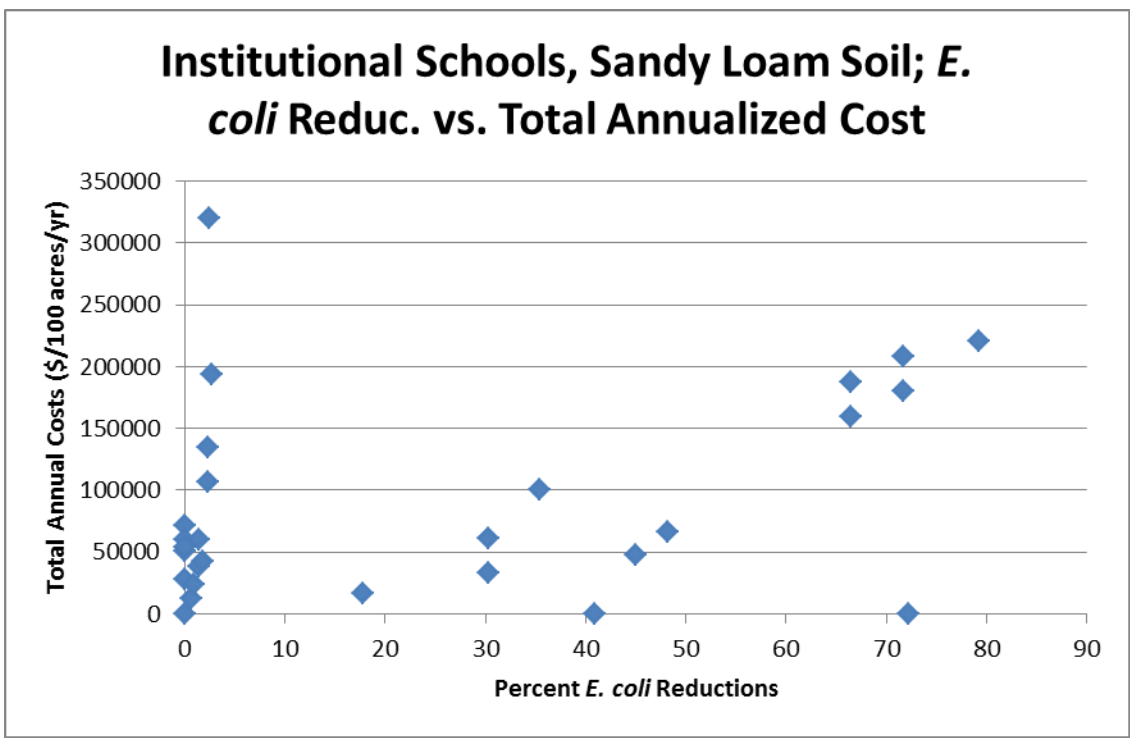
100
Percent TSS Mass Reductions

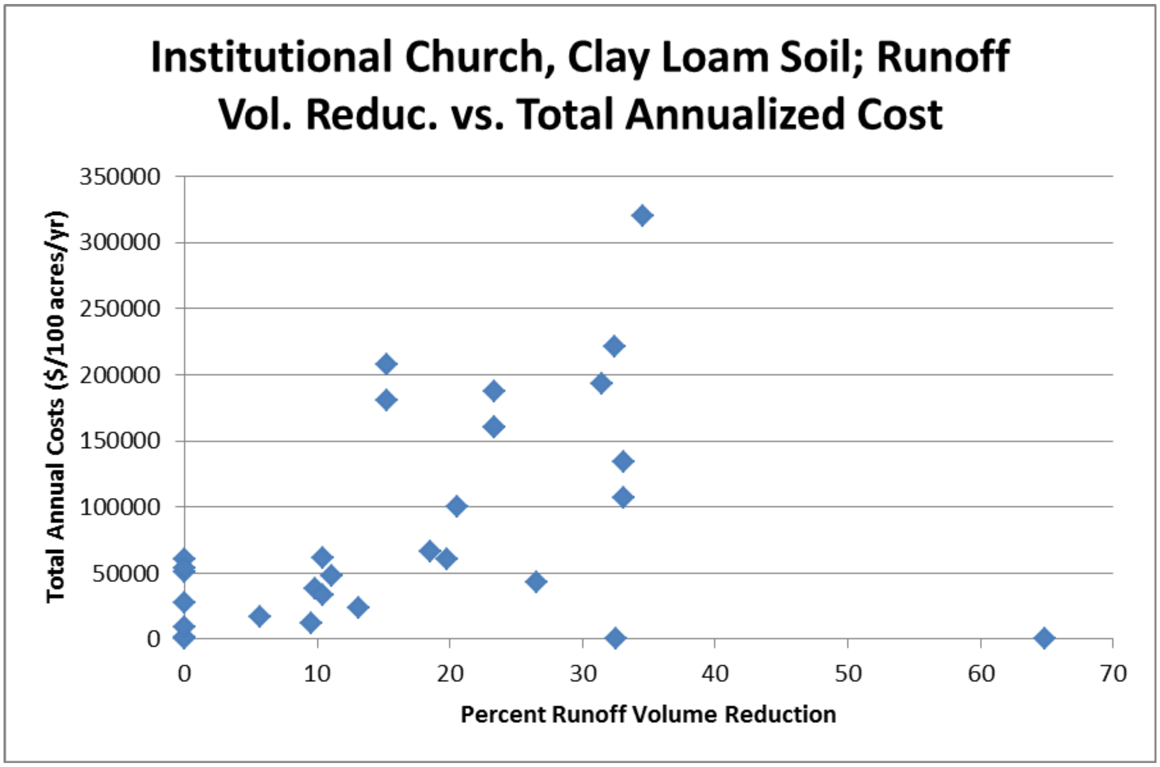

Institutional Schools, Sandy Loam Soil; *E. coli* Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
Percent *E. coli* Reductions

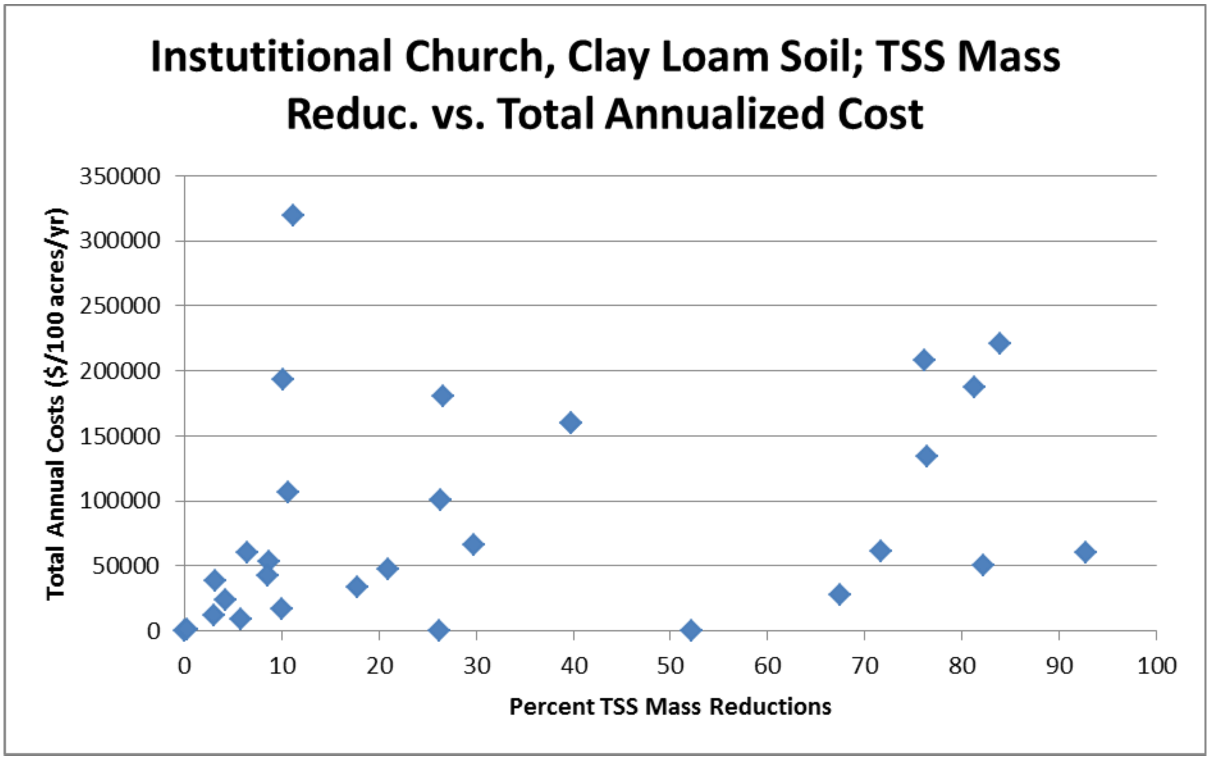
Institutional Schools Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

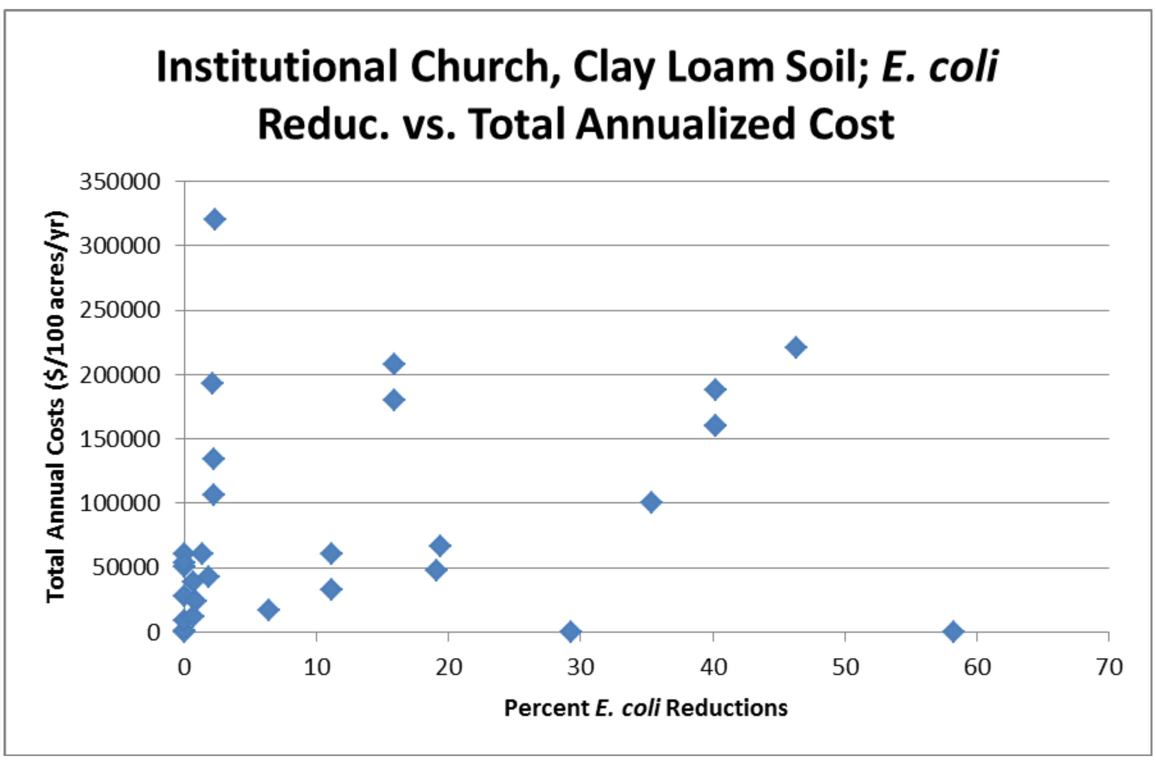
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
04 inst school Linc base	0.44	Poor	n/a	n/a	n/a	68	n/a	n/a	n/a	n/a	n/a	n/a	n/a
04 inst school Linc CB	0.44	Poor	0	16	0	57	566,626	0	26,160	71,628	892,637	-	23.23
04 inst school Linc pond 085 perct	0.44	Poor	0	67	0	22	251,151	9,938	6,907	27,857	347,165	-	2.21
04 inst school Linc pond 17 perct	0.44	Poor	0	82	0	12	463,123	19,875	11,783	50,540	629,841	-	3.29
04 inst school Linc pond 34 perct	0.44	Poor	0	93	0	5	535,234	39,750	14,170	60,308	751,573	-	3.47
04 inst school Linc street cleaning daily	0.44	Poor	0	9	0	62	10,056	0	52,784	53,591	667,860	-	33.10
04 inst school Linc rain barrels few	0.39	Poor	10	3	1	73	84,940	2,400	5,060	12,068	150,397	0.03	20.14
04 inst school Linc rain barrels	0.38	Poor	13	4	1	75	169,880	4,800	10,120	24,136	300,793	0.04	29.53
04 inst school Linc rain barrels many	0.35	Poor	20	7	1	79	424,680	12,000	25,298	60,338	751,946	0.07	49.33
04 inst school Linc roof rain garden 3 perct sandy loam	0.34	Poor	21	7	1	80	255,383	18,017	16,735	38,673	481,948	0.04	30.16
04 inst school Linc rain tanks small	0.32	Poor	27	9	2	85	282,798	10,000	19,144	42,639	531,375	0.04	26.21
04 inst school Linc rain tanks	0.29	Poor	34	11	2	91	706,994	25,000	47,860	106,597	1,328,438	0.07	52.15
04 inst school Linc sml pnd and rain tanks	0.29	Poor	34	77	2	24	958,144	34,938	54,767	134,455	1,675,603	0.09	9.39
04 inst school Linc rain tanks large	0.29	Poor	35	11	2	92	2,120,981	75,000	143,581	319,792	3,985,315	0.21	152.25
04 inst school Linc roof rain garden 15 perct sandy loam	0.26	Poor	40	13	3	98	1,276,914	90,083	83,673	193,364	2,409,741	0.11	80.01
04 inst school Linc curb biofilters 20 sandy loam	0.36	Poor	17	18	18	66	113,367	1,377	7,440	16,648	207,468	0.02	4.83
04 inst school Linc curb biofilters 40 sandy loam	0.31	Poor	29	31	30	66	226,733	2,755	14,881	33,296	414,936	0.03	5.65
04 inst school Linc sml pnd and curb biofilters 40 sandy loam	0.31	Poor	29	77	30	22	477,884	12,692	21,788	61,153	762,101	0.05	4.25
04 inst school Linc porous pvt half sandy loam	0.35	Poor	21	26	35	63	1,204,218	0	4,030	100,660	1,254,445	0.11	20.38

04 inst school Linc half disconnected	0.29	Poor	35	30	41	73	0	0	0	0	0	0.00	0.00
04 inst school Linc biofilt parking 3 perct sandy loam	0.32	Poor	26	35	45	60	317,548	19,017	20,626	47,633	593,613	0.04	7.32
04 inst school Linc curb biofilters 80 sandy loam	0.23	Poor	48	49	48	65	453,466	5,510	29,762	66,591	829,871	0.03	7.19
04 inst school Linc biofilt parking 10 perct sandy loam	0.27	Poor	39	50	66	55	1,065,456	63,809	69,206	159,821	1,991,728	0.09	17.00
04 inst school Linc sml pond and biofilt parking 10 perct sandy loam	0.27	Poor	39	87	66	15	1,316,607	73,746	76,113	187,679	2,338,893	0.11	11.58
04 inst school Linc sml pnd and swale sandy loam	0.13	Good	71	93	72	17	1,864,728	9,938	57,586	208,014	2,592,308	0.07	11.99
04 inst school Linc swale sandy loam	0.13	Good	71	74	72	61	1,613,577	0	50,678	180,156	2,245,143	0.06	12.98
04 inst school Linc disconnected	0.14	Good	68	56	72	93	0	0	0	0	0	0.00	0.00
04 inst school Linc sml pnd and parking biofilt 10 prct and curb biofilters 40 sandy loam	0.16	Fair	63	92	79	16	1,540,260	76,501	90,994	220,727	2,750,749	0.08	12.89

Institutional: Church Land Use
Clay Loam Soil Conditions




Instutitional Church, Clay Loam Soil; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
100
Percent TSS Mass Reductions

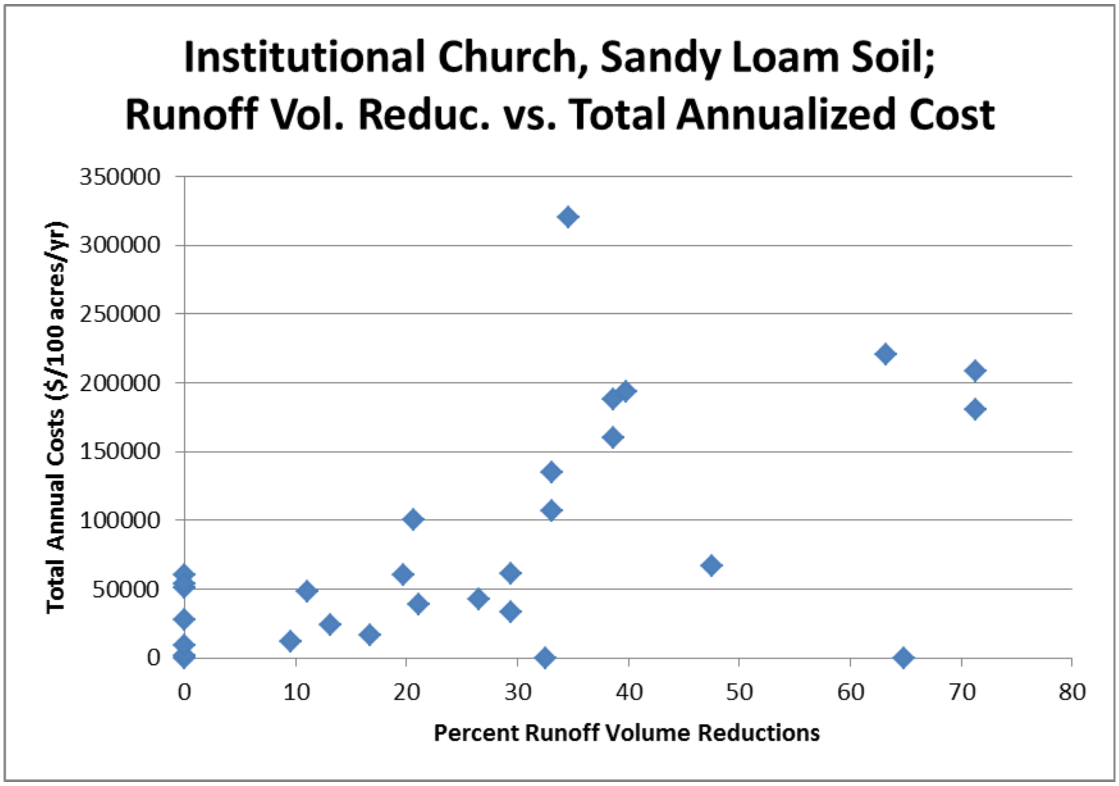

Institutional Church, Clay Loam Soil; *E. coli* Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
Percent *E. coli* Reductions

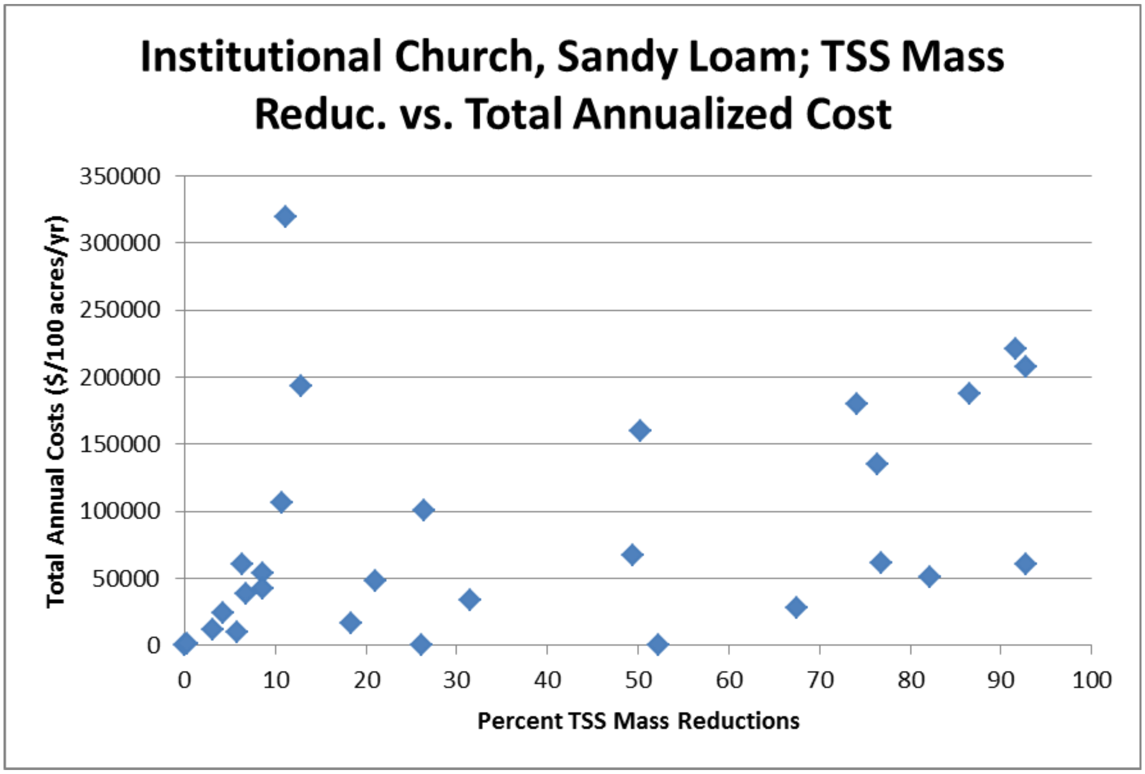
Institutional Church Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
05 inst church Linc base	0.44	Poor	n/a	n/a	n/a	68	n/a	n/a	n/a	n/a	n/a	n/a	n/a
05 inst church Linc CB	0.44	Poor	0	0	0	68	9,444	0	436	1,194	14,877	-	22.09
05 inst church Linc pond 085 perct	0.44	Poor	0	67	0	22	251,151	9,938	6,907	27,857	347,165	-	2.21
05 inst church Linc pond 17 perct	0.44	Poor	0	82	0	12	463,123	19,875	11,783	50,540	629,841	-	3.29
05 inst church Linc pond 34 perct	0.44	Poor	0	93	0	5	535,234	39,750	14,170	60,308	751,573	-	3.47
05 inst church Linc street cleaning daily	0.44	Poor	0	9	0	62	10,056	0	52,784	53,591	667,860	-	33.10
05 inst church Linc street cleaning weekly	0.44	Poor	0	6	0	64	1,740	0	9,134	9,273	115,567	-	8.47
05 inst church Linc rain barrels few	0.39	Poor	10	3	1	73	84,940	2,400	5,060	12,068	150,397	0.03	20.84
05 inst church Linc roof rain garden 3 perct clay loam	0.39	Poor	10	3	1	73	255,383	18,017	16,735	38,673	481,948	0.09	64.57
05 inst church Linc rain barrels	0.38	Poor	13	4	1	75	169,880	4,800	10,120	24,136	300,793	0.04	30.20
05 inst church Linc rain barrels many	0.35	Poor	20	6	1	79	424,680	12,000	25,298	60,338	751,946	0.07	50.31
05 inst church Linc rain tanks small	0.32	Poor	27	9	2	84	282,798	10,000	19,144	42,639	531,375	0.04	26.49
05 inst church Linc roof rain garden 15 perct clay loam	0.30	Poor	32	10	2	89	1,276,914	90,083	83,673	193,364	2,409,741	0.14	101.11
05 inst church Linc rain tanks	0.29	Poor	33	11	2	90	706,994	25,000	47,860	106,597	1,328,438	0.07	53.04
05 inst church Linc sml pnd and rain tanks	0.29	Poor	33	76	2	24	958,144	34,938	54,767	134,455	1,675,603	0.09	9.40
05 inst church Linc rain tanks large	0.29	Poor	35	11	2	92	2,120,981	75,000	143,581	319,792	3,985,315	0.21	152.25
05 inst church Linc curb biofilters 20 clay loam	0.41	Poor	6	10	6	65	113,367	1,377	7,440	16,648	207,468	0.07	8.83
05 inst church Linc curb biofilters 40 clay loam	0.39	Poor	10	18	11	62	226,733	2,755	14,881	33,296	414,936	0.07	9.97
05 inst church Linc sml pnd and curb biofilters 40 clay loam	0.39	Poor	10	72	11	21	477,884	12,692	21,788	61,153	762,101	0.13	4.56

05 inst church Linc sml pnd and swale clay loam	0.37	Poor	15	76	16	19	1,864,728	9,938	57,586	208,014	2,592,308	0.31	14.61
05 inst church Linc swale clay loam	0.37	Poor	15	27	16	59	1,613,577	0	50,678	180,156	2,245,143	0.27	36.10
05 inst church Linc biofilt parking 3 perct clay loam	0.39	Poor	11	21	19	60	317,548	19,017	20,626	47,633	593,613	0.10	12.12
05 inst church Linc curb biofilters 80 clay loam	0.36	Poor	19	30	19	58	453,466	5,510	29,762	66,591	829,871	0.08	11.94
05 inst church Linc half disconnected	0.29	Poor	33	26	29	74	0	0	0	0	0	0.00	0.00
05 inst church Linc porous pvt parking half clay loam	0.35	Poor	21	26	35	63	1,204,218	0	4,030	100,660	1,254,445	0.11	20.38
05 inst church Linc biofilt parking 10 perct clay loam	0.33	Poor	23	40	40	53	1,065,456	63,809	69,206	159,821	1,991,728	0.15	21.45
05 inst church Linc biofilt parking 25 perct clay loam	0.33	Poor	23	40	40	53	1,065,456	63,809	69,206	159,821	1,991,728	0.15	21.45
05 inst church Linc sml pnd and biofilt parking 10 perct clay loam	0.33	Poor	23	81	40	17	1,316,607	73,746	76,113	187,679	2,338,893	0.18	12.34
05 inst church Linc sml pnd and parking biofilt 10 perct and curb biofilters 40 clay loam	0.29	Poor	32	84	46	16	1,540,260	76,501	90,994	220,727	2,750,749	0.15	14.06
05 inst church Linc disconnected	0.15	Fair	65	52	58	92	0	0	0	0	0	0.00	0.00

Sandy Loam Soil Conditions




Institutional Church, Sandy Loam; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
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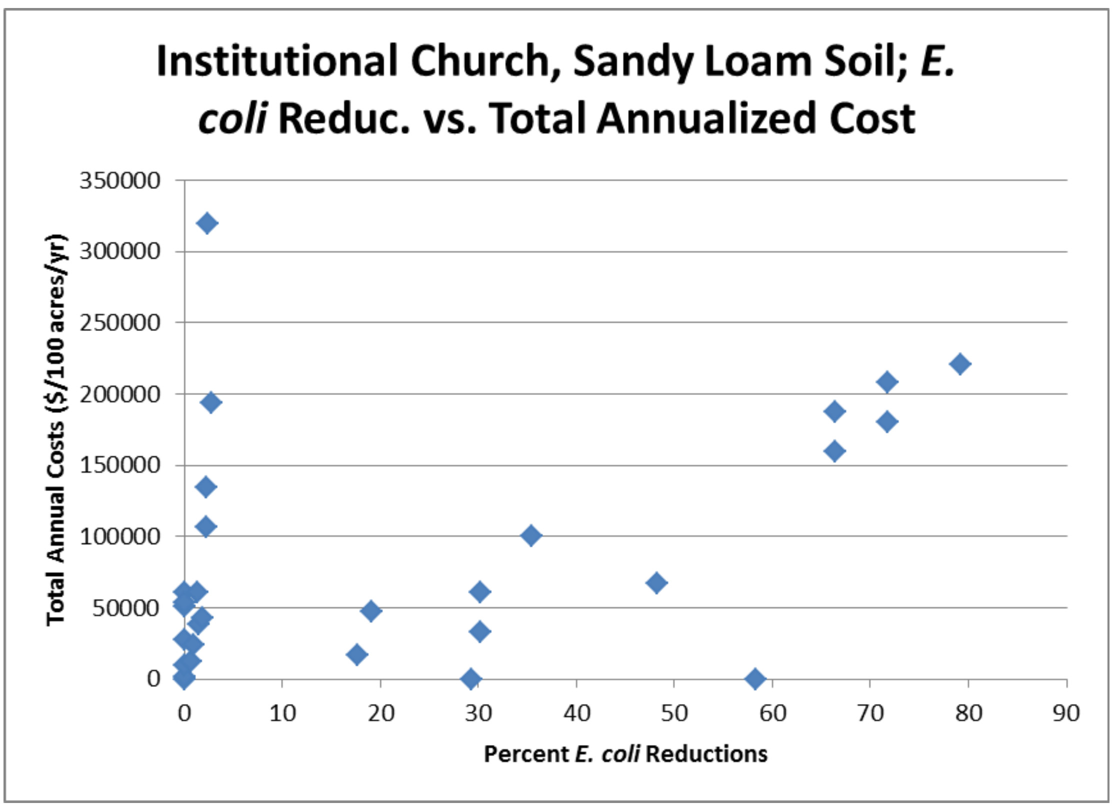
100
Percent TSS Mass Reductions


Institutional Church, Sandy Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
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0
10
20
30
40
50
60
70
80
90
Percent E. coli Reductions

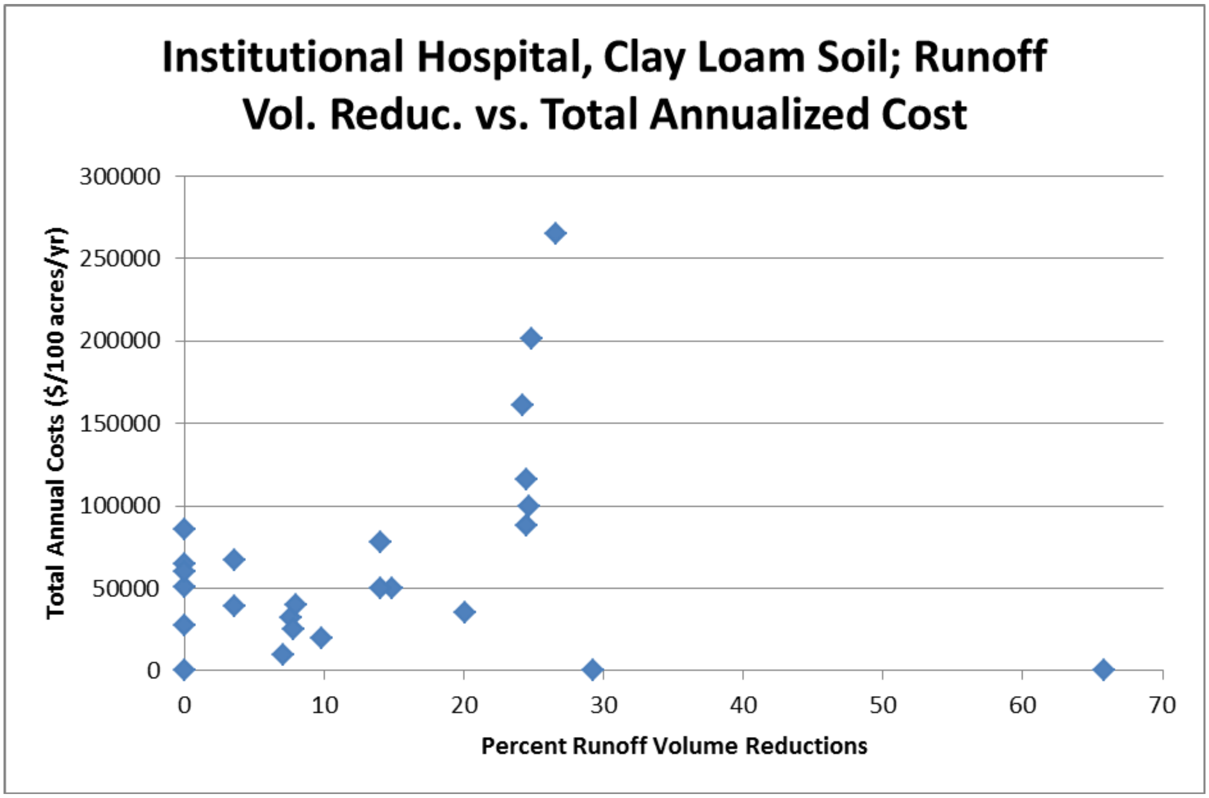
Institutional Church Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

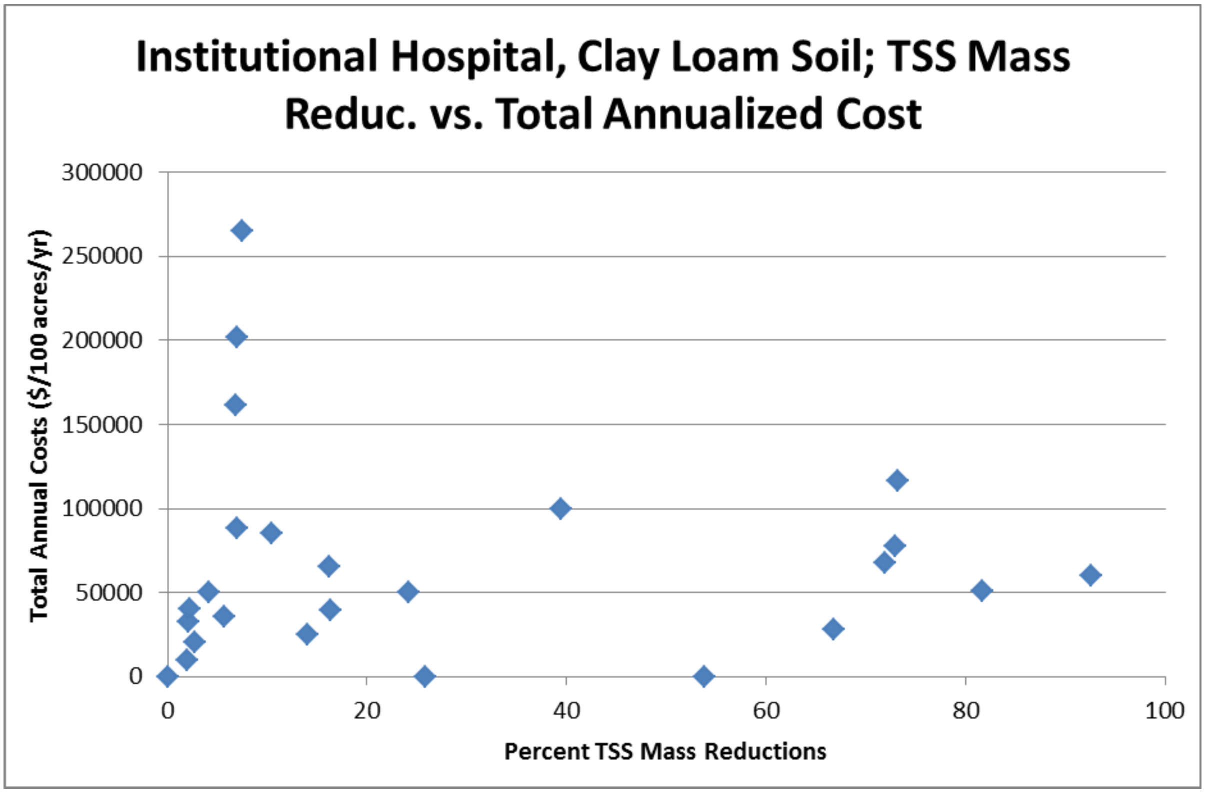
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
05 inst church Linc base	0.44	Poor	n/a	n/a	n/a	68	n/a	n/a	n/a	n/a	n/a	n/a	n/a
05 inst church Linc CB	0.44	Poor	0	0	0	68	9,444	0	436	1,194	14,877	-	22.09
05 inst church Linc pond 085 perct	0.44	Poor	0	67	0	22	251,151	9,938	6,907	27,857	347,165	-	2.21
05 inst church Linc pond 17 perct	0.44	Poor	0	82	0	12	463,123	19,875	11,783	50,540	629,841	-	3.29
05 inst church Linc pond 34 perct	0.44	Poor	0	93	0	5	535,234	39,750	14,170	60,308	751,573	-	3.47
05 inst church Linc street cleaning daily	0.44	Poor	0	9	0	62	10,056	0	52,784	53,591	667,860	-	33.10
05 inst church Linc street cleaning weekly	0.44	Poor	0	6	0	64	1,740	0	9,134	9,273	115,567	-	8.47
05 inst church Linc rain barrels few	0.39	Poor	10	3	1	73	84,940	2,400	5,060	12,068	150,397	0.03	20.84
05 inst church Linc rain barrels	0.38	Poor	13	4	1	75	169,880	4,800	10,120	24,136	300,793	0.04	30.20
05 inst church Linc rain barrels many	0.35	Poor	20	6	1	79	424,680	12,000	25,298	60,338	751,946	0.07	50.31
05 inst church Linc roof rain garden 3 perct sandy loam	0.34	Poor	21	7	1	80	255,383	18,017	16,735	38,673	481,948	0.04	30.16
05 inst church Linc rain tanks small	0.32	Poor	27	9	2	84	282,798	10,000	19,144	42,639	531,375	0.04	26.49
05 inst church Linc rain tanks	0.29	Poor	33	11	2	90	706,994	25,000	47,860	106,597	1,328,438	0.07	53.04
05 inst church Linc sml pnd and rain tanks	0.29	Poor	33	76	2	24	958,144	34,938	54,767	134,455	1,675,603	0.09	9.40
05 inst church Linc rain tanks large	0.29	Poor	35	11	2	92	2,120,981	75,000	143,581	319,792	3,985,315	0.21	152.25
05 inst church Linc roof rain garden 15 perct sandy loam	0.26	Poor	40	13	3	98	1,276,914	90,083	83,673	193,364	2,409,741	0.11	80.01
05 inst church Linc curb biofilters 20 sandy loam	0.36	Poor	17	18	18	66	113,367	1,377	7,440	16,648	207,468	0.02	4.83
05 inst church Linc biofilt parking 3 perct sandy loam	0.39	Poor	11	21	19	60	317,548	19,017	20,626	47,633	593,613	0.10	12.12
05 inst church Linc half disconnected	0.29	Poor	33	26	29	74	0	0	0	0	0	0.00	0.00

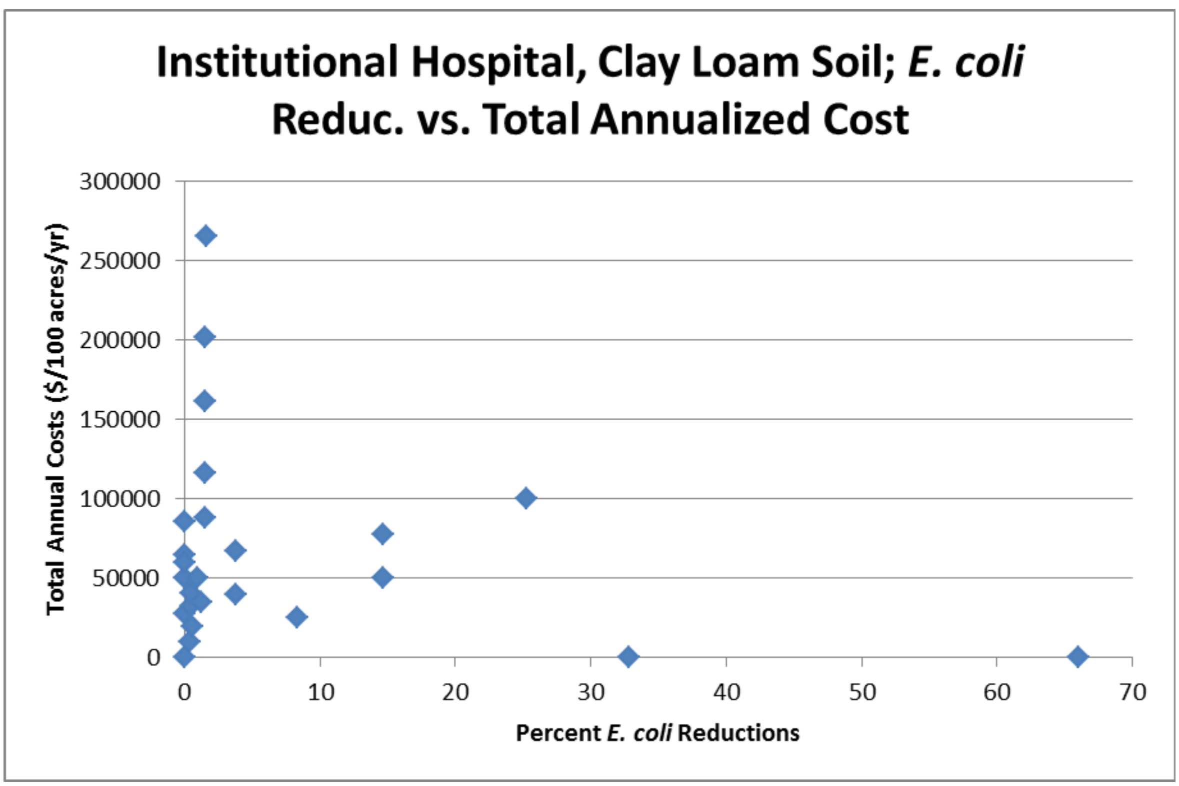
05 inst church Linc curb biofilters 40 sandy loam	0.31	Poor	29	31	30	66	226,733	2,755	14,881	33,296	414,936	0.03	5.65
05 inst church Linc sml pnd and curb biofilters 40 sandy loam	0.31	Poor	29	77	30	22	477,884	12,692	21,788	61,153	762,101	0.05	4.25
05 inst church Linc porous pvt parking half sandy loam	0.35	Poor	21	26	35	63	1,204,218	0	4,030	100,660	1,254,445	0.11	20.38
05 inst church Linc curb biofilters 80 sandy loam	0.23	Poor	48	49	48	65	453,466	5,510	29,762	66,591	829,871	0.03	7.19
05 inst church Linc disconnected	0.15	Fair	65	52	58	92	0	0	0	0	0	0.00	0.00
05 inst church Linc biofilt parking 10 perct sandy loam	0.27	Poor	39	50	66	55	1,065,456	63,809	69,206	159,821	1,991,728	0.09	17.00
05 inst church Linc sml pnd and biofilt parking 10 perct sandy loam	0.27	Poor	39	87	66	15	1,316,607	73,746	76,113	187,679	2,338,893	0.11	11.58
05 inst church Linc sml pnd and swale sandy loam	0.13	Good	71	93	72	17	1,864,728	9,938	57,586	208,014	2,592,308	0.07	11.99
05 inst church Linc swale sandy loam	0.13	Good	71	74	72	61	1,613,577	0	50,678	180,156	2,245,143	0.06	12.98
05 inst church Linc sml pnd and parking biofilt 10 perct and curb biofilters 40 sandy loam	0.16	Fair	63	92	79	16	1,540,260	76,501	90,994	220,727	2,750,749	0.08	12.89

Institutional: Hospital Land Use

Clay Loam Soil Conditions




Institutional Hospital, Clay Loam Soil; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
300000
250000
200000
150000
100000
50000
0
0
20
40
60
80
100
Percent TSS Mass Reductions

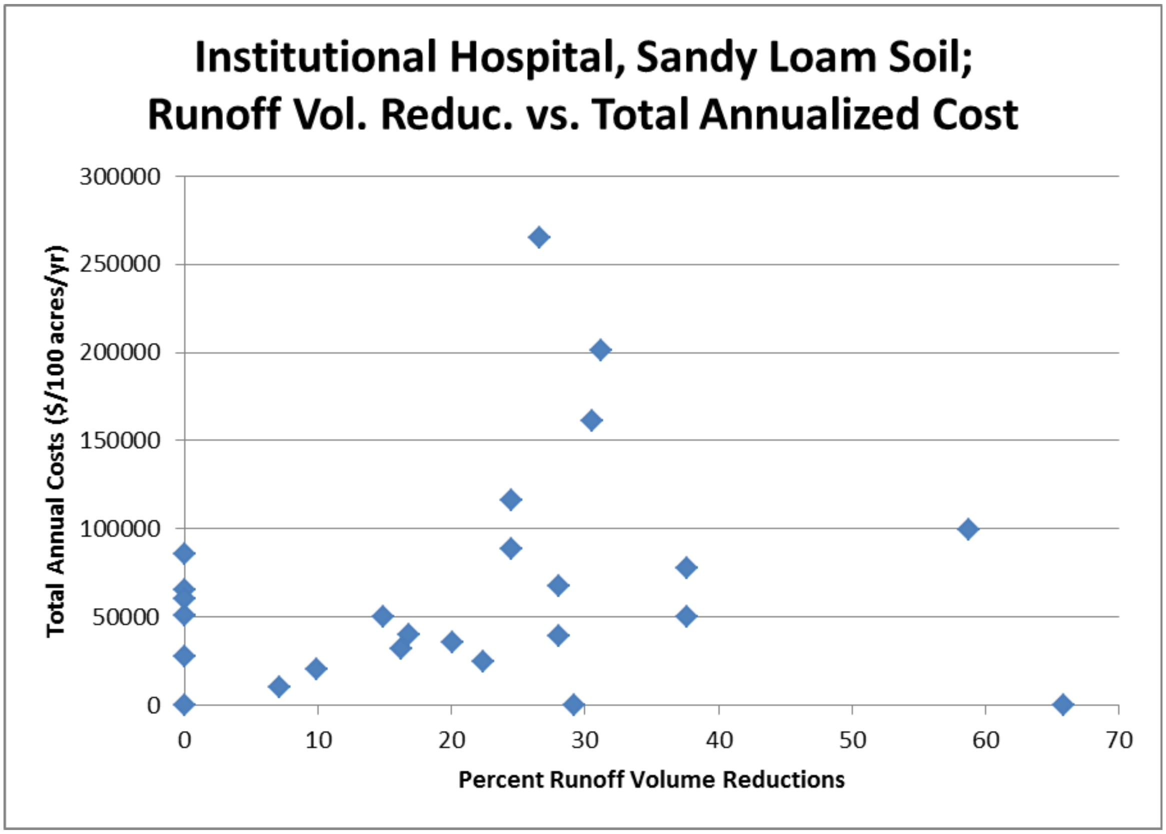

Institutional Hospital, Clay Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
Percent E. coli Reductions

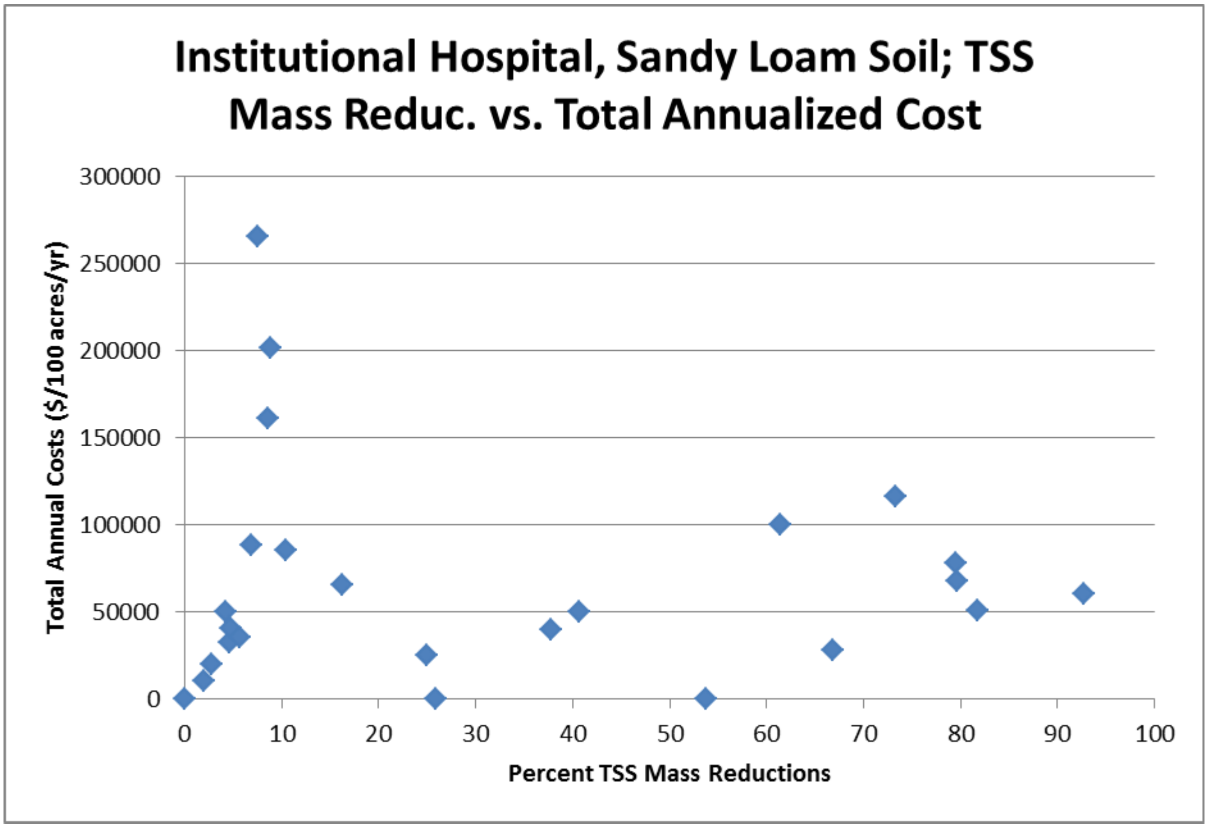
Institutional Hospital Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

