APPENDICES
Appendix A
A-1
Existing Floodplains Map
A-2

Local Floodplain Studies
Floodplain Studies Summary

   a. No stormwater sufficiency addressed. Modeled 4 cross sections in HEC-RAS to
determine if the bridge would change the 100 year base flood elevations and found that
they didn't.

2. Evans Farm Subdivision - Withers & Ravenel - 3/1/2007
   a. Two road culverts were surveyed and "inputted" into the model, though no stormwater
   sufficiency data or conclusions are in the report. Used topo in HecRas to determine 100
   year floodplain boundary.

   a. No stormwater sufficiency addressed. Modeled a 100 year floodplain line using site plan
topography, HEC-RAS, and HydroCAD.
   b. HEC-RAS and HydroCAD models included in CD

   a. Modeled 10, 25, and 100 year storms - connecting the floodplain boundaries to the
Greystone Neighborhood study. Report shows 100 year water surface within 1 ft of
   overtopping road at a culvert
   b. Databases and Hydrolic Model provided in CD

   a. Modeled 100 year storm for the predevelopment and the post development condition.
   Includes cross section for 100 year through 2 culverts.

   a. Model contains both the 100 year storm floodplain boundary and a cross section that
demostrates that the proposed roadway culvert is sufficiently sized for the 100 year storm

7. Weldon Ridge Subdivision - Withers & Ravenel - 5/1/2005
   a. Model performed a HEC-RAS model for two streams that confluence within the project
   boundary. The model includes a cross section at 2 road crossings showing the
   sufficiency of 2 sets of double pipes.

8. Black Creek Greenway Section II - TranSite Consulting Engineers - 12/16/2003
   a. Modeled the 100 year floodplain upstream and downstream of the proposed bridge
crossing.
   b. Report includes floppy disk with HEC-RAS data.

a. Report references a previous culvert analysis for determining 100 year flow. The report models and assesses the stream and culvert based on the built out watershed conditions.

10. Southwest Wake YMCA - Withers & Ravenel - 2/21/2001
   a. Report modeled the 100 year water surface elevation for the Camp Branch Tributary, though not all the way to the FEMA mapping. Report includes modeling of culvert crossing at Holly Springs Rd.

    a. Report modeled the 100 year water surface elevation for UT to Kit Creek and analyzed the sufficiency of a 6 X 12 box culvert under a road crossing.

    a. Report modeled the 100 year water surface elevation for Panther Creek. This model made for Phase V extended the boundary modeled in Phase II. One proposed culvert was modeled in Phase II.

13. Weldon Ridge Subdivision - Withers & Ravenel - 6/1/2005
    a. Report modeled the 100 year water surface elevation of Indian Creek and Cordie Branch through the proposed subdivision. Both streams are not FEMA mapped. HEC-RAS modeling includes culvert analysis.

14. Greystone Neighborhood - Withers & Ravenel - 12/1/2005
    a. Report modeled the 100 year water surface elevation of 3 streams with greater than 50 acres drainage areas. HEC-RAS modeling includes culvert analysis.
    b. Report includes floppy disk with HEC-RAS data.

15. Churchill Estates - Land & Water Design - 6/13/2005
    a. Report modeled the 100 year water surface elevation of a UT to Camp Branch.

    a. Report modeled the 100 year water surface elevation of an un-named stream. One other FEMA stream is within the project area. Includes modeling for culvert replacement design on Alston Avenue.

17. Regency Parkway - Landstar Engineering - 6/1/1999
    a. Report analyzed the response of the culvert under Regency Parkway for the 10, 25, and 100 year storms.

    a. Report analyzed the response of the existing box culvert and the proposed culvert under Maynard Road for the 100 year storm. The peak flows were calculated future zoning conditions.
   a. Report modeled the 100 year water surface elevation of a portion of White Oak Creek.


   a. Report modeled the 100 year water surface elevation for a stream flowing through the Glenkirk subdivision. Report includes an analysis of the sufficiency of a proposed road culvert.

   a. Mapped 100-YR floodplain through property. Mapped 100-YR floodplain through property.

23. Campbell Road - Stewert-Proctor, PLLC - 11/1/2004
   a. There is no narrative, but the floodplain map includes only the FP within the project boundary.

   a. Analyzed proposed conditions for the development of Morris Branch Lake and Dam for the 1/3 PMP (Probable Maximum Precipitation) using a HEC-1 model.

25. Weatherfield Townhomes at Haven Site - Aiken & Yelle Associates PA - 12/7/2006
   a. Study contains no Narrative, but has a floodplain/Drainage area map with cross sections marked on it. The cross sections only extend within the project boundary.

   a. Mapped 100-YR floodplain within project boundary and demonstrated the sufficiency of the stream culvert within the project boundary.

27. Heritage Pines Phase V - Eddy Engineering and Hugh J. Gilleece and Assoc. - 6/10/2003
   a. Mapped floodplain for 300 ft upstream of project all the way through to 300 ft downstream of project. The stream culvert on this site does create a backwater condition during the 100-YR storm event.

   a. Floodplains mapped for streams within project boundary. In addition this study examined two culverts within the boundary.

   a. Mapped 100-YR floodplain through property.
30. UT to Bachelor Branch - Sungate Design Group, PA - 12/3/2004
   a. Mapped 100-YR floodplain through property, no effect on the 100-YR flood by the bridge on site
31. Weycroft - Withers & Ravenel - 4/1/2005
   a. Stormwater Management Report includes water surface elevations for the 1, 10, 50, and 100-YR storms and demonstrated the sufficiency of the proposed stormwater features for the 100-YR storm.
32. Clay Street Crossing @ Walnut Creek - Bass, Nixon, and Kennedy, INC - 1/1/2005
   a. Assessed 100-YR flood stage at the proposed crossing as a result of the downstream backwater condition from existing culvert. The 100-YR flood stage did not exceed the invert of the proposed crossing.
33. The Renaissance at Regency Town Homes - WIthers & Ravenel - 6/1/2005
   a. Report modeled the 25 and 100 year water surface elevation for 2 non-FEMA tributaries to Swift Creek. Report includes an analysis of the sufficiency of a proposed road culvert.
34. The Park at Langston - Withers & Ravenel - 6/1/2007
   a. Report establishes post-development 100 year floodplain boundaries of one stream and one tributary adjacent to project boundary.
35. Busbice Tract - Withers & Ravenel - 10/6/2003
   a. Report establishes post-development 100 year water surface elevation of a stream within the project boundary. Report includes analysis of one road culvert within the subdivision.
36. Estates at Windermere - Withers & Ravenel - 10/6/2003
   a. No narrative included, does include drainage pipe schedule and diagram with hydraulic grade line.
37. Silverton Lake Watershed Study - Withers & Ravenel - 12/1/2006
   a. Format is CD-rom no hard copy.
   b. Format is CD-rom no hard copy.
A-3

Drainage Structure Types
A. Structure Types
Attribute information will be collected for any structure that conveys stormwater. The goal of the inventory is to establish “complete system connectivity” for each watershed in the Town. The following table includes descriptions and example pictures for most of the structure types in the inventory.

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Description</th>
<th>Example Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grate Inlet</td>
<td>Grate inlets can be found in parking lots, roadway medians and along Town streets. These structures are usually located in depressions in the pavement or ground. The survey control point will be the lowest point on the exterior of the grate, centered.</td>
<td></td>
</tr>
<tr>
<td>Curb Inlets</td>
<td>Curb Inlets usually are located along the curb line on most roads and parking lots. This structure typically has one throat to collect runoff, however some curb inlets have two inlets. For a structure to be a curb inlet, it has to be located along a curb or in a parking lot etc. The standard Town curb inlet will have a metal hood the will need to lifted to attribute the structure. The survey control point for these types of curb inlets will be the curbside edge of throat, centered.</td>
<td></td>
</tr>
<tr>
<td>Combination Inlets</td>
<td>Combination Inlets (combo inlets) can usually be found along streets and parking lots. These structures collect stormwater through a “combination” of a grate and an open throat. Any structure that collects stormwater with a grate and throat is considered a combination inlet. The survey control point for these structures is the curbside edge of the throat, centered.</td>
<td></td>
</tr>
<tr>
<td>Yard Inlets</td>
<td>Yard inlets usually have 1-4 openings for stormwater to enter the structure. They are typically located in localized depressions in open, grassy areas to collect stormwater. These structures usually have manholes for access. The survey control point for these structures is centered on the manhole rim. Structures without manholes are considered concrete “slabtop” structures and should be declared inaccessible.</td>
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</tr>
<tr>
<td>Structure Type</td>
<td>Description</td>
<td>Example Photo</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Manhole/Junction Box</td>
<td>Manholes/Junction Boxes are not designed to allow addition flow into the stormwater system. Manholes are placed in a stormwater system for system maintenance, to join two or more stormwater systems, to change the flow direction of a stormwater system, or to increase pipe size(s). The survey control point for these structures is the top of manhole rim, centered.</td>
<td></td>
</tr>
<tr>
<td>Pipe Inlet / Outlet (PipeIO)</td>
<td>Pipe Inlets / Outlets of a storm drain systems are where the stormwater enters or exits a pipe system, respectively. Pipe inlets/outlet structures can be designed to have one of several pipe end sections. If no headwall exists, the survey control point is the top of pipe. If a level headwall exists the survey control point is the top of headwall. The example to the right is a pipe outfall, projecting from fill, flowing into a riprap lined channel.</td>
<td></td>
</tr>
<tr>
<td>Culvert</td>
<td>Culverts typically carry stormwater under roadways. Culverts usually have uniform pipe/barrel sizes, and one entrance and one exit. The example to the right is a double barrel, reinforced concrete box culvert with headwall and flared wingwalls. The survey control point is the top of pipe or top of headwall, as appropriate.</td>
<td></td>
</tr>
<tr>
<td>Bridges</td>
<td>Bridges carry stormwater under roads and highways and typically cross larger streams. This inventory does not include very small bridges such as footbridges and golf course cart path bridges. Bridges can be single span such as the example to the right, or have multiple spans. The survey crew (second-pass) will survey bridges as appropriate.</td>
<td></td>
</tr>
</tbody>
</table>
## Table 1: Structure Types

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Description</th>
<th>Example Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir Spillway</td>
<td>A weir is a low point typically located along the pond dam. A weir spillway can serve as a primary spillway (typically controls the water level in lakes) or serve as an emergency release for high flows. Weir spillways can be concrete, riprap, stone or grass lined. Pictures and comments will be the only attributes collected for these structures. Locations should be submetered, if safely accessible, otherwise location can be established by hand-placing the structure based on available plainmetrics.</td>
<td></td>
</tr>
<tr>
<td>Riser Spillway</td>
<td>Risers typically serve as the primary control structure for waterbodies, but can also be used as emergency spillways for high flows. Risers usually have a low-flow orifice to control the pond level and have an open weir to control high flows. Risers can be round or rectangular. Pictures and comments will be the only attributes collected by the attribute crew. Locations should be submetered, if safely accessible, otherwise location can be established by hand-placing the structure based on available plainmetrics.</td>
<td></td>
</tr>
<tr>
<td>Pipe Spillway</td>
<td>Pipe spillways, when present, typically serve as the primary spillway for a waterbody. These structures are very similar to a pipe inlet (PIPEIO) except they convey water from a waterbody. The survey control point for these structures is the top of pipe or top of headwall, as appropriate.</td>
<td></td>
</tr>
<tr>
<td>Channel - Open</td>
<td>Channels features will be attributed as “Channel” or “Swale/Ditch”. Channels typically are larger, water carrying drainage ways, and have a well-defined geometry. Swales typically convey smaller flows and lack a defined geometry. The sample picture shown here is a “Channel.”</td>
<td></td>
</tr>
</tbody>
</table>
Table 1: Structure Types

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Description</th>
<th>Example Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swale/Ditch – Open Channel</td>
<td>Swales usually carry stormwater from pipe outlets into channels. Swales can be distinguished from channels by the lack of defined geometry and evidence of lower flows.</td>
<td></td>
</tr>
</tbody>
</table>
Stormwater Pipe Condition Maps
Methodology to estimate the age of stormwater infrastructure in the Town of Cary, NC.