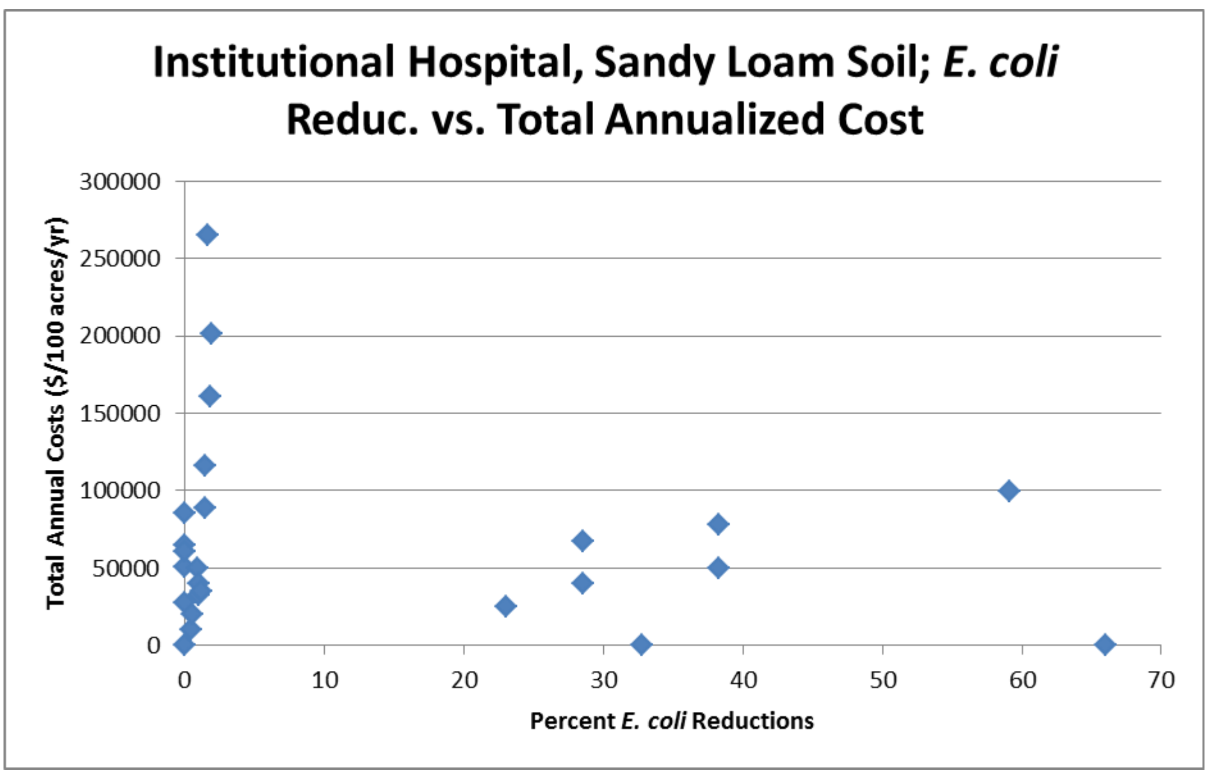
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
06 inst hospital Linc base	0.47	Poor	n/a	n/a	n/a	78	n/a	n/a	n/a	n/a	n/a	n/a	n/a
06 inst hospital Linc CB	0.47	Poor	0	16	0	65	566,626	0	19,620	65,088	811,134	-	17.30
06 inst hospital Linc pond 085 perct	0.47	Poor	0	67	0	26	251,151	9,938	6,907	27,857	347,165	-	1.80
06 inst hospital Linc pond 17 perct	0.47	Poor	0	82	0	14	463,123	19,875	11,783	50,540	629,841	-	2.67
06 inst hospital Linc pond 34 perct	0.47	Poor	0	93	0	6	535,234	39,750	14,170	60,308	751,573	-	2.81
06 inst hospital Linc street cleaning daily	0.47	Poor	0	10	0	70	16,047	0	84,228	85,515	1,065,711	-	35.42
06 inst hospital Linc rain barrels few	0.44	Poor	7	2	0	82	70,418	1,990	4,195	10,005	124,683	0.03	21.59
06 inst hospital Linc connt roof rain garden 3 perct clay loam	0.44	Poor	8	2	0	82	212,819	15,014	13,945	32,227	401,624	0.09	64.62
06 inst hospital Linc all roof rain garden 3 perct clay loam	0.43	Poor	8	2	0	83	266,024	18,767	17,432	40,284	502,030	0.11	76.72
06 inst hospital Linc rain barrels	0.43	Poor	10	3	1	84	140,856	3,980	8,391	20,013	249,402	0.04	30.99
06 inst hospital Linc rain barrels many	0.40	Poor	15	4	1	87	352,129	9,950	20,976	50,030	623,487	0.07	51.41
06 inst hospital Linc rain tanks small	0.38	Poor	20	6	1	92	234,480	8,291	15,873	35,354	440,586	0.04	26.82
06 inst hospital Linc connt roof rain garden 15 perct clay loam	0.36	Poor	24	7	1	96	1,064,095	75,069	69,727	161,137	2,008,118	0.14	101.40
06 inst hospital Linc rain tanks	0.36	Poor	25	7	2	96	586,224	20,729	39,685	88,388	1,101,512	0.08	54.98
06 inst hospital Linc sml pnd and rain tanks	0.36	Poor	25	73	2	28	837,375	30,667	46,592	116,246	1,448,677	0.10	6.85
06 inst hospital Linc all roof rain garden 15 perct clay loam	0.35	Poor	25	7	2	96	1,330,119	93,836	87,159	201,421	2,510,147	0.17	123.66
06 inst hospital Linc rain tanks large	0.35	Poor	27	8	2	98	1,758,655	62,188	119,053	265,162	3,304,505	0.21	152.25

06 inst hospital Linc swale clay loam	0.45	Poor	4	16	4	67	354,200	0	11,125	39,546	492,836	0.23	10.44
06 inst hospital Linc sml pnd and swale clay loam	0.45	Poor	4	72	4	23	605,351	9,938	18,032	67,404	840,001	0.40	4.04
06 inst hospital Linc curb biofilters 20 clay loam	0.43	Poor	8	14	8	72	170,050	2,066	11,161	24,972	311,202	0.07	7.66
06 inst hospital Linc curb biofilters 40 clay loam	0.41	Poor	14	24	15	69	340,100	4,132	22,321	49,943	622,403	0.07	8.92
06 inst hospital Linc sml pnd and curb biofilters 40 clay loam	0.41	Poor	14	73	15	24	591,251	14,070	29,228	77,801	969,569	0.12	4.60
06 inst hospital Linc curb biofilters 80 clay loam	0.36	Poor	25	39	25	63	680,200	8,264	44,642	99,887	1,244,807	0.08	10.94
06 inst hospital Linc half disconnected	0.33	Poor	29	26	33	81	0	0	0	0	0	0.00	0.00
06 inst hospital Linc disconnected	0.16	Fair	66	54	66	105	0	0	0	0	0	0.00	0.00

Sandy Loam Conditions




Institutional Hospital, Sandy Loam Soil; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
100
Percent TSS Mass Reductions

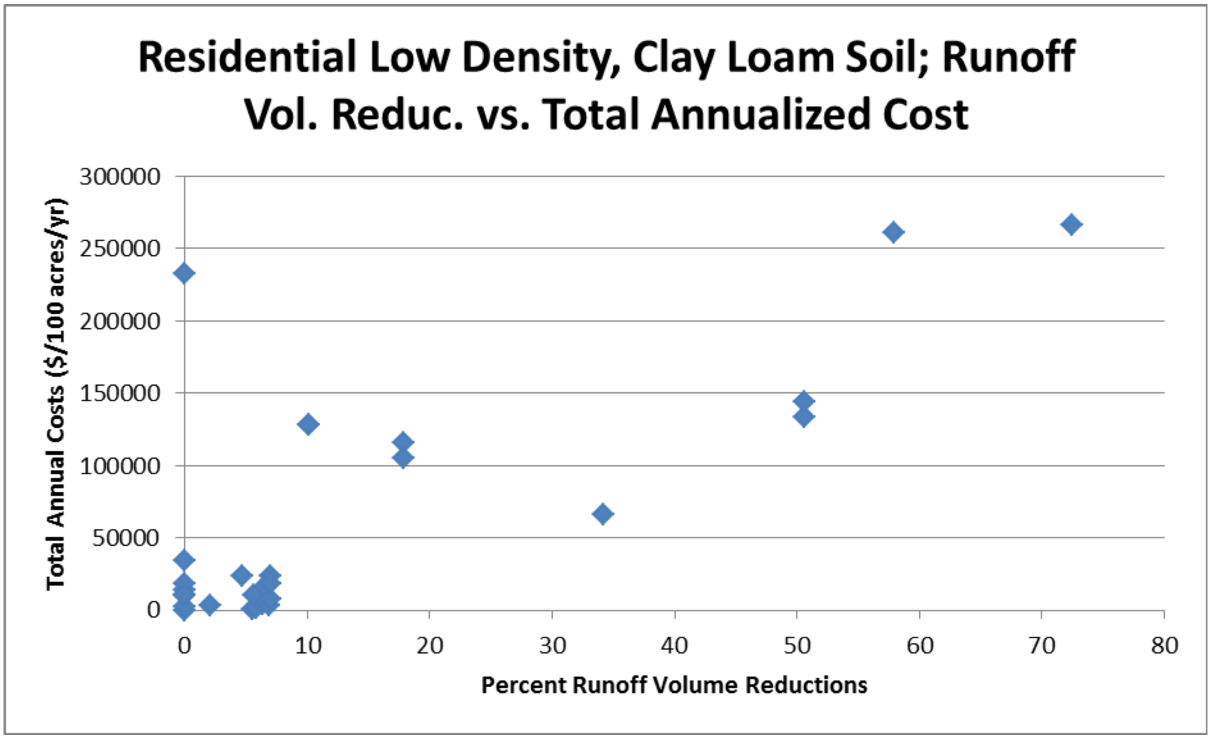

Institutional Hospital, Sandy Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
Percent E. coli Reductions

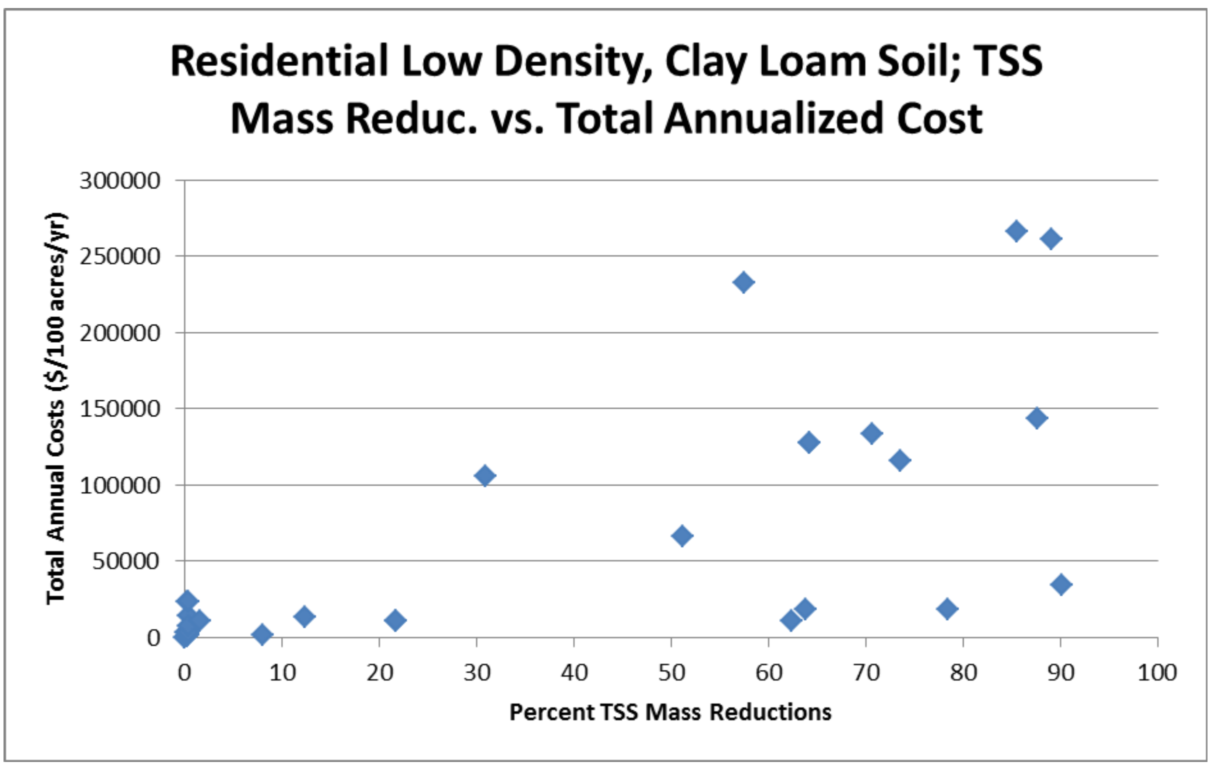
Institutional Hospital Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

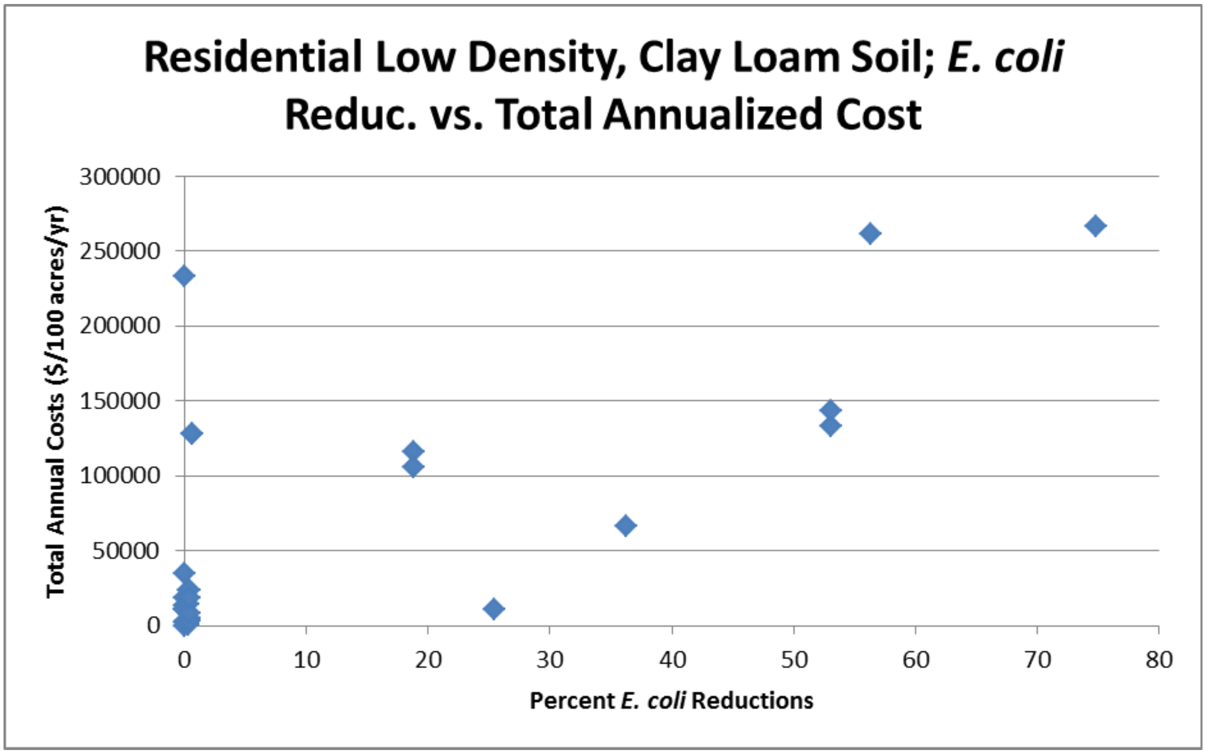
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
06 inst hospital Linc base	0.47	Poor	n/a	n/a	n/a	78	n/a	n/a	n/a	n/a	n/a	n/a	n/a
06 inst hospital Linc CB	0.47	Poor	0	16	0	65	566,626	0	19,620	65,088	811,134	-	17.30
06 inst hospital Linc pond 085 perct	0.47	Poor	0	67	0	26	251,151	9,938	6,907	27,857	347,165	-	1.80
06 inst hospital Linc pond 17 perct	0.47	Poor	0	82	0	14	463,123	19,875	11,783	50,540	629,841	-	2.67
06 inst hospital Linc pond 34 perct	0.47	Poor	0	93	0	6	535,234	39,750	14,170	60,308	751,573	-	2.81
06 inst hospital Linc street cleaning daily	0.47	Poor	0	10	0	70	16,047	0	84,228	85,515	1,065,711	-	35.42
06 inst hospital Linc rain barrels few	0.44	Poor	7	2	0	82	70,418	1,990	4,195	10,005	124,683	0.03	21.59
06 inst hospital Linc rain barrels	0.43	Poor	10	3	1	84	140,856	3,980	8,391	20,013	249,402	0.04	30.99
06 inst hospital Linc rain barrels many	0.40	Poor	15	4	1	87	352,129	9,950	20,976	50,030	623,487	0.07	51.41
06 inst hospital Linc connt roof rain garden 3 perct sandy loam	0.39	Poor	16	5	1	89	212,819	15,014	13,945	32,227	401,624	0.04	30.21
06 inst hospital Linc all roof rain garden 3 perct sandy loam	0.39	Poor	17	5	1	89	266,024	18,767	17,432	40,284	502,030	0.05	36.51
06 inst hospital Linc rain tanks small	0.38	Poor	20	6	1	92	234,480	8,291	15,873	35,354	440,586	0.04	26.82
06 inst hospital Linc rain tanks	0.36	Poor	25	7	2	96	586,224	20,729	39,685	88,388	1,101,512	0.08	54.98
06 inst hospital Linc sml pnd and rain tanks	0.36	Poor	25	73	2	28	837,375	30,667	46,592	116,246	1,448,677	0.10	6.85
06 inst hospital Linc rain tanks large	0.35	Poor	27	8	2	98	1,758,655	62,188	119,053	265,162	3,304,505	0.21	152.25
06 inst hospital Linc connt roof rain garden 15 perct sandy loam	0.33	Poor	31	9	2	102	1,064,095	75,069	69,727	161,137	2,008,118	0.11	80.37
06 inst hospital Linc all roof rain garden 15 perct sandy loam	0.32	Poor	31	9	2	103	1,330,119	93,836	87,159	201,421	2,510,147	0.14	98.52

06 inst hospital Linc curb biofilters 20 sandy loam	0.37	Poor	22	25	23	75	170,050	2,066	11,161	24,972	311,202	0.02	4.31
06 inst hospital Linc sml pnd and swale sandy loam	0.34	Poor	28	80	29	22	605,351	9,938	18,032	67,404	840,001	0.05	3.65
06 inst hospital Linc swale sandy loam	0.34	Poor	28	38	29	67	354,200	0	11,125	39,546	492,836	0.03	4.52
06 inst hospital Linc half disconnected	0.33	Poor	29	26	33	81	0	0	0	0	0	0.00	0.00
06 inst hospital Linc curb biofilters 40 sandy loam	0.29	Poor	38	41	38	74	340,100	4,132	22,321	49,943	622,403	0.03	5.29
06 inst hospital Linc sml pnd and curb biofilters 40 sandy loam	0.29	Poor	38	79	38	26	591,251	14,070	29,228	77,801	969,569	0.04	4.23
06 inst hospital Linc curb biofilters 80 sandy loam	0.19	Poor	59	61	59	73	680,200	8,264	44,642	99,887	1,244,807	0.04	7.02
06 inst hospital Linc disconnected	0.16	Fair	66	54	66	105	0	0	0	0	0	0.00	0.00

Residential: Low Density Land Use
Clay Loam Soil Conditions





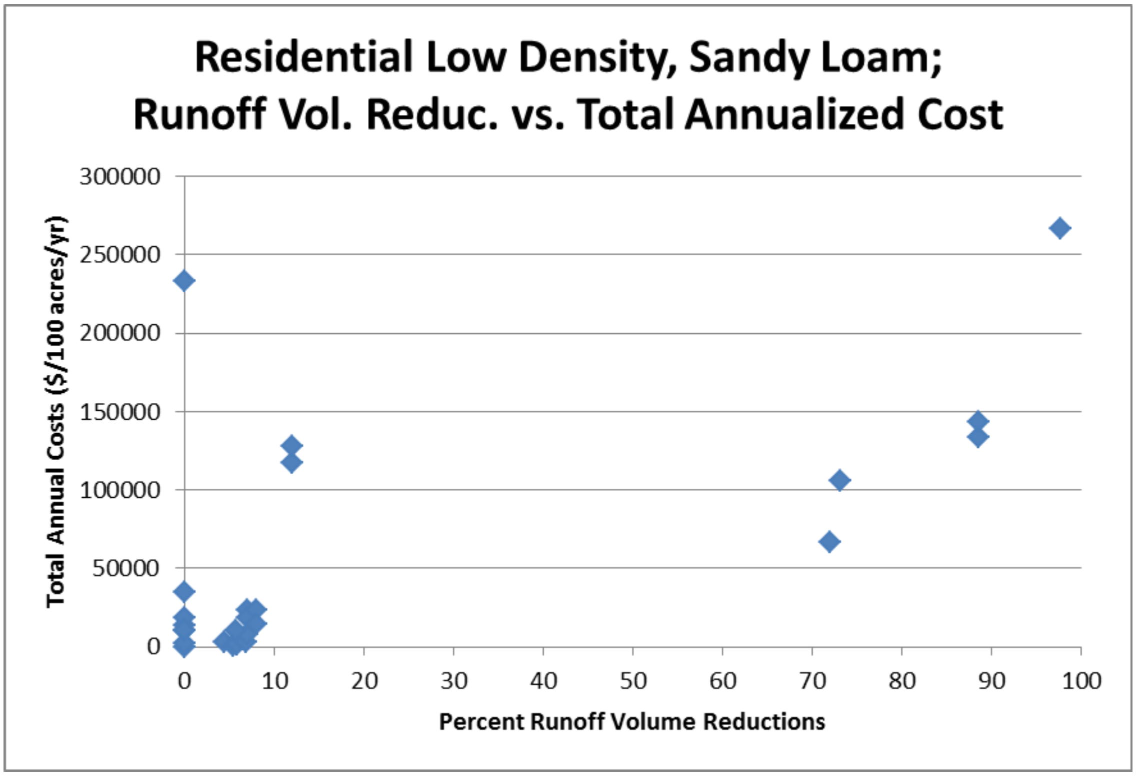

Residential Low Density, Clay Loam Soil; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
Percent E. coli Reductions

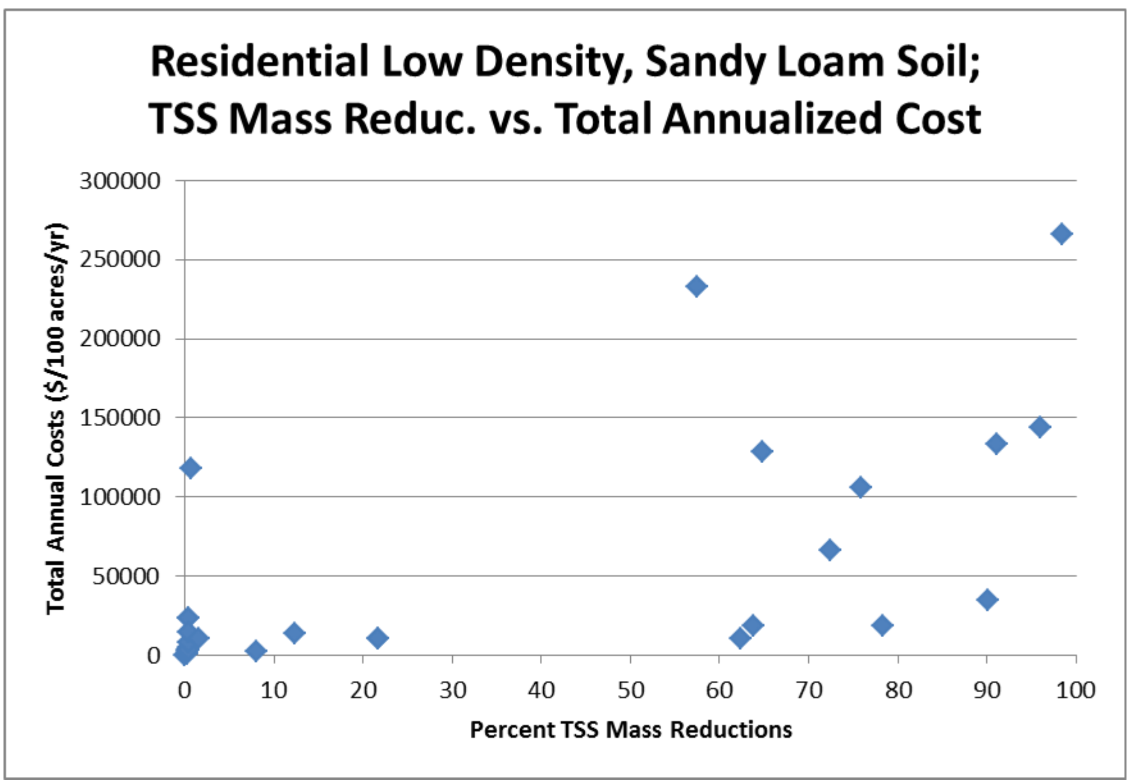
Low Density Residential Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

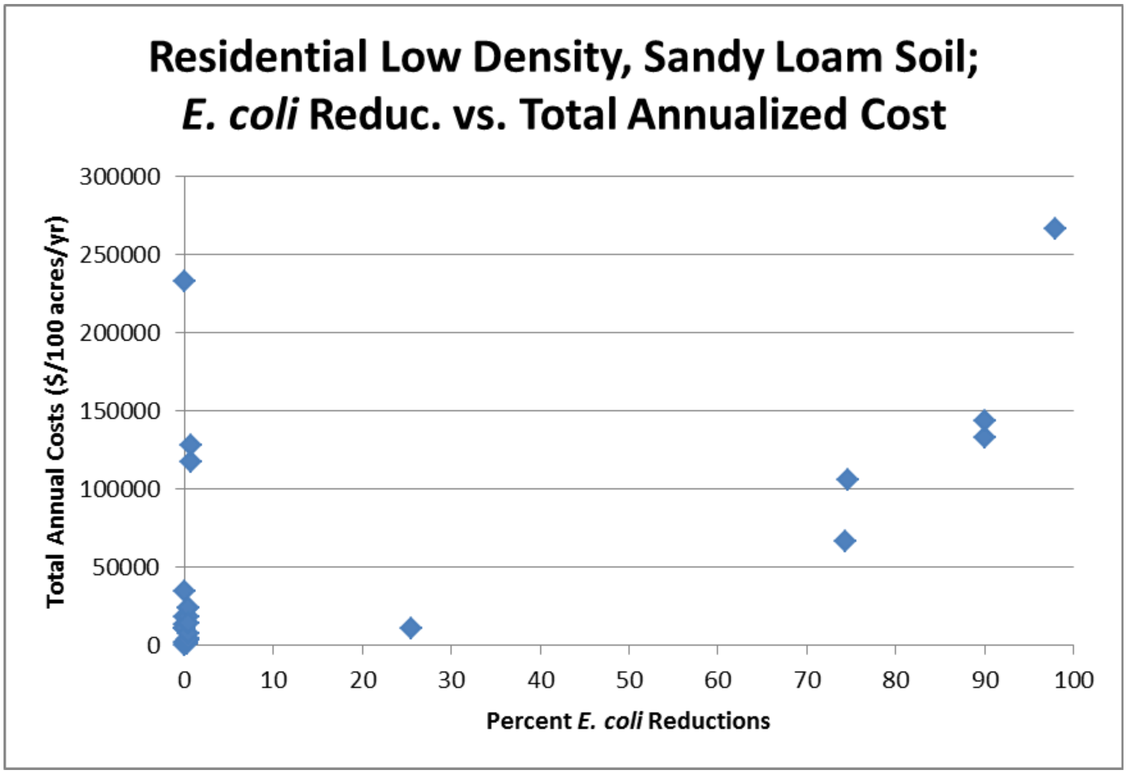
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
07 Low dens resid Linc base	0.19	Poor	n/a	n/a	n/a	83	n/a	n/a	n/a	n/a	n/a	n/a	n/a
07 Low dens resid Linc CB	0.19	Poor	0	12	0	72	118,047	0	4,088	13,560	168,986	-	10.91
07 Low dens resid Linc pond 012 perct	0.19	Poor	0	90	0	8	314,478	15,000	8,179	34,617	431,401	-	3.85
07 Low dens resid Linc pond 03 perct	0.19	Poor	0	62	0	31	88,074	3,750	3,148	10,516	131,058	-	1.69
07 Low dens resid Linc pond 06 perct	0.19	Poor	0	78	0	18	159,613	7,500	4,879	18,288	227,911	-	2.34
07 Low dens resid Linc street cleaning daily	0.19	Poor	0	57	0	35	43,713	0	229,448	232,956	2,903,142	-	40.57
07 Low dens resid Linc street cleaning monthly	0.19	Poor	0	22	0	65	2,025	0	10,631	10,793	134,509	-	4.97
07 Low dens resid Linc street cleaning sp fl	0.19	Poor	0	8	0	76	380	0	1,993	2,024	25,220	-	2.52
07 Low dens resid Linc street cleaning weekly	0.19	Poor	0	22	0	65	2,025	0	10,631	10,793	134,509	-	4.97
07 Low dens resid Linc connt roof rain garden 3 perct clay loam	0.19	Poor	2	0	0	84	21,282	601	1,395	3,150	39,262	0.08	246.47
07 Low dens resid Linc all roof rain garden 3 perct clay loam	0.18	Poor	5	0	0	86	159,614	4,504	10,459	23,628	294,462	0.26	830.16
07 Low dens resid Linc rain barrels few	0.18	Poor	6	0	0	87	6,378	72	380	897	11,184	0.01	26.98
07 Low dens resid Linc rain barrels	0.18	Poor	6	0	0	87	12,735	144	759	1,792	22,333	0.02	50.92
07 Low dens resid Linc connt roof rain garden 15 perct clay loam	0.18	Poor	6	0	0	88	95,769	2,702	6,275	14,177	176,677	0.12	376.71
07 Low dens resid Linc rain barrels many	0.18	Poor	6	0	0	88	31,847	360	1,897	4,482	55,850	0.04	115.64
07 Low dens resid Linc rain tanks small	0.18	Poor	7	0	0	88	21,213	300	1,436	3,162	39,409	0.02	75.71
07 Low dens resid Linc rain tanks large	0.18	Poor	7	0	0	88	159,074	2,250	10,769	23,714	295,524	0.17	555.99
07 Low dens resid Linc rain tanks	0.18	Poor	7	0	0	88	53,025	750	3,590	7,905	98,508	0.06	185.31

07 Low dens resid Linc sml pnd and rain tanks	0.18	Poor	7	64	0	32	141,098	4,500	6,738	18,421	229,566	0.13	2.89
07 Low dens resid Linc all roof rain garden 15 perct clay loam	0.17	Fair	10	64	1	33	882,598	26,171	55,211	128,133	1,596,822	0.65	19.96
07 Low dens resid Linc sml pnd and all roof rain garden 15 perct clay loam	0.17	Fair	10	64	1	33	882,598	26,171	55,211	128,133	1,596,822	0.65	19.96
07 Low dens resid Linc sml pnd and swale clay loam	0.16	Fair	18	74	19	27	1,032,607	3,750	32,814	115,974	1,445,288	0.33	15.78
07 Low dens resid Linc swale clay loam	0.16	Fair	18	31	19	69	944,533	0	29,665	105,457	1,314,230	0.30	34.05
07 Low dens resid Linc porous pvt driveways clay loam	0.18	Poor	6	2	25	86	127,506	0	427	10,658	132,824	0.10	67.20
07 Low dens resid Linc curb biofilters 20 clay loam	0.13	Good	34	51	36	61	453,466	5,510	29,762	66,591	829,871	0.10	13.02
07 Low dens resid Linc curb biofilters 40 clay loam	0.09	Good	51	71	53	49	906,933	11,019	59,523	133,182	1,659,742	0.14	18.86
07 Low dens resid Linc sml pnd and curb biofilters 40 clay loam	0.09	Good	51	88	53	21	995,007	14,769	62,671	143,698	1,790,800	0.15	16.41
07 Low dens resid Linc sml pnd and rain grdn 15 prct and curb biofilters 40 clay loam	0.08	Good	58	89	56	22	1,789,531	37,190	114,734	261,315	3,256,564	0.23	29.38
07 Low dens resid Linc curb biofilters 80 clay loam	0.05	Good	73	86	75	43	1,813,866	22,039	119,046	266,364	3,319,485	0.19	31.18

Sandy Loam Soil Conditions





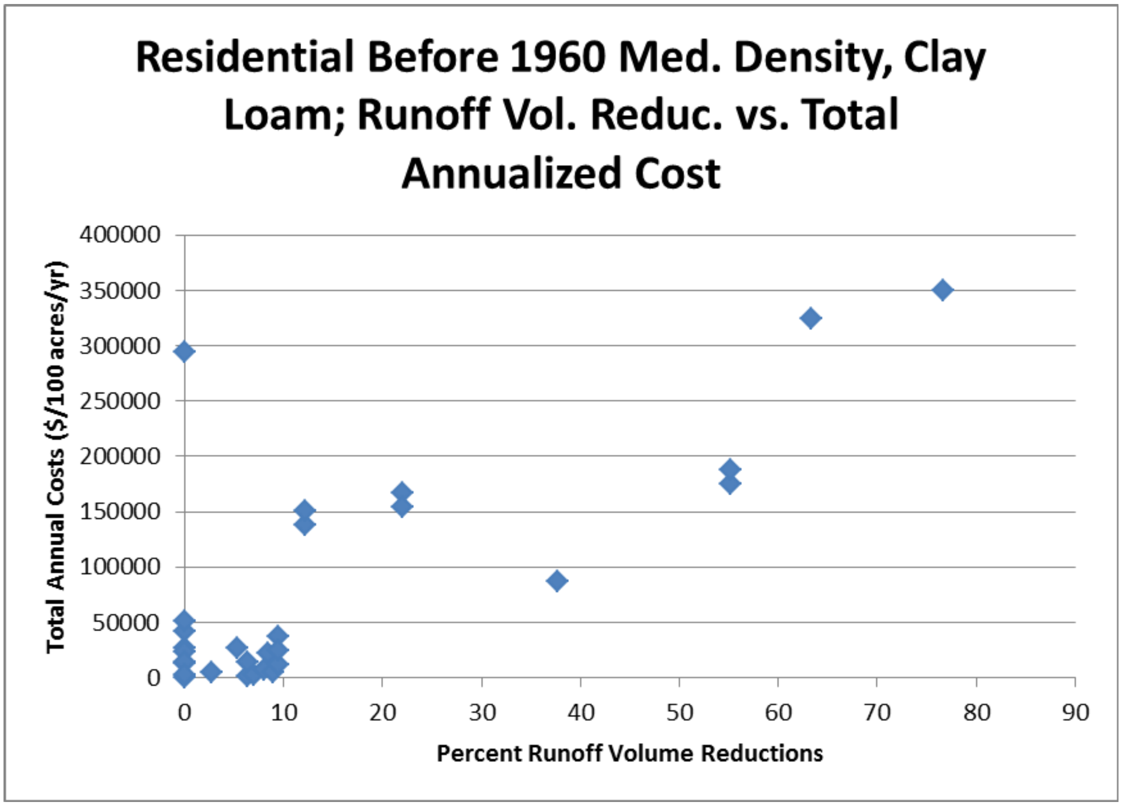

Residential Low Density, Sandy Loam Soil;
E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
100
Percent E. coli Reductions

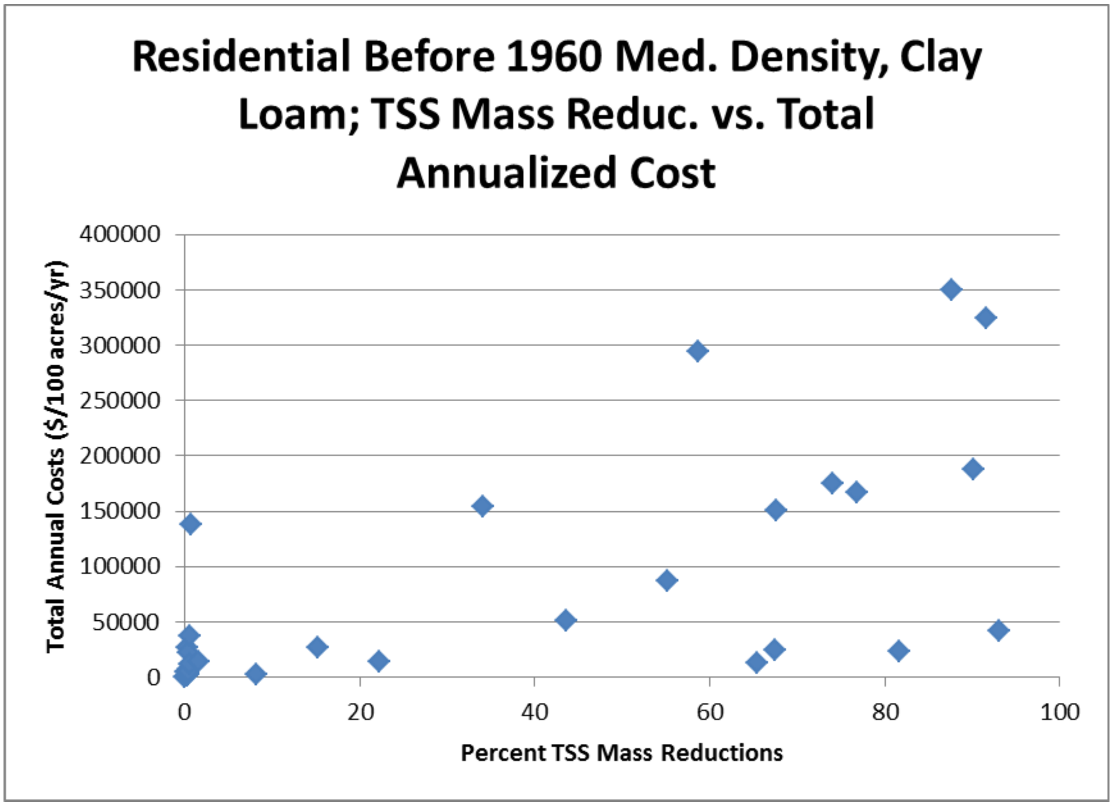
Low Density Residential Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

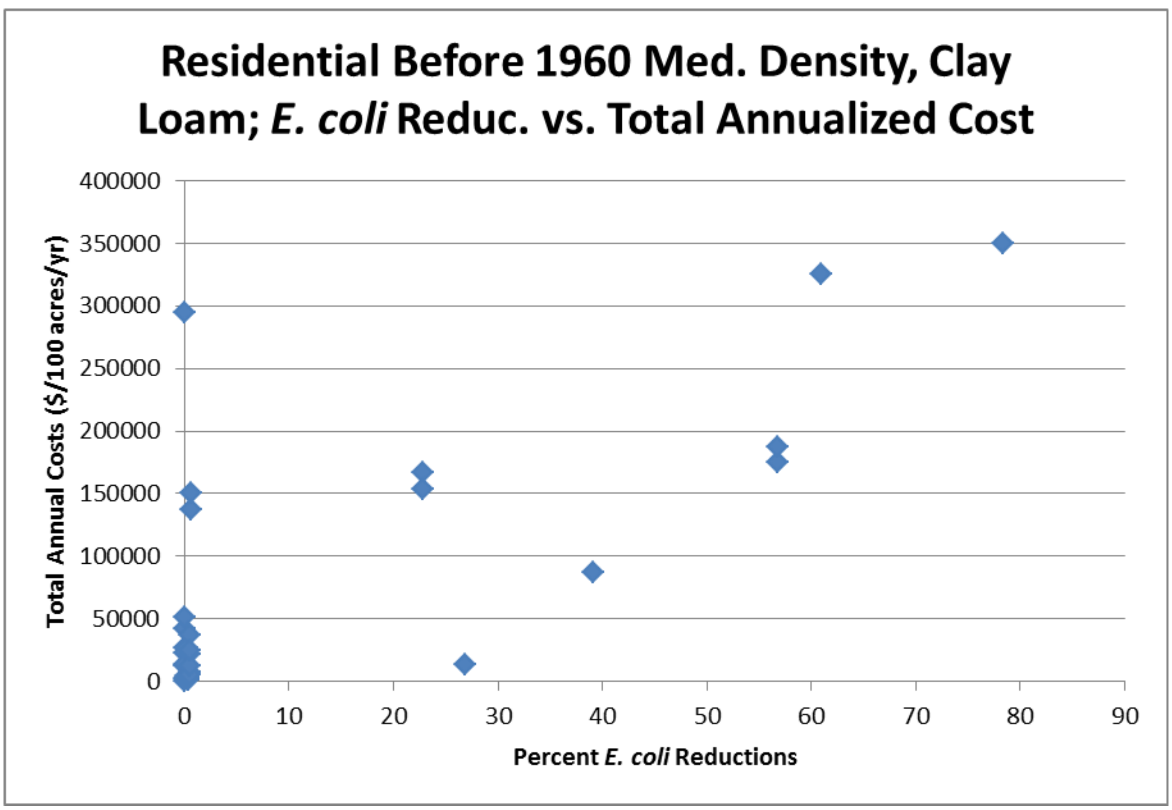
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
07 Low dens resid Linc base	0.19	Poor	n/a	n/a	n/a	83	n/a	n/a	n/a	n/a	n/a	n/a	n/a
07 Low dens resid Linc CB	0.19	Poor	0	12	0	72	118,047	0	4,088	13,560	168,986	-	10.91
07 Low dens resid Linc pond 012 perct	0.19	Poor	0	90	0	8	314,478	15,000	8,179	34,617	431,401	-	3.85
07 Low dens resid Linc pond 03 perct	0.19	Poor	0	62	0	31	88,074	3,750	3,148	10,516	131,058	-	1.69
07 Low dens resid Linc pond 06 perct	0.19	Poor	0	78	0	18	159,613	7,500	4,879	18,288	227,911	-	2.34
07 Low dens resid Linc street cleaning daily	0.19	Poor	0	57	0	35	43,713	0	229,448	232,956	2,903,142	-	40.57
07 Low dens resid Linc street cleaning monthly	0.19	Poor	0	22	0	65	2,025	0	10,631	10,793	134,509	-	4.97
07 Low dens resid Linc street cleaning sp fl	0.19	Poor	0	8	0	76	380	0	1,993	2,024	25,220	-	2.52
07 Low dens resid Linc street cleaning weekly	0.19	Poor	0	22	0	65	2,025	0	10,631	10,793	134,509	-	4.97
07 Low dens resid Linc connt roof rain garden 3 perct sandy loam	0.18	Poor	4	0	0	86	21,282	601	1,395	3,150	39,262	0.04	118.16
07 Low dens resid Linc rain barrels few	0.18	Poor	6	0	0	87	6,378	72	380	897	11,184	0.01	26.98
07 Low dens resid Linc rain barrels	0.18	Poor	6	0	0	87	12,735	144	759	1,792	22,333	0.02	50.92
07 Low dens resid Linc rain barrels many	0.18	Poor	6	0	0	88	31,847	360	1,897	4,482	55,850	0.04	115.64
07 Low dens resid Linc rain tanks small	0.18	Poor	7	0	0	88	21,213	300	1,436	3,162	39,409	0.02	75.71
07 Low dens resid Linc rain tanks large	0.18	Poor	7	0	0	88	159,074	2,250	10,769	23,714	295,524	0.17	555.99
07 Low dens resid Linc rain tanks	0.18	Poor	7	0	0	88	53,025	750	3,590	7,905	98,508	0.06	185.31
07 Low dens resid Linc sml pnd and rain tanks	0.18	Poor	7	64	0	32	141,098	4,500	6,738	18,421	229,566	0.13	2.89
07 Low dens resid Linc all roof rain garden 3 perct sandy loam	0.18	Poor	8	0	0	89	159,614	4,504	10,459	23,628	294,462	0.15	487.79

07 Low dens resid Linc connt roof rain garden 15 perct sandy loam	0.18	Poor	8	0	0	89	95,769	2,702	6,275	14,177	176,677	0.09	291.11
07 Low dens resid Linc all roof rain garden 15 perct sandy loam	0.17	Fair	12	1	1	93	794,524	22,421	52,063	117,617	1,465,764	0.51	1,626.16
07 Low dens resid Linc sml pnd and all roof rain garden 15 perct sandy loam	0.17	Fair	12	65	1	33	882,598	26,171	55,211	128,133	1,596,822	0.55	19.77
07 Low dens resid Linc porous pvt driveways sandy loam	0.18	Poor	6	2	25	86	127,506	0	427	10,658	132,824	0.10	67.20
07 Low dens resid Linc curb biofilters 20 sandy loam	0.05	Good	72	72	74	81	453,466	5,510	29,762	66,591	829,871	0.05	9.21
07 Low dens resid Linc swale sandy loam	0.05	Good	73	76	75	74	944,533	0	29,665	105,457	1,314,230	0.07	13.90
07 Low dens resid Linc curb biofilters 40 sandy loam	0.02	Good	89	91	90	64	906,933	11,019	59,523	133,182	1,659,742	0.08	14.63
07 Low dens resid Linc sml pnd and curb biofilters 40 sandy loam	0.02	Good	89	96	90	29	995,007	14,769	62,671	143,698	1,790,800	0.08	14.98
07 Low dens resid Linc curb biofilters 80 sandy loam	0.00	Good	98	98	98	55	1,813,866	22,039	119,046	266,364	3,319,485	0.14	27.09

Residential Medium Density before 1960 Land Use
Clay Loam Soil Conditions




Residential Before 1960 Med. Density, Clay Loam; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
0
50000
100000
150000
200000
250000
300000
350000
400000
0
20
40
60
80
100
Percent TSS Mass Reductions

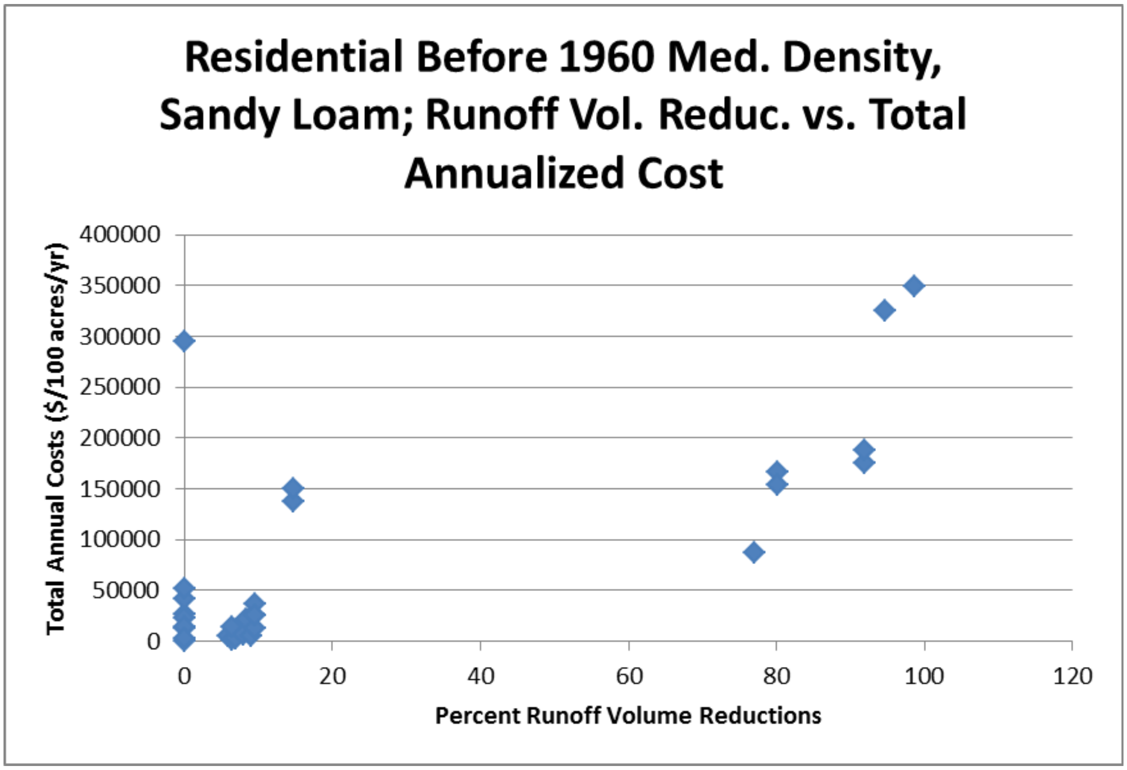

Residential Before 1960 Med. Density, Clay Loam; *E. coli* Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
0
50000
100000
150000
200000
250000
300000
350000
400000
0
10
20
30
40
50
60
70
80
90
Percent *E. coli* Reductions