1. The first method of estimating the age of stormwater infrastructure for the Town of Cary, NC was conducted by Baker using GIS; specifically, ESRI's Spatial Analyst in conjunction with ArcGIS. Due to the absence of readily available age or historical date attributes for features in spatial databases such as stormwater infrastructure, streets, parcels, or land use, infrastructure age was approximated using the age of nearby buildings as a surrogate that contained dates for when structures were built.

The buildings layer database contains parcel identification numbers that were related and spatially joined to the parcel layer; vacant parcels without structures were not coded with dates and were therefore omitted from further analysis. Those parcels coded with dates were symbolized in ranges spanning up to several decades (decade ranges were used beginning in 1981) to illustrate the spatial chronology of parcels or historical perspective of land use within the Town of Cary. For smaller, more urbanized parcels containing multiple buildings having a variety of dates, older structure dates were used. Dates for conveyance infrastructure within street right-of-ways (ROW) and data gaps within the historical parcel layer were approximated using the Euclidean Allocation function in Spatial Analyst. This function assigns dates to these data gap areas based upon the closest parcel containing a date.

Stormwater infrastructure features were dated with the new date attribute in the historical parcel layer using Zonal Statistics in Spatial Analyst. Zonal Statistics is an overlay in raster format of the stormwater features and the historical parcel layer that provides output summarizing the extent or proportion that each stormwater feature coincides with dated cells from the parcel layer. Stormwater features are assigned dates that have the highest number of cell occurrences from the parcel layer when the two layers are overlaid. As with the historical parcel layer, the stormwater features were symbolized with the same decadal ranges to illustrate spatial and temporal correlations between conveyance features throughout the project area. The analysis resulted in the dating of approximately 96 percent of the stormwater infrastructure database. The remaining four percent that were not dated coincided with parcels lacking dates. These features were also far removed from dated parcel clusters, which provide a higher confidence level for accurately estimating structure age. Of the 96 percent that were dated, about 73 percent coincided or overlaid entirely within cells containing one date from the historical parcel layer; and 23 percent coincided within cells containing only two dates, most of which were dates a few years apart or within the same decadal range.

A key assumption in this analysis is that the building dates coincide with the dates of nearby stormwater conveyance features. This assumption is reasonable when considering a large scale residential development project where the land use changed from an undeveloped use (e.g., forest or agriculture). The assumption may lead to somewhat inaccurate dating when structures were built along more major roads that had probably been there for some time prior to building construction.
NCDOT does not have a record of when stormwater conveyance features owned and maintained by them were constructed.

2. The second method for dating stormwater infrastructures features was implemented by Baker using methodology developed by AECOM for dating the Town of Cary’s water distribution system. Most of the age estimation completed using this methodology was done at the subdivision level, assuming those boundaries represent a large area of development of basically the same age. Age data for buildings were joined/populated to the subdivisions, and then the subdivisions were intersected/spatially joined with the drain lines layer (so the drain lines layer captures the age data of the subdivision they fall within). Drain line features located outside of defined subdivisions that did not intersect subdivision polygons were not originally populated with age data via the spatial join. Instead, these features were populated with age data from adjoining drain line features already containing ages using an iterative process outlined by AECOM that creates a “chain-like” process in identifying ages. This iterative process was followed three times until at least 98 percent of the drain line features were populated with age data. Drain line features lacking age data after the third iteration are drain line features located completely outside of subdivision polygons (in road ROWs) that are not connected to adjoining drain lines containing age data and are therefore isolated. The drain line shape file field titled, “Ave_ave”, is the best representation for estimating the age of drain line features using AECOM’s methodology since it is defined by the average age between the subdivision the drain line falls within and the average age of all the buildings contained within the subdivision boundary.
Infrastructure Sufficiency Summary
Infrastructure Capacity / Sufficiency Analysis

This appendix provides further detail on the infrastructure problems identified in Infrastructure Capacity / Sufficiency Analysis.

GIS shapefiles are available for each of the sources used to identify capacity shortcomings in the stormwater conveyance system infrastructure. The shape file attribute tables are provided below.

The following attribute table is for Conflicts and Infrastructure complaints.shp, which identifies seven locations where pipe size decreases in combination with problem notifications in the PWUT work order database or the engineering report database. Two of these locations could not be confirmed.

<table>
<thead>
<tr>
<th>ID</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pipe conflict (30 inch into 24 inch) downstream of one PWUT and one complaint report of flooding and storm drain blockage.</td>
</tr>
<tr>
<td>1</td>
<td>Pipe conflict (24 inch into 15 inch) near 2 complaint reports of blocked structures and 3 PWUT reports of storm drain blockages and repairs.</td>
</tr>
<tr>
<td>2</td>
<td>Pipe conflict (18 inch into 15 inch) downstream of one PWUT and one complaint report of stormwater blockage. Not confirmed.</td>
</tr>
<tr>
<td>3</td>
<td>Pipe conflict (15 inch into 12 inch) downstream several PWUT reports of storm drain blockage.</td>
</tr>
<tr>
<td>4</td>
<td>Pipe conflict (18 inch into 15 inch) downstream of one PWUT report of storm drain blockage.</td>
</tr>
<tr>
<td>5</td>
<td>Pipe conflict (60 inch into 4 inch) downstream of two PWUT reports of storm drain blockage and repair. Not confirmed.</td>
</tr>
<tr>
<td>6</td>
<td>Pipe conflict (18 inch into 15 inch) near several PWUT reports of storm drain blockages.</td>
</tr>
</tbody>
</table>