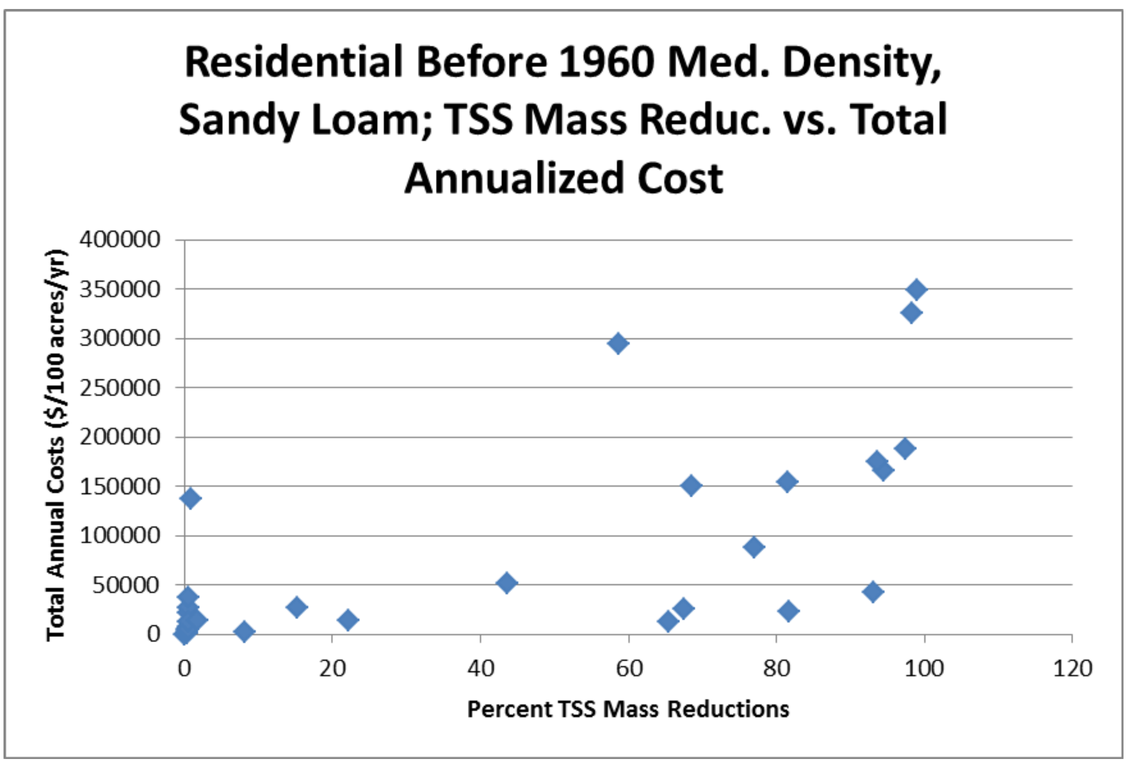
Medium Density Residential Before 1960 Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

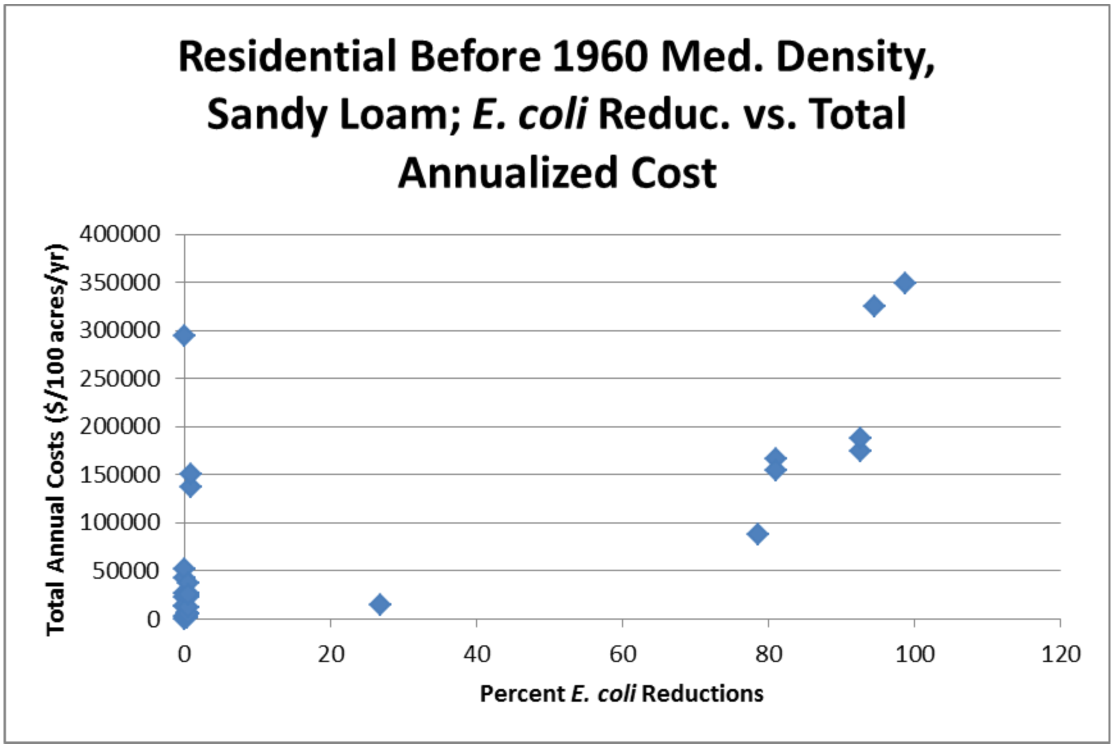
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
08 Med dens resid bfr 1960 Linc base	0.22	Poor	n/a	n/a	n/a	89	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08 Med dens resid bfr 1960 Linc CB	0.22	Poor	0	15	0	75	236,094	0	8,175	27,120	337,973	-	14.37
08 Med dens resid bfr 1960 Linc pond 04 perct	0.22	Poor	0	65	0	31	107,544	5,100	3,583	12,622	157,292	-	1.56
08 Med dens resid bfr 1960 Linc pond 08 perct	0.22	Poor	0	82	0	16	200,509	10,200	5,899	22,807	284,223	-	2.26
08 Med dens resid bfr 1960 Linc pond 16 perct	0.22	Poor	0	93	0	6	379,468	20,400	10,069	42,155	525,348	-	3.66
08 Med dens resid bfr 1960 Linc street cleaning daily	0.22	Poor	0	59	0	37	55,333	0	290,441	294,881	3,674,864	-	40.57
08 Med dens resid bfr 1960 Linc street cleaning monthly	0.22	Poor	0	22	0	69	2,564	0	13,457	13,662	170,264	-	4.97
08 Med dens resid bfr 1960 Linc street cleaning sp fl	0.22	Poor	0	8	0	81	481	0	2,523	2,562	31,924	-	2.52
08 Med dens resid bfr 1960 Linc street cleaning weekly	0.22	Poor	0	44	0	50	9,667	0	50,743	51,519	642,037	-	9.54
08 Med dens resid bfr 1960 Linc connt roof rain garden 3 perct clay loam	0.22	Poor	3	0	0	91	31,923	901	2,092	4,726	58,892	0.08	244.66
08 Med dens resid bfr 1960 Linc all roof rain garden 3 perct clay loam	0.21	Poor	5	0	0	93	180,896	5,105	11,854	26,779	333,723	0.23	731.43
08 Med dens resid bfr 1960 Linc rain barrels few	0.21	Poor	6	0	0	94	9,912	112	590	1,395	17,382	0.01	31.55
08 Med dens resid bfr 1960 Linc rain barrels	0.21	Poor	7	0	0	95	19,823	224	1,181	2,790	34,764	0.02	57.36
08 Med dens resid bfr 1960 Linc rain barrels many	0.20	Poor	8	0	0	96	49,538	560	2,951	6,971	86,873	0.04	125.10
08 Med dens resid bfr 1960 Linc connt roof rain garden 15 perct clay loam	0.20	Poor	8	0	0	96	148,973	4,204	9,762	22,053	274,831	0.12	376.67
08 Med dens resid bfr 1960 Linc rain tanks few	0.20	Poor	9	1	0	97	32,996	467	2,234	4,919	61,300	0.02	78.87
08 Med dens resid bfr 1960 Linc rain tanks large	0.20	Poor	10	1	1	97	247,448	3,500	16,751	36,888	459,703	0.17	555.23

08 Med dens resid bfr 1960 Linc rain tanks	0.20	Poor	10	1	1	97	82,483	1,167	5,584	12,296	153,235	0.06	185.07
08 Med dens resid bfr 1960 Linc sml pnd and rain tanks	0.20	Poor	10	67	1	32	190,027	6,267	9,166	24,917	310,527	0.12	2.99
08 Med dens resid bfr 1960 Linc all roof rain garden 15 perct clay loam	0.19	Poor	12	1	1	100	929,310	26,224	60,895	137,570	1,714,420	0.50	1,617.32
08 Med dens resid bfr 1960 Linc sml pnd and all roof rain garden 15 perct clay loam	0.19	Poor	12	68	1	33	1,036,854	31,324	64,478	150,191	1,871,712	0.55	17.95
08 Med dens resid bfr 1960 Linc sml pnd and swale clay loam	0.17	Fair	22	77	23	26	1,484,988	5,100	46,845	166,413	2,073,877	0.34	17.49
08 Med dens resid bfr 1960 Linc swale clay loam	0.17	Fair	22	34	23	75	1,377,444	0	43,262	153,792	1,916,585	0.31	36.42
08 Med dens resid bfr 1960 Linc porous pvt driveways clay loam	0.21	Poor	6	2	27	93	165,285	0	553	13,816	172,179	0.10	67.20
08 Med dens resid bfr 1960 Linc curb biofilters 20 clay loam	0.14	Fair	38	55	39	64	595,175	7,231	39,062	87,401	1,089,206	0.10	12.79
08 Med dens resid bfr 1960 Linc curb biofilters 40 clay loam	0.10	Good	55	74	57	51	1,190,349	14,463	78,124	174,801	2,178,412	0.14	19.09
08 Med dens resid bfr 1960 Linc sml pnd and curb biofilters 40 clay loam	0.10	Good	55	90	57	20	1,297,893	19,563	81,707	187,423	2,335,704	0.15	16.80
08 Med dens resid bfr 1960 Linc sml pnd and rain grdn 15 prct and curb biofilters 40 clay loam	0.08	Good	63	92	61	20	2,227,203	45,787	142,602	324,992	4,050,124	0.23	28.66
08 Med dens resid bfr 1960 Linc curb biofilters 80 clay loam	0.05	Good	77	88	78	47	2,380,699	28,926	156,248	349,603	4,356,823	0.20	32.20

Sandy Loam Soil Conditions





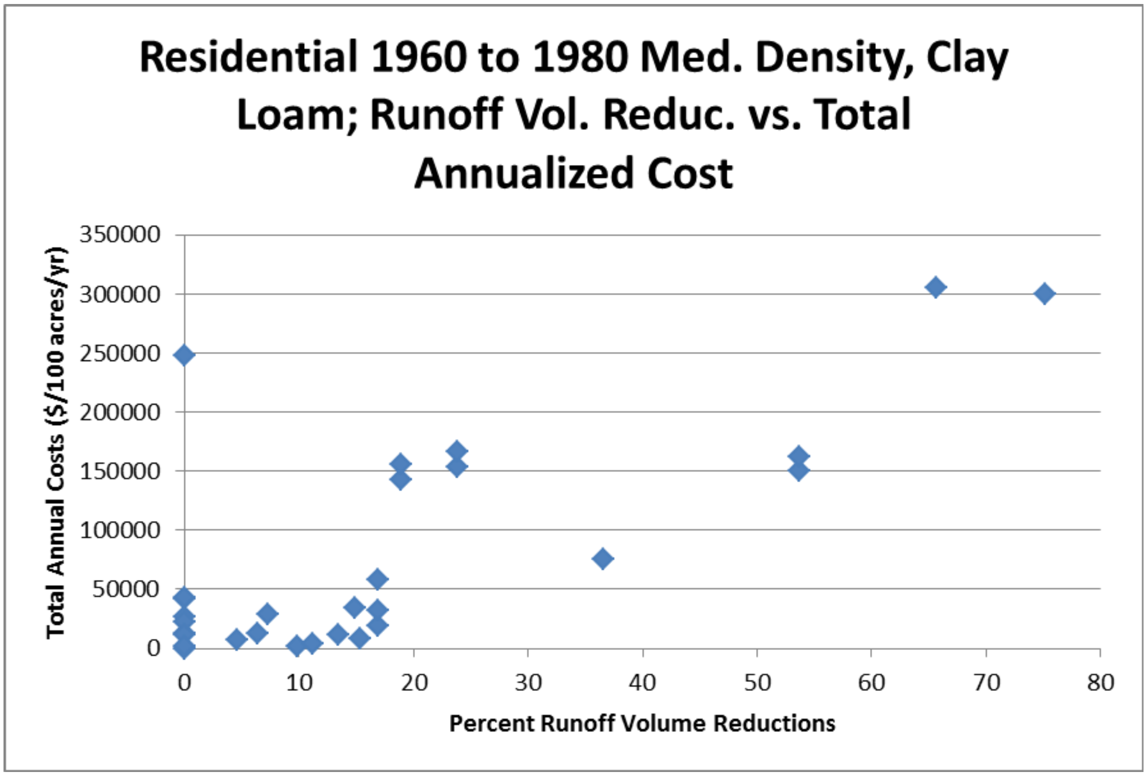

Residential Before 1960 Med. Density, Sandy Loam; E. coli Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
400000
350000
300000
250000
200000
150000
100000
50000
0
0
20
40
60
80
100
120
Percent E. coli Reductions

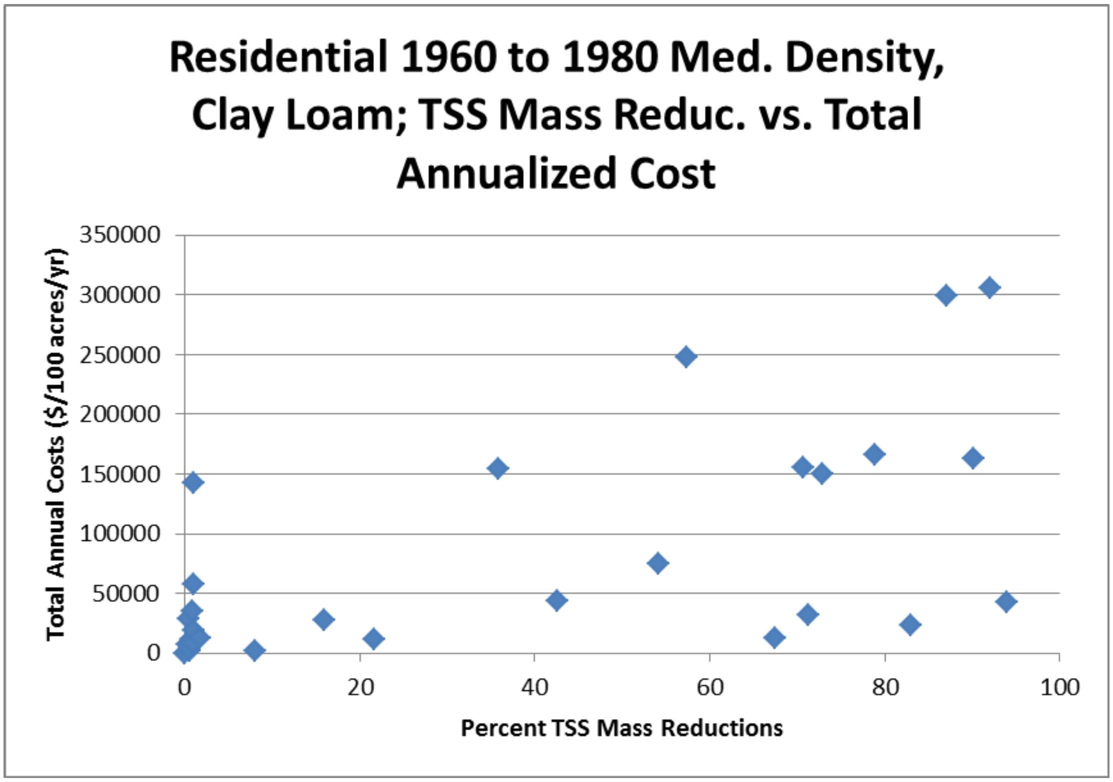
Medium Density Residential Before 1960 Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

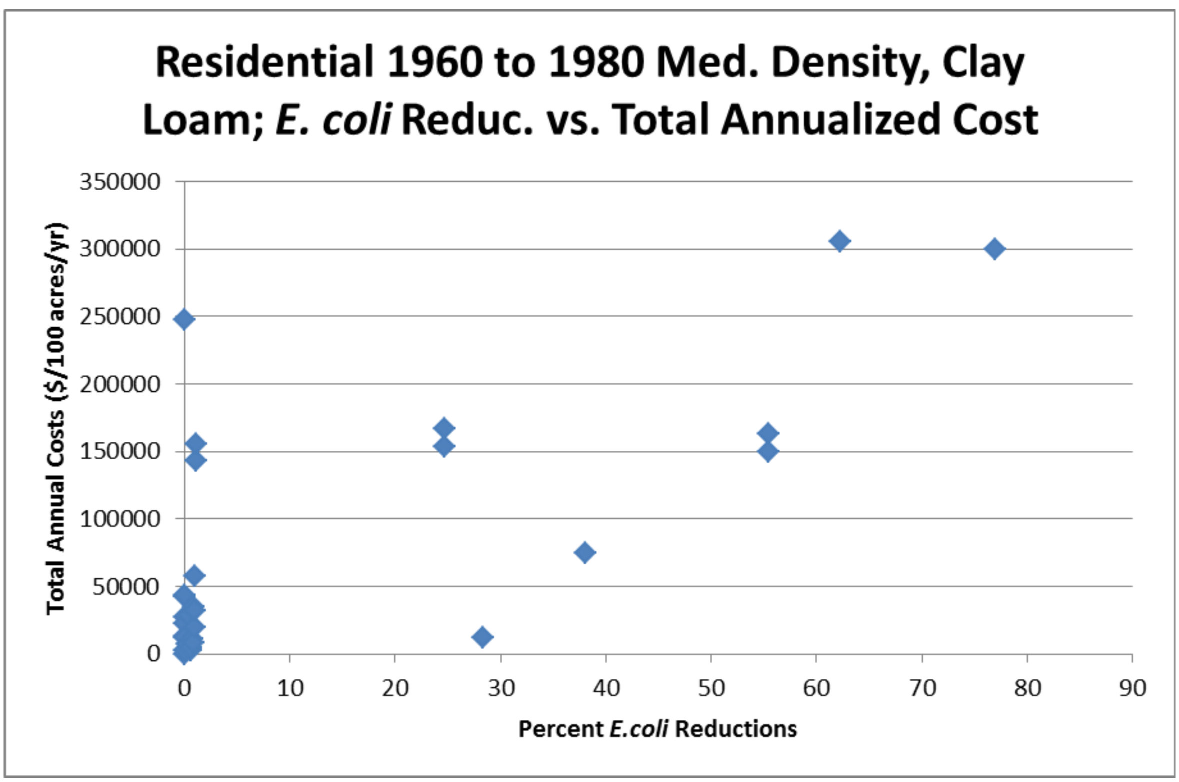
File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
08 Med dens resid bfr 1960 Linc base	0.22	Poor	n/a	n/a	n/a	89	n/a	n/a	n/a	n/a	n/a	n/a	n/a
08 Med dens resid bfr 1960 Linc CB	0.22	Poor	0	15	0	75	236,094	0	8,175	27,120	337,973	-	14.37
08 Med dens resid bfr 1960 Linc pond 04 perct	0.22	Poor	0	65	0	31	107,544	5,100	3,583	12,622	157,292	-	1.56
08 Med dens resid bfr 1960 Linc pond 08 perct	0.22	Poor	0	82	0	16	200,509	10,200	5,899	22,807	284,223	-	2.26
08 Med dens resid bfr 1960 Linc pond 16 perct	0.22	Poor	0	93	0	6	379,468	20,400	10,069	42,155	525,348	-	3.66
08 Med dens resid bfr 1960 Linc street cleaning daily	0.22	Poor	0	59	0	37	55,333	0	290,441	294,881	3,674,864	-	40.57
08 Med dens resid bfr 1960 Linc street cleaning monthly	0.22	Poor	0	22	0	69	2,564	0	13,457	13,662	170,264	-	4.97
08 Med dens resid bfr 1960 Linc street cleaning sp fl	0.22	Poor	0	8	0	81	481	0	2,523	2,562	31,924	-	2.52
08 Med dens resid bfr 1960 Linc street cleaning weekly	0.22	Poor	0	44	0	50	9,667	0	50,743	51,519	642,037	-	9.54
08 Med dens resid bfr 1960 Linc connt roof rain garden 3 perct sandy loam	0.21	Poor	6	0	0	94	31,923	901	2,092	4,726	58,892	0.04	116.47
08 Med dens resid bfr 1960 Linc rain barrels few	0.21	Poor	6	0	0	94	9,912	112	590	1,395	17,382	0.01	31.55
08 Med dens resid bfr 1960 Linc rain barrels	0.21	Poor	7	0	0	95	19,823	224	1,181	2,790	34,764	0.02	57.36
08 Med dens resid bfr 1960 Linc rain barrels many	0.20	Poor	8	0	0	96	49,538	560	2,951	6,971	86,873	0.04	125.10
08 Med dens resid bfr 1960 Linc connt roof rain garden 15 perct sandy loam	0.20	Poor	8	0	0	96	148,973	4,204	9,762	22,053	274,831	0.12	376.67
08 Med dens resid bfr 1960 Linc rain tanks few	0.20	Poor	9	1	0	97	32,996	467	2,234	4,919	61,300	0.02	78.87
08 Med dens resid bfr 1960 Linc all roof rain garden 3 perct sandy loam	0.20	Poor	9	1	1	97	180,896	5,105	11,854	26,779	333,723	0.13	412.85
08 Med dens resid bfr 1960 Linc rain tanks large	0.20	Poor	10	1	1	97	247,448	3,500	16,751	36,888	459,703	0.17	555.23

08 Med dens resid bfr 1960 Linc rain tanks	0.20	Poor	10	1	1	97	82,483	1,167	5,584	12,296	153,235	0.06	185.07
08 Med dens resid bfr 1960 Linc sml pnd and rain tanks	0.20	Poor	10	67	1	32	190,027	6,267	9,166	24,917	310,527	0.12	2.99
08 Med dens resid bfr 1960 Linc all roof rain garden 15 perct sandy loam	0.19	Poor	15	1	1	103	929,310	26,224	60,895	137,570	1,714,420	0.42	1,345.08
08 Med dens resid bfr 1960 Linc small pnd and all roof rain garden 15 perct sandy loam	0.19	Poor	15	69	1	33	1,036,854	31,324	64,478	150,191	1,871,712	0.46	17.71
08 Med dens resid bfr 1960 Linc porous pvt driveways sandy loam	0.21	Poor	6	2	27	93	165,285	0	553	13,816	172,179	0.10	67.20
08 Med dens resid bfr 1960 Linc curb biofilters 20 sandy loam	0.05	Good	77	77	79	89	595,175	7,231	39,062	87,401	1,089,206	0.05	9.18
08 Med dens resid bfr 1960 Linc sml pnd and swale sandy loam	0.04	Good	80	95	81	24	1,484,988	5,100	46,845	166,413	2,073,877	0.09	14.23
08 Med dens resid bfr 1960 Linc swale sandy loam	0.04	Good	80	81	81	83	1,377,444	0	43,262	153,792	1,916,585	0.09	15.26
08 Med dens resid bfr 1960 Linc curb biofilters 40 sandy loam	0.02	Good	92	94	93	70	1,190,349	14,463	78,124	174,801	2,178,412	0.09	15.10
08 Med dens resid bfr 1960 Linc sml pnd and curb biofilters 40 sandy loam	0.02	Good	92	97	93	28	1,297,893	19,563	81,707	187,423	2,335,704	0.09	15.55
08 Med dens resid bfr 1960 Linc sml pnd and rain grdn 15 prct and curb biofilters 40 sandy loam	0.01	Good	95	98	95	29	2,227,203	45,787	142,602	324,992	4,050,124	0.15	26.73
08 Med dens resid bfr 1960 Linc curb biofilters 80 sandy loam	0.00	Good	99	99	99	62	2,380,699	28,926	156,248	349,603	4,356,823	0.16	28.52

Residential Medium Density 1960 to 1980 Land Use
Clay Loam Soil Conditions




Residential 1960 to 1980 Med. Density, Clay Loam; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
20
40
60
80
100
Percent TSS Mass Reductions

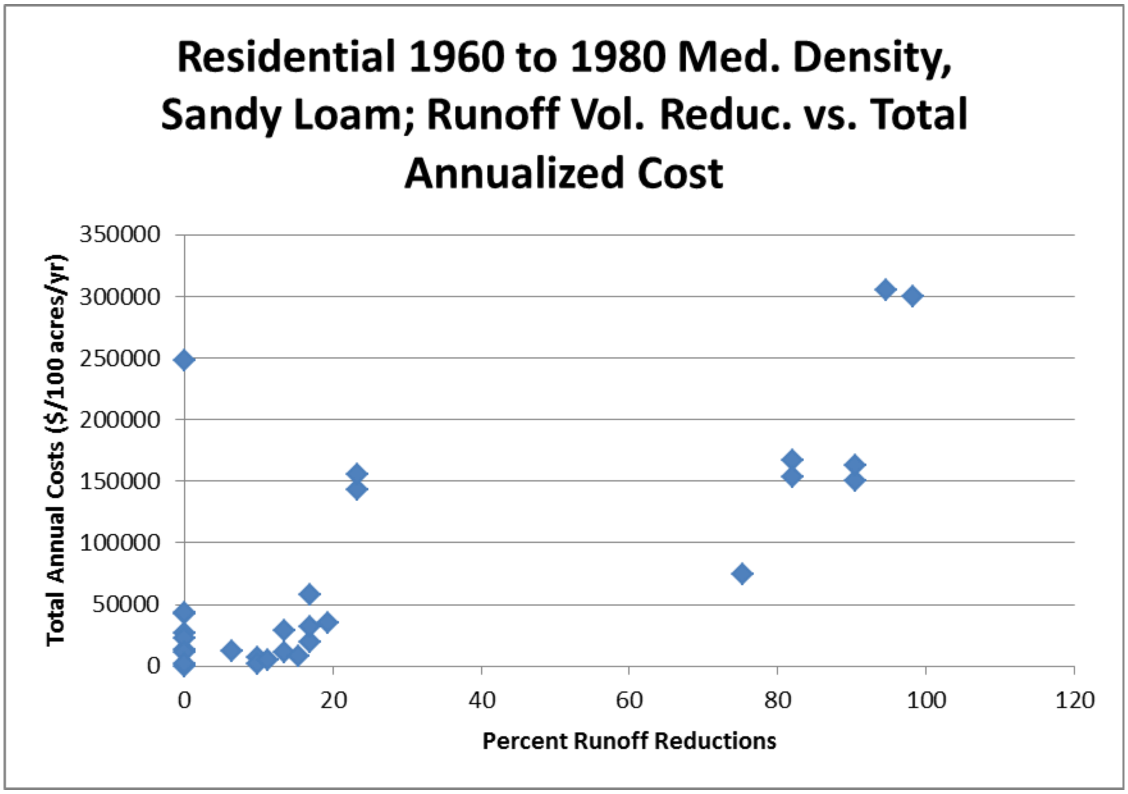

Residential 1960 to 1980 Med. Density, Clay Loam; *E. coli* Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
90
Percent *E.coli* Reductions

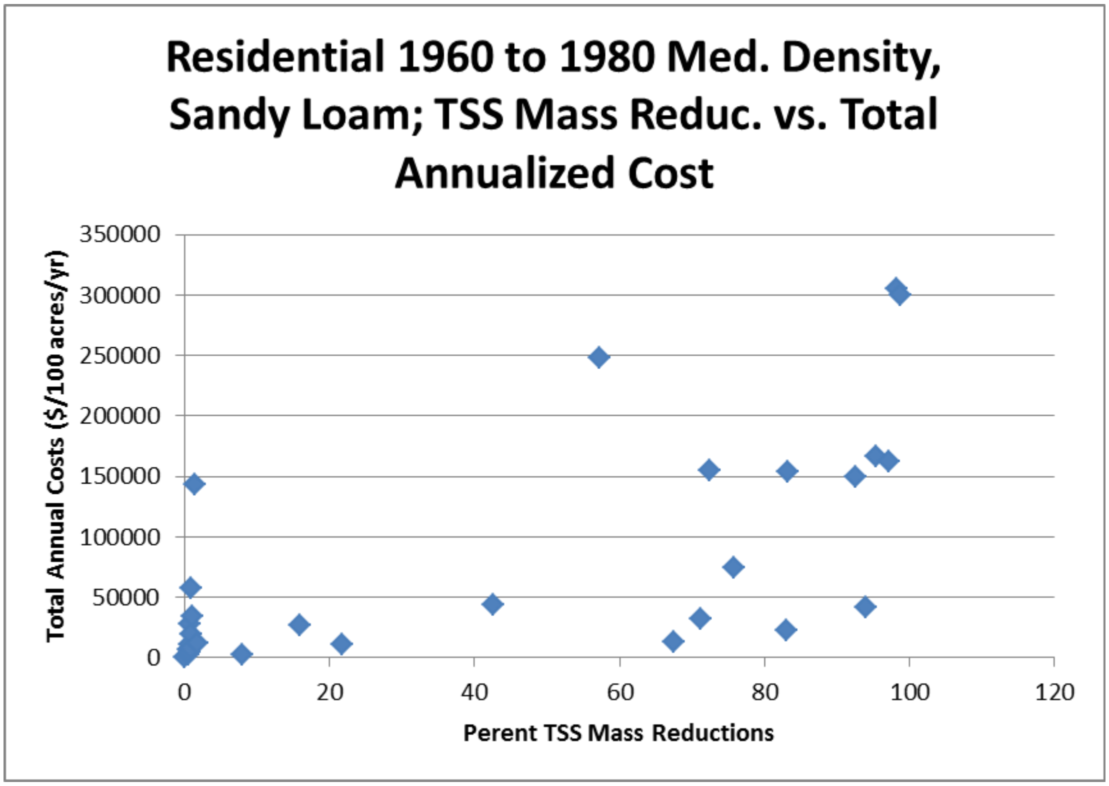
Medium Density Residential 1960 to 1980 Land Use, Clay Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
09 base	0.20	Poor	n/a	n/a	n/a	86	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09 CB	0.20	Poor	0	16	0	72	236,094	0	8,175	27,120	337,973	-	15.98
09 pond 04 perct	0.20	Poor	0	67	0	28	107,544	5,100	3,583	12,622	157,292	-	1.76
09 pond 08 perct	0.20	Poor	0	83	0	15	200,509	10,200	5,899	22,807	284,223	-	2.58
09 pond 16 perct	0.20	Poor	0	94	0	5	379,468	20,400	10,069	42,155	525,348	-	4.21
09 street cleaning daily	0.20	Poor	0	57	0	37	46,480	0	243,970	247,700	3,086,885	-	40.57
09 street cleaning monthly	0.20	Poor	0	22	0	67	2,153	0	11,304	11,476	143,022	-	4.97
09 street cleaning sp fl	0.20	Poor	0	8	0	79	404	0	2,119	2,152	26,817	-	2.52
09 street cleaning weekly	0.20	Poor	0	43	0	49	8,120	0	42,624	43,276	539,311	-	9.54
09 connt roof rain garden 3 perct clay loam	0.19	Poor	5	0	0	90	46,111	1,301	3,022	6,826	85,067	0.07	241.16
09 all roof rain garden 3 perct clay loam	0.18	Poor	7	0	0	92	191,537	5,405	12,551	28,354	353,354	0.20	633.73
09 rain barrels few	0.18	Poor	10	1	1	95	15,578	176	928	2,192	27,319	0.01	35.85
09 rain barrels	0.17	Fair	11	1	1	96	31,137	352	1,855	4,381	54,603	0.02	63.28
09 rain barrels many	0.17	Fair	13	1	1	99	77,852	880	4,638	10,955	136,526	0.04	132.27
09 connt roof rain garden 15 perct clay loam	0.17	Fair	15	1	1	100	234,101	6,606	15,340	34,655	431,877	0.12	376.67
09 rain tanks small	0.17	Fair	15	1	1	101	51,840	733	3,509	7,728	96,307	0.03	81.48
09 rain tanks large	0.16	Fair	17	1	1	103	388,847	5,500	26,323	57,967	722,391	0.17	555.06
09 rain tanks	0.16	Fair	17	1	1	103	129,616	1,833	8,774	19,322	240,797	0.06	185.01
09 sml pnd and rain tanks	0.16	Fair	17	71	1	30	237,160	6,933	12,357	31,944	398,089	0.10	4.21
09 all roof rain garden 15 perct clay loam	0.16	Fair	19	1	1	105	964,779	27,225	63,219	142,820	1,779,856	0.38	1,223.68
09 sml pnd and all roof rain garden 15 perct clay loam	0.16	Fair	19	71	1	31	1,072,323	32,325	66,802	155,442	1,937,148	0.42	20.63
09 swale clay loam	0.15	Fair	24	36	25	73	1,377,444	0	43,262	153,792	1,916,585	0.33	40.20
09 sml pnd and swale clay loam	0.15	Fair	24	79	25	24	1,484,988	5,100	46,845	166,413	2,073,877	0.35	19.80

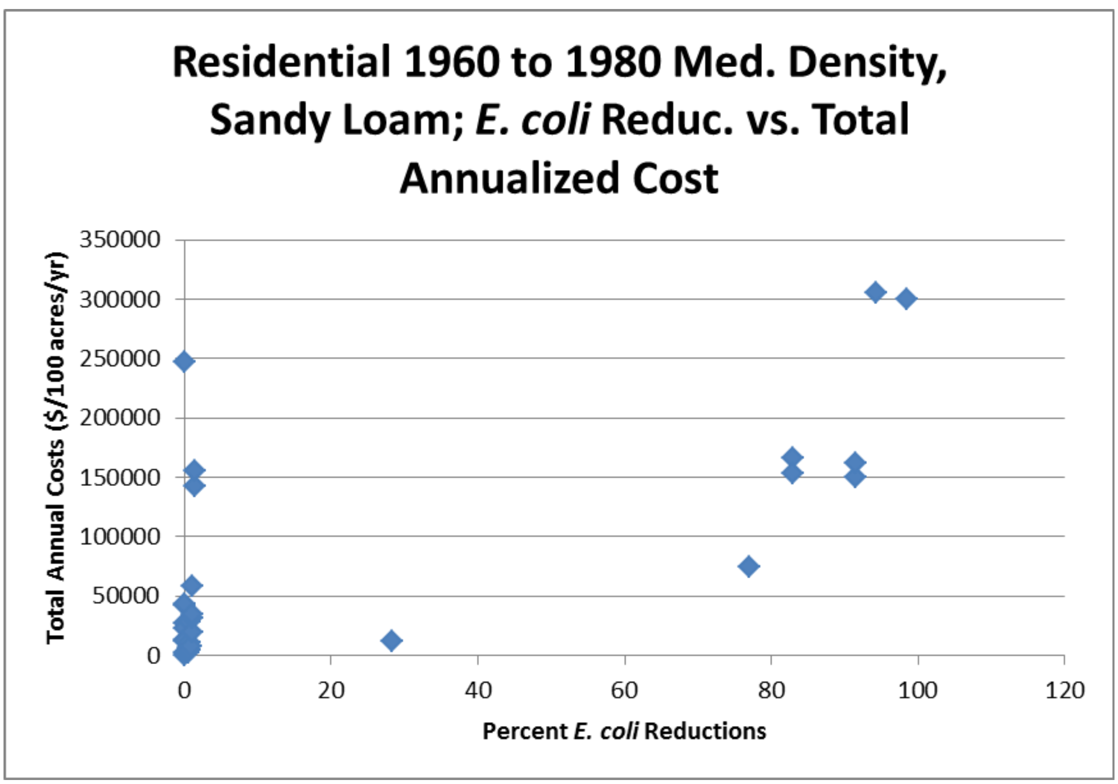
09 porous pvt driveways clay loam	0.18	Poor	6	2	28	90	146,395	0	490	12,237	152,501	0.10	67.20
09 curb biofilters 20 clay loam	0.12	Good	37	54	38	62	510,150	6,198	33,482	74,915	933,605	0.10	13.00
09 curb biofilters 40 clay loam	0.09	Good	54	73	55	50	1,020,300	12,397	66,964	149,830	1,867,210	0.14	19.30
09 sml pnd and curb biofilters 40 clay loam	0.09	Good	54	90	55	18	1,127,844	17,497	70,546	162,451	2,024,502	0.15	16.92
09 sml pnd and rain grdn 15 prct and curb biofilters 40 clay loam	0.07	Good	66	92	62	20	2,092,623	44,722	133,766	305,272	3,804,358	0.23	31.12
09 curb biofilters 80 clay loam	0.05	Good	75	87	77	45	2,040,599	24,793	133,927	299,660	3,734,420	0.20	32.33

Sandy Soil Conditions





Residential 1960 to 1980 Med. Density, Sandy Loam; TSS Mass Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
20
40
60
80
100
120
Perent TSS Mass Reductions



Residential 1960 to 1980 Med. Density, Sandy Loam; *E. coli* Reduc. vs. Total Annualized Cost
Total Annual Costs ($/100 acres/yr)
350000
300000
250000
200000
150000
100000
50000
0
0
20
40
60
80
100
120
Percent *E. coli* Reductions

Medium Density Residential 1960 to 1980 Land Use, Sandy Loam Soil, Sorted by *E. coli* Removal (costs are per 100 acres)

File Name	Rv	Biological Condition	Runoff Volume Percent Reduction	Particulate Solids Yield Percent Reduction	*E. coli* Yield Percent Reduction	Particulate Solids Concentration (mg/L)	Capital Cost	Land Cost	Maintenance Cost	Total Annual Cost	Total Present Value Cost	Cost per cubic foot Runoff Volume Reduced ($/cf)	Cost per pound Particulate Solids Reduced ($/lb)
09 base	0.20	Poor	n/a	n/a	n/a	86	n/a	n/a	n/a	n/a	n/a	n/a	n/a
09 CB	0.20	Poor	0	16	0	72	236,094	0	8,175	27,120	337,973	-	15.98
09 pond 04 perct	0.20	Poor	0	67	0	28	107,544	5,100	3,583	12,622	157,292	-	1.76
09 pond 08 perct	0.20	Poor	0	83	0	15	200,509	10,200	5,899	22,807	284,223	-	2.58
09 pond 16 perct	0.20	Poor	0	94	0	5	379,468	20,400	10,069	42,155	525,348	-	4.21
09 street cleaning daily	0.20	Poor	0	57	0	37	46,480	0	243,970	247,700	3,086,885	-	40.57
09 street cleaning monthly	0.20	Poor	0	22	0	67	2,153	0	11,304	11,476	143,022	-	4.97
09 street cleaning sp fl	0.20	Poor	0	8	0	79	404	0	2,119	2,152	26,817	-	2.52
09 street cleaning weekly	0.20	Poor	0	43	0	49	8,120	0	42,624	43,276	539,311	-	9.54
09 roof rain garden 3 perct sandy loam	0.18	Poor	10	1	1	95	46,111	1,301	3,022	6,826	85,067	0.04	112.75
09 rain barrels few	0.18	Poor	10	1	1	95	15,578	176	928	2,192	27,319	0.01	35.85
09 rain barrels	0.17	Fair	11	1	1	96	31,137	352	1,855	4,381	54,603	0.02	63.28
09 rain barrels many	0.17	Fair	13	1	1	99	77,852	880	4,638	10,955	136,526	0.04	132.27
09 all roof rain garden 3 perct sandy loam	0.17	Fair	14	1	1	99	191,537	5,405	12,551	28,354	353,354	0.11	340.25
09 rain tanks small	0.17	Fair	15	1	1	101	51,840	733	3,509	7,728	96,307	0.03	81.48
09 rain tanks large	0.16	Fair	17	1	1	103	388,847	5,500	26,323	57,967	722,391	0.17	555.06
09 rain tanks	0.16	Fair	17	1	1	103	129,616	1,833	8,774	19,322	240,797	0.06	185.01
09 sml pnd and rain tanks	0.16	Fair	17	71	1	30	237,160	6,933	12,357	31,944	398,089	0.10	4.21
09 connt roof rain garden 15 perct sandy loam	0.16	Fair	19	1	1	106	234,101	6,606	15,340	34,655	431,877	0.09	291.08
09 all roof rain garden 15 perct sandy loam	0.15	Fair	23	1	1	111	964,779	27,225	63,219	142,820	1,779,856	0.31	993.43
09 sml pnd and all roof rain garden 15 perct sandy loam	0.15	Fair	23	72	1	31	1,072,323	32,325	66,802	155,442	1,937,148	0.34	20.14
09 porous pve driveways sandy loam	0.18	Poor	6	2	28	90	146,395	0	490	12,237	152,501	0.10	67.20
09 curb biofilters 20 sandy	0.05	Good	75	76	77	85	510,150	6,198	33,482	74,915	933,605	0.05	9.29

loam													
09 sml pnd and swale sandy loam	0.04	Good	82	95	83	22	1,484,988	5,100	46,845	166,413	2,073,877	0.10	16.40
09 swale sandy loam	0.04	Good	82	83	83	80	1,377,444	0	43,262	153,792	1,916,585	0.09	17.35
09 curb biofilters 40 sandy loam	0.02	Good	90	93	91	66	1,020,300	12,397	66,964	149,830	1,867,210	0.08	15.19
09 sml pnd and curb biofilters 40 sandy loam	0.02	Good	90	97	91	26	1,127,844	17,497	70,546	162,451	2,024,502	0.09	15.71
09 sml pnd and rain grdn 15 prct and curb biofilters 40 sandy loam	0.01	Good	95	98	94	28	2,092,623	44,722	133,766	305,272	3,804,358	0.16	29.19
09 curb biofilters 80 sandy loam	0.00	Good	98	99	98	59	2,040,599	24,793	133,927	299,660	3,734,420	0.15	28.48

Cost-Effective Runoff Volume and Suspended Solids Removals

The following lists show the three most cost-effective controls for volume reductions and for TSS reductions for each land use condition from the above examined alternatives. As noted above, if an alternative stormwater control option provides more control than "needed," the size can be reduced, with concurrent cost savings. These summary tables show a number of common patterns. Each land use group (commercial, institutional, and residential areas) having several land use examples has similar lists of the most cost-effective approach for runoff volume. For suspended solids, all areas show that wet detention ponds are the most cost-effective control option, irrespective of the conditions. As noted below, other factors may influence the selection of the "best" stormwater control program for an area, beyond least cost for the level of control needed. As an example, wet detention ponds, while being the most cost-effective, are likely very difficult to retrofit into existing areas. However, these analyses indicate that these controls should not be rejected without careful evaluations and searching for potential locations. The later discussion of decision analysis to support the selection of stormwater programs illustrates how other factors can be used to identify control program options that address far more objectives than cost alone.

For runoff volume controls, each land use group had similar most cost-effective controls, as shown on the following list for the controls having at least 25% levels of runoff volume reduction potential in areas having clay load soils in the infiltration areas. Other control options have similar potential levels of control, but the others are more costly. These are listed in order with the first control having the lowest level of maximum control, but the highest unit cost-effectiveness; and the last control listed having the highest level of maximum control, but the lowest unit cost-effectiveness. Therefore, if low to moderate levels of control are suitable, the first control option may be best, but if maximum control levels are needed, then the last control option listed would be needed:

• Strip mall and shopping center areas:
  - Porous pavement (in half of the parking areas)
  - Curb-cut biofilters (along 80% of the curbs) for strip malls or biofilters in parking areas (10 percent of the source area) for shopping centers
  - Biofilters in parking areas (10 percent of the source area) and curb-cut biofilters (along 40% of the curbs)

• Light industrial areas:
  - Curb-cut biofilters (along 40% of the curbs)
  - Roofs and parking areas half disconnected
  - Roofs and parking areas all disconnected

• School, church, and hospital institutional areas:
  - Small rain tank (0.10 ft^3 storage per ft^2 of roof area) for schools and churches; rain tank (0.25 ft^3 storage per ft^2 of roof area) for hospitals
  - Roofs and parking areas half disconnected
  - Roofs and parking areas all disconnected

• Low and medium density residential areas:
  - Curb-cut biofilters (along 20% of the curbs)
  - Curb-cut biofilters (along 40% of the curbs)
  - Curb-cut biofilters (along 80% of the curbs)

These cost-effective controls only consider runoff volume and TSS separately. In most cases, and in the absence of specific control goals for multiple attributes or pollutants, runoff volume goals are usually the most robust. Reductions in runoff volume discharges result in similar reductions of all pollutant mass discharges (but not necessarily concentrations), along with peak flow rates and helping to meet other desirable stormwater management objectives. In most current stormwater management programs, runoff volume reductions usually receive the most attention. However, many particulate-bound pollutants can be reduced (both in mass discharges and in concentrations) through the use of wet detention ponds as shown in these analyses. Therefore, a more robust stormwater control program would be one that includes both sedimentation and infiltration controls. Again, the following discussion on decision analyses provides an example of how these data can be used to select the most suitable control programs with a number of objectives.

Strip Mall Commercial Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Commercial Strip Mall Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Porous pavement (in half of the parking areas)	25%	25%	$180,400
Curb-cut biofilters (along 80% of the curbs)	29	67	166,500
Biofilters in parking areas (10 percent of the source area) and curb-cut biofilters (along 40% of the curbs)*	43	80	397,000

* not shown on scatterplots

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Commercial Strip Mall Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.85% of drainage area)	65%	$27,900
Wet detention pond (1.7% of drainage area)	80	50,500
Wet detention pond (3.4% of drainage area)	92	60,300

Shopping Center Commercial Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Commercial Shopping Center Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Porous pavement (in half of the parking areas)	26%	26%	$188,300
Biofilters in parking areas (10 percent of the source area)	29	48	355,600
Biofilters in parking areas (10 percent of the source area) and curb-cut biofilters (along 40% of the curbs)*	41	77	393,800

* not shown on scatterplots

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Commercial Shopping Center Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.85% of drainage area)	64%	$27,900
Wet detention pond (1.7% of drainage area)	79	50,500
Wet detention pond (3.4% of drainage area)	91	60,300

Light Industrial Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Light Industrial Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Curb-cut biofilters (along 40% of the curbs)	26	60	$100,000
Roofs and parking areas half disconnected	32	32	0
Roofs and parking areas all disconnected	61	61	0

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Light Industrial Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (1% of drainage area)	68%	$30,900
Wet detention pond (2% of drainage area)	82	54,700
Wet detention pond (4% of drainage area)	92	61,500

School Institutional Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for School Institutional Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Small rain tank (0.10 ft^3 storage per ft^2 of roof area)	27	27	42,600
Roofs and parking areas half disconnected	35	35	0
Roofs and parking areas all disconnected	68	68	0

Most Cost-Effective Control Programs for TSS Reductions

Control Program for School Institutional Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.85% of drainage area)	67%	$27,900
Wet detention pond (1.7% of drainage area)	82	50,500
Wet detention pond (3.4% of drainage area)	93	60,300

Church Institutional Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Church Institutional Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Small rain tank (0.10 ft^3 storage per ft^2 of roof area)	27%	27%	$42,600
Roofs and parking areas half disconnected	33	33	0
Roofs and parking areas all disconnected	65	65	0

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Church Institutional Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.85% of drainage area)	67%	$27,900
Wet detention pond (1.7% of drainage area)	82	50,500
Wet detention pond (3.4% of drainage area)	93	60,300

Hospital Institutional Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Hospital Institutional Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Rain tank (0.25 ft^3 storage per ft^2 of roof area)	25%	25%	$88,400
Roofs and parking areas half disconnected	29	29	0
Roofs and parking areas all disconnected	66	66	0

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Church Institutional Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.85% of drainage area)	67%	$27,900
Wet detention pond (1.7% of drainage area)	82	50,500
Wet detention pond (3.4% of drainage area)	93	60,300

Low Density Residential Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Low Density Residential Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Curb-cut biofilters (along 20% of the curbs)	34	72	$66,600
Curb-cut biofilters (along 40% of the curbs)	51	89	133,200
Curb-cut biofilters (along 80% of the curbs)	73	98	266,400

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Low Density Residential Land Use	TSS Reductions (% reduction compared to base conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.3% of drainage area)	62%	$10,500
Wet detention pond (0.6% of drainage area)	78	18,300
Wet detention pond (1.2% of drainage area)	90	34,600

Medium Density Residential (before 1960) Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Medium Density Residential (before 1960) Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Curb-cut biofilters (along 20% of the curbs)	38	77	87,401
Curb-cut biofilters (along 40% of the curbs)	55	92	174,801
Curb-cut biofilters (along 80% of the curbs)	77	99	349,600

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Medium Density Residential (before 1960) Land Use	TSS Reductions (% reduction compared to base conditions for clay loam conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.4% of drainage area)	65%	$12,600
Wet detention pond (0.8% of drainage area)	82	22,800
Wet detention pond (1.6% of drainage area)	93	42,200

Medium Density Residential (1960 to 1980) Land Use

Most Cost-Effective Control Programs for Volume Reductions

Control Program for Medium Density Residential (1960 to 1980) Land Use	Volume Reductions (% reduction compared to base conditions for clay loam conditions in infiltration device)	Volume Reductions (% reduction compared to base conditions for sandy loam conditions in infiltration device)	Total Annual Costs ($/100 acres/yr)
Curb-cut biofilters (along 20% of the curbs)	37	75	74,915
Curb-cut biofilters (along 40% of the curbs)	54	90	149,830
Curb-cut biofilters (along 80% of the curbs)	75	98	299,660

Most Cost-Effective Control Programs for TSS Reductions

Control Program for Medium Density Residential (1960 to 1980) Land Use	TSS Reductions (% reduction compared to base conditions for clay loam conditions)	Total Annual Costs ($/100 acres/yr)
Wet detention pond (0.4% of drainage area)	67%	$12,600
Wet detention pond (0.8% of drainage area)	83	22,800
Wet detention pond (1.6% of drainage area)	94	42,200

Using Decision Analysis to Select the Most Suitable Stormwater Control Program Considering Multiple Objectives

There are many attributes and characteristics associated with a stormwater management plan that need to be considered during the selection process. This section presents an example for the Lincoln, NE, medium residential area (1960-1980) that represents the largest fraction of the study area. Some of these characteristics of concern include: *E. coli* discharge reductions, nutrient discharge reductions, costs (initial and maintenance costs, plus total annual costs), land requirements, runoff volume discharge reductions, and TSS discharge reductions. As described in this report, WinSLAMM can calculate these attributes for a broad selection of alternative stormwater programs. The following table summarizes these characteristics for the range of stormwater management plans examined for this land use, based on the 4 years of continuous rain record, a 100 acre homogeneous area, and with sandy loam soils at the infiltration/biofiltration locations. The costs are expressed in $/acre and in $/acre/year, the land needs are expressed as a percentage of the complete drainage area, and the biological conditions represent the receiving water expected conditions if the complete watershed was developed in the same manner.

Characteristics and Attributes of Alternative Stormwater Management Programs for Medium Density Residential Area (1960 – 1980)

Stormwater Control Programs	Sub Basin Capital Cost ($/ac)	Land needs (% of total area)	Sub Basin Total Annual Cost ($/ac/yr)	Runoff Volume Percent Reduction	Rv	Biological Condition	Particulate Solids Yield Percent Reduction	Phos. Yield Percent Reduction	E. coli Yield Percent Reduction
Roof rain garden 3 perct of connected roofs only	461	0.1	17	10	0.18	Poor	1	1	1
Roof rain garden 15 perct of connected roofs only	2,341	0.7	87	19	0.16	Fair	1	2	1
Rain garden 3 perct of all roofs	1,915	0.5	71	14	0.17	Fair	1	1	1
Rain garden 15 perct of all roofs	9,648	2.7	357	23	0.15	Fair	1	3	1
Rain barrels few	156	0.0	5	10	0.18	Poor	1	1	1
Rain barrels	311	0.0	11	11	0.17	Fair	1	1	1
Rain barrels many	779	0.1	27	13	0.17	Fair	1	1	1
Rain tanks small	518	0.1	19	15	0.17	Fair	1	2	1
Rain tanks	1,296	0.2	48	17	0.16	Fair	1	2	1
Rain tanks large	3,888	0.6	145	17	0.16	Fair	1	2	1
Porous pavement on driveways	1,464	0.0	31	6	0.18	Poor	2	2	28
Curb-cut biofilters 20 perct	5,102	0.6	187	75	0.05	Good	76	66	77
Curb-cut biofilters 40 perct	10,203	1.2	375	90	0.02	Good	93	86	91
Curb-cut biofilters 80 perct	20,406	2.5	749	98	0.00	Good	99	97	98
Street cleaning daily	465	0.0	619	0	0.20	Poor	57	13	0
Street cleaning monthly	22	0.0	29	0	0.20	Poor	22	5	0
Street cleaning weekly	81	0.0	108	0	0.20	Poor	43	9	0
Street cleaning once in spring and fall	4	0.0	5	0	0.20	Poor	8	2	0
Catchbasin cleaning	2,361	0.0	68	0	0.20	Poor	16	4	0
Grass swale drainage	13,774	0.0	384	82	0.04	Good	83	78	83
Wet pond 0.4 perct	1,075	0.5	32	0	0.20	Poor	67	16	0
Wet pond 0.8 perct	2,005	1.0	57	0	0.20	Poor	83	19	0
Wet pond 1.6 perct	3,795	2.0	105	0	0.20	Poor	94	22	0
Small wet pond and rain tanks	2,372	0.7	80	17	0.16	Fair	71	18	1
Small wet pond and all roof rain garden 15%	10,723	3.2	389	23	0.15	Fair	72	19	1
Small wet pond and swale	14,850	0.5	416	82	0.04	Good	95	81	83
Small wet pond and curb biofilters 40%	11,278	1.7	406	90	0.02	Good	97	87	91
Small wet pond, grdn 15% and curb biofilters 40%	20,926	4.5	763	95	0.01	Good	98	91	94

Filtering Simple Attributes and Selecting Least Costly Acceptable Alternatives

In the simplest case, the selection of the most suitable control can be based on examining the calculated outcomes and filtering them according to set objectives, and then choosing the least costly alternative. As an example, if the runoff reduction objectives were expressed in expected biological conditions of "good" and the required particulate solids (TSS) mass discharge reductions needed were at least 75%, seven of these 29 control programs would be satisfactory. This combination of high runoff volume reductions (the "good" biological conditions occur with about 75% runoff volume reductions) and particulate solids reductions will also provide high reductions off all of the other pollutants. If only particulate solids reductions were targeted, then the wet detention ponds would be the least costly choice, but they alone would not reduce the discharges of the filterable pollutants, but they do provide excellent particulate pollutant reductions. The seven alternative programs meeting these two simple (but relatively robust) control objectives, along with their estimated annual unit area costs, are shown below:

Stormwater Control Programs	Sub Basin Total Annual Cost ($/ac/yr)	Biological Condition	Particulate Solids Yield Percent Reduction
Curb-cut biofilters 20 perct	187	Good	76
Curb-cut biofilters 40 perct	375	Good	93
Curb-cut biofilters 80 perct	749	Good	99
Grass swale drainage	384	Good	83
Small wet pond and swale	416	Good	95
Small wet pond and curb biofilters 40%	406	Good	97
Small wet pond, grdn 15% and curb biofilters 40%	763	Good	98

The least costly alternative involves the use of curb-cut biofilters along at least 20 percent of the total curb length. If this control program meets other objectives; mainly approval of the residents living in the area, and design specifics to overcome possible problems associated with snowmelt and clogging can be developed, this would be a good choice. Retrofitting grass swales is not a very suitable choice, but can be an excellent option for new development (especially when their moderate costs are compared to the high costs associated with conventional curb and gutter drainages). The combination control options listed all have small wet detention ponds which could be difficult to site in a previously developed area, and are not that necessary in this land use, even with new development, if proper design and use of a swale or biofilter drainage system is possible.

In residential areas, retrofitting the curb-cut biofilters is a reasonable option and usually meets with approval of the residents. Typical concerns are lose of some on-street parking (if use curb-extensions) and maintenance requirements. If the city maintains these (since they are located in the city right-of-way), continued operation is usually ensured, and with proper selection of plants, can significantly increase the street-side aesthetics. These are especially popular in areas not having sidewalks, if sidewalks are added as part of the "package."

The main issues, especially for a northern city like Lincoln, is the potential problem of failure due to excessive sodium discharges with snowmelt, and clogging from high particulate loads into the biofilter area. The sodium and associated SAR problems occur if the biofilter media contains clay. Therefore, the media specified should be sand alone, with a shallow layer of mixed (very low clay content) topsoil on the surface to support plant growth.

The problem of clogging can be overcome with pretreatment by using grass swales between the biofilters to act as grass filters, and/or to increase the surface area of the biofilters to decrease the unit area sediment loading. If 20% of the curb has biofilters, the approximate biofilter area is about 0.6% of the total drainage area. For 100 acres, the total biofilter area would therefore be 0.6 acres (about 26,000 ft^2). As noted during the modeling analyses, the total particulate loading expected to be trapped by the biofilter during four years over 100 acres is about 32,000 lbs. This corresponds to about 0.3 $lb/ft^2/year$ (or about 1.5 $kg/m^2/year$) of operation). As noted previously, biofilter clogging may occur with sediment loads of about 10 to 25 kg/m^2, especially if that cumulative load occurs over just a few years. The predicted maximum loading before clogging would therefore occur between about 6 and 15 years. The shortest period before potential clogging may be problematic, but vigorous plants also tend to help reduce clogging. It is likely, if care is taken in the selection of materials and plants and in construction and maintenance, these biofilters would function for a long period of time.

Utility Functions and Tradeoffs in the Selection of the Most Suitable Stormwater Control Program

Formal decision analysis methods can be used when conflicting and complex attributes and objectives make the simpler filtering method described above impractical. One example used for stormwater programs was described with examples by Pitt and Voorhees ("Using decision analyses to select an urban runoff control program" Chapter 4 in: *Contemporary Modeling of Urban Water Systems*, ISBN 0-9736716-3-7, Monograph 15. Edited by W. James, E.A. McLean, R.E. Pitt, and S.J. Wright. CHI. Guelph, Ontario. pp 71 – 107. 2007). This method uses utility curves and trade-offs between the different attributes. The utility curves should be based on data and not reflect personal attitudes or objectives, while the trade-offs between the attributes reflect different viewpoints. This decision analysis method is therefore a powerful tool that can be used to compare the rankings of alternative stormwater management programs for different groups. In many cases, final rankings may be similar amongst the interested parties, although their specific reasons vary. This tool also completely documents the decision making process, enabling full disclosure. This feature is probably more important for site selection projects for power plants than for small public works projects, but this level of documentation is still critical when public policy and taxes are concerned.

The detail and depth of understanding needed to fully use this decision analysis methodology forces the user to acquire a deeper understanding of the problem being solved. This can be both an advantage and a disadvantage. Multiple experts are usually needed to develop the utility curves, but they can hopefully be used for similar projects in the same region sharing similar problems and objectives. The trade-offs are dependent on the mix of decision makers and stakeholders involved in the process, and are expected to change with time. The depth of knowledge obtained and full documentation always is a positive aspect of these methods, but the required resources to fully implement the system can be an insurmountable obstacle to smaller communities. However, sensitivity analyses can be used to focus resources only on those aspects of greatest importance.

The first step in applying decision analysis techniques consists of defining the alternatives and quantitative measures (attributes) for the objectives. How well each of the 28 alternative stormwater programs in this example achieves the objective is also determined. In this example for the medium density residential (1960 to 1980) land use in Lincoln, five attributes (total annual cost, Rv, TSS reductions, TP reductions, and *E. coli* reductions) are chosen to reflect the different considerations in deciding which stormwater management program to select. These attributes, their units of measurement, and the associated ranges are shown in the following table (obtained from the earlier complete table):

Selected Characteristics and Attributes of Alternative Stormwater Management Programs for Medium Density Residential Area (1960 – 1980)

Program ID Number	Stormwater Control Programs	Sub Basin Total Annual Cost ($/ac/yr)	Rv	Particulate Solids Yield Percent Reduction	Phos. Yield Percent Reduction	*E. coli* Yield Percent Reduction
1	Roof rain garden 3 perct of connected roofs only	17	0.18	1	1	1
2	Roof rain garden 15 perct of connected roofs only	87	0.16	1	2	1
3	Rain garden 3 perct of all roofs	71	0.17	1	1	1
4	Rain garden 15 perct of all roofs	357	0.15	1	3	1
5	Rain barrels few	5	0.18	1	1	1
6	Rain barrels	11	0.17	1	1	1
7	Rain barrels many	27	0.17	1	1	1
8	Rain tanks small	19	0.17	1	2	1
9	Rain tanks	48	0.16	1	2	1
10	Rain tanks large	145	0.16	1	2	1
11	Porous pavement on driveways	31	0.18	2	2	28
12	Curb-cut biofilters 20 perct	187	0.05	76	66	77
13	Curb-cut biofilters 40 perct	375	0.02	93	86	91
14	Curb-cut biofilters 80 perct	749	0.00	99	97	98
15	Street cleaning daily	619	0.20	57	13	0
16	Street cleaning monthly	29	0.20	22	5	0
17	Street cleaning weekly	108	0.20	43	9	0
18	Street cleaning once in spring and fall	5	0.20	8	2	0
19	Catchbasin cleaning	68	0.20	16	4	0
20	Grass swale drainage	384	0.04	83	78	83
21	Wet pond 0.4 perct	32	0.20	67	16	0
22	Wet pond 0.8 perct	57	0.20	83	19	0
23	Wet pond 1.6 perct	105	0.20	94	22	0
24	Small wet pond and rain tanks	80	0.16	71	18	1
25	Small wet pond and all roof rain garden 15%	389	0.15	72	19	1
26	Small wet pond and swale	416	0.04	95	81	83
27	Small wet pond and curb biofilters 40%	406	0.02	97	87	91
28	Small wet pond, grdn 15% and curb biofilters 40%	763	0.01	98	91	94
	minimum	**5**	**<0.01**	**1**	**1**	**0**
	maximum	**763**	**0.20**	**99**	**97**	**98**

The next step consists of quantifying the preferences and tradeoffs for the various attribute levels using utility curves and attribute weighting factors. The concepts of utility theory (such as described in Keeney, R.L. and H. Raiffa. *Decision Analysis with Multiple Conflicting Objectives*. John Wiley & Sons. New York, 1976.) provide a consistent scale to quantify how much one gives up when choosing one attribute over another. Utility curves are first assessed for the individual attributes. These curves quantify the preferences that exist for the total range of each attribute. They also quantify attitudes toward risk. This is important when alternatives yield uncertain consequences. The curves are defined based on technical information and are usually developed by experts. The most preferred point is defined as having a utility value of 1.00 and the least preferred point a utility value of 0.00. The utility assessments establish where the intermediate points fall on the utility scale. The utility curves can take many shapes, from step functions, simple curves to straight lines. The five attributes listed in the table have the following assumed utility curves and associated values:

- Total annual cost: straight line, with $763/acre/yr = 0 and $5/acre/yr = 1.0.

- Volumetric runoff coefficient (Rv) as an indicator of habitat quality and aquatic biology stress:

Attribute value	Expected Habitat Condition	Utility value
<0.1	Good	1.0
0.1 to 0.17	Fair	0.75
0.18 to 0.50	Poor	0.25
0.51 to 1.0	Very poor	0

• Particulate solids yield reduction:

% reduction	Utility value
>90	1.0
75 to 89	0.75
50 to 74	0.25
<50	0

• Phosphorus yield reduction:

% reduction	Utility value
>75	1.0
50 to 74	0.75
25 to 49	0.25
<25	0

• *E. coli* yield reduction:

% reduction	Utility value
>95	1.0
90 to 94	0.75
75 to 89	0.25
<75	0

Trade-offs between attributes are determined by each group of stakeholders. The sum of the trade-offs for all attributes must equal one for each set. There would likely be several sets of these and each would have a different set of trade-off values, depending on their goals. The following table summarizes some example trade-offs for different groups:

	Regulatory Agency	Municipal Gov't	Local Residents
Annual cost	0.05	0.40	0.50
Rv	0.25	0.20	0.20
TSS reductions	0.10	0.20	0.10
TP reductions	0.10	0.10	0.10
E. coli reductions	0.50	0.10	0.10
Sum of trade-off values:	1.00	1.00	1.00

The next step is to calculate the utilities associated with each attribute for each alternative control program. The trade-off values are then used as weighting factors to sum the total score for each alternative. The total scores are then used to rank the alternatives, with the highest total score the most desirable for that stakeholder group. The following table shows these calculations, along the final total scores and ranks, for each stakeholder group:

Calculated Utility Values, Weighted Sum of Factors, and Ranks for Different Stakeholder Groups (top five ranks highlighted for each group)

Program ID Number	Stormwater Control Programs	Cost utility	Rv utility	TSS utility	TP utility	*E. coli* utility	Regulatory Agency Weighted Sum of Factors	Regulatory Agency Rank	Munic. Govt. Weighted Sum of Factors	Munic. Govt. Rank	Local Resid. Weighted Sum of Factors	Local Resid. Rank
1	Roof rain garden 3 perct of connected roofs only	0.98	0.25	0.00	0.00	0.00	0.11	23	0.44	21	0.54	19
2	Roof rain garden 15 perct of connected roofs only	0.89	0.75	0.00	0.00	0.00	0.23	15	0.51	16	0.60	12
3	Rain garden 3 perct of all roofs	0.91	0.75	0.00	0.00	0.00	0.23	14	0.52	15	0.61	11
4	Rain garden 15 perct of all roofs	0.54	0.75	0.00	0.00	0.00	0.21	17	0.36	27	0.42	27
5	Rain barrels few	1.00	0.25	0.00	0.00	0.00	0.11	21	0.45	19	0.55	17
6	Rain barrels	0.99	0.75	0.00	0.00	0.00	0.24	10	0.55	11	0.65	6
7	Rain barrels many	0.97	0.75	0.00	0.00	0.00	0.24	12	0.54	13	0.64	8
8	Rain tanks small	0.98	0.75	0.00	0.00	0.00	0.24	11	0.54	12	0.64	7
9	Rain tanks	0.94	0.75	0.00	0.00	0.00	0.23	13	0.53	14	0.62	10
10	Rain tanks large	0.82	0.75	0.00	0.00	0.00	0.23	16	0.48	18	0.56	15
11	Porous pavement on driveways	0.97	0.25	0.00	0.00	0.00	0.11	25	0.44	23	0.53	21
12	Curb-cut biofilters 20 perct	0.76	1.00	0.75	0.75	0.00	0.44	7	0.73	***3***	0.73	***2***
13	Curb-cut biofilters 40 perct	0.51	1.00	1.00	1.00	0.75	0.85	***2***	0.78	***1***	0.73	***1***
14	Curb-cut biofilters 80 perct	0.02	1.00	1.00	1.00	1.00	0.95	***1***	0.61	6	0.51	22
15	Street cleaning daily	0.19	0.25	0.25	0.00	0.00	0.10	28	0.18	28	0.17	28
16	Street cleaning monthly	0.97	0.25	0.00	0.00	0.00	0.11	24	0.44	22	0.53	20
17	Street cleaning weekly	0.86	0.25	0.00	0.00	0.00	0.11	27	0.40	26	0.48	24
18	Street cleaning once in spring and fall	1.00	0.25	0.00	0.00	0.00	0.11	22	0.45	20	0.55	18
19	Catchbasin cleaning	0.92	0.25	0.00	0.00	0.00	0.11	26	0.42	24	0.51	23
20	Grass swale drainage	0.50	1.00	0.75	1.00	0.25	0.58	6	0.68	***5***	0.65	***5***
21	Wet pond 0.4 perct	0.96	0.25	0.25	0.00	0.00	0.14	20	0.49	17	0.56	16
22	Wet pond 0.8 perct	0.93	0.25	0.75	0.00	0.00	0.18	19	0.57	9	0.59	13
23	Wet pond 1.6 perct	0.87	0.25	1.00	0.00	0.00	0.21	18	0.60	7	0.58	14
24	Small wet pond and rain tanks	0.90	0.75	0.25	0.00	0.00	0.26	8	0.56	10	0.63	9
25	Small wet pond and all roof rain garden 15%	0.49	0.75	0.25	0.00	0.00	0.24	9	0.40	25	0.42	26
26	Small wet pond and swale	0.46	1.00	1.00	1.00	0.25	0.60	***5***	0.71	***4***	0.65	***4***
27	Small wet pond and curb biofilters 40%	0.47	1.00	1.00	1.00	0.75	0.85	***3***	0.76	***2***	0.71	***3***
28	Small wet pond, grdn 15% and curb biofilters 40%	0.00	1.00	1.00	1.00	0.75	0.83	***4***	0.58	8	0.48	25
	Regulatory agency trade-offs	0.05	0.25	0.10	0.10	0.50						
	Municipal government trade-offs	0.40	0.20	0.20	0.10	0.10						
	Local residents trade-offs	0.50	0.20	0.10	0.10	0.10						

It is interesting to note that the top ranked alternatives are generally similar for each stakeholder group, even with very different trade-off values. The municipal governments and local resident's trade-offs are quite similar, but are quite different from the regulatory agency's trade-off values. The overall top ranked alternative is the curb-cut biofilters at 40% of the curb line. This alternative ranked first for the municipal government and local resident stakeholder groups and second for the regulatory agency. The top ranked alternative for the regulatory agency (the curb-cut biofilters at 80% of the curb line) ranked much lower for the other two stakeholder groups due to its much higher costs. The small wet pond plus the curb-cut biofilters at 40% of the curb line ranked second for the municipal government stakeholders and third for the regulatory agency and the local government stakeholder groups. As stated previously, one of the great values of the multiple/conflicting objectives decision analysis procedure is being clear in the process, while showing how diverse stakeholder groups may be closer to agreement than realized.

The decision analysis approach outlined in this section has the flexibility of allowing for variable levels of analytical depth, depending on the problem requirements. The preliminary level of defining the problem explicitly in terms of attributes often serves to make the most preferred alternatives clear. The next level of analysis might consist of a first-cut assessment and ranking as described in this example. Spreadsheet calculations with the model are easily performed, as was done here, making it possible to conduct several decision analysis evaluations using different trade-offs, representing different viewpoints, at one time. It is possible there will be a small set of options that everyone agrees are the best choices, as in this example. Also, this procedure documents the process for later discussion and review. Sensitivity analyses can also be conducted to identify the most significant factors that affect the decisions. The deepest level of analysis can utilize all the analytical information one collects, such as probabilistic forecasts for each of the alternatives and the preferences of experts over the range of individual attributes. Monte Carlo options available in WinSLAMM can also be used that consider the uncertainties in the calculated attributes for each option.

In summary, decision analysis has several important advantages. It is very explicit in specifying trade-offs, objectives, alternatives, and sensitivity of changes to the results. It is mathematically sound in its treatment of trade-offs and uncertainty. Other methods ignore uncertainty and often rank attributes in importance without regard to their ranges in the problem. This decision analysis procedure can be implemented flexibly with varying degrees of analytical depth, depending on the requirements of the problem and the available resources.

Considerations that Affect use of Different Stormwater Controls

Suitable care is needed in interpreting the results shown in this report on the calculated performance of the stormwater controls alternatives. Certain site conditions may restrict the applicability of some of these controls, as briefly discussed in the following subsections (mostly summarized from a prior publication by Pitt, *et al.* (Pitt, R. J. Voorhees, and S. Clark. "Evapotranspiration and related calculations for stormwater biofiltration devices: Proposed calculation scenario and data." In: *Stormwater and Urban Water Systems Modeling*, Monograph 16. (edited by W. James, E.A. McLean, R.E. Pitt and S.J. Wright). CHI. Guelph, Ontario, pp. 309 – 340. 2008.) and from research reported by others at recent technical conferences.

Sodium Adsorption Ratio (SAR)

The sodium adsorption ratio can radically degrade the performance of an infiltration device, especially when clays are present in the infiltration layers of a device. Soils with an excess of sodium ions, compared to calcium and magnesium ions, remain in a dispersed condition, and are almost impermeable to rain or applied water. A "dispersed" soil is extremely sticky when wet, tends to crust, and becomes very hard and cloddy when dry. Water infiltration is therefore severely restricted. Dispersion caused by sodium may result in poor physical soil conditions and water and air do not readily move through the soil. An SAR value of 15, or greater, indicates that an excess of sodium will be adsorbed by the soil clay particles. This can cause the soil to be hard and cloddy when dry, to crust badly, and to take water very slowly. SAR values near 5 can also cause problems, depending on the type of clay present. Montmorillonite, vermiculite, illite and mica-derived clays are more sensitive to sodium than other clays. Additions of gypsum (calcium sulfate) to the soil can be used to free the sodium and allow it to be leached from the soil in some situations.

The SAR is calculated by using the concentrations of sodium, calcium, and magnesium (in meq) in the following formula:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{(Ca^{+2} + Mg^{+2})}{2}}}$$

The following example shows how the SAR is calculated:

A soils lab reported the following chemical analyses (the soil samples are taken as composites over the surface layer of an infiltration device, usually to a depth of about 6 inches):

100 pounds/acre of sodium (Na^{+})
5000 pounds/acre of calcium (Ca^{+2})
1500 pounds/acre of magnesium (Mg^{+2})

These concentrations need to be first converted to parts per million (ppm), and then to meq/L. An acre of soil (43,560 square feet, or 4,047 square meters), 6 inches deep (15 cm), weighs about 2,000,000 pounds (910,000 kg) and contains 22,000 cubic feet of soil (620 cubic meters). The pounds reported per acre are divided by 2 to produce ppm (by weight):

100 pounds/acre of Na divided by 2 = 50 ppm of Sodium
5000 pounds/acre of Ca divided by 2 = 2500 ppm of Calcium
1500 pounds/acre of Mg divided by 2= 750 ppm of Magnesium

The ppm values are divided by the equivalent weight of the element to obtain the relative milliequivalent (meq) values. The milliequivalent weights of Na, Ca, and Mg in this example are:

50 ppm of Na divided by 23 = 2.17 meq
2500 ppm of Ca divided by 20 = 125 meq
750 ppm of Mg divided by 12.2 = 61.5 meq

The SAR is therefore:

$$SAR = \frac{2.17}{\sqrt{\frac{(125 + 61.5)}{2}}} = 0.22$$

This value is well under the critical SAR value of 15, or even the critical value of 5 applicable for some clays. This soil is therefore not expected to be a problem. However, if the runoff water contains high levels of sodium in relationship to calcium and magnesium (such as snowmelt in areas using salt for de-icing control), an SAR problem may occur in the future, necessitating the addition of gypsum to the infiltration area, or more likely replacement of the surface soil with a sand that has no clay content. The amount of gypsum (calcium sulfate) needed to be added can be determined from an analysis of the soil in the infiltration area.

SAR has been documented to be causing premature failures of biofiltration devices in northern communities. These failures occur when snowmelt water is allowed to enter a biofilter that has clay in the soil mixture. In order to minimize this failure, the following are recommended:

1) do not allow snowmelt water to enter a biofilter unit. As an example, roof runoff likely has little salt and SAR problems seldom occur for roof runoff rain gardens. However, if driveway or walkway runoff waters affected by saline deicing chemicals are discharged to these devices, problems may occur. The largest problem is associated with curb-cut biofilters or parking lot biofilters in areas with snowmelt entering these devices, especially if clay is present in the engineered backfill soil.

2) the biofilter fill soil should not have any clay. It appears that even a few percent of clay in the media mix can cause a problem, but little information is currently available on the tolerable clay content of biofilter soils. Some biofilter guidance documents recommend an appreciable clay content in order to slow the water infiltration rate (and therefore increase the hydraulic detention time in the system) in order to improve pollutant capture. Instead of clay used to control the infiltration rates, restrictive underdrains, such as the SmartDrain, should be used. Guidance documents recommending “fines” in the biofilter mixture are usually from areas having mild climates with little or no snowmelt (and deicing chemical use). Gypsum applications (top dressing with about 20 lbs/100 ft^2) may help in recovering infiltration capacity, but this may not be a long term solution. Usually the replacement of the failed engineered soil mixture with a new suitable material will be needed.

3) the most robust engineered soil mixtures used in biofilters should be mixtures of sand and an organic material (such as compost, if nutrient leaching is not a concern, or Canadian peat for a more stable material having little nutrient leaching potential). Other mixtures of biofilter media can be used targeting specific pollutants, but these are usually expensive and likely only appropriate for special applications.

4) if a suitable soil mixture not having clay (should be <3% based on preliminary information), and if snowmelt water will affect the system, then biofilters should not be used in the area. As noted above, rain gardens only receiving roof runoff may be suitable in most situations due to the absence of excessive sodium in the runoff water.

Clogging of Infiltration Devices

The designs of infiltration devices need to be checked based on their clogging potential. As an example, a relatively small and highly efficient biofilter (in an area having a high native infiltrating rate) may capture a large amount of sediment. Having a small surface area, this sediment would accumulate rapidly over the area, possibly reaching a critical clogging load early in its design lifetime. Therefore, the clogging potential can be calculated based on the predicted annual discharge of suspended solids to the biofiltration device and the desired media replacement interval. Infiltration and bioretention devices may show significantly reduced infiltration rates after about 2 to 5 lb/ft^2 (10 to 25 kg/m^2) of particulate solids have been loaded (Clark 1996 and 2000; Urbonas 1996). Deeply-rooted vegetation and a healthy soil structure can extend the actual life much longer. However, abuse (especially compaction and excessive siltation) can significantly reduce the life of the system. If this critical load accumulates relatively slowly (taking about 10 or more years to reach this total load) and if healthy vegetation with deep roots are present, the infiltration rate may not significantly degrade due to the plant's activities in incorporating the imported sediment into the soil column. If this critical load accumulates in just a few years, or if healthy vegetation is not present, the premature failure due to clogging may occur. Therefore, relatively large surface areas may be necessary in areas having large sediment contents in the runoff, or suitable pre-treatment to reduce the sediment load before entering the biofilter or infiltration device would be necessary.

It is possible to use the calculated annual suspended solids loading from an area and to determine the clogging potential for a bioretention device having a specific surface area. The following three examples illustrate these simple calculations:

Example 1
A 1.0 ha paved parking lot (R_v = 0.85), TSS 50 mg/L, in an area receiving 1.0 m (3.3 ft) of rain per year:
(50 mg SS/L) (0.85) (1 m/yr) (1 ha) (10,000 m^2/ha) (1,000 L/m^3) (g/1,000 mg)
= 425,000 g SS/yr

Therefore, if a bioretention device is to be used having an expected suspended solids capacity of 15 kg/m^2 (3 lb/ft^2) before "clogging," then 28 m^2 (300 ft^2) of this bioretention device will be needed for each year of desired operation for this 1.0 ha (2.5 acre) site. This is about 0.3% of the paved area per year of operation, so if 10 years were desired before the media needed to be exchanged, an area of about 3% of the contributing area would be needed for the bioretention device. If this water was pretreated to a high level so the effluent has a much reduced concentration of particulates (to about 5 mg/L suspended solids), then only about 0.03% of the contributing paved area would be needed for the bioretention area for each year of operation. Of course, the final design would need to be based on the infiltration capacity and the desired runoff volume reductions.

Example 2
A 100 ha medium density residential area (R_v = 0.3), TSS = 150 mg/L, 1.0 m of rain per year:
(150 mg SS/L) (0.3) (1 m/yr) (100ha) (10,000 m^2/ha) (1,000 L/m^3) (g/1,000 mg)
= 45,000,000 g SS/yr

The unit area loading of suspended solids for this residential area (425 kg SS/ha-yr) is about the same as in the previous example (450 kg SS/ha-yr), requiring about the same area dedicated for the bioretention device (the reduced amount of runoff is balanced by the higher suspended solids concentration).

Example 3
A 1.0 ha rooftop in an area (R_v = 0.85), TSS = 10 mg/L, having 1.0 m of rain per year:
(10 mg SS/L) (0.85) (1 m/yr) (1 ha) (10,000 m^2/ha) (1,000 L/m^3) (g/1,000 mg)
= 85,000 g SS/yr

The unit area loading of suspended solids from this area is 85 kg SS/ha-yr and would only require a rain garden of about 0.06% of the roofed drainage area per year of operation, to maintain the 15 kg/m^2 loading limit.

In many of the design calculations having biofilters, the loading rates are higher, resulting in premature failure if the minimum size was used only necessary for infiltration. Therefore, a larger area is actually needed to prevent premature failure due to clogging. Therefore, the following considerations apply to infiltration/biofiltration devices to minimize clogging failure:

1) use a sufficient infiltration area to enable at least ten years before the critical sediment loading (10 to 25 kg/m2) occurs, and maintain a healthy deep-rooted plant community to incorporate the sediment into the soil horizon.

2) use pre-treatment to reduce the sediment load entering a biofilter to reduce the TSS concentrations to match the desired maintenance or clogging interval. The use of a grass filter/grass swale before a biofilter can significantly reduce the loading to the device, extending the operational life.

Groundwater Contamination Potential and Over-Irrigation

The basic beneficial use rate using stored stormwater for irrigation is usually considered to be the difference between the evapotranspiration (ET) rate for the soil-plant mixture and the natural rainfall. For a more accurate analysis, these calculations for this report used the available infiltrating stormwater into the landscaped area instead of the total rainfall, as only a fraction of the rainfall is available to the plant, especially in disturbed urban environments. The amount of stored stormwater for later use assumes a perfect match to the demand rates that are used in the model. Obviously, it is likely that some wastage or under-utilization will occur, unless a perfect control system is used to regulate the water use based on real-time soil moisture sensors. This level of sophistication may be available for automatic irrigation systems that are commonly used in both commercial and residential settings.

However, since the objective of the irrigation use of the stored stormwater is to use as much of the stormwater as possible, it may be appropriate to over-irrigate, as long as the plants are not damaged. This would be similar to the discharge of the stormwater to a biofilter or rain garden, where the water application is in great over-abundance to that which is required for just maintaining the plants. Therefore, an upper limit to the use of stormwater should be determined for a site. The calculations in this report assume a conservative use of the stormwater that only matches the ET requirements. Two major restrictions on over-irrigating include damage to the plant and damage to the groundwater resources. Plants can be selected that can safely withstand the over-irrigation if that is the main objective. Groundwater issues are more complex and are site specific.

Groundwater mounding occurs under infiltrating areas and can affect local groundwater movement and interfere with the infiltration device if the mound interacts with the saturated area beneath an infiltration area. During irrigation of stormwater over an extended area, mounding is not likely to be a significant issue. However, some effects on the local groundwater movement may still occur. If the local groundwater is already contaminated, increases in infiltrating water can speed up the movement of that water, moving it towards other areas needing protection. A more serious issue is usually associated with infiltrating stormwater that is contaminated and the effects that water may have on underlying better quality waters.

The potential for infiltrating stormwaters to contaminate groundwaters is dependent on the concentrations of the contaminants in the infiltrating stormwater and how effective those contaminants may travel thru the soils and vadose zone to the groundwater. Source stormwaters from residential areas are not likely to be contaminated with compounds having significant groundwater contaminating potential (with the exception of high salinity snowmelt waters). In contrast, commercial and industrial areas are likely to have greater concentrations of contaminants of concern that may affect the groundwater adversely. Therefore, pretreatment of the stormwater before infiltration may be necessary, or treatment media can be used in a biofilter, or as a soil amendment, to hinder the migration of the stormwater contaminants of concern to the groundwater. Again, these concerns are usually more of a problem in industrial and commercial areas than in residential areas.

Pitt, *et al.* (Pitt, R., S.E. Clark, and R. Field. "Groundwater contamination potential from infiltration of urban stormwater runoff." ASCE/EWRI Technical Committee Report Effects of Urbanization on Groundwater: An Engineering Case-Based Approach for Sustainable Development. Edited by: Ni-Bin Chang. ASCE Press, Reston, VA. 400 pages. ISBN: 978-0-7844-1078-3. 2010) summarized prior research on potential groundwater contamination. The following table can be used for initial estimates of contamination potential of stormwater affecting groundwaters. This table includes likely worst case mobility conditions using sandy soils having low organic content. If the soil was clayey and/or had a high organic content, then most of the organic compounds would be less mobile than shown. The abundance and filterable fraction information is generally applicable for warm weather stormwater runoff at residential and commercial area outfalls. The concentrations and detection frequencies would likely be greater for critical source areas (especially vehicle service areas) and critical land uses (especially manufacturing industrial areas), with greater groundwater contamination potential.

Groundwater Contamination Potential for Stormwater Pollutants Post-Treatment.

Compound Class	Compounds	Surface Infiltration and No Pretreatment*	Surface Infiltration with Sedimentation*	Subsurface Injection with Minimal Pretreatment
Nutrients	Nitrates	Low/moderate	Low/moderate	Low/moderate
Pesticides	2,4-D	Low	Low	Low
	γ-BHC (lindane)	Moderate	Low	Moderate
	Atrazine	Low	Low	Low
	Chlordane	Moderate	Low	Moderate
	Diazinon	Low	Low	Low
Other organics	VOCs	Low	Low	Low
	1,3-dichlorobenzene	Low	Low	**High**
	Benzo(a) anthracene	Moderate	Low	Moderate
	Bis (2-ethyl-hexyl) phthalate	Moderate	Low?	Moderate
	Fluoranthene	Moderate	Moderate	**High**
	Naphthalene	Low	Low	Low
	Phenanthrene	Moderate	Low	Moderate
	Pyrene	Moderate	Moderate	**High**
Pathogens	Enteroviruses	**High**	**High**	**High**
	Shigella	Low/moderate	Low/moderate	**High**
	P. aeruginosa	Low/moderate	Low/moderate	**High**
	Protozoa	Low	Low	**High**
Heavy metals	Cadmium	Low	Low	Low
	Chromium	Low/moderate	Low	Moderate
	Lead	Low	Low	Moderate
	Zinc	Low	Low	**High**
Salts	Chloride	**High**	**High**	**High**

NOTE: Overall contamination potential (the combination of the subfactors of mobility, abundance, and filterable fraction) is the critical influencing factor in determining whether to use infiltration at a site. The ranking of these three subfactors in assessing contamination potential depends of the type of treatment planned, if any, prior to infiltration.

* Even for those compounds with low contamination potential from surface infiltration, the depth to the groundwater must be considered if it is shallow (1 m or less in a sandy soil). Infiltration may be appropriate in an area with a shallow groundwater table if maintenance is sufficiently frequent to replace contaminated vadose zone soils.

Modified from Pitt, *et al.* 1994

Therefore, groundwater contamination potential of infiltrating stormwater can be reduced by:

1) careful placement of the infiltrating devices and selection of the source waters. Most residential stormwater is not highly contaminated with the problematic contaminants, except for chlorides associated with snowmelt.

2) commercial and industrial area stormwater would likely need pretreatment of reduce the potential of groundwater contamination associated with stormwater. The use of specialized media in the biofilter, or external pre-treatment may be needed in these other areas.

Retrofitting and Availability of Land

Most of the control options examined in this report are intended for retrofitting in existing urban areas. Therefore, their increased costs and availability of land will be detrimental in developing highly effective control programs. The selection and construction of stormwater controls at the time of development is usually much more cost effective and can provide a higher level of control. However, many controls can be retro-fitted into existing areas. Practices that can usually be easily retrofitted get the most attention in stormwater management program in existing areas. Of the control options considered in this report, the stormwater controls ability to be retrofitted and the land requirements are as follows:

Controls	Ability to Retrofit	Land Requirements
Roof Runoff Controls		
Rain Gardens	Easy in areas having landscaping	Part of landscaping area
Disconnections	Only suitable if adjacent pervious area is adequate (mild slope and long travel path)	Part of landscaping area
Rain Barrels and Water Tanks	Easy, located close to building, or underground large tanks	Supplements landscaping irrigation, no land requirements
Pavement Controls		
Disconnections	Only suitable if adjacent pervious area is adequate (mild slope and long travel path)	Most large paved areas are not adjacent to suitable large turf areas, except for schools; no additional land requirements, but land is needed.
Biofiltration	Easy if can rebuild parking lot islands as bioinfiltration areas; perimeter areas also possible (especially good if existing stormwater drainage system can be used to easily collect overflows)	Part of landscaped islands in parking areas, or along parking area perimeters
Porous Pavement	Very difficult as a retrofit, as must replace complete pavement system; possible if during re-building effort	Uses parking area
Street Side Drainage Controls		
Grass Swales	Very difficult to retrofit. Suitable if existing swales are to be rebuilt.	Part of street right-of-way
Curb-cut Biofilters	Difficult to retrofit, but much easier than simple swales. Usually build to work with existing drainage system. Can do extensions into parking lanes/shoulders to increase areas.	Part of street right-of-way, but can be major nuisance during construction and may consume street side parking. Can be used to rebuild street edge and improve aesthetics.

Public Works Practices		
Street Cleaning	Very easy, but most effective in areas having smooth streets. If in areas of extensive parking, parking restrictions on days of street cleaning may be needed.	None
Catchbasin Cleaning	Very easy, but requires sumps in catchbasin inlets and hooded outlets for most effective performance. Existing inlets can be replaced with suitable catchbasins	None
Outfall Controls		
Wet Detention Ponds	Usually difficult as land not usually readily available. Can retrofit existing dry detention pond.	Land needed at outfall location, or retrofit existing stormwater control located at outfall location.

The range of difficulties and land requirements varies, mostly depending on available opportunities. In some communities, extensive retro-fitting is occurring including installation of curb-cut biofilters. These can also be installed during scheduled repaving and sidewalk repairs that usually occur in many areas every few decades. Rain gardens are usually installed by the home owners with no cost to the city. Many areas have organized efforts encouraging these, for example. The public works practices usually get the most attention, especially street cleaning, as it can be used with no change to the land. Redevelopment and new construction periods are the most suitable times for installation for many of these controls in order to have the least interferences with current residents and for the least costs.

Maintenance Issues and Costs

As noted, these stormwater controls have varied attributes as far as ease of retrofitting and land requirements. In addition, they also vary in their maintenance requirements and costs. The WinSLAMM modeling conducted for this report includes these considerations. The public works practices (street and catchbasin cleaning) are basically maintenance operations by themselves, while other practices are intended to go for extended periods with minimal maintenance. Practices like porous pavement require frequent maintenance to preserve their function and if clogged, would be extremely difficult to repair. Sizing of many practices are to minimize maintenance issues, usually by particulate clogging. The model in many cases predicts decreasing performance when maintenance is delayed. The cost calculations also consider the costs of maintenance, in addition to land, capital, and interest costs.

The cost data from several comprehensive reports were reviewed and were transformed into equations and utilized to develop the cost module in WinSLAMM. A supplemental Excel spreadsheet model was also developed to estimate the costs of conventional stormwater drainage systems based on the published unit cost data. The cost information available from published literature sources and other references were in the form of tables and equations. The cost information gathered provided regional cost estimates for the control practices for a specific year. Cost indices published by the *Engineering News Record* were used to estimate the present costs from historical cost information and at locations where cost information is unavailable. These cost indices, from 1978 to 2005, were incorporated into WinSLAMM and the spreadsheet model.

The total cost includes capital (construction and land) and annual operation and maintenance costs. Capital costs occur when the stormwater control component is installed, unless retrofits or up-sizing occurs at a later time. Capital costs also include added financing costs that are amortized over the life of the project. The operation and maintenance costs occur periodically throughout the life of the stormwater control device or practice. Capital cost consists primarily of land cost, construction cost, and related site work. Capital costs include all land, labor, equipment and materials costs, excavation and grading, control structure, erosion control, landscaping, and appurtenances. It also includes expenditures for professional/technical services that are necessary to support the construction of the stormwater control device. Capital costs depend on site conditions, size of drainage area and land costs that vary greatly from site to site.

Land costs are site specific and also depend on the surrounding land use. The land requirements vary depending on type of stormwater control, as shown in the following table. These values are the approximate areas needed for each of the listed controls, in relation to the impervious area in the watershed. As an example, wet detention ponds (retention ponds) are normally sized to be about 2 to 3% of the total impervious area in the watershed, while grass filter strips need to be about the same size as the total impervious areas draining towards them.

Relative Land Consumption of Stormwater Controls (US EPA, 1999)

Stormwater Control Type	Land Consumption (% of Impervious Area of the Watershed)
Retention Basin	2 to 3%
Constructed Wetland	3 to 5%
Infiltration Trench	2 to 3%
Infiltration Basin	2 to 3%
Permeable Pavement	0%
Sand Filters	0 to 3%
Bioretention	5%
Swales	10 to 20%
Filter Strips	100%

The costs for the different control practices are calculated by WinSLAMM for Lincoln, NE, conditions. 2005 costs were used for adjustments of the unit cost factors from the various references. Many of these costs are more suited for new controls and may not be applicable for retrofitted controls. In general, the calculated costs (mostly shown as the costs to remove a unit of a contaminant) should be generally accurate for comparative purposes, although many site conditions may affect the actual costs.