The second attribute table is for TCAP_Points2.shp, which includes locations where flooding due to conveyance insufficiencies were identified through the Dewberry TCAP hydraulic model study.
<table>
<thead>
<tr>
<th>ID</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intersection of N. Lake ST. and Pine St. at risk of flooding in 10 yr - 1hr existing storm. Flooding risk to structures around N. side of pond. Flooding affected by undersized pond outlet structure.</td>
</tr>
<tr>
<td>2</td>
<td>Potential flooding because of pipe 6020 which is undersized and creates surcharge at 10 yr storm. Also 15 in pipe receives flow from a 24 inch pipe.</td>
</tr>
<tr>
<td>3</td>
<td>Flooding due to undersized pipes.</td>
</tr>
<tr>
<td>4</td>
<td>Some flooding in backyards and Academy St.</td>
</tr>
<tr>
<td>5</td>
<td>Intersection of Walker St. and Fairview Rd. at risk for 10yr. Flooding affected by headloss associated with 24 inch culverts downstream of Walker St.</td>
</tr>
<tr>
<td>6</td>
<td>S. Harrison and Page St. intersection overtopped by 10 yr. 1hr. future storm events. S. Harrison overtopped at two locations. Flooding headloss associated with 4 box culverts on W. Chatham St.</td>
</tr>
<tr>
<td>8</td>
<td>Pipe system upstream of Harrison undersized. 30in. pipe flows into 24 in. pipe. Down stream of this there is a risk of flooding.</td>
</tr>
<tr>
<td>9</td>
<td>Flooding risk along Old Apex Rd and on W. Chatham St. Flooding at intersection of Chatham st. and High House Rd. is affected by the.</td>
</tr>
<tr>
<td>10</td>
<td>Flooding Risk at South Harrison Ave. and Page St. Flooding Risk due to undersized pipes.</td>
</tr>
<tr>
<td>11</td>
<td>Flooding risk at the NC/Norfork SSouthern Corporation Railroad and nearby area. Flooding is affected by the head loss associated with the.</td>
</tr>
<tr>
<td>12</td>
<td>Flooding risk at W. Johnson St. and Delta Ct. and nearby area. Flooding related to the headloss associated with the 18-inch culverts downstream of W. Johnson St.</td>
</tr>
<tr>
<td>13</td>
<td>Flooding risks at E. Durham Rd. and structures along Chapel Hill Rd, Johnson St., Bowden St., and Academy St. Flooding likely due to an undersized pipe network between pipes 5146 and 5130.</td>
</tr>
<tr>
<td>14</td>
<td>Flooding risk just south of Chapel Hill Rd. and at Sorrell St. Flooding risk likely associated with undersized culverts in surrounding area.</td>
</tr>
<tr>
<td>15</td>
<td>Flooding risk along N. Harrison Ave.,</td>
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</tbody>
</table>
Individual TCAP Building Flood Risk Scores
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Notes:
- "Assumed Use" refers to the assumed use of the building.
- "Map/Build Notes" indicates any additional notes related to mapping or building.
- "Parcel Type" describes the type of parcel.
- "Area [Acres]" indicates the area in acres.
- "Notes" provides additional comments or observations.

Building Risk Table - TCAF Study Area
Town of Cary Stormwater Master Plan
June 2022
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### Data Summary

- **Average**:
  - Avg = 4.0
  - Avg. 4.0
  - Avg. 4.0

- **Range**:
  - Min = 3.5
  - Min. 3.5
  - Min. 3.5

- **SD**:
  - SD = 0.3
  - SD. 0.3
  - SD. 0.3
Appendix B

Impaired Watershed Map
Appendix C

Mecklenburg County Quick-Buy Program Information
Mecklenburg County

2011 Flood Quick Buy Program

Storm Water Services

September 7, 2011
Rainfall – August 5, 2011

- Up to 6.8 inches of rain in 4 hours
- Greatest impact Irwin & Sugar Creek watersheds
Flood Damages

• More than 100 buildings damaged
  – Over 160 units/dwellings impacted
  – About 60 had finished floor flooding

• 2 Fatalities

• 100+ buyout properties
  = No Losses

Homes on Andrill Terrace
Response

• Early warning to emergency responders
• Charlotte Fire Department
  – 100 storm related calls
  – 30 flood rescues
• Damage Assessment Teams
• Federal & State Assistance
2011 Quick Buy

- Similar to 2003 and 2008 Quick Buys
- Reduce future loss of life & property
- Enhance the floodplain benefits
- Reduce emergency response
- Increase resiliency of Charlotte-Mecklenburg
Qualifying Criteria

- Single-family homes
- No Floodplain Ordinance violations
- Flooding in living space or more than 25% in building damage
- Inside Encroachment Area or in vicinity of past buyout areas*

* Note: * New Quick Buy Criteria
Calculation of Offers

• **Without** flood insurance:
  – 2011 tax value* or pre-flood appraisal
  – Minus damages (contractors or adjusters estimate)

• **With** flood insurance:
  – 2011 tax value* or pre-flood appraisal
  – Minus losses (flood insurance claim)

**Note:** * New Quick Buy Criteria
Calculation of Offers

- **All** eligible properties:
  - Credit clean up costs
  - No credit for repairs made
  - Replacement dwelling and moving payments*

**Note:** *New Quick Buy Element*
Proposal $2M funding adequate to address all eligible properties

- Key Elements
  - Inside Encroachment area, greatest to least damage
  - Outside Encroachment area, greatest to least damage
Summary

- 16 to 20 single-family homes will qualify
- Storm Water “Rainy Day” funding available
- SWAC endorsement on Aug 18th
- Offers could begin next week
Locations of Eligible Properties

2011 Quick Buy Potential Areas
- Neighborhood
- Creeks and Streams
- 100 Yr Floodplain
- Watershed Boundaries
Qualifying Criteria Example
MECKLENBURG BOARD OF COUNTY COMMISSIONERS
RESOLUTION
ADOPTING AN ELIGIBILITY & PRIORITIZATION PLAN FOR A VOLUNTARY PROPERTY ACQUISITION PROGRAM FOR FLOODED STRUCTURES FROM THE AUGUST 27 & SEPTEMBER 10, 2008 STORMS

WHEREAS, on December 3, 1997 Mecklenburg County Board of Commissioners adopted the Mecklenburg County Floodplain Management Guidance Document aiming to achieve two objectives: 1) to prevent or reduce the loss of life, disruption of services and damage caused by floods and 2) to preserve and restore the natural and beneficial functions of the floodplain; and

WHEREAS, Mecklenburg County Storm Water Services has relocated over 180 families from the floodplain using a combination of State, Federal and Local funding; and

WHEREAS, on August 27, 2008, approximately 300 single family homes/commercial structures; and 300 multi-family units/dwellings located in the floodplain were flooded; and

WHEREAS, these floodprone properties are located within a FEMA designated Floodplain and are at continued risk of loss of life, disruption of services and damage caused by flooding in the future.