Appendix: Detailed Modeling Results for all Constituents

Commercial: Strip Mall; Clay Loam Soil

File Number	Lincoln, NE, Strip Mall Commercial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	25,715,040	0.64	657,517	410	2,051,392	1,278	220	0.14	817	0.51	8,984	5.6
2	Biofilt parking 10 perct	18,362,660	0.46	234,194	204	1,627,691	1,421	174	0.15	496	0.43	6,865	6.0
3	Biofilt parking 25 perct	15,556,520	0.39	169,998	175	1,465,979	1,510	156	0.16	437	0.45	6,056	6.2
4	Biofilt parking 3 perct	22,209,260	0.55	409,618	295	1,849,361	1,334	198	0.14	634	0.46	7,974	5.8
5	Catchbasin cleaning	25,715,040	0.64	555,138	346	2,051,392	1,278	220	0.14	725	0.45	8,984	5.6
6	Curb biofilters 20	23,310,240	0.58	521,228	358	1,862,753	1,281	202	0.14	847	0.58	8,154	5.6
7	Curb biofilters 40	21,424,610	0.53	439,061	328	1,712,607	1,281	188	0.14	731	0.55	7,494	5.6
8	Curb biofilters 80	18,206,070	0.45	321,460	283	1,455,657	1,281	163	0.14	560	0.49	6,365	5.6
9	Disconnected	23,649,620	0.59	559,279	379	1,905,861	1,291	206	0.14	716	0.49	8,290	5.6
10	Disconnected, half	24,670,020	0.61	608,196	395	1,977,436	1,285	213	0.14	766	0.50	8,634	5.6
11	Wet pond 0.85 perct	25,715,040	0.64	232,027	145	2,051,392	1,278	220	0.14	432	0.27	8,984	5.6
12	Wet pond 1.7 perct	25,715,040	0.64	133,532	83	2,051,392	1,278	220	0.14	342	0.21	8,984	5.6
13	Wet pond 3.4 perct	25,715,040	0.64	55,373	34	2,051,392	1,278	220	0.14	270	0.17	8,984	5.6
14	Porous pvt parking half	19,242,180	0.48	390,400	325	1,678,375	1,398	179	0.15	603	0.50	7,118	5.9
15	Rain barrels few	24,557,140	0.61	640,066	418	1,939,279	1,266	212	0.14	765	0.50	8,474	5.5
16	Rain barrels many	23,215,980	0.58	623,841	430	1,809,419	1,249	204	0.14	715	0.49	7,882	5.4
17	Rain barrels	24,078,370	0.60	633,736	422	1,892,921	1,260	210	0.14	746	0.50	8,262	5.5
18	Rain tanks large	20,685,650	0.52	598,399	463	1,564,420	1,212	188	0.15	635	0.49	6,766	5.2
19	Rain tanks small	22,380,830	0.56	615,140	440	1,728,556	1,238	199	0.14	688	0.49	7,513	5.4
20	Rain tanks	21,569,110	0.54	606,853	451	1,649,961	1,226	194	0.14	662	0.49	7,155	5.3
21	Roof rain garden 15 perct	19,963,830	0.50	588,233	472	1,494,531	1,200	184	0.15	605	0.49	6,447	5.2
22	Roof rain garden 3 perct	23,913,860	0.60	630,555	422	1,876,992	1,258	208	0.14	737	0.49	8,190	5.5
23	Small pnd and biofilt parking 10 perct	18,362,660	0.46	82,359	72	1,627,691	1,421	174	0.15	280	0.24	6,865	6.0
24	Small pnd and curb biofilters 40	21,424,610	0.53	171,919	129	1,712,607	1,281	188	0.14	401	0.30	7,494	5.6
25	Small pnd and park biofilt 10 perc and curb biofilters 40	14,717,520	0.37	61,204	67	1,285,098	1,399	145	0.16	230	0.25	5,444	5.9
26	Small pnd and rain tanks	21,569,110	0.54	198,702	148	1,649,961	1,226	194	0.14	353	0.26	7,155	5.3
27	Small pond and swale	22,759,870	0.57	177,847	125	1,818,051	1,280	197	0.14	360	0.25	7,959	5.6
28	Street cleaning, daily	25,715,040	0.64	641,673	400	2,051,392	1,278	220	0.14	805	0.50	8,984	5.6
29	Swales	22,760,030	0.57	499,026	351	1,818,064	1,280	197	0.14	652	0.46	7,959	5.6

File Number	Lincoln, NE, Strip Mall Commercial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	838	0.52	2,836	1.8	32,657	20	151,034	94	103	64	500	312
2	Biofilt parking 10 perct	673	0.59	1,683	1.5	25,481	22	82,205	72	70	61	218	190
3	Biofilt parking 25 perct	610	0.63	1,470	1.5	22,743	23	70,117	72	58	60	167	172
4	Biofilt parking 3 perct	759	0.55	2,179	1.6	29,235	21	111,508	80	88	63	338	244
5	Catchbasin cleaning	838	0.52	2,529	1.6	32,657	20	132,708	83	103	64	438	273
6	Curb biofilters 20	762	0.52	2,788	1.9	29,604	20	143,745	99	93	64	424	292
7	Curb biofilters 40	701	0.52	2,412	1.8	27,190	20	123,260	92	86	64	364	272
8	Curb biofilters 80	596	0.53	1,854	1.6	23,069	20	93,285	82	73	64	276	243
9	Disconnected	774	0.52	2,486	1.7	30,318	21	130,847	89	95	64	433	293
10	Disconnected, half	806	0.52	2,660	1.7	31,482	20	140,906	92	99	64	466	303
11	Wet pond 0.85 perct	838	0.52	1,554	1.0	32,657	20	74,493	46	103	64	243	151
12	Wet pond 1.7 perct	838	0.52	1,253	0.8	32,657	20	56,771	35	103	64	183	114
13	Wet pond 3.4 perct	838	0.52	1,010	0.6	32,657	20	42,662	27	103	64	136	85
14	Porous pvt parking half	693	0.58	2,067	1.7	26,340	22	105,814	88	74	62	314	261
15	Rain barrels few	781	0.51	2,659	1.7	30,930	20	141,762	93	99	65	484	316
16	Rain barrels many	715	0.49	2,482	1.7	28,930	20	132,747	92	95	66	469	324
17	Rain barrels	757	0.50	2,592	1.7	30,216	20	138,311	92	98	65	479	319
18	Rain tanks large	590	0.46	2,183	1.7	25,156	19	117,973	91	87	67	444	344
19	Rain tanks small	674	0.48	2,381	1.7	27,684	20	127,739	91	92	66	461	330
20	Rain tanks	634	0.47	2,285	1.7	26,474	20	122,946	91	90	67	452	336
21	Roof rain garden 15 perct	555	0.45	2,078	1.7	24,079	19	112,501	90	84	68	435	349
22	Roof rain garden 3 perct	749	0.50	2,562	1.7	29,970	20	136,690	92	97	65	476	319
23	Small pnd and biofilt parking 10 perct	673	0.59	1,015	0.9	25,481	22	44,339	39	70	61	121	106
24	Small pnd and curb biofilters 40	701	0.52	1,376	1.0	27,190	20	64,707	48	86	64	195	146
25	Small pnd and park biofilt 10 perc and curb biofilters 40	532	0.58	801	0.9	20,072	22	34,551	38	57	62	96	105
26	Small pnd and rain tanks	634	0.47	1,195	0.9	26,474	20	58,826	44	90	67	208	155
27	Small pond and swale	744	0.52	1,294	0.9	28,905	20	60,986	43	91	64	198	140
28	Street cleaning, daily	838	0.52	2,796	1.7	32,657	20	149,664	93	103	64	488	304
29	Swales	744	0.52	2,269	1.6	28,906	20	119,018	84	91	64	392	276

File Number	Lincoln, NE, Strip Mall Commercial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.62	0.38	36	22	115	72	1,022	637	1.88E+14	25,886	1.70E+14	23,392
2	Biofilt parking 10 perct	0.50	0.43	16	14	85	74	514	449	1.14E+14	22,029	1.02E+14	19,689
3	Biofilt parking 25 perct	0.45	0.47	12	13	74	76	431	444	8.63E+13	19,596	7.64E+13	17,353
4	Biofilt parking 3 perct	0.56	0.40	24	17	101	73	728	525	1.53E+14	24,366	1.38E+14	21,932
5	Catchbasin cleaning	0.62	0.38	30	19	115	72	881	549	1.88E+14	25,886	1.70E+14	23,392
6	Curb biofilters 20	0.56	0.39	32	22	104	72	997	685	1.70E+14	25,773	1.54E+14	23,284
7	Curb biofilters 40	0.52	0.39	27	20	96	72	846	633	1.56E+14	25,767	1.41E+14	23,278
8	Curb biofilters 80	0.44	0.39	20	17	82	72	629	554	1.33E+14	25,782	1.20E+14	23,293
9	Disconnected	0.57	0.38	31	21	105	71	877	594	1.72E+14	25,772	1.56E+14	23,290
10	Disconnected, half	0.59	0.38	33	22	110	71	949	617	1.80E+14	25,745	1.62E+14	23,263
11	Wet pond 0.85 perct	0.62	0.38	13	8	115	72	435	271	1.88E+14	25,886	1.70E+14	23,392
12	Wet pond 1.7 perct	0.62	0.38	8	5	115	72	299	186	1.88E+14	25,886	1.70E+14	23,392
13	Wet pond 3.4 perct	0.62	0.38	4	2	115	72	191	119	1.88E+14	25,886	1.70E+14	23,392
14	Porous pvt parking half	0.51	0.43	23	19	89	74	694	578	1.23E+14	22,646	1.10E+14	20,281
15	Rain barrels few	0.57	0.37	34	22	107	70	961	627	1.87E+14	26,967	1.70E+14	24,431
16	Rain barrels many	0.51	0.35	32	22	98	68	902	623	1.86E+14	28,354	1.69E+14	25,763
17	Rain barrels	0.55	0.37	34	22	104	69	938	624	1.87E+14	27,445	1.70E+14	24,889
18	Rain tanks large	0.41	0.32	30	23	81	63	807	625	1.84E+14	31,461	1.68E+14	28,749
19	Rain tanks small	0.48	0.34	32	23	92	66	870	623	1.86E+14	29,302	1.69E+14	26,674
20	Rain tanks	0.45	0.33	31	23	87	65	839	623	1.85E+14	30,293	1.69E+14	27,627
21	Roof rain garden 15 perct	0.38	0.31	29	23	76	61	771	619	1.84E+14	32,491	1.68E+14	29,739
22	Roof rain garden 3 perct	0.54	0.36	33	22	103	69	927	621	1.87E+14	27,613	1.70E+14	25,051
23	Small pnd and biofilt parking 10 perct	0.50	0.43	6	5	85	74	227	198	1.14E+14	22,029	1.02E+14	19,689
24	Small pnd and curb biofilters 40	0.52	0.39	11	8	96	72	388	290	1.56E+14	25,767	1.41E+14	23,278
25	Small pnd and park biofilt 10 perc and curb biofilters 40	0.39	0.43	4	5	68	74	181	197	9.40E+13	22,565	8.42E+13	20,205
26	Small pnd and rain tanks	0.45	0.33	10	8	87	65	337	251	1.85E+14	30,293	1.69E+14	27,627
27	Small pond and swale	0.55	0.39	10	7	102	72	347	244	1.66E+14	25,805	1.50E+14	23,314
28	Street cleaning, daily	0.62	0.38	36	22	115	72	1,002	624	1.88E+14	25,886	1.70E+14	23,392
29	Swales	0.55	0.39	27	19	102	72	792	557	1.66E+14	25,805	1.50E+14	23,314

Commercial: Strip Mall; Sandy Loam Soil

File Number	Lincoln, NE, Strip Mall Commercial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	25,715,040	0.64	657,517	410	2,051,392	1,278	220	0.14	817	0.51	8,984	5.6
2	Biofilt parking 10 perct sandy loam	13,577,900	0.34	140,990	166	1,351,956	1,596	144	0.17	406	0.48	5,485	6.5
3	Biofilt parking 3 perct sandy loam	17,460,290	0.44	276,196	253	1,575,689	1,446	168	0.15	518	0.48	6,605	6.1
4	Catchbasin cleaning	25,715,040	0.64	555,138	346	2,051,392	1,278	220	0.14	725	0.45	8,984	5.6
5	Curb-cut biofilters 20	18,876,200	0.47	432,947	367	1,509,618	1,282	168	0.14	705	0.60	6,602	5.6
6	Curb-cut biofilters 40	14,471,610	0.36	315,949	350	1,157,475	1,282	133	0.15	524	0.58	5,057	5.6
7	Curb-cut biofilters 80	8,576,582	0.21	173,125	323	685,954	1,282	83	0.15	296	0.55	2,992	5.6
8	Disconnected impervious areas	23,649,620	0.59	559,279	379	1,905,861	1,291	206	0.14	716	0.49	8,290	5.6
9	Disconnected impervious areas (half)	24,670,020	0.61	608,196	395	1,977,436	1,285	213	0.14	766	0.50	8,634	5.6
10	Wet pond 0.85 perct	25,715,040	0.64	232,027	145	2,051,392	1,278	220	0.14	432	0.27	8,984	5.6
11	Wet pond 1.7 perct	25,715,040	0.64	133,532	83	2,051,392	1,278	220	0.14	342	0.21	8,984	5.6
12	Wet pond 3.4 perct	25,715,040	0.64	55,373	34	2,051,392	1,278	220	0.14	270	0.17	8,984	5.6
13	Porous pvt parking half	19,242,180	0.48	390,400	325	1,678,375	1,398	179	0.15	603	0.50	7,118	5.9
14	Rain barrels few	24,557,140	0.61	640,066	418	1,939,279	1,266	212	0.14	765	0.50	8,474	5.5
15	Rain barrels many	23,215,980	0.58	623,841	430	1,809,419	1,249	204	0.14	715	0.49	7,882	5.4
16	Rain barrels	24,078,370	0.60	633,736	422	1,892,921	1,260	210	0.14	746	0.50	8,262	5.5
17	Rain tanks large	20,685,650	0.52	598,399	463	1,564,420	1,212	188	0.15	635	0.49	6,766	5.2
18	Rain tanks small	22,380,830	0.56	615,140	440	1,728,556	1,238	199	0.14	688	0.49	7,513	5.4
19	Rain tanks	21,569,110	0.54	606,853	451	1,649,961	1,226	194	0.14	662	0.49	7,155	5.3
20	Roof rain garden 15 perct	18,447,480	0.46	574,067	498	1,347,711	1,171	174	0.15	559	0.49	5,778	5.0
21	Roof rain garden 3 perct	21,858,650	0.54	607,859	445	1,677,996	1,230	196	0.14	666	0.49	7,283	5.3
22	Small wet pond and biofilt parking 10 perct	13,577,900	0.34	40,267	48	1,351,956	1,596	144	0.17	215	0.25	5,485	6.5

23	Small wet pond and curb biofilters 40 perct	14,471,610	0.36	118,577	131	1,157,475	1,282	133	0.15	279	0.31	5,057	5.6
24	Small wet pond and park biofilt 10 perc and curb biofilters 40 perct	5,045,390	0.13	16,025	51	491,887	1,562	62	0.20	88	0.28	2,000	6.4
25	Small wet pond and rain tanks	21,569,110	0.54	198,702	148	1,649,961	1,226	194	0.14	353	0.26	7,155	5.3
26	Small wet pond and swale	9,433,202	0.24	61,638	105	754,539	1,282	86	0.15	143	0.24	3,297	5.6
27	Street cleaning daily	25,715,040	0.64	641,673	400	2,051,392	1,278	220	0.14	805	0.50	8,984	5.6
28	Grass swales	9,433,202	0.24	195,608	332	754,539	1,282	86	0.15	265	0.45	3,297	5.6

File Number	Lincoln, NE, Strip Mall Commercial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	838	0.52	2,836	1.8	32,657	20	151,034	94	103	64	500	312
2	Biofilt parking 10 perct sandy loam	566	0.67	1,358	1.6	20,812	25	63,961	75	49	58	141	167
3	Biofilt parking 3 perct sandy loam	653	0.60	1,761	1.6	24,600	23	87,442	80	66	61	238	219
4	Catchbasin cleaning	838	0.52	2,529	1.6	32,657	20	132,708	83	103	64	438	273
5	Curb-cut biofilters 20	619	0.53	2,309	2.0	23,936	20	118,848	101	76	64	350	297
6	Curb-cut biofilters 40	475	0.53	1,712	1.9	18,307	20	87,377	97	58	64	258	286
7	Curb-cut biofilters 80	282	0.53	964	1.8	10,801	20	48,509	91	34	64	144	268
8	Disconnected impervious areas	774	0.52	2,486	1.7	30,318	21	130,847	89	95	64	433	293
9	Disconnected impervious areas (half)	806	0.52	2,660	1.7	31,482	20	140,906	92	99	64	466	303
10	Wet pond 0.85 perct	838	0.52	1,554	1.0	32,657	20	74,493	46	103	64	243	151
11	Wet pond 1.7 perct	838	0.52	1,253	0.8	32,657	20	56,771	35	103	64	183	114
12	Wet pond 3.4 perct	838	0.52	1,010	0.6	32,657	20	42,662	27	103	64	136	85
13	Porous pvt parking half	693	0.58	2,067	1.7	26,340	22	105,814	88	74	62	314	261
14	Rain barrels few	781	0.51	2,659	1.7	30,930	20	141,762	93	99	65	484	316
15	Rain barrels many	715	0.49	2,482	1.7	28,930	20	132,747	92	95	66	469	324
16	Rain barrels	757	0.50	2,592	1.7	30,216	20	138,311	92	98	65	479	319
17	Rain tanks large	590	0.46	2,183	1.7	25,156	19	117,973	91	87	67	444	344
18	Rain tanks small	674	0.48	2,381	1.7	27,684	20	127,739	91	92	66	461	330
19	Rain tanks	634	0.47	2,285	1.7	26,474	20	122,946	91	90	67	452	336
20	Roof rain garden 15 perct	480	0.42	1,906	1.7	21,818	19	104,114	90	80	69	420	365
21	Roof rain garden 3 perct	648	0.48	2,306	1.7	26,905	20	123,812	91	91	66	454	333
22	Small wet pond and biofilt parking 10 perct	566	0.67	787	0.9	20,812	25	32,519	38	49	58	75	88

23	Small wet pond and curb biofilters 40 perct	475	0.53	942	1.0	18,307	20	44,150	49	58	64	133	147
24	Small wet pond and park biofilt 10 perc and curb biofilters 40 perct	207	0.66	288	0.9	7,474	24	11,684	37	18	59	29	92
25	Small wet pond and rain tanks	634	0.47	1,195	0.9	26,474	20	58,826	44	90	67	208	155
26	Small wet pond and swale	309	0.53	503	0.9	11,937	20	23,045	39	38	64	75	127
27	Street cleaning daily	838	0.52	2,796	1.7	32,657	20	149,664	93	103	64	488	304
28	Grass swales	309	0.53	913	1.6	11,937	20	47,182	80	38	64	156	264

File Number	Lincoln, NE, Strip Mall Commercial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.62	0.38	36	22	115	72	1,022	637	1.9E+14	25,886	1.7E+14	23,392
2	Biofilt parking 10 perct sandy loam	0.42	0.50	11	13	66	78	390	460	6.6E+13	17,275	5.8E+13	15,125
3	Biofilt parking 3 perct sandy loam	0.48	0.44	18	16	82	75	558	512	1.1E+14	21,332	9.4E+13	19,020
4	Catchbasin cleaning	0.62	0.38	30	19	115	72	881	549	1.9E+14	25,886	1.7E+14	23,392
5	Curb-cut biofilters 20	0.45	0.39	26	22	85	72	826	701	1.4E+14	25,755	1.2E+14	23,267
6	Curb-cut biofilters 40	0.35	0.39	19	21	65	72	603	668	1.1E+14	25,800	9.6E+13	23,311
7	Curb-cut biofilters 80	0.21	0.38	10	20	38	72	332	620	6.3E+13	25,864	5.7E+13	23,373
8	Disconnected impervious areas	0.57	0.38	31	21	105	71	877	594	1.7E+14	25,772	1.6E+14	23,290
9	Disconnected impervious areas (half)	0.59	0.38	33	22	110	71	949	617	1.8E+14	25,745	1.6E+14	23,263
10	Wet pond 0.85 perct	0.62	0.38	13	8	115	72	435	271	1.9E+14	25,886	1.7E+14	23,392
11	Wet pond 1.7 perct	0.62	0.38	8	5	115	72	299	186	1.9E+14	25,886	1.7E+14	23,392
12	Wet pond 3.4 perct	0.62	0.38	4	2	115	72	191	119	1.9E+14	25,886	1.7E+14	23,392
13	Porous pvt parking half	0.51	0.43	23	19	89	74	694	578	1.2E+14	22,646	1.1E+14	20,281
14	Rain barrels few	0.57	0.37	34	22	107	70	961	627	1.9E+14	26,967	1.7E+14	24,431
15	Rain barrels many	0.51	0.35	32	22	98	68	902	623	1.9E+14	28,354	1.7E+14	25,763
16	Rain barrels	0.55	0.37	34	22	104	69	938	624	1.9E+14	27,445	1.7E+14	24,889
17	Rain tanks large	0.41	0.32	30	23	81	63	807	625	1.8E+14	31,461	1.7E+14	28,749
18	Rain tanks small	0.48	0.34	32	23	92	66	870	623	1.9E+14	29,302	1.7E+14	26,674
19	Rain tanks	0.45	0.33	31	23	87	65	839	623	1.9E+14	30,293	1.7E+14	27,627
20	Roof rain garden 15 perct	0.32	0.28	27	24	66	57	717	623	1.8E+14	34,919	1.7E+14	32,072
21	Roof rain garden 3 perct	0.46	0.34	31	23	89	65	844	619	1.9E+14	29,931	1.7E+14	27,279
22	Small wet pond and biofilt parking 10 perct	0.42	0.50	3	4	66	78	153	181	6.6E+13	17,275	5.8E+13	15,125
23	Small wet pond and curb biofilters 40 perct	0.35	0.39	7	8	65	72	266	294	1.1E+14	25,800	9.6E+13	23,311

24	Small wet pond and park biofilt 10 perc and curb biofilters 40 perct	0.15	0.48	1	4	24	77	57	181	2.6E+13	18,299	2.3E+13	16,114
25	Small wet pond and rain tanks	0.45	0.33	10	8	87	65	337	251	1.9E+14	30,293	1.7E+14	27,627
26	Small wet pond and swale	0.23	0.39	4	6	42	72	127	216	6.9E+13	25,787	6.2E+13	23,299
27	Street cleaning daily	0.62	0.38	36	22	115	72	1,002	624	1.9E+14	25,886	1.7E+14	23,392
28	Grass swales	0.23	0.39	11	18	42	72	312	529	6.9E+13	25,787	6.2E+13	23,299

Commercial: Shopping Center; Clay Loam Soil

File Number	Lincoln, NE, Shopping Center Commercial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	26,272,990	0.65	679,973	415	2,074,474	1,265	212	0.13	835	0.51	9,196	5.6
2	Biofilt parking 10 perct	18,598,950	0.46	238,127	205	1,632,237	1,406	164	0.14	501	0.43	6,984	6.0
3	Biofilt parking 25 perct	15,669,760	0.39	171,117	175	1,463,434	1,497	146	0.15	439	0.45	6,139	6.3
4	Bbiofilt parking 3 perct	22,613,640	0.56	421,218	298	1,863,594	1,321	189	0.13	645	0.46	8,141	5.8
5	Catchbasin cleaning	26,272,990	0.65	574,874	350	2,074,474	1,265	212	0.13	740	0.45	9,196	5.6
6	Curb-cut biofilters 20	24,287,320	0.60	562,356	371	1,920,773	1,267	198	0.13	909	0.60	8,512	5.6
7	Curb-cut biofilters 40	22,685,360	0.57	487,012	344	1,794,610	1,268	187	0.13	802	0.57	7,950	5.6
8	Curb-cut biofilters 80	19,954,180	0.50	380,141	305	1,578,738	1,268	167	0.13	647	0.52	6,991	5.6
9	Disconnected impervious areas	24,106,280	0.60	577,093	383	1,921,608	1,277	198	0.13	730	0.49	8,464	5.6
10	Disconnected impervious areas (half)	25,177,090	0.63	628,003	400	1,997,107	1,271	205	0.13	782	0.50	8,826	5.6
11	Wet pond 0.85 perct	26,272,990	0.65	242,585	148	2,074,474	1,265	212	0.13	436	0.27	9,196	5.6
12	Wet pond 1.7 perct	26,272,990	0.65	142,681	87	2,074,474	1,265	212	0.13	344	0.21	9,196	5.6
13	Wet pond 3.4 perct	26,272,990	0.65	58,980	36	2,074,474	1,265	212	0.13	267	0.16	9,196	5.6
14	Porous pvt parking half	19,516,820	0.49	401,167	329	1,685,131	1,384	170	0.14	612	0.50	7,248	6.0
15	Rain barrels few	25,133,080	0.63	662,604	422	1,964,103	1,252	205	0.13	784	0.50	8,693	5.5
16	Rain barrels many	23,941,660	0.60	647,928	434	1,848,745	1,237	198	0.13	739	0.49	8,168	5.5
17	Rain barrels	24,696,950	0.62	656,762	426	1,921,875	1,247	202	0.13	767	0.50	8,501	5.5
18	Rain tanks large	21,819,200	0.54	626,095	460	1,643,237	1,207	184	0.14	671	0.49	7,231	5.3
19	Rain tanks small	23,230,320	0.58	640,181	441	1,779,869	1,228	193	0.13	715	0.49	7,854	5.4
20	Rain tanks	22,805,620	0.57	635,706	447	1,738,748	1,222	191	0.13	701	0.49	7,666	5.4
21	Rain garden 15 perct	20,048,620	0.50	604,964	483	1,471,802	1,176	173	0.14	606	0.48	6,450	5.2
22	Roof rain garden 3 perct	24,326,380	0.61	650,821	429	1,885,994	1,242	200	0.13	749	0.49	8,337	5.5
23	Small wet pond and biofilt parking 10 perct	18,598,950	0.46	84,582	73	1,632,237	1,406	164	0.14	275	0.24	6,984	6.0

24	Small wet pond and curb biofilters 40	22,685,360	0.57	190,986	135	1,794,610	1,268	187	0.13	428	0.30	7,950	5.6
25	Small wet pond and parking biofilt 10 perc and curb biofilters 40	15,592,130	0.39	67,021	69	1,350,639	1,388	141	0.15	237	0.24	5,801	6.0
26	Small wet pond and rain tanks	22,805,620	0.57	215,042	151	1,738,748	1,222	191	0.13	370	0.26	7,666	5.4
27	Small wet pond and swale	25,562,400	0.64	208,999	131	2,019,413	1,266	207	0.13	400	0.25	8,951	5.6
28	Street cleaning daily	26,272,990	0.65	664,554	405	2,074,474	1,265	212	0.13	824	0.50	9,196	5.6
29	Grass swale	25,562,400	0.64	578,952	363	2,019,413	1,266	207	0.13	739	0.46	8,951	5.6

File Number	Lincoln, NE, Shopping Center Commercial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	860	0.52	2,928	1.8	33,174	20	157,279	96	105	64	515	314
2	Biofilt parking 10 perct	688	0.59	1,725	1.5	25,685	22	85,438	74	71	61	221	190
3	Biofilt parking 25 perct	622	0.64	1,503	1.5	22,826	23	72,819	74	58	59	168	172
4	Bbiofilt parking 3 perct	778	0.55	2,243	1.6	29,603	21	116,022	82	89	63	347	246
5	Catchbasin cleaning	860	0.52	2,613	1.6	33,174	20	138,212	84	105	64	452	276
6	Curb-cut biofilters 20	798	0.53	3,002	2.0	30,679	20	157,499	104	97	64	454	300
7	Curb-cut biofilters 40	746	0.53	2,659	1.9	28,642	20	138,429	98	91	64	399	282
8	Curb-cut biofilters 80	656	0.53	2,153	1.7	25,167	20	110,730	89	80	64	320	257
9	Disconnected impervious areas	793	0.53	2,560	1.7	30,700	20	135,982	90	96	64	445	296
10	Disconnected impervious areas (half)	826	0.53	2,742	1.7	31,926	20	146,535	93	101	64	480	305
11	Wet pond 0.85 perct	860	0.52	1,607	1.0	33,174	20	77,515	47	105	64	251	153
12	Wet pond 1.7 perct	860	0.52	1,302	0.8	33,174	20	59,290	36	105	64	191	117
13	Wet pond 3.4 perct	860	0.52	1,043	0.6	33,174	20	43,981	27	105	64	141	86
14	Porous pvt parking half	708	0.58	2,126	1.7	26,581	22	110,079	90	75	62	321	264
15	Rain barrels few	804	0.51	2,753	1.8	31,474	20	148,069	94	102	65	500	319
16	Rain barrels many	745	0.50	2,594	1.7	29,697	20	139,946	94	98	65	486	325
17	Rain barrels	783	0.51	2,692	1.7	30,824	20	144,892	94	100	65	495	321
18	Rain tanks large	641	0.47	2,340	1.7	26,532	19	127,341	94	91	67	465	341
19	Rain tanks small	710	0.49	2,506	1.7	28,637	20	135,536	94	95	66	479	330
20	Rain tanks	689	0.48	2,454	1.7	28,003	20	132,968	93	94	66	474	333
21	Rain garden 15 perct	553	0.44	2,108	1.7	23,892	19	115,564	92	85	68	445	355
22	Roof rain garden 3 perct	764	0.50	2,633	1.7	30,271	20	141,771	93	99	65	489	322
23	Small wet pond and biofilt parking 10 perct	688	0.59	1,040	0.9	25,685	22	45,654	39	71	61	123	106
24	Small wet pond and curb biofilters 40	746	0.53	1,500	1.1	28,642	20	71,579	51	91	64	211	149

25	Small wet pond and parking biofilt 10 perc and curb biofilters 40	569	0.59	866	0.9	21,225	22	37,710	39	60	62	103	106
26	Small wet pond and rain tanks	689	0.48	1,310	0.9	28,003	20	64,507	45	94	66	223	156
27	Small wet pond and swale	838	0.53	1,482	0.9	32,284	20	70,497	44	102	64	228	143
28	Street cleaning daily	860	0.52	2,890	1.8	33,174	20	155,945	95	105	64	504	307
29	Grass swale	838	0.53	2,603	1.6	32,284	20	138,092	87	102	64	452	283

File Number	Lincoln, NE, Shopping Center Commercial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.64	0.39	38	23	120	73	1,066	651	1.9E+14	24,951	1.7E+14	22,508
2	Biofilt parking 10 perct	0.52	0.44	16	14	89	77	537	462	1.1E+14	20,590	9.7E+13	18,328
3	Biofilt parking 25 perct	0.47	0.48	13	13	77	79	449	459	7.9E+13	17,800	6.9E+13	15,653
4	Bbiofilt parking 3 perct	0.58	0.41	25	18	105	75	760	538	1.5E+14	23,241	1.3E+14	20,869
5	Catchbasin cleaning	0.64	0.39	32	19	120	73	921	562	1.9E+14	24,951	1.7E+14	22,508
6	Curb-cut biofilters 20	0.59	0.39	35	23	111	73	1,093	721	1.7E+14	24,843	1.5E+14	22,404
7	Curb-cut biofilters 40	0.55	0.39	30	21	104	73	954	674	1.6E+14	24,833	1.4E+14	22,395
8	Curb-cut biofilters 80	0.49	0.39	24	19	91	73	753	605	1.4E+14	24,845	1.3E+14	22,407
9	Disconnected impervious areas	0.59	0.39	32	21	109	73	914	607	1.7E+14	24,900	1.5E+14	22,463
10	Disconnected impervious areas (half)	0.61	0.39	35	22	115	73	989	630	1.8E+14	24,896	1.6E+14	22,459
11	Wet pond 0.85 perct	0.64	0.39	14	8	120	73	457	279	1.9E+14	24,951	1.7E+14	22,508
12	Wet pond 1.7 perct	0.64	0.39	8	5	120	73	319	194	1.9E+14	24,951	1.7E+14	22,508
13	Wet pond 3.4 perct	0.64	0.39	4	2	120	73	202	123	1.9E+14	24,951	1.7E+14	22,508
14	Porous pvt parking half	0.53	0.44	24	20	93	76	724	595	1.2E+14	21,293	1.1E+14	19,001
15	Rain barrels few	0.59	0.38	36	23	112	72	1,006	641	1.9E+14	25,949	1.7E+14	23,468
16	Rain barrels many	0.54	0.36	34	23	104	70	953	638	1.8E+14	27,093	1.7E+14	24,568
17	Rain barrels	0.57	0.37	35	23	109	71	985	639	1.8E+14	26,355	1.7E+14	23,858
18	Rain tanks large	0.46	0.34	32	23	90	66	871	640	1.8E+14	29,440	1.7E+14	26,825
19	Rain tanks small	0.51	0.35	33	23	100	69	924	637	1.8E+14	27,832	1.7E+14	25,278
20	Rain tanks	0.50	0.35	33	23	97	68	907	638	1.8E+14	28,295	1.7E+14	25,724
21	Rain garden 15 perct	0.38	0.31	30	24	78	62	795	635	1.8E+14	31,779	1.7E+14	29,074
22	Roof rain garden 3 perct	0.56	0.37	35	23	107	70	964	635	1.8E+14	26,711	1.7E+14	24,201
23	Small wet pond and biofilt parking 10 perct	0.52	0.44	6	5	89	77	238	205	1.1E+14	20,590	9.7E+13	18,328
24	Small wet pond and curb biofilters 40	0.55	0.39	12	9	104	73	436	308	1.6E+14	24,833	1.4E+14	22,395

25	Small wet pond and parking biofilt 10 perc and curb biofilters 40	0.43	0.44	5	5	74	76	201	207	9.3E+13	21,111	8.3E+13	18,827
26	Small wet pond and rain tanks	0.50	0.35	12	8	97	68	377	265	1.8E+14	28,295	1.7E+14	25,724
27	Small wet pond and swale	0.62	0.39	12	8	117	73	408	256	1.8E+14	24,919	1.6E+14	22,478
28	Street cleaning daily	0.64	0.39	37	23	120	73	1,047	639	1.9E+14	24,951	1.7E+14	22,508
29	Grass swale	0.62	0.39	32	20	117	73	924	579	1.8E+14	24,919	1.6E+14	22,478

Commercial: Shopping Center; Sandy Loam Soil

File Number	Lincoln, NE, Shopping Center Commercial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	26,272,990	0.65	679,973	415	2,074,474	1,265	212	0.13	835	0.51	9,196	5.6
2	Biofilt parking 10 perct	13,604,670	0.34	140,842	166	1,344,428	1,584	133	0.16	407	0.48	5,544	6.5
3	Biofilt parking 3 perct	17,656,840	0.44	281,960	256	1,577,945	1,432	158	0.14	524	0.48	6,712	6.1
4	Catchbasin cleaning	26,272,990	0.65	574,874	350	2,074,474	1,265	212	0.13	740	0.45	9,196	5.6
5	Curb-cut biofilters 20	20,540,230	0.51	484,373	378	1,625,616	1,268	171	0.13	785	0.61	7,199	5.6
6	Curb-cut biofilters 40	16,538,810	0.41	372,229	361	1,308,880	1,268	141	0.14	612	0.59	5,792	5.6
7	Curb-cut biofilters 80	11,037,100	0.28	233,179	338	873,166	1,268	97	0.14	391	0.57	3,860	5.6
8	Disconnected impervious areas	24,106,280	0.60	577,093	383	1,921,608	1,277	198	0.13	730	0.49	8,464	5.6
9	Disconnected impervious areas (half)	25,177,090	0.63	628,003	400	1,997,107	1,271	205	0.13	782	0.50	8,826	5.6
10	Wet pond 0.85 perct	26,272,990	0.65	242,585	148	2,074,474	1,265	212	0.13	436	0.27	9,196	5.6
11	Wet pond 1.7 perct	26,272,990	0.65	142,681	87	2,074,474	1,265	212	0.13	344	0.21	9,196	5.6
12	Wet pond 3.4 perct	26,272,990	0.65	58,980	36	2,074,474	1,265	212	0.13	267	0.16	9,196	5.6
13	Porous pvt parking half	19,516,820	0.49	401,167	329	1,685,131	1,384	170	0.14	612	0.50	7,248	6.0
14	Rain barrels few	25,133,080	0.63	662,604	422	1,964,103	1,252	205	0.13	784	0.50	8,693	5.5
15	Rain barrels many	23,941,660	0.60	647,928	434	1,848,745	1,237	198	0.13	739	0.49	8,168	5.5
16	Rain barrels	24,696,950	0.62	656,762	426	1,921,875	1,247	202	0.13	767	0.50	8,501	5.5
17	Rain tanks large	21,819,200	0.54	626,095	460	1,643,237	1,207	184	0.14	671	0.49	7,231	5.3
18	Rain tanks small	23,230,320	0.58	640,181	441	1,779,869	1,228	193	0.13	715	0.49	7,854	5.4
19	Rain tanks	22,805,620	0.57	635,706	447	1,738,748	1,222	191	0.13	701	0.49	7,666	5.4
20	Roof rain garden 15 perct	18,397,900	0.46	589,541	513	1,311,972	1,143	163	0.14	557	0.48	5,722	5.0
21	Roof rain garden 3 perct	22,102,570	0.55	626,249	454	1,670,676	1,211	186	0.13	673	0.49	7,356	5.3
22	Small wet pond and biofilt parking 10 perct	13,604,670	0.34	40,453	48	1,344,428	1,584	133	0.16	207	0.24	5,544	6.5
23	Small wet pond and curb biofilters 40	16,538,810	0.41	141,522	137	1,308,880	1,268	141	0.14	319	0.31	5,792	5.6

24	Small wet pond and parking biofilt 10 perct and curb biofilters 40	6,110,713	0.15	18,964	50	593,481	1,556	67	0.18	99	0.26	2,452	6.4
25	Small wet pond and rain tanks	22,805,620	0.57	215,042	151	1,738,748	1,222	191	0.13	370	0.26	7,666	5.4
26	Small wet pond and swale sandy loam	20,349,320	0.51	158,604	125	1,609,604	1,268	168	0.13	314	0.25	7,130	5.6
27	Street cleaning daily	26,272,990	0.65	664,554	405	2,074,474	1,265	212	0.13	824	0.50	9,196	5.6
28	Grass swale	20,349,320	0.51	445,002	350	1,609,604	1,268	168	0.13	578	0.46	7,130	5.6

File Number	Lincoln, NE, Shopping Center Commercial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	860	0.52	2,928	1.79	33,174	20	157,279	96	105	64	515	314
2	Biofilt parking 10 perct	576	0.68	1,386	1.63	20,811	25	66,395	78	49	57	141	166
3	Biofilt parking 3 perct	667	0.61	1,806	1.64	24,766	22	90,902	83	67	61	242	220
4	Catchbasin cleaning	860	0.52	2,613	1.59	33,174	20	138,212	84	105	64	452	276
5	Curb-cut biofilters 20	676	0.53	2,582	2.01	25,923	20	135,346	106	82	64	389	304
6	Curb-cut biofilters 40	544	0.53	2,012	1.95	20,835	20	104,728	101	66	64	302	292
7	Curb-cut biofilters 80	363	0.53	1,286	1.87	13,860	20	66,229	96	44	64	191	278
8	Disconnected impervious areas	793	0.53	2,560	1.70	30,700	20	135,982	90	96	64	445	296
9	Disconnected impervious areas (half)	826	0.53	2,742	1.75	31,926	20	146,535	93	101	64	480	305
10	Wet pond 0.85 perct	860	0.52	1,607	0.98	33,174	20	77,515	47	105	64	251	153
11	Wet pond 1.7 perct	860	0.52	1,302	0.79	33,174	20	59,290	36	105	64	191	117
12	Wet pond 3.4 perct	860	0.52	1,043	0.64	33,174	20	43,981	27	105	64	141	86
13	Porous pvt parking half	708	0.58	2,126	1.75	26,581	22	110,079	90	75	62	321	264
14	Rain barrels few	804	0.51	2,753	1.76	31,474	20	148,069	94	102	65	500	319
15	Rain barrels many	745	0.50	2,594	1.74	29,697	20	139,946	94	98	65	486	325
16	Rain barrels	783	0.51	2,692	1.75	30,824	20	144,892	94	100	65	495	321
17	Rain tanks large	641	0.47	2,340	1.72	26,532	19	127,341	94	91	67	465	341
18	Rain tanks small	710	0.49	2,506	1.73	28,637	20	135,536	94	95	66	479	330
19	Rain tanks	689	0.48	2,454	1.72	28,003	20	132,968	93	94	66	474	333
20	Roof rain garden 15 perct	472	0.41	1,921	1.67	21,430	19	106,433	93	80	69	429	374
21	Roof rain garden 3 perct	655	0.47	2,355	1.71	26,955	20	127,830	93	92	66	466	338
22	Small wet pond and biofilt parking 10 perct	576	0.68	801	0.94	20,811	25	33,182	39	49	57	75	88
23	Small wet pond and curb biofilters 40	544	0.53	1,105	1.07	20,835	20	52,619	51	66	64	155	151

24	Small wet pond and parking biofilt 10 perct and curb biofilters 40	255	0.67	353	0.92	9,105	24	14,370	38	22	58	35	91
25	Small wet pond and rain tanks	689	0.48	1,310	0.92	28,003	20	64,507	45	94	66	223	156
26	Small wet pond and swale sandy loam	669	0.53	1,159	0.91	25,689	20	54,686	43	81	64	177	139
27	Street cleaning daily	860	0.52	2,890	1.76	33,174	20	155,945	95	105	64	504	307
28	Grass swale	669	0.53	2,033	1.60	25,689	20	107,191	84	81	64	350	275

File Number	Lincoln, NE, Shopping Center Commercial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.64	0.39	38	23	120	73	1,066	651	1.9E+14	24,951	1.7E+14	22,508
2	Biofilt parking 10 perct	0.43	0.51	12	14	69	81	407	479	5.8E+13	15,110	5.0E+13	13,074
3	Biofilt parking 3 perct	0.50	0.45	18	17	85	77	582	529	9.9E+13	19,794	8.8E+13	17,564
4	Catchbasin cleaning	0.64	0.39	32	19	120	73	921	562	1.9E+14	24,951	1.7E+14	22,508
5	Curb-cut biofilters 20	0.50	0.39	30	24	94	73	941	734	1.4E+14	24,814	1.3E+14	22,377
6	Curb-cut biofilters 40	0.40	0.39	23	22	76	73	724	702	1.2E+14	24,856	1.1E+14	22,418
7	Curb-cut biofilters 80	0.27	0.39	14	21	50	73	455	660	7.8E+13	24,927	7.0E+13	22,487
8	Disconnected impervious areas	0.59	0.39	32	21	109	73	914	607	1.7E+14	24,900	1.5E+14	22,463
9	Disconnected impervious areas (half)	0.61	0.39	35	22	115	73	989	630	1.8E+14	24,896	1.6E+14	22,459
10	Wet pond 0.85 perct	0.64	0.39	14	8	120	73	457	279	1.9E+14	24,951	1.7E+14	22,508
11	Wet pond 1.7 perct	0.64	0.39	8	5	120	73	319	194	1.9E+14	24,951	1.7E+14	22,508
12	Wet pond 3.4 perct	0.64	0.39	4	2	120	73	202	123	1.9E+14	24,951	1.7E+14	22,508
13	Porous pvt parking half	0.53	0.44	24	20	93	76	724	595	1.2E+14	21,293	1.1E+14	19,001
14	Rain barrels few	0.59	0.38	36	23	112	72	1,006	641	1.9E+14	25,949	1.7E+14	23,468
15	Rain barrels many	0.54	0.36	34	23	104	70	953	638	1.8E+14	27,093	1.7E+14	24,568
16	Rain barrels	0.57	0.37	35	23	109	71	985	639	1.8E+14	26,355	1.7E+14	23,858
17	Rain tanks large	0.46	0.34	32	23	90	66	871	640	1.8E+14	29,440	1.7E+14	26,825
18	Rain tanks small	0.51	0.35	33	23	100	69	924	637	1.8E+14	27,832	1.7E+14	25,278
19	Rain tanks	0.50	0.35	33	23	97	68	907	638	1.8E+14	28,295	1.7E+14	25,724
20	Roof rain garden 15 perct	0.32	0.27	28	25	67	58	736	641	1.8E+14	34,364	1.6E+14	31,561
21	Roof rain garden 3 perct	0.47	0.34	32	23	92	67	874	633	1.8E+14	29,101	1.7E+14	26,499
22	Small wet pond and biofilt parking 10 perct	0.43	0.51	3	4	69	81	160	189	5.8E+13	15,110	5.0E+13	13,074
23	Small wet pond and curb biofilters 40	0.40	0.39	9	9	76	73	321	311	1.2E+14	24,856	1.1E+14	22,418
24	Small wet pond and parking biofilt 10 perct	0.19	0.50	2	4	31	81	71	186	2.8E+13	16,050	2.4E+13	13,979

	and curb biofilters 40												
25	Small wet pond and rain tanks	0.50	0.35	12	8	97	68	377	265	1.8E+14	28,295	1.7E+14	25,724
26	Small wet pond and swale sandy loam	0.50	0.39	9	7	93	73	314	247	1.4E+14	24,847	1.3E+14	22,409
27	Street cleaning daily	0.64	0.39	37	23	120	73	1,047	639	1.9E+14	24,951	1.7E+14	22,508
28	Grass swale	0.50	0.39	25	19	93	73	714	562	1.4E+14	24,847	1.3E+14	22,409

Light Industrial Land Use; Clay Loam Soil

File Number	Lincoln, NE, Light Industrial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	18,250,050	0.45	103,628	91	1,450,673	1,274	145	0.13	212	0.19	6,519	5.7
2	Roof rain garden 15 perct	16,849,650	0.42	101,618	97	1,404,325	1,336	143	0.14	208	0.20	5,829	5.5
3	Roof rain garden 3 perct	17,772,020	0.44	102,942	93	1,434,852	1,294	145	0.13	210	0.19	6,284	5.7
4	Biofilt parking 10 perct	16,914,730	0.42	93,980	89	1,316,355	1,247	142	0.13	203	0.19	6,077	5.8
5	Biofilt parking 25 perct	16,406,210	0.41	92,347	90	1,265,204	1,236	141	0.14	201	0.20	5,908	5.8
6	Biofilt parking 3 perct	17,611,110	0.44	98,215	89	1,386,402	1,262	144	0.13	207	0.19	6,308	5.7
7	Catchbasin cleaning	18,250,050	0.45	88,247	77	1,450,673	1,274	145	0.13	202	0.18	6,519	5.7
8	Roof rain garden 15 perct	16,955,050	0.42	101,769	96	1,407,813	1,331	144	0.14	208	0.20	5,881	5.6
9	Roof rain garden 3 perct	17,842,600	0.44	103,043	93	1,437,188	1,291	145	0.13	210	0.19	6,318	5.7
10	Curb-cut biofilters 20	15,557,110	0.39	73,828	76	1,234,086	1,271	124	0.13	180	0.19	5,561	5.7
11	Curb-cut biofilters 40	13,547,540	0.34	57,350	68	1,074,216	1,271	109	0.13	152	0.18	4,843	5.7
12	Curb-cut biofilters 80	10,646,330	0.27	36,916	56	843,669	1,270	86	0.13	114	0.17	3,805	5.7
13	Disconnected impervious areas	7,067,697	0.18	55,743	126	535,464	1,214	105	0.24	142	0.32	2,691	6.1
14	Disconnected impervious areas (half)	12,364,290	0.31	75,577	98	920,539	1,193	124	0.16	174	0.22	4,610	6.0
15	Wet pond 1 perct	18,250,050	0.45	33,280	29	1,450,673	1,274	145	0.13	167	0.15	6,519	5.7
16	Wet pond 2 perct	18,250,050	0.45	19,162	17	1,450,673	1,274	145	0.13	158	0.14	6,519	5.7
17	Wet pond 4 perct	18,250,050	0.45	8,500	7	1,450,673	1,274	145	0.13	151	0.13	6,519	5.7
18	Rain barrel few	17,791,190	0.44	102,970	93	1,435,487	1,293	145	0.13	210	0.19	6,293	5.7
19	Rain barrel many	17,373,150	0.43	102,369	94	1,421,650	1,311	144	0.13	209	0.19	6,087	5.6
20	Rain barrel	17,650,570	0.44	102,768	93	1,430,832	1,299	144	0.13	210	0.19	6,224	5.7
21	Rain tanks large	16,835,110	0.42	101,597	97	1,403,844	1,336	143	0.14	208	0.20	5,822	5.5
22	Rain tanks small	17,107,780	0.43	101,988	95	1,412,867	1,323	144	0.13	208	0.20	5,956	5.6
23	Rain tanks	16,850,330	0.42	101,619	97	1,404,347	1,336	143	0.14	208	0.20	5,829	5.5

24	Small wet pond and biofilt parking 10 perct	16,914,730	0.42	29,260	28	1,316,355	1,247	142	0.13	161	0.15	6,077	5.8
25	Small wet pond and curb biofilters 40	13,547,540	0.34	21,559	25	1,074,216	1,271	109	0.13	125	0.15	4,843	5.7
26	Small wet pond and parking biofilt 10 perc and curb biofilters 40	12,379,570	0.31	18,684	24	963,870	1,248	104	0.13	119	0.15	4,447	5.8
27	Small wet pond and rain tanks	16,850,330	0.42	31,189	30	1,404,347	1,336	143	0.14	164	0.16	5,829	5.5
28	Small wet pond and swale	15,485,380	0.39	23,988	25	1,228,985	1,272	124	0.13	139	0.14	5,535	5.7
29	Street cleaning daily	18,250,050	0.45	79,688	70	1,450,673	1,274	145	0.13	198	0.17	6,519	5.7
30	Grass swale	15,485,380	0.39	73,082	76	1,228,985	1,272	124	0.13	171	0.18	5,535	5.7

File Number	Lincoln, NE, Light Industrial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	872	0.77	1,367	1.20	64,781	57	107,263	94	67	59	124	109
2	Roof rain garden 15 perct	747	0.71	1,218	1.16	62,101	59	103,118	98	65	62	111	106
3	Roof rain garden 3 perct	829	0.75	1,316	1.19	63,866	58	105,848	95	66	60	119	108
4	Biofilt parking 10 perct	821	0.78	1,277	1.21	61,345	58	99,666	94	62	59	115	109
5	Biofilt parking 25 perct	802	0.78	1,251	1.22	60,037	59	97,653	95	60	59	112	110
6	Biofilt parking 3 perct	847	0.77	1,321	1.20	63,137	57	103,284	94	64	59	119	108
7	Catchbasin cleaning	872	0.77	1,294	1.14	64,781	57	101,004	89	67	59	115	101
8	Roof rain garden 15 perct	756	0.71	1,229	1.16	62,303	59	103,430	98	65	62	112	106
9	Roof rain garden 3 perct	835	0.75	1,324	1.19	64,001	57	106,057	95	66	60	120	108
10	Curb-cut biofilters 20	747	0.77	1,192	1.23	55,140	57	88,282	91	57	58	125	129
11	Curb-cut biofilters 40	652	0.77	1,000	1.18	47,965	57	73,745	87	49	58	102	121
12	Curb-cut biofilters 80	514	0.77	740	1.11	37,642	57	54,270	82	39	58	73	109
13	Disconnected impervious areas	379	0.86	642	1.45	40,536	92	61,820	140	34	78	61	139
14	Disconnected impervious areas (half)	646	0.84	1,016	1.32	51,481	67	81,864	106	48	62	93	120
15	Wet pond 1 perct	872	0.77	1,033	0.91	64,781	57	78,606	69	67	59	85	75
16	Wet pond 2 perct	872	0.77	965	0.85	64,781	57	72,789	64	67	59	78	68
17	Wet pond 4 perct	872	0.77	913	0.80	64,781	57	68,362	60	67	59	72	63
18	Rain barrel few	831	0.75	1,318	1.19	63,903	58	105,905	95	66	60	120	108
19	Rain barrel many	794	0.73	1,274	1.17	63,103	58	104,667	97	66	61	116	107
20	Rain barrel	818	0.74	1,303	1.18	63,634	58	105,489	96	66	60	118	107
21	Rain tanks large	746	0.71	1,217	1.16	62,074	59	103,075	98	65	62	111	106
22	Rain tanks small	770	0.72	1,246	1.17	62,595	59	103,882	97	66	61	113	106
23	Rain tanks	747	0.71	1,218	1.16	62,103	59	103,120	98	65	62	111	106

24	Small wet pond and biofilt parking 10 perct	821	0.78	965	0.91	61,345	58	73,468	70	62	59	79	75
25	Small wet pond and curb biofilters 40	652	0.77	784	0.93	47,965	57	57,681	68	49	58	69	82
26	Small wet pond and parking biofilt 10 perc and curb biofilters 40	604	0.78	722	0.93	44,621	58	53,065	69	45	58	63	81
27	Small wet pond and rain tanks	747	0.71	893	0.85	62,103	59	74,858	71	65	62	79	76
28	Small wet pond and swale	742	0.77	858	0.89	54,916	57	64,908	67	56	58	70	72
29	Street cleaning daily	872	0.77	1,264	1.11	64,781	57	99,078	87	67	59	113	99
30	Grass swale	742	0.77	1,093	1.13	54,916	57	85,005	88	56	58	97	100