WHEREAS, Mecklenburg County has exhausted all State and Federal funding currently available for the acquisition of structures in the floodplain; now, therefore be it

RESOLVED by the Mecklenburg Board of County Commissioners that the following ELIGIBILITY CRITERIA are approved to establish minimum qualifications for the Voluntary Property Acquisition Program for Flooded Structures from the August 27 and September 10, 2008 storms, and that the following PRIORITIZATION & PROCESS be used to prioritize and present offers to eligible homeowners for the Voluntary Property Acquisition Program for Flooded Structures from the August 27 and September 10, 2008 storms.

ELIGIBILITY CRITERIA
Each single-family residential and commercial structure that was flooded on either August 27 or September 10, 2008 will be considered for acquisition under the Voluntary Property Acquisition Program if the following criteria are met:

STORM WATER SPECIAL REVENUE FUND CRITERIA
- Extent to which the structure is Damaged or Substantially Damaged as such terms are defined in the City of Charlotte and Mecklenburg County Floodplain Ordinances. The structure has either flood damage within the living space, or flood damage of 25% or greater than the value of the structure prior to the flood event. The Substantial Damage definition in the Floodplain Ordinance states if repairs to the structure are 50% or greater than the value of the structure prior to the flood event, or if repairs/improvements in two separate occasions (each 25% or greater) during a 10-year period, then the structure has suffered Substantial Damage;
- The structure is located in the Community Encroachment Area portion of the floodplain; and
- The property does not have finished living space that is in violation of Floodplain Regulations, and was subsequently damaged by one of the floods.
PARK & RECREATION CRITERIA

- Identified in the greenway/park master plan
- Structures located in the following geographic priority areas for future greenway
  1. Commonwealth to Harbinger Ct (along Briar Creek)
  2. Dunlavin Way “A” – Harrow Place to Country Club Dr (along Briar Creek)
  3. Dunlavin Way “B” – Harrow Place to Eastway Dr (along Briar Creek)
  4. Other future greenway needs along Briar Creek identified in Greenway Master Plan
- Structures located in the following geographic priority areas for future park (dependant upon passage of 2008 Park and Recreation Bonds)
  1. Shannonhouse Dr to Galway Ct (along Briar Creek)

PRIORITIZATION & PROCESS

Mecklenburg County will present offers to participate in the Voluntary Property Acquisition Program based on the following:

(a) for properties **without** flood insurance, the fair market value as of August 26, 2008 (pre-flood value) or September 9, 2008 (pre-flood value) depending on which flood impacted the structure; minus damages caused by the flood based on information provided by either the property owner’s contractor or independent adjuster retained by the County as determined by the County to be an accurate assessment of the value of the damages.

(b) for properties **with** flood insurance, the fair market value as of August 26, 2008 (pre-flood value) or September 9, 2008 (pre-flood value) depending on which flood impacted the structure, minus the Actual Cash Value Loss (Damages) listed on the Flood Insurance Claim.

The funding sources will be from Storm Water Special Revenue Fund (Available Fund Balance), or various Park & Recreation Bonds.

STORM WATER SPECIAL REVENUE FUND PRIORITIZATION

Due to limited Storm Water Funding, the County will prioritize the order in which property owners will be presented an opportunity to present the County with an offer to sell. The following prioritization will be used to make offers for those owners of properties that meet the STORM WATER SPECIAL REVENUE FUND ELIGIBILITY CRITERIA until appropriated funds are exhausted. Property owners that have rejected a previous grant funded offer by the County to acquire their property will be placed in the third category below.

1. Structures within the Community Encroachment Area that have been Substantially Damaged
2. Structures within the Community Encroachment Area that have damages of 25% or greater than the value of the structure prior to the flood event
3. Other structures meeting the STORM WATER SPECIAL REVENUE FUND CRITERIA in the vicinity of areas listed under the PARK & RECREATION ELIGIBILITY CRITERIA
4. Other structures meeting the STORM WATER SPECIAL REVENUE FUND CRITERIA.

PARK & RECREATION PRIORITIZATION

Due to limited Park & Recreation Bond Funding, the County will prioritize the order in which property owners will be presented an opportunity to present the County with an offer to sell. The following prioritization will be used to make offers to those owners of properties that meet the PARK & RECREATION ELIGIBILITY CRITERIA.

1. Geographic priority (listed in Eligibility)
2. Adjacent to existing public land
3. Provides connectivity between eligible storm water purchases
Acquisition will proceed in chronological order based upon the criteria as described in the ELIGIBILITY CRITERIA and offers to participate in the Program will be made as described in the PRIORITIZATION & PROCESS. Property owners will have twenty-one (21) days to sign or reject an offer to participate in the Program. If the homeowner does not respond within twenty-one (21) days, funds will no longer be reserved for that acquisition and the opportunity to present the County with an offer to sell will be invalid. Offers to participate in the Program will be made until available funds are exhausted. Property owners who fail to respond within twenty-one (21) days will be given another chance to participate in the Program once offers to participate have been made to all property owners meeting the ELIGIBILITY CRITERIA, if funds are still available at that time.

ADOPTED the 16th day of September 2008.

Approved as to form:

_________________________________________
County Attorney

CERTIFICATION

I, Janice S. Paige, Clerk of the Board of Commissioners of Mecklenburg County, DO HEREBY CERTIFY that the foregoing is a true and exact copy of a resolution adopted by the Board of Commissioners, in regular session convened on the 16 day of September, 2008.

WITNESS my hand and the seal of the County of Mecklenburg, North Carolina, this the day of , 2008.

_________________________________________
Janice S. Paige, Clerk to the Board
Appendix D

Sample Stormwater Materials

City of Portland, OR

City of Austin, TX

Naperville, IL
How to manage stormwater

Rain Gardens

stormwater management for clean rivers
How to build a residential rain garden

Portland gets an average of 37 inches of rain a year. Rain that runs off your roof or patio can flow into a sewer pipe, stream or groundwater. Why not put it to better use? You can create an attractive rain garden in your yard that captures runoff and lets it to soak into the ground. Containing rainwater from hard surfaces on your property also reduces wear and tear on the sewer system and protects water quality in local streams and groundwater.

What is a rain garden?
A rain garden is a shallow depression that collects rainwater and is often planted with native plants. They can blend with your existing landscape, and design can be formal or informal. A rain garden is a great place to direct the water from disconnected downspouts or paved areas, or to capture the overflow from a rainwater harvesting system.

Other brochures in this series show you How to disconnect downspouts, build a soakage trench, or rain barrel to manage the stormwater runoff. Refer to the resources section on page 7 to learn how to get copies.

Why plant a rain garden?
When rain falls, it washes over roofs, driveways and other impervious surfaces. If stormwater runoff isn’t managed properly, it can wash dirt, oil and chemicals into rivers, streams and groundwater.

A rain garden that filters pollutants as water soaks into the ground also replenishes groundwater, helps reduce flooding and erosion in streams, keeps sewers from backing up into basements, and reduces combined sewer overflows (CSOs). Rain gardens can also provide habitat for birds, butterflies, and beneficial insects, like bees.

Are there incentives?
A rain garden can save you money. When you contain the rain on your property, you could qualify for a discount on your city utility bill’s on-site stormwater management fee.

How to begin
Start by learning about your site and preparing a good plan to ensure that the plants in your rain garden thrive and stormwater soaks into the ground. This brochure describes an easy, four step process to help you create your rain garden. See the resources section for more information on managing stormwater safely on your property.
1 observe your site

Are your roof downspouts already disconnected to your lawn? Are they connected to the sewer system or a drywell? Does your driveway runoff go into your yard or into the street? Locate your rain garden where it will intercept and collect the most runoff.

Draw What You See

- Sketch a site plan. You can start by printing an aerial view of your property from www.portlandmaps.com.
- Mark the locations of downspouts and paved areas. You can always move a downspout and re-grade gutters so the rain drains to a suitable location to build your rain garden, such as landscaped or lawn areas.
- Estimate the square footage of your roof area and pavement that will drain to the rain garden.
- Map out where you might construct a rain garden. Choose spots that are down slope of the downspouts or paved areas that will drain to the rain garden.

Safety Considerations

- **Call before you dig.** Make sure you don’t damage underground utilities by digging a rain garden. Call 1-800-332-2344 to locate all underground utilities. The service is free.
- You may need to add or remove soil to make sure that the slope of the ground allows water to flow away from buildings, including your house and garage.
- Disconnected downspouts must discharge water at least six feet from a building’s basement and two feet from a building’s crawl space or concrete slab foundation.
- Water in your rain garden must be at least five feet away from neighboring properties and three feet away from public sidewalks.
- Do not locate the rain garden over a septic system, drain field or underground oil tank unless they have been decommissioned.

- Avoid building a rain garden in an area that is too small for good drainage or too close to a retaining wall.

Other Factors To Consider

- It’s easier to build a rain garden in a relatively flat area.
- A naturally low spot with good drainage is ideal for a rain garden because water already ends up there.
- Avoid building a rain garden where water ponds, because that indicates that soils don’t drain well.
- Consider removing paved surfaces to create space for a rain garden, or replacing pavement or concrete with pavers or gravel where appropriate.
- Avoid placing rain gardens underneath the canopy of existing trees.

You do not need city permits to construct a residential rain garden if:

- You don’t excavate or remove more than 10 cubic yards of dirt (that’s about enough to fill one standard size dump truck);
- You don’t disturb over 500 square feet of landscape area (about the size of a small two-car garage);
- Your property has less than a 10% slope (see “Measuring slope”);
- Your property is not within 50 feet of a wetland or waterbody;
- Your property is not in a floodplain; or
- You do not install underground piping (such as soakage trenches or French drains).

If any of these conditions do apply to your property, you may need to include additional options to safely manage stormwater. See the brochures resources section for more information on managing stormwater safely on your property.
**2 Design Your Rain Garden**

Add your rain garden to your existing site plan. Mark where you might move downspouts, where stormwater comes from and flows to, and where you might add or move plants.

Make sure your rain garden is large enough to drain the water directed to it within 36 hours. This keeps water from stagnating and mosquitoes from breeding. Size your rain garden to be at least 10% of the area that drains to it.

* For example, if 500 square feet of rooftop drains to your rain garden, the rain garden should be at least 50 square feet.

```
roof area  sizing factor  rain garden size
500 sq. ft.  x 10%  = 50 sq. ft. (or 5' x 10')
```

If your soils drain slowly, your rain garden may need to be larger.

**Test Your Soils**

Dig a hole two feet deep and two feet wide where the deepest part of the rain garden will be. Fill the hole with water and let it drain completely. Fill it again and monitor how fast the water drains. If it drains within 24 hours, this is a good spot to locate a rain garden. It’s a good idea to dig a couple of holes to see if drainage in your yard is uniform.

Sand, gravel or compost can improve drainage. Till in a mix of two thirds sandy loam topsoil and one third compost to improve conditions for plant growth. Blend it well to a depth of 18 inches to loosen compacted soil and allow plant roots to establish more quickly.

**Direct Water Away From Your House**

An above-ground pipe is the easiest way to convey water from your downspout to your rain garden. Metal downspout material is durable and easy to find at hardware stores. Make sure that materials you use are sturdy and made for outdoor conditions (no dryer hose or indoor tubing). Suggested materials include cast iron and Schedule 40 ABS or PVC. If you are draining less than 1,500 square feet of roof to your rain garden, you should use 3-inch pipe. If you are draining more roof area, use 4-inch pipe. You may want to:

- Direct the water into a shallow conveyance swale (make sure the swale is lined if it’s close to buildings);
- Build a rock-lined swale that looks like a dry creek bed;
- Carve a channel in a piece of flagstone;
- Send water through a piece of bamboo into a container or let it splash onto a rock; or
- Use a concrete or plastic splashblock.

Plan where the rain garden will overflow when it’s full. Make sure excess water will flow away from buildings and neighboring properties. You may need to use additional stormwater management options to handle the overflow or if you only have a small area available for a rain garden. See this brochures resources section for more information on managing stormwater safely on your property.
Plan in advance where the rain garden will overflow if it ever gets completely full. Make sure excess water will flow away from buildings and neighboring properties.