File Number	Lincoln, NE, Light Industrial Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	3.4	3.0	26	23	89	78	170	149	1.3E+14	24,462	1.5E+14	29,864
2	Roof rain garden 15 perct	3.2	3.0	25	24	79	76	153	146	1.3E+14	26,362	1.5E+14	32,344
3	Roof rain garden 3 perct	3.3	3.0	26	23	86	77	164	148	1.3E+14	25,077	1.5E+14	30,666
4	Biofilt parking 10 perct	3.2	3.0	24	22	83	79	155	147	1.3E+14	26,146	1.5E+14	31,966
5	Biofilt parking 25 perct	3.1	3.0	23	23	80	79	151	148	1.3E+14	26,860	1.5E+14	32,857
6	Biofilt parking 3 perct	3.3	3.0	25	22	86	78	162	147	1.3E+14	25,236	1.5E+14	30,830
7	Catchbasin cleaning	3.4	3.0	23	20	89	78	158	139	1.3E+14	24,462	1.5E+14	29,864
8	Roof rain garden 15 perct	3.2	3.0	25	24	80	76	154	146	1.3E+14	26,208	1.5E+14	32,143
9	Roof rain garden 3 perct	3.3	3.0	26	23	86	78	165	148	1.3E+14	24,984	1.5E+14	30,545
10	Curb-cut biofilters 20	2.9	3.0	21	21	76	78	150	154	1.1E+14	24,380	1.3E+14	29,807
11	Curb-cut biofilters 40	2.5	3.0	16	19	66	78	123	146	9.3E+13	24,307	1.1E+14	29,751
12	Curb-cut biofilters 80	2.0	3.0	11	17	51	77	88	133	7.3E+13	24,216	9.0E+13	29,691
13	Disconnected impervious areas	1.3	3.0	12	28	45	102	80	182	5.3E+13	26,412	7.9E+13	39,513
14	Disconnected impervious areas (half)	2.3	3.0	18	24	67	87	124	161	8.9E+13	25,449	1.2E+14	33,091
15	Wet pond 1 perct	3.4	3.0	11	9	89	78	115	101	1.3E+14	24,462	1.5E+14	29,864
16	Wet pond 2 perct	3.4	3.0	8	7	89	78	104	92	1.3E+14	24,462	1.5E+14	29,864
17	Wet pond 4 perct	3.4	3.0	5	5	89	78	96	84	1.3E+14	24,462	1.5E+14	29,864
18	Rain barrel few	3.3	3.0	26	23	86	77	164	148	1.3E+14	25,051	1.5E+14	30,633
19	Rain barrel many	3.3	3.0	26	24	83	77	159	147	1.3E+14	25,616	1.5E+14	31,370
20	Rain barrel	3.3	3.0	26	23	85	77	163	148	1.3E+14	25,238	1.5E+14	30,877
21	Rain tanks large	3.2	3.0	25	24	79	76	153	146	1.3E+14	26,383	1.5E+14	32,371
22	Rain tanks small	3.2	3.0	25	24	81	76	156	146	1.3E+14	25,988	1.5E+14	31,856
23	Rain tanks	3.2	3.0	25	24	79	76	153	146	1.3E+14	26,361	1.5E+14	32,342

24	Small wet pond and biofilt parking 10 perct	3.2	3.0	10	9	83	79	106	100	1.3E+14	26,146	1.5E+14	31,966
25	Small wet pond and curb biofilters 40	2.5	3.0	8	9	66	78	87	103	9.3E+13	24,307	1.1E+14	29,751
26	Small wet pond and parking biofilt 10 perc and curb biofilters 40	2.3	3.0	7	9	60	78	79	102	9.0E+13	25,709	1.1E+14	31,515
27	Small wet pond and rain tanks	3.2	3.0	10	10	79	76	102	97	1.3E+14	26,361	1.5E+14	32,342
28	Small wet pond and swale	2.9	3.0	8	9	75	78	94	98	1.1E+14	24,414	1.3E+14	29,835
29	Street cleaning daily	3.4	3.0	22	19	89	78	157	138	1.3E+14	24,462	1.5E+14	29,864
30	Grass swale	2.9	3.0	19	20	75	78	133	137	1.1E+14	24,414	1.3E+14	29,835

Light Industrial Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Light Industrial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	18,250,050	0.45	103,628	91	1,450,673	1,274	145	0.13	212	0.19	6,519	5.7
2	Roof rain garden 15 perct	16,514,740	0.41	101,137	98	1,393,240	1,352	143	0.14	207	0.20	5,664	5.5
3	Roof rain garden 3 perct	17,282,110	0.43	102,239	95	1,418,637	1,315	144	0.13	209	0.19	6,042	5.6
4	Biofilt parking 10 perct	16,045,710	0.40	91,632	91	1,228,940	1,227	140	0.14	200	0.20	5,789	5.8
5	Biofilt parking 3 perct	16,747,020	0.42	95,016	91	1,299,484	1,244	141	0.14	203	0.19	6,021	5.8
6	Catchbasin cleaning	18,250,050	0.45	88,247	77	1,450,673	1,274	145	0.13	202	0.18	6,519	5.7
7	Roof rain garden 15 perct	16,620,140	0.41	101,288	98	1,396,729	1,347	143	0.14	207	0.20	5,716	5.5
8	Roof rain garden 3 perct	17,379,580	0.43	102,379	94	1,421,864	1,311	144	0.13	209	0.19	6,090	5.6
9	Curb-cut biofilters 20	11,127,470	0.28	55,806	80	881,784	1,270	90	0.13	132	0.19	3,978	5.7
10	Curb-cut biofilters 40	7,258,813	0.18	35,191	78	574,967	1,269	59	0.13	86	0.19	2,594	5.7
11	Curb-cut biofilters 80	3,204,370	0.08	14,760	74	253,342	1,267	27	0.13	38	0.19	1,145	5.7
12	Disconnected impervious areas	7,067,697	0.18	55,743	126	535,464	1,214	105	0.24	142	0.32	2,691	6.1
13	Disconnected of half of impervious areas	12,364,290	0.31	75,577	98	920,539	1,193	124	0.16	174	0.22	4,610	6.0
14	Wet pond 1 perct	18,250,050	0.45	33,280	29	1,450,673	1,274	145	0.13	167	0.15	6,519	5.7
15	Wet pond 2 perct	18,250,050	0.45	19,162	17	1,450,673	1,274	145	0.13	158	0.14	6,519	5.7
16	Wet pond 4 perct	18,250,050	0.45	8,500	7	1,450,673	1,274	145	0.13	151	0.13	6,519	5.7
17	Rain barrel few	17,791,190	0.44	102,970	93	1,435,487	1,293	145	0.13	210	0.19	6,293	5.7
18	Rain barrel many	17,373,150	0.43	102,369	94	1,421,650	1,311	144	0.13	209	0.19	6,087	5.6
19	Rain barrel	17,650,570	0.44	102,768	93	1,430,832	1,299	144	0.13	210	0.19	6,224	5.7
20	Rain tanks large	16,835,110	0.42	101,597	97	1,403,844	1,336	143	0.14	208	0.20	5,822	5.5
21	Rain tanks small	17,107,780	0.43	101,988	95	1,412,867	1,323	144	0.13	208	0.20	5,956	5.6
22	Rain tanks	16,850,330	0.42	101,619	97	1,404,347	1,336	143	0.14	208	0.20	5,829	5.5
23	Small wet pond and biofilt parking 10 perct	16,045,710	0.40	27,565	28	1,228,940	1,227	140	0.14	158	0.16	5,789	5.8

24	Small wet pond and curb biofilters 40 percent	7,258,813	0.18	12,571	28	574,967	1,269	59	0.13	69	0.15	2,594	5.7
25	Small wet pond and parking biofilt 10 perct and curb biofilters 40	5,726,962	0.14	9,349	26	438,291	1,226	51	0.14	58	0.16	2,065	5.8
26	Small wet pond and rain tanks	16,850,330	0.42	31,189	30	1,404,347	1,336	143	0.14	164	0.16	5,829	5.5
27	Small wet pond and swale	5,842,031	0.15	7,974	22	462,753	1,269	47	0.13	53	0.14	2,088	5.7
28	Street cleaning daily	18,250,050	0.45	79,688	70	1,450,673	1,274	145	0.13	198	0.17	6,519	5.7
29	Swales	5,842,031	0.15	27,050	74	462,753	1,269	47	0.13	65	0.18	2,088	5.7

File Number	Lincoln, NE, Light Industrial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	872	0.77	1,367	1.20	64,781	57	107,263	94	67	59	124	109
2	Roof rain garden 15 perct	717	0.70	1,183	1.15	61,461	60	102,126	99	65	63	108	105
3	Roof rain garden 3 perct	785	0.73	1,264	1.17	62,929	58	104,398	97	66	61	115	107
4	Biofilt parking 10 perct	788	0.79	1,235	1.23	59,110	59	96,417	96	59	59	111	110
5	Biofilt parking 3 perct	815	0.78	1,275	1.22	60,914	58	99,681	95	61	59	115	110
6	Catchbasin cleaning	872	0.77	1,294	1.14	64,781	57	101,004	89	67	59	115	101
7	Roof rain garden 15 perct	726	0.70	1,194	1.15	61,662	59	102,438	99	65	63	109	105
8	Roof rain garden 3 perct	794	0.73	1,274	1.18	63,115	58	104,686	97	66	61	116	107
9	Curb-cut biofilters 20	536	0.77	876	1.26	39,358	57	64,451	93	40	58	92	133
10	Curb-cut biofilters 40	352	0.78	568	1.25	25,601	57	41,455	92	26	58	59	130
11	Curb-cut biofilters 80	157	0.78	250	1.25	11,242	56	17,920	90	12	58	25	125
12	Disconnected impervious areas	379	0.86	642	1.45	40,536	92	61,820	140	34	78	61	139
13	Disconnected of half of impervious areas	646	0.84	1,016	1.32	51,481	67	81,864	106	48	62	93	120
14	Wet pond 1 perct	872	0.77	1,033	0.91	64,781	57	78,606	69	67	59	85	75
15	Wet pond 2 perct	872	0.77	965	0.85	64,781	57	72,789	64	67	59	78	68
16	Wet pond 4 perct	872	0.77	913	0.80	64,781	57	68,362	60	67	59	72	63
17	Rain barrel few	831	0.75	1,318	1.19	63,903	58	105,905	95	66	60	120	108
18	Rain barrel many	794	0.73	1,274	1.17	63,103	58	104,667	97	66	61	116	107
19	Rain barrel	818	0.74	1,303	1.18	63,634	58	105,489	96	66	60	118	107
20	Rain tanks large	746	0.71	1,217	1.16	62,074	59	103,075	98	65	62	111	106
21	Rain tanks small	770	0.72	1,246	1.17	62,595	59	103,882	97	66	61	113	106

22	Rain tanks	747	0.71	1,218	1.16	62,103	59	103,120	98	65	62	111	106
23	Small wet pond and biofilt parking 10 perct	788	0.79	924	0.92	59,110	59	70,516	70	59	59	75	75
24	Small wet pond and curb biofilters 40 percent	352	0.78	430	0.95	25,601	57	31,281	69	26	58	38	84
25	Small wet pond and parking biofilt 10 perct and curb biofilters 40	285	0.80	346	0.97	20,858	58	25,108	70	21	58	30	83
26	Small wet pond and rain tanks	747	0.71	893	0.85	62,103	59	74,858	71	65	62	79	76
27	Small wet pond and swale	282	0.77	321	0.88	20,643	57	23,969	66	21	58	26	70
28	Street cleaning daily	872	0.77	1,264	1.11	64,781	57	99,078	87	67	59	113	99
29	Swales	282	0.77	413	1.13	20,643	57	31,849	87	21	58	36	100

File Number	Lincoln, NE, Light Industrial Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	3	3	26	23	89	78	170	149	1.3E+14	24,462	1.5E+14	29,864
2	Roof rain garden 15 perct	3	3	25	24	77	75	149	145	1.3E+14	26,864	1.5E+14	32,999
3	Roof rain garden 3 perct	3	3	25	24	82	76	158	147	1.3E+14	25,742	1.5E+14	31,535
4	Biofilt parking 10 perct	3	3	23	23	79	79	149	149	1.2E+14	27,393	1.5E+14	33,522
5	Biofilt parking 3 perct	3	3	24	23	82	79	155	148	1.3E+14	26,377	1.5E+14	32,254
6	Catchbasin cleaning	3	3	23	20	89	78	158	139	1.3E+14	24,462	1.5E+14	29,864
7	Roof rain garden 15 perct	3	3	25	24	78	75	150	145	1.3E+14	26,704	1.5E+14	32,790
8	Roof rain garden 3 perct	3	3	26	24	83	77	159	147	1.3E+14	25,607	1.5E+14	31,358
9	Curb-cut biofilters 20	2	3	16	22	54	77	110	158	7.6E+13	24,243	9.4E+13	29,712
10	Curb-cut biofilters 40	1	3	10	22	35	77	70	154	4.9E+13	24,044	6.1E+13	29,548
11	Curb-cut biofilters 80	1	3	4	21	15	76	30	149	2.2E+13	23,688	2.7E+13	29,274
12	Disconnected impervious areas	1	3	12	28	45	102	80	182	5.3E+13	26,412	7.9E+13	39,513
13	Disconnected of half of impervious areas	2	3	18	24	67	87	124	161	8.9E+13	25,449	1.2E+14	33,091
14	Wet pond 1 perct	3	3	11	9	89	78	115	101	1.3E+14	24,462	1.5E+14	29,864
15	Wet pond 2 perct	3	3	8	7	89	78	104	92	1.3E+14	24,462	1.5E+14	29,864
16	Wet pond 4 perct	3	3	5	5	89	78	96	84	1.3E+14	24,462	1.5E+14	29,864
17	Rain barrel few	3	3	26	23	86	77	164	148	1.3E+14	25,051	1.5E+14	30,633
18	Rain barrel many	3	3	26	24	83	77	159	147	1.3E+14	25,616	1.5E+14	31,370
19	Rain barrel	3	3	26	23	85	77	163	148	1.3E+14	25,238	1.5E+14	30,877
20	Rain tanks large	3	3	25	24	79	76	153	146	1.3E+14	26,383	1.5E+14	32,371
21	Rain tanks small	3	3	25	24	81	76	156	146	1.3E+14	25,988	1.5E+14	31,856
22	Rain tanks	3	3	25	24	79	76	153	146	1.3E+14	26,361	1.5E+14	32,342
23	Small wet pond and biofilt parking 10 perct	3	3	9	9	79	79	100	100	1.2E+14	27,393	1.5E+14	33,522
24	Small wet pond and	1	3	4	10	35	77	47	105	4.9E+13	24,044	6.1E+13	29,548

	curb biofilters 40 percent												
25	Small wet pond and parking biofilt 10 perct and curb biofilters 40	1	3	3	9	27	77	37	103	4.3E+13	26,577	5.3E+13	32,765
26	Small wet pond and rain tanks	3	3	10	10	79	76	102	97	1.3E+14	26,361	1.5E+14	32,342
27	Small wet pond and swale	1	3	3	8	28	77	34	94	4.0E+13	24,175	4.9E+13	29,661
28	Street cleaning daily	3	3	22	19	89	78	157	138	1.3E+14	24,462	1.5E+14	29,864
29	Swales	1	3	7	19	28	77	49	135	4.0E+13	24,175	4.9E+13	29,661

Institutional: Schools Land Use; Clay Loam Soil

File Number	Lincoln, NE, Schools Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	17,524,100	0.44	74,178	68	93,113	85	228	0.21	272	0.25	696	0.6
2	Biofilt parking 10 perct	13,421,630	0.33	44,642	53	78,337	94	203	0.24	236	0.28	566	0.7
3	Biofilt parking 25 perct	11,856,450	0.30	39,280	53	72,700	98	193	0.26	224	0.30	516	0.7
4	Biofilt parking 3 perct	15,577,310	0.39	58,596	60	86,102	89	216	0.22	254	0.26	634	0.7
5	Catchbasin cleaning	17,524,100	0.44	61,952	57	93,113	85	228	0.21	265	0.24	696	0.6
6	Curb-cut biofilters 20	16,525,020	0.41	66,699	65	88,077	85	219	0.21	273	0.26	657	0.6
7	Curb-cut biofilters 40	15,698,930	0.39	60,940	62	83,805	86	211	0.22	260	0.27	625	0.6
8	Curb-cut biofilters 80	14,275,710	0.36	52,071	58	76,382	86	197	0.22	239	0.27	568	0.6
9	Disconnected impervious areas	5,617,436	0.14	32,457	93	34,872	99	145	0.41	166	0.47	223	0.6
10	Disconnected of half impervious areas	11,438,020	0.29	52,245	73	63,142	88	184	0.26	215	0.30	456	0.6
11	Wet pond 0.85 perct	17,524,100	0.44	24,153	22	93,113	85	228	0.21	243	0.22	696	0.6
12	Wet pond 1.7 perct	17,524,100	0.44	13,204	12	93,113	85	228	0.21	236	0.22	696	0.6
13	Wet pond 3.4 perct	17,524,100	0.44	5,329	5	93,113	85	228	0.21	232	0.21	696	0.6
14	Porous pvt parking half	13,912,330	0.35	54,596	63	80,105	92	206	0.24	243	0.28	581	0.7
15	Rain barrels few	15,794,130	0.39	71,802	73	82,645	84	217	0.22	258	0.26	612	0.6
16	Rain barrels many	13,992,570	0.35	69,328	79	71,742	82	206	0.24	243	0.28	524	0.6
17	Rain barrels	15,164,170	0.38	70,937	75	78,832	83	214	0.23	253	0.27	581	0.6
18	Rain tanks large	11,459,950	0.29	65,850	92	56,416	79	190	0.27	223	0.31	401	0.6
19	Rain tanks small	12,828,180	0.32	67,729	85	64,696	81	199	0.25	234	0.29	468	0.6
20	Rain tanks	11,623,130	0.29	66,074	91	57,403	79	191	0.26	224	0.31	409	0.6
21	Roof rain garden 15 perct	12,002,930	0.30	66,596	89	59,702	80	194	0.26	227	0.30	428	0.6
22	Roof rain garden 3 perct	15,794,950	0.39	71,804	73	82,650	84	217	0.22	258	0.26	612	0.6
23	Small wet pond and biofilt parking 10 perct	13,421,630	0.33	13,891	17	78,337	94	203	0.24	213	0.25	566	0.7

24	Small wet pond and curb biofilters 40	15,698,930	0.39	20,968	21	83,805	86	211	0.22	228	0.23	625	0.6
25	Small wet pond and parking biofilt 10 perc and curb biofilters 40	11,831,860	0.29	11,946	16	68,796	93	185	0.25	196	0.27	496	0.7
26	Small wet pond and rain tanks	11,623,130	0.29	17,378	24	57,403	79	191	0.26	201	0.28	409	0.6
27	Small wet pond and swale	14,851,920	0.37	17,724	19	79,254	86	199	0.22	210	0.23	591	0.6
28	Street cleaning daily	17,524,100	0.44	67,758	62	93,113	85	228	0.21	269	0.25	696	0.6
29	Grass swales	14,851,920	0.37	54,393	59	79,254	86	199	0.22	232	0.25	591	0.6

File Number	Lincoln, NE, Schools Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	1,011	0.9	1,572	1.4	31,904	29	61,937	57	12	11	19	18
2	Biofilt parking 10 perct	875	1.0	1,331	1.6	28,525	34	49,484	59	9	11	13	16
3	Biofilt parking 25 perct	823	1.1	1,261	1.7	27,236	37	46,548	63	8	10	11	15
4	Biofilt parking 3 perct	946	1.0	1,452	1.5	30,301	31	55,547	57	11	11	16	17
5	Catchbasin cleaning	1,011	0.9	1,486	1.4	31,904	29	57,099	52	12	11	18	17
6	Curb-cut biofilters 20	958	0.9	1,487	1.4	30,169	29	67,822	66	11	11	19	18
7	Curb-cut biofilters 40	912	0.9	1,399	1.4	28,639	29	63,045	64	11	11	17	18
8	Curb-cut biofilters 80	831	0.9	1,252	1.4	25,981	29	55,360	62	10	11	15	17
9	Disconnected impervious areas	359	1.0	707	2.0	8,958	26	21,436	61	4	11	7	19
10	Disconnected of half impervious areas	681	1.0	1,128	1.6	20,322	28	41,266	58	8	11	13	18
11	Wet pond 0.85 perct	1,011	0.9	1,213	1.1	31,904	29	41,968	38	12	11	14	13
12	Wet pond 1.7 perct	1,011	0.9	1,124	1.0	31,904	29	37,455	34	12	11	13	12
13	Wet pond 3.4 perct	1,011	0.9	1,056	1.0	31,904	29	34,141	31	12	11	13	12
14	Porous pvt parking half	891	1.0	1,383	1.6	28,929	33	52,946	61	9	11	15	17
15	Rain barrels few	875	0.9	1,411	1.4	26,464	27	54,330	55	11	11	18	18
16	Rain barrels many	733	0.8	1,244	1.4	20,798	24	46,407	53	10	11	17	19
17	Rain barrels	825	0.9	1,353	1.4	24,482	26	51,559	54	11	11	18	19
18	Rain tanks large	534	0.7	1,009	1.4	12,833	18	35,270	49	9	12	15	21
19	Rain tanks small	641	0.8	1,136	1.4	17,136	21	41,287	52	9	12	16	20
20	Rain tanks	547	0.8	1,024	1.4	13,346	18	35,987	50	9	12	15	21
21	Roof rain garden 15 perct	576	0.8	1,059	1.4	14,540	19	37,658	50	9	12	15	20
22	Roof rain garden 3 perct	875	0.9	1,412	1.4	26,466	27	54,333	55	11	11	18	18
23	Small wet pond and biofilt parking 10 perct	875	1.0	1,030	1.2	28,525	34	35,178	42	9	11	10	12
24	Small wet pond and	912	0.9	1,085	1.1	28,639	29	40,459	41	11	11	13	13

	curb biofilters 40												
25	Small wet pond and parking biofilt 10 perc and curb biofilters 40	768	1.0	880	1.2	24,725	33	32,082	43	8	11	9	12
26	Small wet pond and rain tanks	547	0.8	689	1.0	13,346	18	19,650	27	9	12	10	14
27	Small wet pond and swale	862	0.9	1,014	1.1	27,079	29	34,515	37	10	11	12	13
28	Street cleaning daily	1,011	0.9	1,548	1.4	31,904	29	60,766	56	12	11	19	17
29	Grass swales	862	0.9	1,287	1.4	27,079	29	49,360	53	10	11	16	17

File Number	Lincoln, NE, Schools Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	3.5	3.2	29	27	127	116	210	192	2.2E+14	43,630	2.2E+13	4,363
2	Biofilt parking 10 perct	3.0	3.6	19	22	102	122	155	185	1.3E+14	34,041	1.3E+13	3,404
3	Biofilt parking 25 perct	2.8	3.8	16	22	93	125	140	190	9.6E+13	28,634	9.6E+12	2,863
4	Biofilt parking 3 perct	3.3	3.4	24	24	115	119	182	187	1.8E+14	39,709	1.8E+13	3,971
5	Catchbasin cleaning	3.5	3.2	25	23	127	116	196	179	2.2E+14	43,630	2.2E+13	4,363
6	Curb-cut biofilters 20	3.3	3.2	36	34	120	117	230	223	2.0E+14	43,320	2.0E+13	4,332
7	Curb-cut biofilters 40	3.2	3.2	33	33	114	116	214	218	1.9E+14	43,249	1.9E+13	4,325
8	Curb-cut biofilters 80	2.9	3.2	28	31	104	116	188	211	1.8E+14	43,194	1.8E+13	4,319
9	Disconnected impervious areas	1.0	2.9	10	28	34	97	62	177	6.0E+13	37,810	6.0E+12	3,781
10	Disconnected of half impervious areas	2.2	3.2	19	27	80	113	135	189	1.3E+14	39,530	1.3E+13	3,953
11	Wet pond 0.85 perct	3.5	3.2	12	11	127	116	153	140	2.2E+14	43,630	2.2E+13	4,363
12	Wet pond 1.7 perct	3.5	3.2	8	7	127	116	141	129	2.2E+14	43,630	2.2E+13	4,363
13	Wet pond 3.4 perct	3.5	3.2	5	5	127	116	133	122	2.2E+14	43,630	2.2E+13	4,363
14	Porous pvt parking half	3.1	3.6	22	25	105	121	168	194	1.4E+14	35,486	1.4E+13	3,549
15	Rain barrels few	3.0	3.0	27	28	109	111	185	188	2.2E+14	48,080	2.2E+13	4,808
16	Rain barrels many	2.5	2.8	25	28	91	104	160	183	2.1E+14	53,884	2.1E+13	5,388
17	Rain barrels	2.8	3.0	26	28	103	109	176	186	2.1E+14	49,953	2.1E+13	4,995
18	Rain tanks large	1.7	2.4	21	30	65	90	124	174	2.1E+14	65,130	2.1E+13	6,513
19	Rain tanks small	2.1	2.6	23	29	79	98	144	179	2.1E+14	58,503	2.1E+13	5,850
20	Rain tanks	1.7	2.4	22	30	66	91	127	175	2.1E+14	64,257	2.1E+13	6,426
21	Roof rain garden 15 perct	1.9	2.5	22	30	70	94	132	176	2.1E+14	62,319	2.1E+13	6,232
22	Roof rain garden 3 perct	3.0	3.0	27	28	109	111	185	188	2.2E+14	48,078	2.2E+13	4,808
23	Small wet pond and biofilt parking 10 perct	3.0	3.6	8	9	102	122	118	140	1.3E+14	34,041	1.3E+13	3,404
24	Small wet pond and curb biofilters 40	3.2	3.2	13	13	114	116	148	151	1.9E+14	43,249	1.9E+13	4,325

25	Small wet pond and parking biofilt 10 perc and curb biofilters 40	2.6	3.6	9	12	90	121	110	149	1.2E+14	34,671	1.2E+13	3,467
26	Small wet pond and rain tanks	1.7	2.4	7	10	66	91	82	112	2.1E+14	64,257	2.1E+13	6,426
27	Small wet pond and swale	3.0	3.2	9	10	108	116	127	137	1.8E+14	43,297	1.8E+13	4,330
28	Street cleaning daily	3.5	3.2	28	26	127	116	202	185	2.2E+14	43,630	2.2E+13	4,363
29	Grass swales	3.0	3.2	22	24	108	116	168	181	1.8E+14	43,297	1.8E+13	4,330

Institution: Schools Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Schools Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	17,524,100	0.44	74,178	68	93,113	85	228	0.21	272	0.25	696	0.6
2	Biofilt parking 10 perct	10,751,740	0.27	36,906	55	68,721	102	186	0.28	217	0.32	481	0.7
3	Biofilt parking 3 perct	12,932,390	0.32	48,376	60	76,575	95	200	0.25	234	0.29	550	0.7
4	Catchbasin cleaning	17,524,100	0.44	61,952	57	93,113	85	228	0.21	265	0.24	696	0.6
5	Curb-cut biofilters 20	14,581,260	0.36	60,520	66	77,981	86	199	0.22	248	0.27	580	0.6
6	Curb-cut biofilters 40	12,367,840	0.31	50,832	66	66,373	86	175	0.23	217	0.28	492	0.6
7	Curb-cut biofilters 80	9,185,112	0.23	37,471	65	49,541	86	137	0.24	168	0.29	365	0.6
8	Disconnected impervious areas	5,617,436	0.14	32,457	93	34,872	99	145	0.41	166	0.47	223	0.6
9	Disconnection of half impervious areas	11,438,020	0.29	52,245	73	63,142	88	184	0.26	215	0.30	456	0.6
10	Wet pond 0.85 perct	17,524,100	0.44	24,153	22	93,113	85	228	0.21	243	0.22	696	0.6
11	Wet pond 1.7 perct	17,524,100	0.44	13,204	12	93,113	85	228	0.21	236	0.22	696	0.6
12	Wet pond 3.4 perct	17,524,100	0.44	5,329	5	93,113	85	228	0.21	232	0.21	696	0.6
13	Porous pvt half	13,912,330	0.35	54,596	63	80,105	92	206	0.24	243	0.28	581	0.7
14	Rain barrels few	15,794,130	0.39	71,802	73	82,645	84	217	0.22	258	0.26	612	0.6
15	Rain barrels many	13,992,570	0.35	69,328	79	71,742	82	206	0.24	243	0.28	524	0.6
16	Rain barrels	15,164,170	0.38	70,937	75	78,832	83	214	0.23	253	0.27	581	0.6
17	Rain tanks large	11,459,950	0.29	65,850	92	56,416	79	190	0.27	223	0.31	401	0.6
18	Rain tanks small	12,828,180	0.32	67,729	85	64,696	81	199	0.25	234	0.29	468	0.6
19	Rain tanks	11,623,130	0.29	66,074	91	57,403	79	191	0.26	224	0.31	409	0.6
20	Rain garden 15 perct	10,547,240	0.26	64,596	98	50,893	77	185	0.28	215	0.33	357	0.5
21	Roof rain garden 3 perct	13,821,950	0.34	69,094	80	70,710	82	205	0.24	242	0.28	516	0.6
22	Small wet pond and curb biofilters 40	12,367,840	0.31	17,153	22	66,373	86	175	0.23	189	0.25	492	0.6
23	Small wet pond and parking biofilt 10 prct and curb biofilters 40	6,435,470	0.16	6,256	16	41,314	103	127	0.32	133	0.33	285	0.7

24	Small wet pond and rain tanks	11,623,130	0.29	17,378	24	57,403	79	191	0.26	201	0.28	409	0.6
25	Small wet pond and swale sandy loam	5,019,981	0.13	5,408	17	27,112	87	76	0.24	79	0.25	199	0.6
26	Wet small pond and biofilt parking 10 perct	10,751,740	0.27	9,943	15	68,721	102	186	0.28	195	0.29	481	0.7
27	Street cleaning daily	17,524,100	0.44	67,758	62	93,113	85	228	0.21	269	0.25	696	0.6
28	Grass swale	5,019,981	0.13	19,137	61	27,112	87	76	0.24	88	0.28	199	0.6

File Number	Lincoln, NE, Schools Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	1,011	0.92	1,572	1.44	31,904	29	61,937	57	12	11	19	18
2	Biofilt parking 10 perct	787	1.17	1,216	1.81	26,326	39	44,909	67	7	10	10	15
3	Biofilt parking 3 perct	859	1.06	1,329	1.65	28,122	35	50,228	62	8	10	13	16
4	Catchbasin cleaning	1,011	0.92	1,486	1.36	31,904	29	57,099	52	12	11	18	17
5	Curb-cut biofilters 20	849	0.93	1,333	1.47	26,590	29	60,791	67	10	11	17	18
6	Curb-cut biofilters 40	723	0.94	1,134	1.47	22,446	29	51,147	66	9	11	14	18
7	Curb-cut biofilters 80	540	0.94	848	1.48	16,536	29	37,657	66	6	11	10	18
8	Disconnected impervious areas	359	1.02	707	2.02	8,958	26	21,436	61	4	11	7	19
9	Disconnection of half impervious areas	681	0.95	1,128	1.58	20,322	28	41,266	58	8	11	13	18
10	Wet pond 0.85 perct	1,011	0.92	1,213	1.11	31,904	29	41,968	38	12	11	14	13
11	Wet pond 1.7 perct	1,011	0.92	1,124	1.03	31,904	29	37,455	34	12	11	13	12
12	Wet pond 3.4 perct	1,011	0.92	1,056	0.97	31,904	29	34,141	31	12	11	13	12
13	Porous pvt half	891	1.03	1,383	1.59	28,929	33	52,946	61	9	11	15	17
14	Rain barrels few	875	0.89	1,411	1.43	26,464	27	54,330	55	11	11	18	18
15	Rain barrels many	733	0.84	1,244	1.42	20,798	24	46,407	53	10	11	17	19
16	Rain barrels	825	0.87	1,353	1.43	24,482	26	51,559	54	11	11	18	19
17	Rain tanks large	534	0.75	1,009	1.41	12,833	18	35,270	49	9	12	15	21
18	Rain tanks small	641	0.80	1,136	1.42	17,136	21	41,287	52	9	12	16	20
19	Rain tanks	547	0.75	1,024	1.41	13,346	18	35,987	50	9	12	15	21
20	Rain garden 15 perct	462	0.70	924	1.40	9,962	15	31,256	47	8	12	14	22
21	Roof rain garden 3 perct	719	0.83	1,228	1.42	20,261	23	45,657	53	10	12	17	19
22	Small wet pond and curb biofilters 40	723	0.94	866	1.12	22,446	29	32,112	42	9	11	10	13
23	Small wet pond and parking biofilt 10 prct and curb biofilters 40	473	1.18	542	1.35	15,258	38	19,584	49	4	10	5	12

24	Small wet pond and rain tanks	547	0.75	689	0.95	13,346	18	19,650	27	9	12	10	14
25	Small wet pond and swale sandy loam	296	0.94	345	1.10	9,032	29	11,335	36	3	11	4	13
26	Wet small pond and biofilt parking 10 perct	787	1.17	914	1.36	26,326	39	31,484	47	7	10	8	11
27	Street cleaning daily	1,011	0.92	1,548	1.42	31,904	29	60,766	56	12	11	19	17
28	Grass swale	296	0.94	458	1.46	9,032	29	17,014	54	3	11	5	17

File Number	Lincoln, NE, Schools Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	3.5	3.2	29	27	127	116	210	192	2.2E+14	43,630	2.2E+13	4,363
2	Biofilt parking 10 perct	2.7	4.0	16	23	86	128	131	196	7.3E+13	23,870	7.3E+12	2,387
3	Biofilt parking 3 perct	3.0	3.7	20	25	99	123	156	193	1.2E+14	32,492	1.2E+13	3,249
4	Catchbasin cleaning	3.5	3.2	25	23	127	116	196	179	2.2E+14	43,630	2.2E+13	4,363
5	Curb-cut biofilters 20	2.9	3.2	32	35	106	116	205	225	1.8E+14	43,144	1.8E+13	4,314
6	Curb-cut biofilters 40	2.5	3.2	27	35	90	116	172	223	1.5E+14	43,116	1.5E+13	4,312
7	Curb-cut biofilters 80	1.8	3.2	20	34	66	115	126	221	1.1E+14	43,103	1.1E+13	4,310
8	Disconnected impervious areas	1.0	2.9	10	28	34	97	62	177	6.0E+13	37,810	6.0E+12	3,781
9	Disconnection of half impervious areas	2.2	3.2	19	27	80	113	135	189	1.3E+14	39,530	1.3E+13	3,953
10	Wet pond 0.85 perct	3.5	3.2	12	11	127	116	153	140	2.2E+14	43,630	2.2E+13	4,363
11	Wet pond 1.7 perct	3.5	3.2	8	7	127	116	141	129	2.2E+14	43,630	2.2E+13	4,363
12	Wet pond 3.4 perct	3.5	3.2	5	5	127	116	133	122	2.2E+14	43,630	2.2E+13	4,363
13	Porous pvt half	3.1	3.6	22	25	105	121	168	194	1.4E+14	35,486	1.4E+13	3,549
14	Rain barrels few	3.0	3.0	27	28	109	111	185	188	2.2E+14	48,080	2.2E+13	4,808
15	Rain barrels many	2.5	2.8	25	28	91	104	160	183	2.1E+14	53,884	2.1E+13	5,388
16	Rain barrels	2.8	3.0	26	28	103	109	176	186	2.1E+14	49,953	2.1E+13	4,995
17	Rain tanks large	1.7	2.4	21	30	65	90	124	174	2.1E+14	65,130	2.1E+13	6,513
18	Rain tanks small	2.1	2.6	23	29	79	98	144	179	2.1E+14	58,503	2.1E+13	5,850
19	Rain tanks	1.7	2.4	22	30	66	91	127	175	2.1E+14	64,257	2.1E+13	6,426
20	Rain garden 15 perct	1.4	2.1	20	31	55	84	112	169	2.1E+14	70,506	2.1E+13	7,051
21	Roof rain garden 3 perct	2.4	2.8	25	28	89	103	158	183	2.1E+14	54,512	2.1E+13	5,451
22	Small wet pond and curb biofilters 40	2.5	3.2	11	14	90	116	117	152	1.5E+14	43,116	1.5E+13	4,312
23	Small wet pond and parking biofilt 10 prct and curb biofilters 40	1.6	4.0	5	12	51	126	62	155	4.5E+13	24,658	4.5E+12	2,466

24	Small wet pond and rain tanks	1.7	2.4	7	10	66	91	82	112	2.1E+14	64,257	2.1E+13	6,426
25	Small wet pond and swale sandy loam	1.0	3.2	3	9	36	115	42	133	6.1E+13	43,042	6.1E+12	4,304
26	Wet small pond and biofilt parking 10 perct	2.7	4.0	6	9	86	128	97	145	7.3E+13	23,870	7.3E+12	2,387
27	Street cleaning daily	3.5	3.2	28	26	127	116	202	185	2.2E+14	43,630	2.2E+13	4,363
28	Grass swale	1.0	3.2	8	24	36	115	56	180	6.1E+13	43,042	6.1E+12	4,304

Institutional: Church Land Use; Clay Loam Soil

File Number	Lincoln, NE, Church Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	17,524,100	0.44	74,178	68	93,113	85	228	0.21	272	0.25	696	0.6
2	Biofilt parking 10 perct	13,421,630	0.33	44,642	53	78,337	94	203	0.24	236	0.28	566	0.7
3	Biofilt parking 25 perct	13,421,630	0.33	44,642	53	78,337	94	203	0.24	236	0.28	566	0.7
4	Biofilt parking 3 perct	15,577,310	0.39	58,596	60	86,102	89	216	0.22	254	0.26	634	0.7
5	Catchbasin cleaning	17,524,100	0.44	73,964	68	93,113	85	228	0.21	272	0.25	696	0.6
6	Cur-cut biofilters 20	16,525,020	0.41	66,699	65	88,077	85	219	0.21	273	0.26	657	0.6
7	Curb-cut biofilters 40	15,698,930	0.39	60,940	62	83,805	86	211	0.22	260	0.27	625	0.6
8	Curb-cut biofilters 80	14,275,710	0.36	52,071	58	76,382	86	197	0.22	239	0.27	568	0.6
9	Disconnected impervious areas	6,148,446	0.15	35,430	92	38,275	100	157	0.41	180	0.47	239	0.6
10	Disconnected half impervious areas	11,825,060	0.29	54,743	74	65,654	89	193	0.26	226	0.31	467	0.6
11	Wet pond 0.85 perct	17,524,100	0.44	24,153	22	93,113	85	228	0.21	243	0.22	696	0.6
12	Wet pond 1.7 perct	17,524,100	0.44	13,204	12	93,113	85	228	0.21	236	0.22	696	0.6
13	Wet pond 3.4 perct	17,524,100	0.44	5,329	5	93,113	85	228	0.21	232	0.21	696	0.6
14	Porous pvt parking half	13,912,330	0.35	54,596	63	80,105	92	206	0.24	243	0.28	581	0.7
15	Rain barrels few	15,852,570	0.39	71,883	73	82,998	84	218	0.22	258	0.26	615	0.6
16	Rain barrels many	14,061,750	0.35	69,423	79	72,161	82	207	0.24	244	0.28	528	0.6
17	Rain barrels	15,216,670	0.38	71,009	75	79,150	83	214	0.23	253	0.27	584	0.6
18	Rain tanks large	11,459,930	0.29	65,850	92	56,416	79	190	0.27	223	0.31	401	0.6
19	Rain tanks small	12,876,810	0.32	67,796	84	64,990	81	199	0.25	234	0.29	470	0.6
20	Rain tanks	11,722,370	0.29	66,210	90	58,004	79	192	0.26	225	0.31	414	0.6
21	Rain garden 15 perct	12,002,930	0.30	66,596	89	59,702	80	194	0.26	227	0.30	428	0.6
22	Roof rain garden 3 perct	15,794,950	0.39	71,804	73	82,650	84	217	0.22	258	0.26	612	0.6
23	Small wet pond and biofilt parking 10 perct	13,421,630	0.33	13,891	17	78,337	94	203	0.24	213	0.25	566	0.7

24	Small wet pond and curb biofilters 40 perct	15,698,930	0.39	20,968	21	83,805	86	211	0.22	228	0.23	625	0.6
25	Small wet pond and parking biofilt 10 perct and curb biofilters 40 perct	11,831,860	0.29	11,946	16	68,796	93	185	0.25	196	0.27	496	0.7
26	Small wet pond and rain tanks	11,722,370	0.29	17,477	24	58,004	79	192	0.26	201	0.28	414	0.6
27	Small sand pond and swale clay loam	14,851,920	0.37	17,724	19	79,254	86	199	0.22	210	0.23	591	0.6
28	Street cleaning daily	17,524,100	0.44	67,758	62	93,113	85	228	0.21	269	0.25	696	0.6
29	Street cleaning weekly	17,524,100	0.44	69,835	64	93,113	85	228	0.21	270	0.25	696	0.6
30	Grass swale	14,851,920	0.37	54,393	59	79,254	86	199	0.22	232	0.25	591	0.6

File Number	Lincoln, NE, Church Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	1,011	0.9	1,572	1.4	31,904	29	61,937	57	12	11	19	18
2	Biofilt parking 10 perct	875	1.0	1,331	1.6	28,525	34	49,484	59	9	11	13	16
3	Biofilt parking 25 perct	875	1.0	1,331	1.6	28,525	34	49,484	59	9	11	13	16
4	Biofilt parking 3 perct	946	1.0	1,452	1.5	30,301	31	55,547	57	11	11	16	17
5	Catchbasin cleaning	1,011	0.9	1,571	1.4	31,904	29	61,852	57	12	11	19	18
6	Cur-cut biofilters 20	958	0.9	1,487	1.4	30,169	29	67,822	66	11	11	19	18
7	Curb-cut biofilters 40	912	0.9	1,399	1.4	28,639	29	63,045	64	11	11	17	18
8	Curb-cut biofilters 80	831	0.9	1,252	1.4	25,981	29	55,360	62	10	11	15	17
9	Disconnected impervious areas	376	1.0	747	1.9	9,396	24	22,823	59	4	11	7	19
10	Disconnected half impervious areas	693	0.9	1,159	1.6	20,641	28	42,352	57	8	11	13	18
11	Wet pond 0.85 perct	1,011	0.9	1,213	1.1	31,904	29	41,968	38	12	11	14	13
12	Wet pond 1.7 perct	1,011	0.9	1,124	1.0	31,904	29	37,455	34	12	11	13	12
13	Wet pond 3.4 perct	1,011	0.9	1,056	1.0	31,904	29	34,141	31	12	11	13	12
14	Porous pvt parking half	891	1.0	1,383	1.6	28,929	33	52,946	61	9	11	15	17
15	Rain barrels few	879	0.9	1,417	1.4	26,647	27	54,586	55	11	11	18	18
16	Rain barrels many	738	0.8	1,250	1.4	21,015	24	46,711	53	10	11	17	19
17	Rain barrels	829	0.9	1,358	1.4	24,647	26	51,790	55	11	11	18	19
18	Rain tanks large	534	0.7	1,008	1.4	12,833	18	35,270	49	9	12	15	21
19	Rain tanks small	645	0.8	1,140	1.4	17,289	22	41,501	52	9	12	16	20
20	Rain tanks	554	0.8	1,033	1.4	13,658	19	36,424	50	9	12	15	21
21	Rain garden 15 perct	576	0.8	1,059	1.4	14,540	19	37,658	50	9	12	15	20
22	Roof rain garden 3 perct	875	0.9	1,412	1.4	26,466	27	54,333	55	11	11	18	18
23	Small wet pond and biofilt parking 10 perct	875	1.0	1,030	1.2	28,525	34	35,178	42	9	11	10	12
24	Small wet pond and curb biofilters 40 perct	912	0.9	1,085	1.1	28,639	29	40,459	41	11	11	13	13

25	Small wet pond and parking biofilt 10 perct and curb biofilters 40 perct	768	1.0	880	1.2	24,725	33	32,082	43	8	11	9	12
26	Small wet pond and rain tanks	554	0.8	698	1.0	13,658	19	20,022	27	9	12	10	14
27	Small sand pond and swale clay loam	862	0.9	1,014	1.1	27,079	29	34,515	37	10	11	12	13
28	Street cleaning daily	1,011	0.9	1,548	1.4	31,904	29	60,766	56	12	11	19	17
29	Street cleaning weekly	1,011	0.9	1,556	1.4	31,904	29	61,145	56	12	11	19	17
30	Grass swale	862	0.9	1,287	1.4	27,079	29	49,360	53	10	11	16	17

File Number	Lincoln, NE, Church Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	3.5	3.2	29	27	127	116	210	192	2.2E+14	43,630	2.2E+13	4,363
2	Biofilt parking 10 perct	3.0	3.6	19	22	102	122	155	185	1.3E+14	34,041	1.3E+13	3,404
3	Biofilt parking 25 perct	3.0	3.6	19	22	102	122	155	185	1.3E+14	34,041	1.3E+13	3,404
4	Biofilt parking 3 perct	3.3	3.4	24	24	115	119	182	187	1.8E+14	39,709	1.8E+13	3,971
5	Catchbasin cleaning	3.5	3.2	29	27	127	116	209	191	2.2E+14	43,630	2.2E+13	4,363
6	Cur-cut biofilters 20	3.3	3.2	36	34	120	117	230	223	2.0E+14	43,320	2.0E+13	4,332
7	Curb-cut biofilters 40	3.2	3.2	33	33	114	116	214	218	1.9E+14	43,249	1.9E+13	4,325
8	Curb-cut biofilters 80	2.9	3.2	28	31	104	116	188	211	1.8E+14	43,194	1.8E+13	4,319
9	Disconnected impervious areas	1.1	2.9	10	27	34	89	65	168	9.0E+13	51,871	9.0E+12	5,187
10	Disconnected half impervious areas	2.3	3.1	20	27	81	109	137	186	1.5E+14	45,743	1.5E+13	4,574
11	Wet pond 0.85 perct	3.5	3.2	12	11	127	116	153	140	2.2E+14	43,630	2.2E+13	4,363
12	Wet pond 1.7 perct	3.5	3.2	8	7	127	116	141	129	2.2E+14	43,630	2.2E+13	4,363
13	Wet pond 3.4 perct	3.5	3.2	5	5	127	116	133	122	2.2E+14	43,630	2.2E+13	4,363
14	Porous pvt parking half	3.1	3.6	22	25	105	121	168	194	1.4E+14	35,486	1.4E+13	3,549
15	Rain barrels few	3.0	3.0	27	27	110	111	186	188	2.2E+14	47,914	2.2E+13	4,791
16	Rain barrels many	2.5	2.8	25	28	91	104	161	183	2.1E+14	53,634	2.1E+13	5,363
17	Rain barrels	2.8	3.0	26	28	103	109	177	187	2.1E+14	49,791	2.1E+13	4,979
18	Rain tanks large	1.7	2.4	21	30	65	90	124	174	2.1E+14	65,130	2.1E+13	6,513
19	Rain tanks small	2.1	2.6	23	29	79	99	144	180	2.1E+14	58,293	2.1E+13	5,829
20	Rain tanks	1.8	2.4	22	30	67	92	128	175	2.1E+14	63,739	2.1E+13	6,374
21	Rain garden 15 perct	1.9	2.5	22	30	70	94	132	176	2.1E+14	62,319	2.1E+13	6,232
22	Roof rain garden 3 perct	3.0	3.0	27	28	109	111	185	188	2.2E+14	48,078	2.2E+13	4,808
23	Small wet pond and biofilt parking 10 perct	3.0	3.6	8	9	102	122	118	140	1.3E+14	34,041	1.3E+13	3,404
24	Small wet pond and curb biofilters 40 perct	3.2	3.2	13	13	114	116	148	151	1.9E+14	43,249	1.9E+13	4,325

25	Small wet pond and parking biofilt 10 perct and curb biofilters 40 perct	2.6	3.6	9	12	90	121	110	149	1.2E+14	34,671	1.2E+13	3,467
26	Small wet pond and rain tanks	1.8	2.4	7	10	67	92	83	113	2.1E+14	63,739	2.1E+13	6,374
27	Small sand pond and swale clay loam	3.0	3.2	9	10	108	116	127	137	1.8E+14	43,297	1.8E+13	4,330
28	Street cleaning daily	3.5	3.2	28	26	127	116	202	185	2.2E+14	43,630	2.2E+13	4,363
29	Street cleaning weekly	3.5	3.2	28	26	127	116	205	187	2.2E+14	43,630	2.2E+13	4,363
30	Grass swale	3.0	3.2	22	24	108	116	168	181	1.8E+14	43,297	1.8E+13	4,330

Institutional: Church Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Church Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base condition	17,524,100	0.44	74,178	68	93,113	85	228	0.21	272	0.25	696	0.6
2	Biofilt parking 10 perct	10,751,740	0.27	36,906	55	68,721	102	186	0.28	217	0.32	481	0.7
3	Biofilt parking 3 perct	15,577,310	0.39	58,596	60	86,102	89	216	0.22	254	0.26	634	0.7
4	Catchbasin cleaning	17,524,100	0.44	73,964	68	93,113	85	228	0.21	272	0.25	696	0.6
5	Curb-cut biofilters 20 perct	14,581,260	0.36	60,520	66	77,981	86	199	0.22	248	0.27	580	0.6
6	Curb-cut biofilters 40 perct	12,367,840	0.31	50,832	66	66,373	86	175	0.23	217	0.28	492	0.6
7	Curb-cut biofilters 80 perct	9,185,112	0.23	37,471	65	49,541	86	137	0.24	168	0.29	365	0.6
8	Disconnected impervious areas	6,148,446	0.15	35,430	92	38,275	100	157	0.41	180	0.47	239	0.6
9	Disconnected of half of impervious areas	11,825,060	0.29	54,743	74	65,654	89	193	0.26	226	0.31	467	0.6
10	Wet pond 0.85 perct	17,524,100	0.44	24,153	22	93,113	85	228	0.21	243	0.22	696	0.6
11	Wet pond 1.7 perct	17,524,100	0.44	13,204	12	93,113	85	228	0.21	236	0.22	696	0.6
12	Wet pond 3.4 perct	17,524,100	0.44	5,329	5	93,113	85	228	0.21	232	0.21	696	0.6
13	Porous pvt parking half	13,912,330	0.35	54,596	63	80,105	92	206	0.24	243	0.28	581	0.7
14	Rain barrels few	15,852,570	0.39	71,883	73	82,998	84	218	0.22	258	0.26	615	0.6
15	Rain barrels many	14,061,750	0.35	69,423	79	72,161	82	207	0.24	244	0.28	528	0.6
16	Rain barrels	15,216,670	0.38	71,009	75	79,150	83	214	0.23	253	0.27	584	0.6
17	Rain tanks large	11,459,930	0.29	65,850	92	56,416	79	190	0.27	223	0.31	401	0.6
18	Rain tanks small	12,876,810	0.32	67,796	84	64,990	81	199	0.25	234	0.29	470	0.6
19	Rain tanks	11,722,370	0.29	66,210	90	58,004	79	192	0.26	225	0.31	414	0.6
20	Roof rain garden 15 perct	10,547,240	0.26	64,596	98	50,893	77	185	0.28	215	0.33	357	0.5
21	Roof rain garden 3 perct	13,821,950	0.34	69,094	80	70,710	82	205	0.24	242	0.28	516	0.6
22	Small wet pond and biofilt parking 10 perct	10,751,740	0.27	9,943	15	68,721	102	186	0.28	195	0.29	481	0.7