**Choose Your Plant Palette**

Plants are an important living feature of rain gardens. They filter pollutants and keep soil in place. Plant root systems loosen soil and improve drainage. They stimulate biological activity that helps the soil break down pollutants and increase runoff infiltration and retention. There are a wide variety of native plants that resist disease and provide wildlife habitat. Many non-native plants will also work well in your rain garden.

Choose plants suitable for the different water levels of your rain garden. In the bottom two thirds, use plants like wetland rushes and sedges that can tolerate lots of water. Upland plants that need less water will do well in the upper one third. Dogwoods, spirea and flowering currants are good choices. Keep in mind the height and width of the plants when they mature when you make your selections.

Native plant nursery professionals or garden clubs can help you choose plants that are best suited for your garden based on soil, sunlight and your design. Take your site sketch with you when you purchase your plants.
3 building it

Now you’re ready to start.

A Use string and stakes to outline the area you’re going to dig.

B Moist the hard soils with a garden hose to make digging easier. Dig up existing grass and plants. Set aside any plants you might be able to replant in the rain garden.

C Dig the entire rain garden about 18 inches deep to loosen soil, then add a few inches of soil, sloping the sides at about 20% (or at a ratio of 3:1) to reduce the risk of erosion and soil falling back into the bottom of the rain garden.

D The minimum suggested depth of the finished rain garden should be 6 to 12 inches. The deepest part of your rain garden should be furthest from buildings, a suggested ten foot distance.

E Plant your rain garden. Use a variety of species and plant densely to make it harder for weeds to take root and to reduce soil erosion. After planting, add some compost to prevent erosion and provide nutrients to plants. Consider using weed-free straw for soil cover during the first winter.

F Disconnect your downspouts. After the plants are established in a few months, disconnect your downspouts to water your new rain garden.

Measuring a slope

Tie a level string from a stake pounded into the ground at an uphill spot to a stake pounded into the ground downhill. Measure the distance between the stakes (width) and from the string to the ground at the downhill stake to the ground (height). Divide the height by the width to get the slope in decimal format. Multiply this by 100 to obtain the percent.

Example drawing:

If the width is 10 feet and height is 6 inches, then your slope is 5%.

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<th>Height</th>
<th>Width</th>
<th>percentage</th>
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<td>6 inches (0.5 feet)</td>
<td>10 feet</td>
<td>0.05 x 100</td>
<td>5%</td>
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</table>

- Make the main basin of the garden as level as possible so that water spreads evenly.
- If the garden is on a slight slope, add a berm on the downhill slope to hold in rainwater.
- Use plastic or concrete splashblocks, rocks or boulders at the end of downspouts to control erosion and add visual interest.
4 maintenance

Maintain your rain garden regularly as you would with any other kind of garden. After the garden is established in one to three years, maintenance should be minimal. Inspect your rain garden periodically, especially after a heavy rain.

- Irrigate deeply once a week during dry months to encourage root growth and keep plants strong, especially while plants are getting established.
- Avoid chemical weed killers or fertilizers in stormwater management facilities. Pull weeds by hand before they become established.
- Remove sediment and debris, watch for erosion, and replace plants as needed.
- Add compost or mulch two to three inches deep once a year to boost stormwater infiltration and feed the plants.

Be Flexible
If a plant isn’t thriving where you first placed it, move it to another part of the rain garden. Some areas in a rain garden will be wetter or drier than others. Sometimes it isn’t easy to tell where a plant will grow best until it’s rained a few times. A rain garden is a living system, so go with the flow.

resources

Clean River Rewards
Clean River Rewards is Portland’s stormwater discount program. When you contain the rain safely on your property, you qualify for an on-site stormwater management charge discount on your city utility bill. Go to www.CleanRiverRewards.com or call 503-823-1371 for more information.

At www.CleanRiverRewards.com, you can download publications to help you plan, build and maintain your stormwater management options, and find other technical assistance information and useful links.

Download all the How to brochures at www.CleanRiverRewards.com

More Resources

Rain Garden Network
www.raingardenetwork.com/

East Multnomah Soil and Water Conservation District
http://emswcd/raingarden

Rain Garden Examples
For inspiration, check out these beautiful rain gardens:
- Glencoe Elementary School, 825 SE 51st Avenue
- Mt. Tabor Elementary School, 5800 SE Ash
- Hayhurst Elementary School, 5037 SW Iowa
- Astor Elementary School, 5601 N Yale
- Whitaker Ponds, 7040 NE 47th Avenue
- East Multnomah Soil and Water Conservation District, 5211 N Williams Avenue

Walk through your neighborhood. You may be surprised at the number of yards that already have something similar. Ask neighbors about their rain gardens to see what worked for them.
Environmental Services
Dan Saltzman, Commissioner
Dean Marriott, Director

1120 SW Fifth Avenue
Portland Oregon, 97204

503-823-7740
www.cleanriverspdx.org

Other publications in this brochure series:
How to manage stormwater - Downspout Disconnection
How to manage stormwater - Soakage Trenchs
How to manage stormwater - Rain Barrels

To help ensure equal access to city programs, services, and activities, the city will reasonably accommodate persons with disabilities. Call 503-823-7740 or 1-800-735-2900 with such requests. TDD 503-823-6868.
1) PORTLAND BUILDING
2) HAMILTON WEST APARTMENTS
3) NATIVE AMERICAN STUDENT AND COMMUNITY CENTER
4) MERIWETHER CONDOMINIUMS
5) MULTNOMAH COUNTY BUILDING
6) HAWTHORNE HOSTEL
7) BUCKMAN TERRACE APARTMENTS
8) METRO REGIONAL CENTER
9) WHITAKER PONDS
10) CATHEDRAL PARK PLACE
ECOROOFs

An ecoroof is a lightweight, self-sustaining roof system consisting of vegetation and 2-6 inches of soil.

Ecoroofs provide multiple benefits, including:

- Mitigating stormwater peak flows, reducing flow volumes and improving water quality.
- Absorbing heat and reducing the urban heat island effect.
- Creating habitat for birds and invertebrates.
- Insulating structures and conserving energy by lowering heating and cooling needs.
- Absorbing carbon and producing oxygen.
- Filtering particulates from the air.