23	Small wet pond and curb biofilters 40 perct	12,367,840	0.31	17,153	22	66,373	86	175	0.23	189	0.25	492	0.6
24	Small wet pond and parking biofilt 10 perct and curb biofilters 40 perct	6,435,470	0.16	6,256	16	41,314	103	127	0.32	133	0.33	285	0.7
25	Small wet pond and rain tanks	11,722,370	0.29	17,477	24	58,004	79	192	0.26	201	0.28	414	0.6
26	Small wet pond and swale	5,019,981	0.13	5,408	17	27,112	87	76	0.24	79	0.25	199	0.6
27	Street cleaning daily	17,524,100	0.44	67,758	62	93,113	85	228	0.21	269	0.25	696	0.6
28	Street cleaning weekly	17,524,100	0.44	69,835	64	93,113	85	228	0.21	270	0.25	696	0.6
29	Grass swale	5,019,981	0.13	19,137	61	27,112	87	76	0.24	88	0.28	199	0.6

File Number	Lincoln, NE, Church Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base condition	1,011	0.9	1,572	1.4	31,904	29	61,937	57	12.1	11	19	18
2	Biofilt parking 10 perct	787	1.2	1,216	1.8	26,326	39	44,909	67	6.7	10	10	15
3	Biofilt parking 3 perct	946	1.0	1,452	1.5	30,301	31	55,547	57	10.6	11	16	17
4	Catchbasin cleaning	1,011	0.9	1,571	1.4	31,904	29	61,852	57	12.1	11	19	18
5	Curb-cut biofilters 20 perct	849	0.9	1,333	1.5	26,590	29	60,791	67	10.0	11	17	18
6	Curb-cut biofilters 40 perct	723	0.9	1,134	1.5	22,446	29	51,147	66	8.5	11	14	18
7	Curb-cut biofilters 80 perct	540	0.9	848	1.5	16,536	29	37,657	66	6.3	11	10	18
8	Disconnected impervious areas	376	1.0	747	1.9	9,396	24	22,823	59	4.2	11	7	19
9	Disconnected of half of impervious areas	693	0.9	1,159	1.6	20,641	28	42,352	57	8.2	11	13	18
10	Wet pond 0.85 perct	1,011	0.9	1,213	1.1	31,904	29	41,968	38	12.1	11	14	13
11	Wet pond 1.7 perct	1,011	0.9	1,124	1.0	31,904	29	37,455	34	12.1	11	13	12
12	Wet pond 3.4 perct	1,011	0.9	1,056	1.0	31,904	29	34,141	31	12.1	11	13	12
13	Porous pvt parking half	891	1.0	1,383	1.6	28,929	33	52,946	61	9.2	11	15	17
14	Rain barrels few	879	0.9	1,417	1.4	26,647	27	54,586	55	11.1	11	18	18
15	Rain barrels many	738	0.8	1,250	1.4	21,015	24	46,711	53	10.1	11	17	19
16	Rain barrels	829	0.9	1,358	1.4	24,647	26	51,790	55	10.8	11	18	19
17	Rain tanks large	534	0.7	1,008	1.4	12,833	18	35,270	49	8.6	12	15	21
18	Rain tanks small	645	0.8	1,140	1.4	17,289	22	41,501	52	9.4	12	16	20
19	Rain tanks	554	0.8	1,033	1.4	13,658	19	36,424	50	8.7	12	15	21
20	Roof rain garden 15 perct	462	0.7	924	1.4	9,962	15	31,256	47	8.0	12	14	22
21	Roof rain garden 3 perct	719	0.8	1,228	1.4	20,261	23	45,657	53	9.9	12	17	19
22	Small wet pond and biofilt parking 10 perct	787	1.2	914	1.4	26,326	39	31,484	47	6.7	10	8	11
23	Small wet pond and	723	0.9	866	1.1	22,446	29	32,112	42	8.5	11	10	13

	curb biofilters 40 perct												
24	Small wet pond and parking biofilt 10 perct and curb biofilters 40 perct	473	1.2	542	1.3	15,258	38	19,584	49	4.0	10	5	12
25	Small wet pond and rain tanks	554	0.8	698	1.0	13,658	19	20,022	27	8.7	12	10	14
26	Small wet pond and swale	296	0.9	345	1.1	9,032	29	11,335	36	3.4	11	4	13
27	Street cleaning daily	1,011	0.9	1,548	1.4	31,904	29	60,766	56	12.1	11	19	17
28	Street cleaning weekly	1,011	0.9	1,556	1.4	31,904	29	61,145	56	12.1	11	19	17
29	Grass swale	296	0.9	458	1.5	9,032	29	17,014	54	3.4	11	5	17

File Number	Lincoln, NE, Church Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base condition	3.5	3.2	29	27	127	116	210	192	2.2E+14	43,630	2.2E+13	4,363
2	Biofilt parking 10 perct	2.7	4.0	16	23	86	128	131	196	7.3E+13	23,870	7.3E+12	2,387
3	Biofilt parking 3 perct	3.3	3.4	24	24	115	119	182	187	1.8E+14	39,709	1.8E+13	3,971
4	Catchbasin cleaning	3.5	3.2	29	27	127	116	209	191	2.2E+14	43,630	2.2E+13	4,363
5	Curb-cut biofilters 20 perct	2.9	3.2	32	35	106	116	205	225	1.8E+14	43,144	1.8E+13	4,314
6	Curb-cut biofilters 40 perct	2.5	3.2	27	35	90	116	172	223	1.5E+14	43,116	1.5E+13	4,312
7	Curb-cut biofilters 80 perct	1.8	3.2	20	34	66	115	126	221	1.1E+14	43,103	1.1E+13	4,310
8	Disconnected impervious areas	1.1	2.9	10	27	34	89	65	168	9.0E+13	51,871	9.0E+12	5,187
9	Disconnected of half of impervious areas	2.3	3.1	20	27	81	109	137	186	1.5E+14	45,743	1.5E+13	4,574
10	Wet pond 0.85 perct	3.5	3.2	12	11	127	116	153	140	2.2E+14	43,630	2.2E+13	4,363
11	Wet pond 1.7 perct	3.5	3.2	8	7	127	116	141	129	2.2E+14	43,630	2.2E+13	4,363
12	Wet pond 3.4 perct	3.5	3.2	5	5	127	116	133	122	2.2E+14	43,630	2.2E+13	4,363
13	Porous pvt parking half	3.1	3.6	22	25	105	121	168	194	1.4E+14	35,486	1.4E+13	3,549
14	Rain barrels few	3.0	3.0	27	27	110	111	186	188	2.2E+14	47,914	2.2E+13	4,791
15	Rain barrels many	2.5	2.8	25	28	91	104	161	183	2.1E+14	53,634	2.1E+13	5,363
16	Rain barrels	2.8	3.0	26	28	103	109	177	187	2.1E+14	49,791	2.1E+13	4,979
17	Rain tanks large	1.7	2.4	21	30	65	90	124	174	2.1E+14	65,130	2.1E+13	6,513
18	Rain tanks small	2.1	2.6	23	29	79	99	144	180	2.1E+14	58,293	2.1E+13	5,829
19	Rain tanks	1.8	2.4	22	30	67	92	128	175	2.1E+14	63,739	2.1E+13	6,374
20	Roof rain garden 15 perct	1.4	2.1	20	31	55	84	112	169	2.1E+14	70,506	2.1E+13	7,051
21	Roof rain garden 3 perct	2.4	2.8	25	28	89	103	158	183	2.1E+14	54,512	2.1E+13	5,451
22	Small wet pond and biofilt parking 10 perct	2.7	4.0	6	9	86	128	97	145	7.3E+13	23,870	7.3E+12	2,387
23	Small wet pond and curb biofilters 40 perct	2.5	3.2	11	14	90	116	117	152	1.5E+14	43,116	1.5E+13	4,312

24	Small wet pond and parking biofilt 10 perct and curb biofilters 40 perct	1.6	4.0	5	12	51	126	62	155	4.5E+13	24,658	4.5E+12	2,466
25	Small wet pond and rain tanks	1.8	2.4	7	10	67	92	83	113	2.1E+14	63,739	2.1E+13	6,374
26	Small wet pond and swale	1.0	3.2	3	9	36	115	42	133	6.1E+13	43,042	6.1E+12	4,304
27	Street cleaning daily	3.5	3.2	28	26	127	116	202	185	2.2E+14	43,630	2.2E+13	4,363
28	Street cleaning weekly	3.5	3.2	28	26	127	116	205	187	2.2E+14	43,630	2.2E+13	4,363
29	Grass swale	1.0	3.2	8	24	36	115	56	180	6.1E+13	43,042	6.1E+12	4,304

Institutional: Hospital Land Use; Clay Loam Soil

File Number	Lincoln, NE, Hospital Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	18,930,230	0.47	91,871	78	93,759	79	206	0.17	252	0.21	724	0.6
2	Roof rain garden 15 perct	14,227,670	0.35	85,413	96	65,301	74	177	0.20	214	0.24	495	0.6
3	Roof rain garden 3 perct	17,414,290	0.43	89,789	83	84,585	78	196	0.18	240	0.22	650	0.6
4	Catchbasin cleaning	18,930,230	0.47	76,958	65	93,759	79	206	0.17	245	0.21	724	0.6
5	Roof rain garden 15 perct	14,342,230	0.36	85,570	96	65,994	74	177	0.20	215	0.24	500	0.6
6	Connected roof rain garden 3 perct	17,490,560	0.44	89,894	82	85,046	78	197	0.18	240	0.22	653	0.6
7	Curb-cut biofilters 20 perct	17,459,520	0.43	78,950	72	86,774	80	194	0.18	249	0.23	668	0.6
8	Curb-cut biofilters 40 perct	16,281,330	0.41	69,681	69	81,048	80	184	0.18	233	0.23	623	0.6
9	Curb-cut biofilters 80 perct	14,267,420	0.36	55,672	63	71,190	80	165	0.19	205	0.23	546	0.6
10	Disconnected impervious areas	6,460,257	0.16	42,461	105	37,844	94	128	0.32	151	0.38	251	0.6
11	Disconnection of half of impervious areas	13,397,900	0.33	68,131	81	70,053	84	171	0.21	207	0.25	521	0.6
12	Wet pond 0.85 perct	18,930,230	0.47	30,474	26	93,759	79	206	0.17	222	0.19	724	0.6
13	Wet pond 1.7 perct	18,930,230	0.47	16,765	14	93,759	79	206	0.17	215	0.18	724	0.6
14	Wet pond 3.4 perct	18,930,230	0.47	6,738	6	93,759	79	206	0.17	209	0.18	724	0.6
15	Rain barrels few	17,592,190	0.44	90,034	82	85,661	78	198	0.18	241	0.22	658	0.6
16	Rain barrels many	16,120,940	0.40	88,013	87	76,758	76	188	0.19	229	0.23	587	0.6
17	Rain barrels	17,066,120	0.43	89,311	84	82,478	77	194	0.18	237	0.22	633	0.6
18	Rain tanks large	13,902,020	0.35	84,966	98	63,330	73	175	0.20	211	0.24	479	0.6
19	Rain tanks small	15,124,410	0.38	86,644	92	70,727	75	182	0.19	221	0.23	538	0.6
20	Rain tanks	14,289,070	0.36	85,497	96	65,672	74	177	0.20	215	0.24	498	0.6
21	Small wet pond and curb biofilters 40 perct	16,281,330	0.41	24,826	24	81,048	80	184	0.18	201	0.20	623	0.6
22	Small wet pond and	14,289,070	0.36	24,541	28	65,672	74	177	0.20	188	0.21	498	0.6

	rain tanks												
23	Small wet pond and swale	18,255,410	0.45	25,727	23	90,525	79	200	0.18	213	0.19	698	0.6
24	Street cleaning daily	18,930,230	0.47	82,299	70	93,759	79	206	0.17	249	0.21	724	0.6
25	Grass swale	18,255,420	0.45	76,857	67	90,525	79	200	0.18	239	0.21	698	0.6

File Number	Lincoln, NE, Hospital Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	990	0.8	1,550	1.3	30,672	26	62,803	53	14	11	23	20
2	Roof rain garden 15 perct	621	0.7	1,112	1.3	15,882	18	42,124	47	11	12	20	22
3	Roof rain garden 3 perct	871	0.8	1,409	1.3	25,904	24	56,137	52	13	12	22	20
4	Catchbasin cleaning	990	0.8	1,464	1.2	30,672	26	57,679	49	14	11	22	18
5	Roof rain garden 15 perct	630	0.7	1,123	1.3	16,242	18	42,627	48	11	12	20	22
6	Connected roof rain garden 3 perct	877	0.8	1,416	1.3	26,144	24	56,472	52	13	12	22	20
7	Curb-cut biofilters 20 perct	919	0.8	1,459	1.3	28,391	26	67,856	62	12	11	21	19
8	Curb-cut biofilters 40 perct	858	0.8	1,339	1.3	26,458	26	61,278	60	12	11	19	19
9	Curb-cut biofilters 80 perct	754	0.8	1,143	1.3	23,132	26	50,922	57	10	11	16	18
10	Disconnected impervious areas	373	0.9	714	1.8	9,976	25	23,199	58	5	11	9	22
11	Disconnection of half of impervious areas	737	0.9	1,197	1.4	22,534	27	46,091	55	9	11	17	20
12	Wet pond 0.85 perct	990	0.8	1,192	1.0	30,672	26	41,563	35	14	11	17	14
13	Wet pond 1.7 perct	990	0.8	1,105	0.9	30,672	26	36,721	31	14	11	15	13
14	Wet pond 3.4 perct	990	0.8	1,036	0.9	30,672	26	33,099	28	14	11	14	12
15	Rain barrels few	885	0.8	1,425	1.3	26,463	24	56,919	52	13	12	22	20
16	Rain barrels many	770	0.8	1,288	1.3	21,836	22	50,449	50	12	12	21	21
17	Rain barrels	844	0.8	1,376	1.3	24,809	23	54,606	51	12	12	22	20
18	Rain tanks large	595	0.7	1,082	1.2	14,858	17	40,691	47	11	12	19	22
19	Rain tanks small	691	0.7	1,196	1.3	18,702	20	46,067	49	11	12	20	22
20	Rain tanks	626	0.7	1,118	1.3	16,075	18	42,394	48	11	12	20	22
21	Small wet pond and curb biofilters 40 perct	858	0.8	1,034	1.0	26,458	26	38,842	38	12	11	14	14
22	Small wet pond and rain tanks	626	0.7	783	0.9	16,075	18	23,937	27	11	12	13	15

23	Small wet pond and swale	957	0.8	1,129	1.0	29,622	26	38,832	34	13	11	16	14
24	Street cleaning daily	990	0.8	1,513	1.3	30,672	26	61,057	52	14	11	22	19
25	Grass swale	957	0.8	1,429	1.3	29,622	26	56,585	50	13	11	21	19

File Number	Lincoln, NE, Hospital Institutional Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	3.4	2.9	35	29	133	112	233	198	2.6E+14	48,945	2.6E+13	4,894
2	Roof rain garden 15 perct	2.0	2.3	28	32	84	95	167	189	2.6E+14	64,130	2.6E+13	6,413
3	Roof rain garden 3 perct	3.0	2.8	33	30	117	108	212	195	2.6E+14	52,944	2.6E+13	5,294
4	Catchbasin cleaning	3.4	2.9	30	25	133	112	217	184	2.6E+14	48,945	2.6E+13	4,894
5	Roof rain garden 15 perct	2.1	2.3	29	32	85	95	169	189	2.6E+14	63,642	2.6E+13	6,364
6	Connected roof rain garden 3 perct	3.0	2.8	33	30	118	108	213	195	2.6E+14	52,726	2.6E+13	5,273
7	Curb-cut biofilters 20 perct	3.2	2.9	39	36	123	113	242	222	2.4E+14	48,635	2.4E+13	4,863
8	Curb-cut biofilters 40 perct	3.0	2.9	35	34	114	113	219	216	2.2E+14	48,570	2.2E+13	4,857
9	Curb-cut biofilters 80 perct	2.6	2.9	28	31	100	112	184	206	2.0E+14	48,519	2.0E+13	4,852
10	Disconnected impervious areas	1.1	2.8	13	31	38	94	79	196	8.9E+13	48,699	8.9E+12	4,870
11	Disconnection of half of impervious areas	2.5	3.0	24	29	93	111	166	199	1.8E+14	46,476	1.8E+13	4,648
12	Wet pond 0.85 perct	3.4	2.9	14	12	133	112	165	140	2.6E+14	48,945	2.6E+13	4,894
13	Wet pond 1.7 perct	3.4	2.9	9	8	133	112	151	128	2.6E+14	48,945	2.6E+13	4,894
14	Wet pond 3.4 perct	3.4	2.9	6	5	133	112	140	119	2.6E+14	48,945	2.6E+13	4,894
15	Rain barrels few	3.0	2.8	33	30	119	108	215	196	2.6E+14	52,439	2.6E+13	5,244
16	Rain barrels many	2.6	2.6	31	31	104	103	194	193	2.6E+14	56,951	2.6E+13	5,695
17	Rain barrels	2.9	2.7	32	30	114	107	207	195	2.6E+14	53,963	2.6E+13	5,396
18	Rain tanks large	1.9	2.2	28	32	81	93	163	188	2.6E+14	65,562	2.6E+13	6,556
19	Rain tanks small	2.3	2.4	30	31	94	99	180	191	2.6E+14	60,506	2.6E+13	6,051
20	Rain tanks	2.1	2.3	28	32	85	95	168	189	2.6E+14	63,868	2.6E+13	6,387
21	Small wet pond and curb biofilters 40 perct	3.0	2.9	14	14	114	113	151	149	2.2E+14	48,570	2.2E+13	4,857
22	Small wet pond and rain tanks	2.1	2.3	10	11	85	95	108	121	2.6E+14	63,868	2.6E+13	6,387

23	Small wet pond and swale	3.3	2.9	12	11	128	113	156	137	2.5E+14	48,831	2.5E+13	4,883
24	Street cleaning daily	3.4	2.9	33	28	133	112	223	189	2.6E+14	48,945	2.6E+13	4,894
25	Grass swale	3.3	2.9	29	26	128	113	212	186	2.5E+14	48,831	2.5E+13	4,883

Institutional: Hospital Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Hospital Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	18,930,230	0.47	91,871	78	93,759	79	206	0.17	252	0.21	724	0.6
2	Roof rain garden 15 perct	13,027,730	0.32	83,765	103	58,039	71	169	0.21	204	0.25	436	0.5
3	Roof rain garden 3 perct	15,744,900	0.39	87,497	89	74,482	76	186	0.19	226	0.23	568	0.6
4	Catchbasin cleaning	18,930,230	0.47	76,958	65	93,759	79	206	0.17	245	0.21	724	0.6
5	Roof rain garden 15 perct	13,142,300	0.33	83,922	102	58,733	72	170	0.21	205	0.25	442	0.5
6	Roof rain garden 3 perct	15,850,600	0.39	87,642	89	75,122	76	187	0.19	227	0.23	574	0.6
7	Curb-cut biofilters 20 perct	14,698,750	0.37	68,888	75	73,313	80	169	0.18	217	0.24	563	0.6
8	Curb-cut biofilters 40 perct	11,799,670	0.29	54,455	74	59,045	80	141	0.19	179	0.24	451	0.6
9	Curb-cut biofilters 80 perct	7,815,016	0.19	35,419	73	39,306	81	99	0.20	124	0.25	299	0.6
10	Disconnected impervious areas	6,460,257	0.16	42,461	105	37,844	94	128	0.32	151	0.38	251	0.6
11	Disconnection of half impervious areas	13,397,900	0.33	68,131	81	70,053	84	171	0.21	207	0.25	521	0.6
12	Wet pond 0.85 perct	18,930,230	0.47	30,474	26	93,759	79	206	0.17	222	0.19	724	0.6
13	Wet pond 1.7 perct	18,930,230	0.47	16,765	14	93,759	79	206	0.17	215	0.18	724	0.6
14	Wet pond 3.4 perct	18,930,230	0.47	6,738	6	93,759	79	206	0.17	209	0.18	724	0.6
15	Rain barrels few	17,592,190	0.44	90,034	82	85,661	78	198	0.18	241	0.22	658	0.6
16	Rain barrels many	16,120,940	0.40	88,013	87	76,758	76	188	0.19	229	0.23	587	0.6
17	Rain barrels	17,066,120	0.43	89,311	84	82,478	77	194	0.18	237	0.22	633	0.6
18	Rain tanks large	13,902,020	0.35	84,966	98	63,330	73	175	0.20	211	0.24	479	0.6
19	Rain tanks small	15,124,410	0.38	86,644	92	70,727	75	182	0.19	221	0.23	538	0.6
20	Rain tanks	14,289,070	0.36	85,497	96	65,672	74	177	0.20	215	0.24	498	0.6
21	Small wet pond and curb biofilters 40 perct	11,799,670	0.29	18,879	26	59,045	80	141	0.19	154	0.21	451	0.6
22	Small wet pond and	14,289,070	0.36	24,541	28	65,672	74	177	0.20	188	0.21	498	0.6

	rain tanks												
23	Small wet pond and swale	13,630,470	0.34	18,691	22	67,910	80	155	0.18	165	0.19	522	0.6
24	Street cleaning daily	18,930,230	0.47	82,299	70	93,759	79	206	0.17	249	0.21	724	0.6
25	Grass swale	13,630,470	0.34	57,147	67	67,910	80	155	0.18	185	0.22	522	0.6

File Number	Lincoln, NE, Hospital Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	06 inst hospital Linc base	990	0.8	1,550	1.3	30,672	26	62,803	53	14	11	23	20
2	06 inst hospital Linc all roof rain garden 15 perct sandy loam	526	0.6	1,001	1.2	12,108	15	36,847	45	10	12	19	23
3	06 inst hospital Linc all roof rain garden 3 perct sandy loam	740	0.8	1,253	1.3	20,654	21	48,796	50	12	12	21	21
4	06 inst hospital Linc CB	990	0.8	1,464	1.2	30,672	26	57,679	49	14	11	22	18
5	06 inst hospital Linc connt roof rain garden 15 perct sandy loam	535	0.7	1,012	1.2	12,469	15	37,351	46	10	12	19	23
6	06 inst hospital Linc connt roof rain garden 3 perct sandy loam	748	0.8	1,263	1.3	20,986	21	49,260	50	12	12	21	21
7	06 inst hospital Linc curb biofilters 20 sandy loam	777	0.8	1,252	1.4	23,876	26	58,336	64	10	11	18	20
8	06 inst hospital Linc curb biofilters 40 sandy loam	626	0.9	1,006	1.4	19,082	26	46,281	63	8	11	14	19
9	06 inst hospital Linc curb biofilters 80 sandy loam	417	0.9	669	1.4	12,545	26	30,197	62	6	11	9	19
10	06 inst hospital Linc disconnected	373	0.9	714	1.8	9,976	25	23,199	58	5	11	9	22
11	06 inst hospital Linc half disconnected	737	0.9	1,197	1.4	22,534	27	46,091	55	9	11	17	20
12	06 inst hospital Linc pond 085 perct	990	0.8	1,192	1.0	30,672	26	41,563	35	14	11	17	14
13	06 inst hospital Linc pond 17 perct	990	0.8	1,105	0.9	30,672	26	36,721	31	14	11	15	13
14	06 inst hospital Linc pond 34 perct	990	0.8	1,036	0.9	30,672	26	33,099	28	14	11	14	12
15	06 inst hospital Linc rain barrels few	885	0.8	1,425	1.3	26,463	24	56,919	52	13	12	22	20
16	06 inst hospital Linc rain barrels many	770	0.8	1,288	1.3	21,836	22	50,449	50	12	12	21	21

17	06 inst hospital Linc rain barrels	844	0.8	1,376	1.3	24,809	23	54,606	51	12	12	22	20
18	06 inst hospital Linc rain tanks large	595	0.7	1,082	1.2	14,858	17	40,691	47	11	12	19	22
19	06 inst hospital Linc rain tanks small	691	0.7	1,196	1.3	18,702	20	46,067	49	11	12	20	22
20	06 inst hospital Linc rain tanks	626	0.7	1,118	1.3	16,075	18	42,394	48	11	12	20	22
21	06 inst hospital Linc sml pnd and curb biofilters 40 sandy loam	626	0.9	762	1.0	19,082	26	28,494	39	8	11	10	14
22	06 inst hospital Linc sml pnd and rain tanks	626	0.7	783	0.9	16,075	18	23,937	27	11	12	13	15
23	06 inst hospital Linc sml pnd and swale sandy loam	719	0.8	848	1.0	22,126	26	28,858	34	10	11	12	14
24	06 inst hospital Linc street cleaning daily	990	0.8	1,513	1.3	30,672	26	61,057	52	14	11	22	19
25	06 inst hospital Linc swale sandy loam	719	0.8	1,082	1.3	22,126	26	42,395	50	10	11	16	18

File Number	Lincoln, NE, Hospital Institutional Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	06 inst hospital Linc base	3.4	2.9	35	29	133	112	233	198	2.6E+14	48,945	2.6E+13	4,894
2	06 inst hospital Linc all roof rain garden 15 perct sandy loam	1.7	2.1	27	33	72	88	151	185	2.6E+14	69,761	2.6E+13	6,976
3	06 inst hospital Linc all roof rain garden 3 perct sandy loam	2.5	2.5	30	31	100	102	189	192	2.6E+14	58,240	2.6E+13	5,824
4	06 inst hospital Linc CB	3.4	2.9	30	25	133	112	217	184	2.6E+14	48,945	2.6E+13	4,894
5	06 inst hospital Linc connt roof rain garden 15 perct sandy loam	1.7	2.1	27	33	73	89	152	186	2.6E+14	69,179	2.6E+13	6,918
6	06 inst hospital Linc connt roof rain garden 3 perct sandy loam	2.5	2.5	31	31	101	102	190	192	2.6E+14	57,871	2.6E+13	5,787
7	06 inst hospital Linc curb biofilters 20 sandy loam	2.7	2.9	34	37	103	113	207	226	2.0E+14	48,478	2.0E+13	4,848
8	06 inst hospital Linc curb biofilters 40 sandy loam	2.2	2.9	27	36	83	112	164	223	1.6E+14	48,453	1.6E+13	4,845
9	06 inst hospital Linc curb biofilters 80 sandy loam	1.4	2.9	17	36	55	112	107	220	1.1E+14	48,415	1.1E+13	4,841
10	06 inst hospital Linc disconnected	1.1	2.8	13	31	38	94	79	196	8.9E+13	48,699	8.9E+12	4,870
11	06 inst hospital Linc half disconnected	2.5	3.0	24	29	93	111	166	199	1.8E+14	46,476	1.8E+13	4,648
12	06 inst hospital Linc pond 085 perct	3.4	2.9	14	12	133	112	165	140	2.6E+14	48,945	2.6E+13	4,894
13	06 inst hospital Linc pond 17 perct	3.4	2.9	9	8	133	112	151	128	2.6E+14	48,945	2.6E+13	4,894
14	06 inst hospital Linc pond 34 perct	3.4	2.9	6	5	133	112	140	119	2.6E+14	48,945	2.6E+13	4,894
15	06 inst hospital Linc rain barrels few	3.0	2.8	33	30	119	108	215	196	2.6E+14	52,439	2.6E+13	5,244
16	06 inst hospital Linc rain barrels many	2.6	2.6	31	31	104	103	194	193	2.6E+14	56,951	2.6E+13	5,695
17	06 inst hospital Linc	2.9	2.7	32	30	114	107	207	195	2.6E+14	53,963	2.6E+13	5,396

	rain barrels												
18	06 inst hospital Linc rain tanks large	1.9	2.2	28	32	81	93	163	188	2.6E+14	65,562	2.6E+13	6,556
19	06 inst hospital Linc rain tanks small	2.3	2.4	30	31	94	99	180	191	2.6E+14	60,506	2.6E+13	6,051
20	06 inst hospital Linc rain tanks	2.1	2.3	28	32	85	95	168	189	2.6E+14	63,868	2.6E+13	6,387
21	06 inst hospital Linc sml pnd and curb biofilters 40 sandy loam	2.2	2.9	11	14	83	112	111	150	1.6E+14	48,453	1.6E+13	4,845
22	06 inst hospital Linc sml pnd and rain tanks	2.1	2.3	10	11	85	95	108	121	2.6E+14	63,868	2.6E+13	6,387
23	06 inst hospital Linc sml pnd and swale sandy loam	2.5	2.9	9	10	96	112	115	136	1.9E+14	48,562	1.9E+13	4,856
24	06 inst hospital Linc street cleaning daily	3.4	2.9	33	28	133	112	223	189	2.6E+14	48,945	2.6E+13	4,894
25	06 inst hospital Linc swale sandy loam	2.5	2.9	22	26	96	112	158	185	1.9E+14	48,562	1.9E+13	4,856

Residential: Low Density Land Use; Clay Loam Soil

File Number	Lincoln, NE, Low Density Residential Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	7,689,765	0.19	39,608	83	94,097	196	123	0.26	157	0.33	1,201	2.5
2	Roof rain garden 15 perct	6,910,884	0.17	14,158	33	89,431	207	122	0.28	134	0.31	1,056	2.4
3	Roof rain garden 3 perct	7,327,594	0.18	39,495	86	91,927	201	123	0.27	156	0.34	1,133	2.5
4	Catchbasin cleaning	7,689,765	0.19	34,679	72	94,097	196	123	0.26	153	0.32	1,201	2.5
5	Roof rain garden 15 perct	7,211,031	0.18	39,459	88	91,229	203	122	0.27	156	0.35	1,112	2.5
6	Roof rain garden 3 perct	7,526,787	0.19	39,557	84	93,120	198	123	0.26	157	0.33	1,170	2.5
7	Curb-cut biofilters 20 perct	5,059,208	0.13	19,328	61	63,215	200	94	0.30	113	0.36	793	2.5
8	Curb-cut biofilters 40 perct	3,795,389	0.09	11,613	49	47,904	202	75	0.32	87	0.37	596	2.5
9	Curb-cut biofilters 80 perct	2,114,211	0.05	5,733	43	27,257	207	48	0.36	53	0.41	333	2.5
10	Wet pond 1.2 perct	7,689,765	0.19	3,915	8	94,097	196	123	0.26	127	0.26	1,201	2.5
11	Wet pond 0.3 perct	7,689,765	0.19	14,886	31	94,097	196	123	0.26	136	0.28	1,201	2.5
12	Wet pond 0.6 perct	7,689,765	0.19	8,562	18	94,097	196	123	0.26	131	0.27	1,201	2.5
13	Porous pvt driveways	7,251,498	0.18	38,979	86	88,911	196	121	0.27	154	0.34	1,146	2.5
14	Rain barrels few	7,266,649	0.18	39,476	87	91,562	202	123	0.27	156	0.34	1,122	2.5
15	Rain barrels many	7,197,053	0.18	39,454	88	91,145	203	122	0.27	156	0.35	1,109	2.5
16	Rain barrels	7,242,329	0.18	39,468	87	91,416	202	122	0.27	156	0.35	1,117	2.5
17	Rain tanks large	7,147,571	0.18	39,439	88	90,849	204	122	0.27	156	0.35	1,100	2.5
18	Rain tanks small	7,158,739	0.18	39,442	88	90,916	204	122	0.27	156	0.35	1,102	2.5
19	Rain tanks	7,147,501	0.18	39,439	88	90,848	204	122	0.27	156	0.35	1,100	2.5
20	Small wet pond and all roof rain garden 15 perct	6,910,884	0.17	14,158	33	89,431	207	122	0.28	134	0.31	1,056	2.4
21	Small wet pond and curb biofilters 40 perct	3,795,389	0.09	4,894	21	47,904	202	75	0.32	80	0.34	596	2.5

22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	3,231,767	0.08	4,340	22	43,072	214	71	0.35	76	0.37	498	2.5
23	Small wet pond and rain tanks	7,147,501	0.18	14,320	32	90,848	204	122	0.27	135	0.30	1,100	2.5
24	Small wet pond and swale	6,316,665	0.16	10,458	27	77,894	198	107	0.27	116	0.30	988	2.5
25	Street cleaning daily	7,689,765	0.19	16,840	35	94,097	196	123	0.26	139	0.29	1,201	2.5
26	Street cleaning monthly	7,689,765	0.19	31,005	65	94,097	196	123	0.26	150	0.31	1,201	2.5
27	Street cleaning sp fl	7,689,765	0.19	36,428	76	94,097	196	123	0.26	154	0.32	1,201	2.5
28	Street cleaning weekly	7,689,765	0.19	31,005	65	94,097	196	123	0.26	150	0.31	1,201	2.5
29	Grass swale clay loam	6,316,652	0.16	27,329	69	77,894	198	107	0.27	131	0.33	988	2.5

File Number	Lincoln, NE, Low Density Residential Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	511	1.1	816	1.7	16,922	35	31,656	66	35	74	51	107
2	Roof rain garden 15 perct	469	1.1	588	1.4	15,616	36	20,898	48	32	75	38	88
3	Roof rain garden 3 perct	492	1.1	795	1.7	16,315	36	30,933	68	34	74	50	109
4	Catchbasin cleaning	511	1.1	781	1.6	16,922	35	29,840	62	35	74	49	103
5	Roof rain garden 15 perct	486	1.1	788	1.8	16,119	36	30,700	68	34	75	49	109
6	Roof rain garden 3 perct	502	1.1	807	1.7	16,649	35	31,331	67	35	74	51	108
7	Curb-cut biofilters 20 perct	361	1.1	634	2.0	10,827	34	20,632	65	23	74	32	102
8	Curb-cut biofilters 40 perct	280	1.2	454	1.9	8,007	34	13,968	59	18	74	23	96
9	Curb-cut biofilters 80 perct	167	1.3	256	1.9	4,317	33	7,282	55	10	74	12	94
10	Wet pond 1.2 perct	511	1.1	547	1.1	16,922	35	18,420	38	35	74	37	77
11	Wet pond 0.3 perct	511	1.1	636	1.3	16,922	35	22,529	47	35	74	41	86
12	Wet pond 0.6 perct	511	1.1	588	1.2	16,922	35	20,192	42	35	74	39	81
13	Porous pvt driveways	492	1.1	791	1.7	16,249	36	30,621	68	32	71	47	105
14	Rain barrels few	488	1.1	792	1.7	16,213	36	30,811	68	34	75	49	109
15	Rain barrels many	485	1.1	788	1.8	16,096	36	30,672	68	34	75	49	110
16	Rain barrels	487	1.1	790	1.7	16,172	36	30,763	68	34	75	49	109
17	Rain tanks large	482	1.1	785	1.8	16,013	36	30,573	69	33	75	49	110
18	Rain tanks small	483	1.1	785	1.8	16,032	36	30,596	68	33	75	49	110
19	Rain tanks	482	1.1	785	1.8	16,013	36	30,573	69	33	75	49	110
20	Small wet pond and all roof rain garden 15 perct	469	1.1	588	1.4	15,616	36	20,898	48	32	75	38	88
21	Small wet pond and curb biofilters 40 perct	280	1.2	359	1.5	8,007	34	10,567	45	18	74	20	83
22	Small wet pond and	247	1.2	319	1.6	6,934	34	8,997	45	15	75	17	84

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	482	1.1	602	1.4	16,013	36	21,375	48	33	75	39	87
24	Small wet pond and swale	431	1.1	521	1.3	13,760	35	17,716	45	29	74	33	84
25	Street cleaning daily	511	1.1	704	1.5	16,922	35	23,904	50	35	74	42	88
26	Street cleaning monthly	511	1.1	774	1.6	16,922	35	28,727	60	35	74	48	100
27	Street cleaning sp fl	511	1.1	800	1.7	16,922	35	30,573	64	35	74	50	104
28	Street cleaning weekly	511	1.1	774	1.6	16,922	35	28,727	60	35	74	48	100
29	Grass swale clay loam	431	1.1	649	1.6	13,760	35	23,979	61	29	74	40	101

File Number	Lincoln, NE, Low Density Residential Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.5	1.1	2.6	5.5	57	120	83	174	1.0E+14	47,290	1.7E+14	76,410
2	Roof rain garden 15 perct	0.5	1.1	1.2	2.8	47	109	56	130	1.0E+14	52,303	1.7E+14	84,509
3	Roof rain garden 3 perct	0.5	1.1	2.5	5.6	53	115	78	171	1.0E+14	49,488	1.7E+14	79,962
4	Catchbasin cleaning	0.5	1.1	2.4	4.9	57	120	80	167	1.0E+14	47,290	1.7E+14	76,410
5	Roof rain garden 15 perct	0.5	1.1	2.5	5.6	51	113	77	170	1.0E+14	50,243	1.7E+14	81,181
6	Roof rain garden 3 perct	0.5	1.1	2.6	5.5	55	118	81	173	1.0E+14	48,253	1.7E+14	77,966
7	Curb-cut biofilters 20 perct	0.4	1.1	2.4	7.7	38	122	53	169	6.6E+13	45,780	1.1E+14	73,970
8	Curb-cut biofilters 40 perct	0.3	1.2	1.5	6.4	29	123	38	160	4.8E+13	45,010	7.8E+13	72,725
9	Curb-cut biofilters 80 perct	0.2	1.2	0.8	5.9	17	125	21	158	2.6E+13	43,255	4.2E+13	69,890
10	Wet pond 1.2 perct	0.5	1.1	0.8	1.6	57	120	60	125	1.0E+14	47,290	1.7E+14	76,410
11	Wet pond 0.3 perct	0.5	1.1	1.3	2.8	57	120	67	139	1.0E+14	47,290	1.7E+14	76,410
12	Wet pond 0.6 perct	0.5	1.1	1.0	2.1	57	120	63	131	1.0E+14	47,290	1.7E+14	76,410
13	Porous pvt driveways	0.5	1.1	2.5	5.6	57	126	82	181	7.7E+13	37,384	1.2E+14	60,403
14	Rain barrels few	0.5	1.1	2.5	5.6	52	114	77	171	1.0E+14	49,880	1.7E+14	80,594
15	Rain barrels many	0.5	1.1	2.5	5.6	51	113	76	170	1.0E+14	50,335	1.7E+14	81,329
16	Rain barrels	0.5	1.1	2.5	5.6	51	114	77	171	1.0E+14	50,038	1.7E+14	80,849
17	Rain tanks large	0.5	1.1	2.5	5.6	50	113	76	170	1.0E+14	50,664	1.7E+14	81,861
18	Rain tanks small	0.5	1.1	2.5	5.6	50	113	76	170	1.0E+14	50,589	1.7E+14	81,740
19	Rain tanks	0.5	1.1	2.5	5.6	50	113	76	170	1.0E+14	50,664	1.7E+14	81,862
20	Small wet pond and all roof rain garden 15 perct	0.5	1.1	1.2	2.8	47	109	56	130	1.0E+14	52,303	1.7E+14	84,509
21	Small wet pond and curb biofilters 40 perct	0.3	1.2	0.8	3.4	29	123	33	138	4.8E+13	45,010	7.8E+13	72,725
22	Small wet pond and rain grdn 15 prct and	0.2	1.1	0.6	2.9	23	114	26	127	4.5E+13	49,089	7.3E+13	79,316

	curb biofilters 40 perct												
23	Small wet pond and rain tanks	0.5	1.1	1.2	2.8	50	113	59	133	1.0E+14	50,664	1.7E+14	81,862
24	Small wet pond and swale	0.4	1.1	1.0	2.6	47	120	54	137	8.4E+13	46,731	1.4E+14	75,507
25	Street cleaning daily	0.5	1.1	1.6	3.3	57	120	68	142	1.0E+14	47,290	1.7E+14	76,410
26	Street cleaning monthly	0.5	1.1	2.2	4.7	57	120	78	162	1.0E+14	47,290	1.7E+14	76,410
27	Street cleaning sp fl	0.5	1.1	2.5	5.2	57	120	81	169	1.0E+14	47,290	1.7E+14	76,410
28	Street cleaning weekly	0.5	1.1	2.2	4.7	57	120	78	162	1.0E+14	47,290	1.7E+14	76,410
29	Grass swale clay loam	0.4	1.1	1.9	4.8	47	120	65	165	8.4E+13	46,731	1.4E+14	75,507

Residential: Low Density Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Low Density Residential Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	7,689,765	0.19	39,608	83	94,097	196	123	0.26	157	0.33	1,201	2.5
2	Roof rain garden 15 perct	6,770,303	0.17	39,321	93	88,589	210	122	0.29	155	0.37	1,029	2.4
3	Roof rain garden 3 perct	7,073,741	0.18	39,416	89	90,406	205	122	0.28	156	0.35	1,086	2.5
4	Catchbasin cleaning	7,689,765	0.19	34,679	72	94,097	196	123	0.26	153	0.32	1,201	2.5
5	Roof rain garden 15 perct	7,070,451	0.18	39,415	89	90,387	205	122	0.28	156	0.35	1,085	2.5
6	Roof rain garden 3 perct	7,350,377	0.18	39,502	86	92,064	201	123	0.27	156	0.34	1,138	2.5
7	Curb-cut biofilters 20 perct	2,156,234	0.05	10,936	81	27,756	206	48	0.36	59	0.44	340	2.5
8	Curb-cut biofilters 40 perct	881,687	0.02	3,519	64	11,655	212	23	0.41	27	0.48	140	2.5
9	Curb-cut biofilters 80 perct	179,565	0.00	614	55	2,403	214	5	0.44	6	0.50	29	2.5
10	Wet pond 1.2 perct	7,689,765	0.19	3,915	8	94,097	196	123	0.26	127	0.26	1,201	2.5
11	Wet pond 0.3 perct	7,689,765	0.19	14,886	31	94,097	196	123	0.26	136	0.28	1,201	2.5
12	Wet pond 0.6 perct	7,689,765	0.19	8,562	18	94,097	196	123	0.26	131	0.27	1,201	2.5
13	Porous pvt driveways	7,251,498	0.18	38,979	86	88,911	196	121	0.27	154	0.34	1,146	2.5
14	Rain barrels few	7,266,649	0.18	39,476	87	91,562	202	123	0.27	156	0.34	1,122	2.5
15	Rain barrels many	7,197,053	0.18	39,454	88	91,145	203	122	0.27	156	0.35	1,109	2.5
16	Rain barrels	7,242,329	0.18	39,468	87	91,416	202	122	0.27	156	0.35	1,117	2.5
17	Rain tanks large	7,147,571	0.18	39,439	88	90,849	204	122	0.27	156	0.35	1,100	2.5
18	rain tanks small	7,158,739	0.18	39,442	88	90,916	204	122	0.27	156	0.35	1,102	2.5
19	Rain tanks	7,147,501	0.18	39,439	88	90,848	204	122	0.27	156	0.35	1,100	2.5
20	Small wet pond and all roof rain garden 15 perct	6,770,303	0.17	13,906	33	88,589	210	122	0.29	134	0.32	1,029	2.4
21	Small wet pond and curb biofilters 40 perct	881,687	0.02	1,575	29	11,655	212	23	0.41	24	0.45	140	2.5

22	Small wet pond and rain tanks	7,147,501	0.18	14,320	32	90,848	204	122	0.27	135	0.30	1,100	2.5
23	Street cleaning daily	7,689,765	0.19	16,840	35	94,097	196	123	0.26	139	0.29	1,201	2.5
24	Street cleaning monthly	7,689,765	0.19	31,005	65	94,097	196	123	0.26	150	0.31	1,201	2.5
25	Street cleaning sp fl	7,689,765	0.19	36,428	76	94,097	196	123	0.26	154	0.32	1,201	2.5
26	Street cleaning weekly	7,689,765	0.19	31,005	65	94,097	196	123	0.26	150	0.31	1,201	2.5
27	Grass swale	2,066,712	0.05	9,533	74	26,153	203	42	0.32	50	0.39	325	2.5

File Number	Lincoln, NE, Low Density Residential Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	511	1.1	816	1.7	16,922	35	31,656	66	35	74	51	107
2	Roof rain garden 15 perct	462	1.1	763	1.8	15,380	36	29,820	71	32	75	47	112
3	Roof rain garden 3 perct	478	1.1	780	1.8	15,889	36	30,426	69	33	75	49	110
4	Catchbasin cleaning	511	1.1	781	1.6	16,922	35	29,840	62	35	74	49	103
5	Roof rain garden 15 perct	478	1.1	780	1.8	15,884	36	30,420	69	33	75	49	110
6	Roof rain garden 3 perct	493	1.1	796	1.7	16,353	36	30,978	68	34	74	50	109
7	Curb-cut biofilters 20 perct	170	1.3	335	2.5	4,414	33	10,042	75	10	74	15	111
8	Curb-cut biofilters 40 perct	75	1.4	138	2.5	1,728	31	3,610	66	4	74	6	102
9	Curb-cut biofilters 80 perct	16	1.4	28	2.5	345	31	679	61	1	74	1	97
10	Wet pond 1.2 perct	511	1.1	547	1.1	16,922	35	18,420	38	35	74	37	77
11	Wet pond 0.3 perct	511	1.1	636	1.3	16,922	35	22,529	47	35	74	41	86
12	Wet pond 0.6 perct	511	1.1	588	1.2	16,922	35	20,192	42	35	74	39	81
13	Porous pvt driveways	492	1.1	791	1.7	16,249	36	30,621	68	32	71	47	105
14	Rain barrels few	488	1.1	792	1.7	16,213	36	30,811	68	34	75	49	109
15	Rain barrels many	485	1.1	788	1.8	16,096	36	30,672	68	34	75	49	110
16	Rain barrels	487	1.1	790	1.7	16,172	36	30,763	68	34	75	49	109
17	Rain tanks large	482	1.1	785	1.8	16,013	36	30,573	69	33	75	49	110
18	rain tanks small	483	1.1	785	1.8	16,032	36	30,596	68	33	75	49	110
19	Rain tanks	482	1.1	785	1.8	16,013	36	30,573	69	33	75	49	110
20	Small wet pond and all roof rain garden 15 perct	462	1.1	578	1.4	15,380	36	20,556	49	32	75	37	88
21	Small wet pond and curb biofilters 40 perct	75	1.4	104	1.9	1,728	31	2,579	47	4	74	5	86
22	Small wet pond and	482	1.1	602	1.4	16,013	36	21,375	48	33	75	39	87

	rain tanks												
23	Street cleaning daily	511	1.1	704	1.5	16,922	35	23,904	50	35	74	42	88
24	Street cleaning monthly	511	1.1	774	1.6	16,922	35	28,727	60	35	74	48	100
25	Street cleaning sp fl	511	1.1	800	1.7	16,922	35	30,573	64	35	74	50	104
26	Street cleaning weekly	511	1.1	774	1.6	16,922	35	28,727	60	35	74	48	100
27	Grass swale	154	1.2	235	1.8	4,341	34	7,935	62	10	74	13	103

File Number	Lincoln, NE, Low Density Residential Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.5	1.1	2.6	5.5	57	120	83	174	1.0E+14	47,290	1.7E+14	76,410
2	Roof rain garden 15 perct	0.5	1.1	2.4	5.8	45	107	71	167	1.0E+14	53,330	1.7E+14	86,169
3	Roof rain garden 3 perct	0.5	1.1	2.5	5.7	49	111	75	169	1.0E+14	51,163	1.7E+14	82,668
4	Catchbasin cleaning	0.5	1.1	2.4	4.9	57	120	80	167	1.0E+14	47,290	1.7E+14	76,410
5	Roof rain garden 15 perct	0.5	1.1	2.5	5.7	49	111	75	169	1.0E+14	51,186	1.7E+14	82,704
6	Roof rain garden 3 perct	0.5	1.1	2.6	5.6	53	115	79	171	1.0E+14	49,344	1.7E+14	79,728
7	Curb-cut biofilters 20 perct	0.2	1.2	1.3	10.0	17	125	25	186	2.7E+13	43,388	4.3E+13	70,105
8	Curb-cut biofilters 40 perct	0.1	1.2	0.5	8.4	7	129	10	173	1.0E+13	41,140	1.7E+13	66,473
9	Curb-cut biofilters 80 perct	0.0	1.2	0.1	7.5	1	130	2	167	2.0E+12	40,093	3.3E+12	64,781
10	Wet pond 1.2 perct	0.5	1.1	0.8	1.6	57	120	60	125	1.0E+14	47,290	1.7E+14	76,410
11	Wet pond 0.3 perct	0.5	1.1	1.3	2.8	57	120	67	139	1.0E+14	47,290	1.7E+14	76,410
12	Wet pond 0.6 perct	0.5	1.1	1.0	2.1	57	120	63	131	1.0E+14	47,290	1.7E+14	76,410
13	Porous pvt driveways	0.5	1.1	2.5	5.6	57	126	82	181	7.7E+13	37,384	1.2E+14	60,403
14	Rain barrels few	0.5	1.1	2.5	5.6	52	114	77	171	1.0E+14	49,880	1.7E+14	80,594
15	Rain barrels many	0.5	1.1	2.5	5.6	51	113	76	170	1.0E+14	50,335	1.7E+14	81,329
16	Rain barrels	0.5	1.1	2.5	5.6	51	114	77	171	1.0E+14	50,038	1.7E+14	80,849
17	Rain tanks large	0.5	1.1	2.5	5.6	50	113	76	170	1.0E+14	50,664	1.7E+14	81,861
18	rain tanks small	0.5	1.1	2.5	5.6	50	113	76	170	1.0E+14	50,589	1.7E+14	81,740
19	Rain tanks	0.5	1.1	2.5	5.6	50	113	76	170	1.0E+14	50,664	1.7E+14	81,862
20	Small wet pond and all roof rain garden 15 perct	0.5	1.1	1.2	2.8	45	107	54	128	1.0E+14	53,330	1.7E+14	86,169
21	Small wet pond and curb biofilters 40 perct	0.1	1.2	0.2	4.5	7	129	8	148	1.0E+13	41,140	1.7E+13	66,473
22	Small wet pond and rain tanks	0.5	1.1	1.2	2.8	50	113	59	133	1.0E+14	50,664	1.7E+14	81,862

23	Street cleaning daily	0.5	1.1	1.6	3.3	57	120	68	142	1.0E+14	47,290	1.7E+14	76,410
24	Street cleaning monthly	0.5	1.1	2.2	4.7	57	120	78	162	1.0E+14	47,290	1.7E+14	76,410
25	Street cleaning sp fl	0.5	1.1	2.5	5.2	57	120	81	169	1.0E+14	47,290	1.7E+14	76,410
26	Street cleaning weekly	0.5	1.1	2.2	4.7	57	120	78	162	1.0E+14	47,290	1.7E+14	76,410
27	Grass swale	0.1	1.2	0.7	5.1	16	123	22	170	2.6E+13	44,766	4.2E+13	72,331

Residential: Medium Density Residential before 1960 Land Use; Clay Loam Soil

File Number	Lincoln, NE, Medium Density Residential before 1960 Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	8,868,523	0.22	49,063	89	104,623	189	118	0.21	159	0.29	1,384	2.5
2	Roof rain garden 15 perct	7,787,024	0.19	48,726	100	98,144	202	116	0.24	156	0.32	1,183	2.4
3	Roof rain garden 3 perct	8,402,452	0.21	48,918	93	101,831	194	117	0.22	158	0.30	1,297	2.5
4	Catchbasin cleaning	8,868,523	0.22	41,580	75	104,623	189	118	0.21	152	0.28	1,384	2.5
5	Roof rain garden 15 perct	8,123,829	0.20	48,831	96	100,162	198	116	0.23	157	0.31	1,245	2.5
6	Roof rain garden 3 perct	8,622,158	0.22	48,987	91	103,147	192	117	0.22	158	0.29	1,338	2.5
7	Curb-cut biofilters 20 perct	5,527,814	0.14	21,972	64	66,474	193	85	0.25	106	0.31	865	2.5
8	Curb-cut biofilters 40 perct	3,976,026	0.10	12,751	51	48,257	195	66	0.27	78	0.31	623	2.5
9	Curb-cut biofilters 80 perct	2,066,760	0.05	6,017	47	25,637	199	40	0.31	46	0.35	325	2.5
10	Wet pond 0.4 perct	8,868,523	0.22	16,959	31	104,623	189	118	0.21	132	0.24	1,384	2.5
11	Wet pond 0.8 perct	8,868,523	0.22	8,973	16	104,623	189	118	0.21	125	0.23	1,384	2.5
12	Wet pond 1.6 perct	8,868,523	0.22	3,396	6	104,623	189	118	0.21	121	0.22	1,384	2.5
13	Porous pvt driveways	8,300,405	0.21	48,248	93	97,901	189	115	0.22	155	0.30	1,313	2.5
14	Rain barrels few	8,306,307	0.21	48,888	94	101,255	195	117	0.23	157	0.30	1,280	2.5
15	Rain barrels many	8,159,987	0.20	48,842	96	100,378	197	116	0.23	157	0.31	1,252	2.5
16	Rain barrels	8,250,100	0.21	48,870	95	100,918	196	117	0.23	157	0.31	1,269	2.5
17	Rain tanks few	8,075,599	0.20	48,816	97	99,873	198	116	0.23	157	0.31	1,236	2.5
18	Rain tanks large	8,023,911	0.20	48,800	97	99,563	199	116	0.23	157	0.31	1,227	2.5
19	Rain tanks	8,023,835	0.20	48,800	97	99,563	199	116	0.23	157	0.31	1,227	2.5
20	Small wet pond and all roof rain garden 15 perct	7,787,024	0.19	15,878	33	98,144	202	116	0.24	129	0.27	1,183	2.4
21	Small wet pond and curb biofilters 40 perct	3,976,026	0.10	4,841	20	48,257	195	66	0.27	71	0.28	623	2.5

22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	3,248,652	0.08	4,099	20	41,888	207	61	0.30	65	0.32	498	2.5
23	Small wet pond and rain tanks	8,023,835	0.20	15,986	32	99,563	199	116	0.23	130	0.26	1,227	2.5
24	Small wet pond and swale	6,910,908	0.17	11,330	26	82,158	191	98	0.23	107	0.25	1,080	2.5
25	Street cleaning daily	8,868,523	0.22	20,243	37	104,623	189	118	0.21	136	0.25	1,384	2.5
26	Street cleaning monthly	8,868,523	0.22	38,173	69	104,623	189	118	0.21	150	0.27	1,384	2.5
27	Street cleaning sp fl	8,868,523	0.22	45,038	81	104,623	189	118	0.21	155	0.28	1,384	2.5
28	Street cleaning weekly	8,868,523	0.22	27,651	50	104,623	189	118	0.21	142	0.26	1,384	2.5
29	Grass swale	6,910,908	0.17	32,320	75	82,158	191	98	0.23	125	0.29	1,080	2.5

File Number	Lincoln, NE, Medium Density Residential before 1960 Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	546	1.0	889	1.6	19,822	36	37,896	68	41	74	61	111
2	Roof rain garden 15 perct	488	1.0	827	1.7	18,008	37	35,738	74	37	76	57	117
3	Roof rain garden 3 perct	521	1.0	863	1.6	19,040	36	36,966	71	39	75	59	113
4	Catchbasin cleaning	546	1.0	840	1.5	19,822	36	35,157	64	41	74	58	105
5	Roof rain garden 15 perct	506	1.0	846	1.7	18,573	37	36,410	72	38	76	58	115
6	Roof rain garden 3 perct	533	1.0	875	1.6	19,408	36	37,405	70	40	75	60	112
7	Curb-cut biofilters 20 perct	364	1.1	647	1.9	12,098	35	23,555	68	26	75	37	107
8	Curb-cut biofilters 40 perct	270	1.1	442	1.8	8,606	35	15,309	62	19	75	25	100
9	Curb-cut biofilters 80 perct	151	1.2	236	1.8	4,348	34	7,542	58	10	75	13	98
10	Wet pond 0.4 perct	546	1.0	674	1.2	19,822	36	26,130	47	41	74	48	87
11	Wet pond 0.8 perct	546	1.0	619	1.1	19,822	36	23,206	42	41	74	45	81
12	Wet pond 1.6 perct	546	1.0	574	1.0	19,822	36	21,105	38	41	74	43	77
13	Porous pvt driveways	522	1.0	857	1.7	18,948	37	36,556	71	37	71	56	109
14	Rain barrels few	516	1.0	857	1.7	18,879	36	36,774	71	39	75	59	114
15	Rain barrels many	508	1.0	848	1.7	18,633	37	36,482	72	39	76	58	114
16	Rain barrels	513	1.0	854	1.7	18,784	36	36,662	71	39	75	59	114
17	Rain tanks few	504	1.0	844	1.7	18,492	37	36,314	72	38	76	58	115
18	Rain tanks large	501	1.0	841	1.7	18,405	37	36,210	72	38	76	58	115
19	Rain tanks	501	1.0	841	1.7	18,405	37	36,210	72	38	76	58	115
20	Small wet pond and all roof rain garden 15 perct	488	1.0	608	1.3	18,008	37	23,854	49	37	76	43	89
21	Small wet pond and curb biofilters 40 perct	270	1.1	341	1.4	8,606	35	11,196	45	19	75	21	84
22	Small wet pond and	229	1.1	289	1.4	7,191	35	9,172	45	15	76	17	85

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	501	1.0	621	1.2	18,405	37	24,307	49	38	76	44	89
24	Small wet pond and swale	437	1.0	525	1.2	15,317	36	19,547	45	32	75	37	85
25	Street cleaning daily	546	1.0	747	1.4	19,822	36	28,084	51	41	74	50	90
26	Street cleaning monthly	546	1.0	836	1.5	19,822	36	34,189	62	41	74	57	103
27	Street cleaning sp fl	546	1.0	870	1.6	19,822	36	36,526	66	41	74	60	108
28	Street cleaning weekly	546	1.0	784	1.4	19,822	36	30,606	55	41	74	53	95
29	Grass swale	437	1.0	670	1.6	15,317	36	27,277	63	32	75	45	105

File Number	Lincoln, NE, Medium Density Residential before 1960 Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.6	1.1	3.2	5.8	66	118	99	178	1.3E+14	50,420	2.0E+14	81,467
2	Roof rain garden 15 perct	0.5	1.1	3.0	6.1	51	106	84	172	1.3E+14	57,032	2.0E+14	92,150
3	Roof rain garden 3 perct	0.6	1.1	3.1	5.9	59	113	92	176	1.3E+14	53,061	2.0E+14	85,734
4	Catchbasin cleaning	0.6	1.1	2.8	5.1	66	118	93	169	1.3E+14	50,420	2.0E+14	81,467
5	Roof rain garden 15 perct	0.6	1.1	3.0	6.0	56	110	88	174	1.3E+14	54,784	2.0E+14	88,518
6	Roof rain garden 3 perct	0.6	1.1	3.1	5.8	62	116	95	177	1.3E+14	51,780	2.0E+14	83,665
7	Curb-cut biofilters 20 perct	0.4	1.1	2.9	8.5	41	120	60	174	7.7E+13	49,196	1.2E+14	79,489
8	Curb-cut biofilters 40 perct	0.3	1.1	1.8	7.2	30	121	41	164	5.5E+13	48,545	8.8E+13	78,438
9	Curb-cut biofilters 80 perct	0.2	1.2	0.9	6.7	16	124	21	162	2.7E+13	46,837	4.4E+13	75,678
10	Wet pond 0.4 perct	0.6	1.1	1.5	2.7	66	118	77	139	1.3E+14	50,420	2.0E+14	81,467
11	Wet pond 0.8 perct	0.6	1.1	1.1	2.0	66	118	71	129	1.3E+14	50,420	2.0E+14	81,467
12	Wet pond 1.6 perct	0.6	1.1	0.8	1.4	66	118	68	122	1.3E+14	50,420	2.0E+14	81,467
13	Porous pvt driveways	0.6	1.1	3.0	5.9	65	126	97	187	9.3E+13	39,415	1.5E+14	63,686
14	Rain barrels few	0.6	1.1	3.1	5.9	58	112	91	175	1.3E+14	53,642	2.0E+14	86,673
15	Rain barrels many	0.6	1.1	3.0	6.0	56	110	89	174	1.3E+14	54,554	2.0E+14	88,146
16	Rain barrels	0.6	1.1	3.1	5.9	57	111	90	175	1.3E+14	53,989	2.0E+14	87,233
17	Rain tanks few	0.6	1.1	3.0	6.0	55	109	88	174	1.3E+14	55,094	2.0E+14	89,020
18	Rain tanks large	0.5	1.1	3.0	6.0	54	109	87	173	1.3E+14	55,431	2.0E+14	89,564
19	Rain tanks	0.5	1.1	3.0	6.0	54	109	87	173	1.3E+14	55,432	2.0E+14	89,564
20	Small wet pond and all roof rain garden 15 perct	0.5	1.1	1.3	2.7	51	106	62	127	1.3E+14	57,032	2.0E+14	92,150
21	Small wet pond and curb biofilters 40 perct	0.3	1.1	0.9	3.5	30	121	34	137	5.5E+13	48,545	8.8E+13	78,438
22	Small wet pond and	0.2	1.1	0.6	2.9	22	111	25	125	4.9E+13	53,674	8.0E+13	86,724

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	0.5	1.1	1.4	2.7	54	109	65	130	1.3E+14	55,432	2.0E+14	89,564
24	Small wet pond and swale	0.5	1.1	1.1	2.5	51	119	59	136	9.8E+13	49,925	1.6E+14	80,667
25	Street cleaning daily	0.6	1.1	1.9	3.4	66	118	79	143	1.3E+14	50,420	2.0E+14	81,467
26	Street cleaning monthly	0.6	1.1	2.7	4.9	66	118	91	165	1.3E+14	50,420	2.0E+14	81,467
27	Street cleaning sp fl	0.6	1.1	3.0	5.4	66	118	96	173	1.3E+14	50,420	2.0E+14	81,467
28	Street cleaning weekly	0.6	1.1	2.2	4.0	66	118	84	152	1.3E+14	50,420	2.0E+14	81,467
29	Grass swale	0.5	1.1	2.2	5.1	51	119	73	169	9.8E+13	49,925	1.6E+14	80,667

Residential: Medium Density before 1960 Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Medium Density Residential before 1960 Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	8,868,523	0.22	49,063	89	104,623	189	118	0.21	159	0.29	1,384	2.5
2	Roof rain garden 15 perct	7,568,343	0.19	48,658	103	96,834	205	115	0.24	156	0.33	1,142	2.4
3	Roof rain garden 3 perct	8,043,597	0.20	48,806	97	99,681	199	116	0.23	157	0.31	1,231	2.5
4	Catchbasin cleaning	8,868,523	0.22	41,580	75	104,623	189	118	0.21	152	0.28	1,384	2.5
5	Roof rain garden 15 perct	8,123,829	0.20	48,831	96	100,162	198	116	0.23	157	0.31	1,245	2.5
6	Roof rain garden 3 perct	8,352,111	0.21	48,902	94	101,529	195	117	0.22	157	0.30	1,288	2.5
7	Curb-cut biofilters 20 perct	2,037,485	0.05	11,313	89	25,222	198	39	0.30	50	0.39	321	2.5
8	Curb-cut biofilters 40 perct	725,861	0.02	3,155	70	9,189	203	16	0.35	19	0.42	115	2.5
9	Curb-cut biofilters 80 perct	116,597	0.00	451	62	1,492	205	3	0.37	3	0.44	18	2.5
10	Wet pond 0.4 perct	8,868,523	0.22	16,959	31	104,623	189	118	0.21	132	0.24	1,384	2.5
11	Wet pond 0.8 perct	8,868,523	0.22	8,973	16	104,623	189	118	0.21	125	0.23	1,384	2.5
12	Wet pond 1.6 perct	8,868,523	0.22	3,396	6	104,623	189	118	0.21	121	0.22	1,384	2.5
13	Porous pvt driveways	8,300,405	0.21	48,248	93	97,901	189	115	0.22	155	0.30	1,313	2.5
14	Rain barrels few	8,306,307	0.21	48,888	94	101,255	195	117	0.23	157	0.30	1,280	2.5
15	Rain barrels many	8,159,987	0.20	48,842	96	100,378	197	116	0.23	157	0.31	1,252	2.5
16	Rain barrels	8,250,100	0.21	48,870	95	100,918	196	117	0.23	157	0.31	1,269	2.5
17	Rain tanks few	8,075,599	0.20	48,816	97	99,873	198	116	0.23	157	0.31	1,236	2.5
18	Rain tanks large	8,023,911	0.20	48,800	97	99,563	199	116	0.23	157	0.31	1,227	2.5
19	Rain tanks	8,023,835	0.20	48,800	97	99,563	199	116	0.23	157	0.31	1,227	2.5
20	Small wet pond and all roof rain garden 15 perct	7,568,343	0.19	15,434	33	96,834	205	115	0.24	128	0.27	1,142	2.4
21	Small wet pond and curb biofilters 40 perct	725,861	0.02	1,261	28	9,189	203	16	0.35	17	0.38	115	2.5

22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	472,028	0.01	860	29	6,482	220	12	0.41	13	0.44	73	2.5
23	Small wet pond and rain tanks	8,023,835	0.20	15,986	32	99,563	199	116	0.23	130	0.26	1,227	2.5
24	Small wet pond and swale sandy loam	1,756,249	0.04	2,682	24	21,396	195	30	0.27	32	0.29	276	2.5
25	Street cleaning daily	8,868,523	0.22	20,243	37	104,623	189	118	0.21	136	0.25	1,384	2.5
26	Street cleaning monthly	8,868,523	0.22	38,173	69	104,623	189	118	0.21	150	0.27	1,384	2.5
27	Street cleaning sp fl	8,868,523	0.22	45,038	81	104,623	189	118	0.21	155	0.28	1,384	2.5
28	Street cleaning weekly	8,868,523	0.22	27,651	50	104,623	189	118	0.21	142	0.26	1,384	2.5
29	Grass swale	1,756,249	0.04	9,094	83	21,396	195	30	0.27	38	0.34	276	2.5

File Number	Lincoln, NE, Medium Density Residential before 1960 Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	546	1.0	889	1.6	19,822	36	37,896	68	41	74	61	111
2	Roof rain garden 15 perct	477	1.0	814	1.7	17,641	37	35,301	75	36	77	56	118
3	Roof rain garden 3 perct	502	1.0	842	1.7	18,438	37	36,250	72	38	76	58	115
4	Catchbasin cleaning	546	1.0	840	1.5	19,822	36	35,157	64	41	74	58	105
5	Roof rain garden 15 perct	506	1.0	846	1.7	18,573	37	36,410	72	38	76	58	115
6	Roof rain garden 3 perct	519	1.0	860	1.6	18,955	36	36,866	71	39	75	59	113
7	Curb-cut biofilters 20 perct	148	1.2	304	2.4	4,299	34	10,278	81	10	75	15	119
8	Curb-cut biofilters 40 perct	57	1.3	107	2.4	1,485	33	3,208	71	3	75	5	108
9	Curb-cut biofilters 80 perct	9	1.3	17	2.3	235	32	485	67	1	75	1	104
10	Wet pond 0.4 perct	546	1.0	674	1.2	19,822	36	26,130	47	41	74	48	87
11	Wet pond 0.8 perct	546	1.0	619	1.1	19,822	36	23,206	42	41	74	45	81
12	Wet pond 1.6 perct	546	1.0	574	1.0	19,822	36	21,105	38	41	74	43	77
13	Porous pvt driveways	522	1.0	857	1.7	18,948	37	36,556	71	37	71	56	109
14	Rain barrels few	516	1.0	857	1.7	18,879	36	36,774	71	39	75	59	114
15	Rain barrels many	508	1.0	848	1.7	18,633	37	36,482	72	39	76	58	114
16	Rain barrels	513	1.0	854	1.7	18,784	36	36,662	71	39	75	59	114
17	Rain tanks few	504	1.0	844	1.7	18,492	37	36,314	72	38	76	58	115
18	Rain tanks large	501	1.0	841	1.7	18,405	37	36,210	72	38	76	58	115
19	Rain tanks	501	1.0	841	1.7	18,405	37	36,210	72	38	76	58	115
20	Small wet pond and all roof rain garden 15 perct	477	1.0	593	1.3	17,641	37	23,306	49	36	77	42	90
21	Small wet pond and curb biofilters 40 perct	57	1.3	78	1.7	1,485	33	2,180	48	3	75	4	88
22	Small wet pond and	39	1.3	54	1.8	987	34	1,403	48	2	77	3	88

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	501	1.0	621	1.2	18,405	37	24,307	49	38	76	44	89
24	Small wet pond and swale sandy loam	121	1.1	143	1.3	3,782	35	4,792	44	8	75	9	84
25	Street cleaning daily	546	1.0	747	1.4	19,822	36	28,084	51	41	74	50	90
26	Street cleaning monthly	546	1.0	836	1.5	19,822	36	34,189	62	41	74	57	103
27	Street cleaning sp fl	546	1.0	870	1.6	19,822	36	36,526	66	41	74	60	108
28	Street cleaning weekly	546	1.0	784	1.4	19,822	36	30,606	55	41	74	53	95
29	Grass swale	121	1.1	190	1.7	3,782	35	7,161	65	8	75	12	108

File Number	Lincoln, NE, Medium Density Residential before 1960 Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.6	1.1	3.2	5.8	66	118	99	178	1.3E+14	50,420	2.0E+14	81,467
2	Roof rain garden 15 perct	0.5	1.1	2.9	6.2	48	102	81	171	1.3E+14	58,598	2.0E+14	94,681
3	Roof rain garden 3 perct	0.5	1.1	3.0	6.0	55	109	87	174	1.3E+14	55,302	2.0E+14	89,356
4	Catchbasin cleaning	0.6	1.1	2.8	5.1	66	118	93	169	1.3E+14	50,420	2.0E+14	81,467
5	Roof rain garden 15 perct	0.6	1.1	3.0	6.0	56	110	88	174	1.3E+14	54,784	2.0E+14	88,518
6	Roof rain garden 3 perct	0.6	1.1	3.1	5.9	59	113	91	175	1.3E+14	53,364	2.0E+14	86,223
7	Curb-cut biofilters 20 perct	0.1	1.2	1.5	11.6	16	124	25	197	2.7E+13	47,001	4.4E+13	75,943
8	Curb-cut biofilters 40 perct	0.1	1.2	0.4	9.6	6	126	8	181	9.3E+12	45,210	1.5E+13	73,048
9	Curb-cut biofilters 80 perct	0.0	1.2	0.1	8.8	1	127	1	175	1.5E+12	44,369	2.4E+12	71,691
10	Wet pond 0.4 perct	0.6	1.1	1.5	2.7	66	118	77	139	1.3E+14	50,420	2.0E+14	81,467
11	Wet pond 0.8 perct	0.6	1.1	1.1	2.0	66	118	71	129	1.3E+14	50,420	2.0E+14	81,467
12	Wet pond 1.6 perct	0.6	1.1	0.8	1.4	66	118	68	122	1.3E+14	50,420	2.0E+14	81,467
13	Porous pvt driveways	0.6	1.1	3.0	5.9	65	126	97	187	9.3E+13	39,415	1.5E+14	63,686
14	Rain barrels few	0.6	1.1	3.1	5.9	58	112	91	175	1.3E+14	53,642	2.0E+14	86,673
15	Rain barrels many	0.6	1.1	3.0	6.0	56	110	89	174	1.3E+14	54,554	2.0E+14	88,146
16	Rain barrels	0.6	1.1	3.1	5.9	57	111	90	175	1.3E+14	53,989	2.0E+14	87,233
17	Rain tanks few	0.6	1.1	3.0	6.0	55	109	88	174	1.3E+14	55,094	2.0E+14	89,020
18	Rain tanks large	0.5	1.1	3.0	6.0	54	109	87	173	1.3E+14	55,431	2.0E+14	89,564
19	Rain tanks	0.5	1.1	3.0	6.0	54	109	87	173	1.3E+14	55,432	2.0E+14	89,564
20	Small wet pond and all roof rain garden 15 perct	0.5	1.1	1.3	2.7	48	102	58	124	1.3E+14	58,598	2.0E+14	94,681
21	Small wet pond and curb biofilters 40 perct	0.1	1.2	0.2	4.6	6	126	7	148	9.3E+12	45,210	1.5E+13	73,048
22	Small wet pond and	0.0	1.2	0.1	3.5	3	114	4	131	6.9E+12	51,373	1.1E+13	83,007

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	0.5	1.1	1.4	2.7	54	109	65	130	1.3E+14	55,432	2.0E+14	89,564
24	Small wet pond and swale sandy loam	0.1	1.2	0.3	2.5	13	122	15	138	2.4E+13	48,218	3.9E+13	77,910
25	Street cleaning daily	0.6	1.1	1.9	3.4	66	118	79	143	1.3E+14	50,420	2.0E+14	81,467
26	Street cleaning monthly	0.6	1.1	2.7	4.9	66	118	91	165	1.3E+14	50,420	2.0E+14	81,467
27	Street cleaning sp fl	0.6	1.1	3.0	5.4	66	118	96	173	1.3E+14	50,420	2.0E+14	81,467
28	Street cleaning weekly	0.6	1.1	2.2	4.0	66	118	84	152	1.3E+14	50,420	2.0E+14	81,467
29	Grass swale	0.1	1.2	0.6	5.5	13	122	19	176	2.4E+13	48,218	3.9E+13	77,910

Residential: Medium Density 1960 to 1980 Land Use; Clay Loam Soil

File Number	Lincoln, NE, Medium Density Residential 1960 to 1980 Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	7,852,948	0.20	42,226	86	89,983	184	116	0.24	152	0.31	1,251	2.6
2	Rain garden 15 perct	6,368,821	0.16	41,763	105	81,092	204	114	0.29	149	0.37	974	2.5
3	Roof rain garden 3 perct	7,283,096	0.18	42,049	92	86,569	190	115	0.25	151	0.33	1,144	2.5
4	Catchbasin cleaning	7,852,948	0.20	35,498	72	89,983	184	116	0.24	146	0.30	1,251	2.6
5	Rain garden 15 perct	6,682,713	0.17	41,861	100	82,973	199	114	0.27	149	0.36	1,032	2.5
6	Rain garden 3 perct	7,491,871	0.19	42,114	90	87,820	188	116	0.25	151	0.32	1,183	2.5
7	Curb-cut biofilters 20 perct	4,983,596	0.12	19,369	62	58,673	189	87	0.28	105	0.34	795	2.6
8	Curb-cut biofilters 40 perct	3,637,737	0.09	11,446	50	43,389	191	68	0.30	79	0.35	581	2.6
9	Curb-cut biofilters 80 perct	1,950,836	0.05	5,470	45	23,928	197	42	0.35	47	0.39	312	2.6
10	Wet pond 0.4 perct	7,852,948	0.20	13,733	28	89,983	184	116	0.24	128	0.26	1,251	2.6
11	Wet pond 0.8 perct	7,852,948	0.20	7,158	15	89,983	184	116	0.24	123	0.25	1,251	2.6
12	Wet pond 1.6 perct	7,852,948	0.20	2,548	5	89,983	184	116	0.24	119	0.24	1,251	2.6
13	Porous pvt driveways	7,349,756	0.18	41,504	90	84,029	183	114	0.25	149	0.32	1,188	2.6
14	Rain barrels few	7,075,159	0.18	41,984	95	85,324	193	115	0.26	150	0.34	1,106	2.5
15	Rain barrels many	6,799,714	0.17	41,898	99	83,673	197	114	0.27	150	0.35	1,054	2.5
16	Rain barrels	6,972,257	0.17	41,952	96	84,707	195	115	0.26	150	0.34	1,086	2.5
17	Rain tanks large	6,525,240	0.16	41,812	103	82,029	201	114	0.28	149	0.37	1,003	2.5
18	Rain tanks small	6,646,988	0.17	41,850	101	82,759	200	114	0.28	149	0.36	1,026	2.5
19	Rain tanks	6,525,176	0.16	41,812	103	82,029	201	114	0.28	149	0.37	1,003	2.5
20	Small wet pond and all roof rain garden 15 perct	6,368,821	0.16	12,354	31	81,092	204	114	0.29	124	0.31	974	2.5
21	Small wet pond and curb biofilters 40 perct	3,637,737	0.09	4,168	18	43,389	191	68	0.30	72	0.32	581	2.6
22	Small wet pond and	2,697,235	0.07	3,336	20	35,076	208	60	0.36	64	0.38	419	2.5

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	6,525,176	0.16	12,146	30	82,029	201	114	0.28	124	0.31	1,003	2.5
24	Small wet pond and swale	5,978,424	0.15	8,906	24	69,350	186	95	0.26	103	0.28	953	2.6
25	Street cleaning daily	7,852,948	0.20	18,017	37	89,983	184	116	0.24	133	0.27	1,251	2.6
26	Street cleaning monthly	7,852,948	0.20	33,078	67	89,983	184	116	0.24	145	0.30	1,251	2.6
27	Street cleaning sp fl	7,852,948	0.20	38,845	79	89,983	184	116	0.24	149	0.30	1,251	2.6
28	Street cleaning weekly	7,852,948	0.20	24,240	49	89,983	184	116	0.24	138	0.28	1,251	2.6
29	Grass swale	5,978,427	0.15	27,059	73	69,350	186	95	0.26	118	0.32	953	2.6

File Number	Lincoln, NE, Medium Density Residential 1960 to 1980 Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	519	1.1	835	1.7	16,474	34	32,343	66	37	75	54	110
2	Rain garden 15 perct	439	1.1	749	1.9	13,984	35	29,380	74	31	78	48	120
3	Roof rain garden 3 perct	488	1.1	802	1.8	15,518	34	31,206	69	34	76	51	113
4	Catchbasin cleaning	519	1.1	787	1.6	16,474	34	29,833	61	37	75	51	104
5	Rain garden 15 perct	456	1.1	767	1.8	14,511	35	30,007	72	32	77	49	117
6	Rain garden 3 perct	500	1.1	814	1.7	15,868	34	31,622	68	35	75	52	112
7	Curb-cut biofilters 20 perct	353	1.1	638	2.1	10,247	33	21,568	69	23	75	34	109
8	Curb-cut biofilters 40 perct	267	1.2	442	1.9	7,400	33	14,117	62	17	75	23	102
9	Curb-cut biofilters 80 perct	154	1.3	241	2.0	3,868	32	7,093	58	9	75	12	99
10	Wet pond 0.4 perct	519	1.1	631	1.3	16,474	34	21,700	44	37	75	42	86
11	Wet pond 0.8 perct	519	1.1	582	1.2	16,474	34	19,241	39	37	75	39	80
12	Wet pond 1.6 perct	519	1.1	541	1.1	16,474	34	17,455	36	37	75	38	77
13	Porous pvt driveways	497	1.1	806	1.8	15,700	34	31,155	68	33	71	49	108
14	Rain barrels few	477	1.1	790	1.8	15,169	34	30,790	70	34	76	50	114
15	Rain barrels many	462	1.1	774	1.8	14,707	35	30,240	71	32	77	49	116
16	Rain barrels	472	1.1	784	1.8	14,997	34	30,585	70	33	76	50	115
17	Rain tanks large	448	1.1	758	1.9	14,247	35	29,692	73	31	77	48	118
18	Rain tanks small	454	1.1	765	1.8	14,451	35	29,936	72	32	77	49	117
19	Rain tanks	448	1.1	758	1.9	14,247	35	29,692	73	31	77	48	118
20	Small wet pond and all roof rain garden 15 perct	439	1.1	541	1.4	13,984	35	18,621	47	31	78	36	90
21	Small wet pond and curb biofilters 40 perct	267	1.2	336	1.5	7,400	33	9,870	43	17	75	19	84
22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	211	1.3	269	1.6	5,601	33	7,379	44	13	77	14	86

23	Small wet pond and rain tanks	448	1.1	548	1.3	14,247	35	18,814	46	31	77	36	89
24	Small wet pond and swale	408	1.1	483	1.3	12,428	33	15,834	42	28	75	31	84
25	Street cleaning daily	519	1.1	716	1.5	16,474	34	24,100	49	37	75	44	90
26	Street cleaning monthly	519	1.1	790	1.6	16,474	34	29,228	60	37	75	50	102
27	Street cleaning sp fl	519	1.1	818	1.7	16,474	34	31,192	64	37	75	52	107
28	Street cleaning weekly	519	1.1	746	1.5	16,474	34	26,219	54	37	75	46	95
29	Grass swale	408	1.1	618	1.7	12,428	33	22,654	61	28	75	39	104

File Number	Lincoln, NE, Medium Density Residential 1960 to 1980 Areas, Clay Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.6	1.2	2.9	5.9	63	129	92	187	1.1E+14	47,740	1.7E+14	77,136
2	Rain garden 15 perct	0.5	1.1	2.6	6.5	44	110	71	179	1.1E+14	58,208	1.7E+14	94,051
3	Roof rain garden 3 perct	0.5	1.2	2.8	6.1	56	123	84	184	1.1E+14	51,255	1.7E+14	82,816
4	Catchbasin cleaning	0.6	1.2	2.5	5.2	63	129	87	178	1.1E+14	47,740	1.7E+14	77,136
5	Rain garden 15 perct	0.5	1.2	2.7	6.4	48	115	75	181	1.1E+14	55,607	1.7E+14	89,847
6	Rain garden 3 perct	0.5	1.2	2.8	6.0	58	125	87	185	1.1E+14	49,905	1.7E+14	80,635
7	Curb-cut biofilters 20 perct	0.4	1.2	3.2	10.3	40	130	58	188	6.6E+13	46,553	1.1E+14	75,219
8	Curb-cut biofilters 40 perct	0.3	1.2	1.9	8.6	30	131	40	177	4.7E+13	45,897	7.6E+13	74,159
9	Curb-cut biofilters 80 perct	0.1	1.2	0.9	7.8	16	133	21	173	2.4E+13	44,245	4.0E+13	71,490
10	Wet pond 0.4 perct	0.6	1.2	1.3	2.7	63	129	72	148	1.1E+14	47,740	1.7E+14	77,136
11	Wet pond 0.8 perct	0.6	1.2	1.0	2.0	63	129	68	139	1.1E+14	47,740	1.7E+14	77,136
12	Wet pond 1.6 perct	0.6	1.2	0.7	1.5	63	129	65	132	1.1E+14	47,740	1.7E+14	77,136
13	Porous pvt driveways	0.5	1.2	2.8	6.1	63	137	90	197	7.6E+13	36,549	1.2E+14	59,054
14	Rain barrels few	0.5	1.2	2.7	6.2	53	120	81	183	1.1E+14	52,678	1.7E+14	85,116
15	Rain barrels many	0.5	1.2	2.7	6.3	49	116	77	182	1.1E+14	54,698	1.7E+14	88,380
16	Rain barrels	0.5	1.2	2.7	6.2	52	119	79	183	1.1E+14	53,414	1.7E+14	86,305
17	Rain tanks large	0.5	1.1	2.6	6.4	46	112	73	180	1.1E+14	56,881	1.7E+14	91,906
18	Rain tanks small	0.5	1.2	2.6	6.4	47	114	75	181	1.1E+14	55,890	1.7E+14	90,306
19	Rain tanks	0.5	1.1	2.6	6.4	46	112	73	180	1.1E+14	56,881	1.7E+14	91,907
20	Small wet pond and all roof rain garden 15 perct	0.5	1.1	1.1	2.8	44	110	52	130	1.1E+14	58,208	1.7E+14	94,051
21	Small wet pond and curb biofilters 40 perct	0.3	1.2	0.9	3.9	30	131	33	147	4.7E+13	45,897	7.6E+13	74,159
22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	0.2	1.2	0.6	3.3	20	118	22	132	4.0E+13	52,423	6.5E+13	84,703

23	Small wet pond and rain tanks	0.5	1.1	1.1	2.7	46	112	54	131	1.1E+14	56,881	1.7E+14	91,907
24	Small wet pond and swale	0.4	1.2	0.9	2.5	48	130	54	145	8.0E+13	47,193	1.3E+14	76,252
25	Street cleaning daily	0.6	1.2	1.8	3.7	63	129	75	154	1.1E+14	47,740	1.7E+14	77,136
26	Street cleaning monthly	0.6	1.2	2.5	5.1	63	129	86	175	1.1E+14	47,740	1.7E+14	77,136
27	Street cleaning sp fl	0.6	1.2	2.8	5.6	63	129	89	182	1.1E+14	47,740	1.7E+14	77,136
28	Street cleaning weekly	0.6	1.2	2.1	4.3	63	129	80	162	1.1E+14	47,740	1.7E+14	77,136
29	Grass swale	0.4	1.2	1.9	5.2	48	130	66	178	8.0E+13	47,193	1.3E+14	76,252

Residential: Medium Density 1960 to 1980 Land Use; Sandy Loam Soil

File Number	Lincoln, NE, Medium Density Residential 1960 to 1980 Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Runoff Volume (ft^3)	Rv	Part. Solids Yield, TSS (lbs)	Part. Solids Conc., TSS (mg/L)	Filterable Solids Yield, TDS (lbs)	Filterable Solids Conc., TDS (mg/L)	Filterable Phosphorus Yield (lbs)	Filterable Phosphorus Conc. (mg/L)	Total Phosphorus Yield (lbs)	Total Phosphorus Conc. (mg/L)	Nitrate Yield (lbs)	Nitrate Conc. (mg/L)
1	Base conditions	7,852,948	0.20	42,226	86	89,983	184	116	0.24	152	0.31	1,251	2.6
2	Rain garden 15 perct	6,025,180	0.15	41,656	111	79,034	210	113	0.30	148	0.39	910	2.4
3	Rain garden 3 perct	6,792,872	0.17	41,896	99	83,632	197	114	0.27	150	0.35	1,053	2.5
4	Catchbasin cleaning	7,852,948	0.20	35,498	72	89,983	184	116	0.24	146	0.30	1,251	2.6
5	Rain garden 15 perct	6,339,072	0.16	41,754	106	80,914	205	114	0.29	149	0.38	968	2.4
6	Curb-cut biofilters 20 perct	1,942,523	0.05	10,257	85	23,779	196	41	0.34	52	0.43	311	2.6
7	Curb-cut biofilters 40 perct	751,914	0.02	3,114	66	9,475	202	18	0.39	22	0.46	121	2.6
8	Curb-cut biofilters 80 perct	137,687	0.00	503	59	1,758	205	4	0.41	4	0.48	22	2.6
9	Wet pond 0.4 perct	7,852,948	0.20	13,733	28	89,983	184	116	0.24	128	0.26	1,251	2.6
10	Wet pond 0.8 perct	7,852,948	0.20	7,158	15	89,983	184	116	0.24	123	0.25	1,251	2.6
11	Wet pond 1.6 perct	7,852,948	0.20	2,548	5	89,983	184	116	0.24	119	0.24	1,251	2.6
12	Porous pve driveways	7,349,756	0.18	41,504	90	84,029	183	114	0.25	149	0.32	1,188	2.6
13	Rain barrels few	7,075,159	0.18	41,984	95	85,324	193	115	0.26	150	0.34	1,106	2.5
14	Rain barrels many	6,799,714	0.17	41,898	99	83,673	197	114	0.27	150	0.35	1,054	2.5
15	Rain barrels	6,972,257	0.17	41,952	96	84,707	195	115	0.26	150	0.34	1,086	2.5
16	Rain tanks large	6,525,240	0.16	41,812	103	82,029	201	114	0.28	149	0.37	1,003	2.5
17	Rain tanks small	6,646,988	0.17	41,850	101	82,759	200	114	0.28	149	0.36	1,026	2.5
18	Rain tanks	6,525,176	0.16	41,812	103	82,029	201	114	0.28	149	0.37	1,003	2.5
19	Roof rain garden 3 perct	7,082,410	0.18	41,986	95	85,367	193	115	0.26	150	0.34	1,107	2.5
20	Small wet pond and all roof rain garden 15 perct	6,025,180	0.15	11,622	31	79,034	210	113	0.30	123	0.33	910	2.4
21	Small wet pond and curb biofilters 40 perct	751,914	0.02	1,220	26	9,475	202	18	0.39	20	0.42	121	2.6
22	Small wet pond and	427,929	0.01	758	28	6,019	225	13	0.48	14	0.51	66	2.5

	rain grdn 15 prct and curb biofilters 40 perct												
23	Small wet pond and rain tanks	6,525,176	0.16	12,146	30	82,029	201	114	0.28	124	0.31	1,003	2.5
24	Small wet pond and swale	1,414,780	0.04	1,980	22	17,020	193	28	0.31	29	0.33	226	2.6
25	Street cleaning daily	7,852,948	0.20	18,017	37	89,983	184	116	0.24	133	0.27	1,251	2.6
26	Street cleaning monthly	7,852,948	0.20	33,078	67	89,983	184	116	0.24	145	0.30	1,251	2.6
27	Street cleaning sp fl	7,852,948	0.20	38,845	79	89,983	184	116	0.24	149	0.30	1,251	2.6
28	Street cleaning weekly	7,852,948	0.20	24,240	49	89,983	184	116	0.24	138	0.28	1,251	2.6
29	Grass swale	1,414,780	0.04	7,074	80	17,020	193	28	0.31	34	0.38	226	2.6

File Number	Lincoln, NE, Medium Density Residential 1960 to 1980 Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable TKN Yield (lbs)	Filterable TKN Conc. (mg/L)	Total TKN Yield (lbs)	Total TKN Conc. (mg/L)	Filterable Chemical Oxygen Demand Yield (lbs)	Filterable Chemical Oxygen Demand Conc. (mg/L)	Total Chemical Oxygen Demand Yield (lbs)	Total Chemical Oxygen Demand Conc. (mg/L)	Filterable Copper Yield (lbs)	Filterable Copper Conc. (µg/L)	Total Copper Yield (lbs)	Total Copper Conc. (µg/L)
1	Base conditions	519	1.1	835	1.7	16,474	34	32,343	66	37	75	54	110
2	Rain garden 15 perct	421	1.1	729	1.9	13,408	36	28,694	76	30	78	46	123
3	Rain garden 3 perct	462	1.1	774	1.8	14,696	35	30,227	71	32	77	49	116
4	Catchbasin cleaning	519	1.1	787	1.6	16,474	34	29,833	61	37	75	51	104
5	Rain garden 15 perct	438	1.1	747	1.9	13,934	35	29,321	74	31	78	47	120
6	Curb-cut biofilters 20 perct	152	1.3	313	2.6	3,859	32	9,893	82	9	75	15	120
7	Curb-cut biofilters 40 perct	63	1.4	119	2.5	1,453	31	3,314	71	4	75	5	109
8	Curb-cut biofilters 80 perct	12	1.4	21	2.5	263	31	565	66	1	75	1	104
9	Wet pond 0.4 perct	519	1.1	631	1.3	16,474	34	21,700	44	37	75	42	86
10	Wet pond 0.8 perct	519	1.1	582	1.2	16,474	34	19,241	39	37	75	39	80
11	Wet pond 1.6 perct	519	1.1	541	1.1	16,474	34	17,455	36	37	75	38	77
12	Porous pve driveways	497	1.1	806	1.8	15,700	34	31,155	68	33	71	49	108
13	Rain barrels few	477	1.1	790	1.8	15,169	34	30,790	70	34	76	50	114
14	Rain barrels many	462	1.1	774	1.8	14,707	35	30,240	71	32	77	49	116
15	Rain barrels	472	1.1	784	1.8	14,997	34	30,585	70	33	76	50	115
16	Rain tanks large	448	1.1	758	1.9	14,247	35	29,692	73	31	77	48	118
17	Rain tanks small	454	1.1	765	1.8	14,451	35	29,936	72	32	77	49	117
18	Rain tanks	448	1.1	758	1.9	14,247	35	29,692	73	31	77	48	118
19	Roof rain garden 3 perct	478	1.1	790	1.8	15,181	34	30,805	70	34	76	51	114
20	Small wet pond and all roof rain garden 15 perct	421	1.1	517	1.4	13,408	36	17,748	47	30	78	34	91
21	Small wet pond and curb biofilters 40 perct	63	1.4	86	1.8	1,453	31	2,185	47	4	75	4	88
22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	39	1.5	54	2.0	843	32	1,238	46	2	78	2	89

23	Small wet pond and rain tanks	448	1.1	548	1.3	14,247	35	18,814	46	31	77	36	89
24	Small wet pond and swale	106	1.2	124	1.4	2,855	32	3,619	41	7	75	7	84
25	Street cleaning daily	519	1.1	716	1.5	16,474	34	24,100	49	37	75	44	90
26	Street cleaning monthly	519	1.1	790	1.6	16,474	34	29,228	60	37	75	50	102
27	Street cleaning sp fl	519	1.1	818	1.7	16,474	34	31,192	64	37	75	52	107
28	Street cleaning weekly	519	1.1	746	1.5	16,474	34	26,219	54	37	75	46	95
29	Grass swale	106	1.2	164	1.9	2,855	32	5,540	63	7	75	9	107

File Number	Lincoln, NE, Medium Density Residential 1960 to 1980 Areas, Sandy Loam Soil Conditions (100 acres; 4 years of rains)	Filterable Lead Yield (lbs)	Filterable Lead Con. (µg/L)	Total Lead Yield (lbs)	Total Lead Conc. (µg/L)	Filterable Zinc Yield (lbs)	Filterable Zinc Conc. (µg/L)	Total Zinc Yield (lbs)	Total Zinc Conc. (µg/L)	Fecal Coliform Bacteria Yield (count)	Fecal Coliform Bacteria Conc. (#/100 ml)	E. coli Yield (count)	E. coli Conc. (#/100 ml)
1	Base conditions	0.6	1.2	2.9	5.9	63	129	92	187	1.1E+14	47,740	1.7E+14	77,136
2	Rain garden 15 perct	0.4	1.1	2.5	6.7	39	104	66	177	1.1E+14	61,368	1.7E+14	99,156
3	Rain garden 3 perct	0.5	1.2	2.7	6.3	49	116	77	182	1.1E+14	54,751	1.7E+14	88,464
4	Catchbasin cleaning	0.6	1.2	2.5	5.2	63	129	87	178	1.1E+14	47,740	1.7E+14	77,136
5	Rain garden 15 perct	0.5	1.1	2.6	6.5	43	109	71	179	1.1E+14	58,468	1.7E+14	94,471
6	Curb-cut biofilters 20 perct	0.1	1.2	1.6	13.6	16	133	25	209	2.4E+13	44,368	3.9E+13	71,689
7	Curb-cut biofilters 40 perct	0.1	1.3	0.5	10.9	6	134	9	190	9.1E+12	42,610	1.5E+13	68,849
8	Curb-cut biofilters 80 perct	0.0	1.3	0.1	9.7	1	135	2	183	1.6E+12	41,836	2.6E+12	67,597
9	Wet pond 0.4 perct	0.6	1.2	1.3	2.7	63	129	72	148	1.1E+14	47,740	1.7E+14	77,136
10	Wet pond 0.8 perct	0.6	1.2	1.0	2.0	63	129	68	139	1.1E+14	47,740	1.7E+14	77,136
11	Wet pond 1.6 perct	0.6	1.2	0.7	1.5	63	129	65	132	1.1E+14	47,740	1.7E+14	77,136
12	Porous pve driveways	0.5	1.2	2.8	6.1	63	137	90	197	7.6E+13	36,549	1.2E+14	59,054
13	Rain barrels few	0.5	1.2	2.7	6.2	53	120	81	183	1.1E+14	52,678	1.7E+14	85,116
14	Rain barrels many	0.5	1.2	2.7	6.3	49	116	77	182	1.1E+14	54,698	1.7E+14	88,380
15	Rain barrels	0.5	1.2	2.7	6.2	52	119	79	183	1.1E+14	53,414	1.7E+14	86,305
16	Rain tanks large	0.5	1.1	2.6	6.4	46	112	73	180	1.1E+14	56,881	1.7E+14	91,906
17	Rain tanks small	0.5	1.2	2.6	6.4	47	114	75	181	1.1E+14	55,890	1.7E+14	90,306
18	Rain tanks	0.5	1.1	2.6	6.4	46	112	73	180	1.1E+14	56,881	1.7E+14	91,907
19	Roof rain garden 3 perct	0.5	1.2	2.7	6.2	53	120	81	183	1.1E+14	52,627	1.7E+14	85,034
20	Small wet pond and all roof rain garden 15 perct	0.4	1.1	1.0	2.7	39	104	47	124	1.1E+14	61,368	1.7E+14	99,156
21	Small wet pond and curb biofilters 40 perct	0.1	1.3	0.2	5.0	6	134	7	156	9.1E+12	42,610	1.5E+13	68,849
22	Small wet pond and rain grdn 15 prct and curb biofilters 40 perct	0.0	1.2	0.1	3.9	3	119	4	136	6.1E+12	50,375	9.9E+12	81,394

23	Small wet pond and rain tanks	0.5	1.1	1.1	2.7	46	112	54	131	1.1E+14	56,881	1.7E+14	91,907
24	Small wet pond and swale	0.1	1.2	0.2	2.5	12	131	13	146	1.8E+13	45,352	2.9E+13	73,278
25	Street cleaning daily	0.6	1.2	1.8	3.7	63	129	75	154	1.1E+14	47,740	1.7E+14	77,136
26	Street cleaning monthly	0.6	1.2	2.5	5.1	63	129	86	175	1.1E+14	47,740	1.7E+14	77,136
27	Street cleaning sp fl	0.6	1.2	2.8	5.6	63	129	89	182	1.1E+14	47,740	1.7E+14	77,136
28	Street cleaning weekly	0.6	1.2	2.1	4.3	63	129	80	162	1.1E+14	47,740	1.7E+14	77,136
29	Grass swale	0.1	1.2	0.5	5.6	12	131	16	184	1.8E+13	45,352	2.9E+13	73,278