A BRIEF HISTORY OF ECOROOFs IN PORTLAND

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>First ecoroof installed on a residential garage.</td>
</tr>
<tr>
<td>1999</td>
<td>The ecoroof is officially recognized as a stormwater management technique. Hamilton Apartments ecoroofs are completed and monitoring begins.</td>
</tr>
<tr>
<td>2001</td>
<td>Zoning code is amended to include ecoroofs as a floor area ratio bonus option in the central city.</td>
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<tr>
<td>2004</td>
<td>City sponsors Greening Rooftops Conference in Portland</td>
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<tr>
<td>2005</td>
<td>Green Building Resolution adopted stating all city-owned buildings will have at least 70% ecoroof coverage.</td>
</tr>
<tr>
<td>2006</td>
<td>The Clean River Rewards program begins, offering stormwater fee reductions for ecoroofs.</td>
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</tbody>
</table>
ECOROOFs

A River Renaissance

The Willamette River is at the heart of Portland’s economy, history, landscape and culture. Growth and prosperity have placed a heavy burden on Willamette Valley rivers and streams. These waterways and their fish runs face many critical challenges: pollution, sewer overflows, erosion, and the loss of trees and wildlife habitat.

Ecoroofs are an important part of Portland's efforts to reduce the negative impact of unmanaged stormwater runoff on rivers and streams.

Environmental Services and the Office of Sustainable Development promote the use of ecoroofs, research ecoroof technology and give information and technical assistance to building owners who are considering installing an ecoroof.

Portland’s Ecoroof Program

Research
Environmental Services monitors and evaluates ecoroofs in Portland to gather data on how effective they are in reducing stormwater runoff and improving water quality.

Education
Environmental Services staff provide technical assistance, tours, presentations and online resources for interested citizens and people installing ecoroofs.

Funding
City grants have funded ecoroofs ranging from high rise apartment complexes and office buildings to small park shelters and community based projects.

Policy
The City encourages ecoroof construction through building and zoning codes. New development is required to treat all stormwater on site and an ecoroof is an approved treatment facility. Development in the nine square miles of central Portland is eligible for Floor Area Ratio bonuses for installing an ecoroof. Through Clean River Rewards, stormwater fee discounts are available to properties that reduce impervious area with ecoroofs.
1. The Portland Building  1120 SW 5th Ave.

Type: Reroof  
Completed: 2006  
Ecoroof square footage: 18,000  
Soil depth: 3 inches  
Not accessible to the public
2. Hamilton West Apartments  1212 SW Clay St.

Type: New construction
Completed: 1999
Ecoroof square footage: 6000
Soil depth: 3-5 inches
*Not accessible to the public*
3. Native American Student and Community Center 710 SW Jackson St.

Type: New roof garden
Completed: 2003
Ecoroof square footage: 4000
Soil depth: 12-24 inches
Accessible to the public
4. The Meriwether Condominiums  3570 SW River Pkwy.

Type: New construction
Completed: 2007
Ecoroof square footage: 41,400
Soil depth: 3 inches
Not accessible to the public
5. Multnomah County Building  501 SE Hawthorne Blvd.

Type: Reroof  
Completed: 2003  
Ecoroof square footage: 12,000  
Soil depth: 6 inches  
Accessible to the public

Type: Reroof
Completed: 2002
Ecoroof square footage: 650
Soil depth: 3 inches
Visible from the sidewalk
7. Buckman Terrace Apartments  303 NE Sandy Blvd.

Type: New construction
Completed: 2000
Ecoroof square footage: 1700
Soil depth: 3-8 inches
Not accessible to the public
8. Metro Regional Center  600 NE Grand Ave.

Type: Reroof
Completed: 2005
Ecoroof square footage: 2500
Soil depth: 3 inches
Accessible to the public
9. Whitaker Ponds Natural Area  7040 NE 47th Ave.

Type: New construction
Completed: 2000
Ecoroof square footage: 500
Soil depth: 4 inches
Visible
10. Cathedral Park Place  6635 N Baltimore Ave.

Type: Reroof
Completed: 2005
Ecoroof square footage: 7100
Soil depth: 3 inches
Accessible to the public
Residential Ecoroofs

Type: New or reroof
Over 25 built in the city
Visit www.portlandonline.com/sustainablestormwater to access our ecoroof case studies, vegetation and monitoring reports, resource list and more.
A Sustainable Approach to Stormwater Management

When it rains, stormwater runoff that isn't properly managed can flow ever impervious surfaces picking up pollutants along the way and washing them into rivers and streams. Stormwater runoff can also cause flooding and erosion, destroy habitat and contribute to combined sewer overflows (CSOs).

Stormwater management systems that mimic nature by integrating stormwater into buildings and site development can reduce the damaging effects of urbanization on rivers and streams. Disconnecting the flow from storm sewers and directing runoff to natural systems like landscaped planters, swales and rain gardens or implementing an eco-roof reduces and filters stormwater runoff.

Portland has received international attention for its projects and designs in sustainable stormwater management. To read more about our program history and development, please visit the Water Environment Research Foundation case study report for Portland.

For more information about the Sustainable Stormwater Program, contact Emily Rust at 503-823-7378.

Bureau of Environmental Services. 1120 SW 5th Ave., Rm 1000, Portland, OR 97204

What's New
- Rain Garden & Naturescaping Classes
- Green Street Steward Program
- Be A Partner for Watershed Health
- How to Build a Rain Garden video
- Portland in the News
- Portland's Grey to Green Initiative
- Tabor to the River - Brooklyn Creek Basin Program & Upcoming Events
- EPA Sustainable Stormwater Video
Watershed Protection Department

Watershed Protection protects lives, property and the environment of our community by reducing the impact of flood, erosion and water pollution.

Austin is particularly vulnerable to these problems due to our torrential downpours and rocky landscape. We take a multi-tiered approach including a wide variety of ongoing programs such as Grow Green and the Lady Bird Lake Cleanup Crew, construction projects such as stormwater ponds and streambank restorations, and regulations to help prevent future problems.

Call 3-1-1 to report a drainage problem. To report potential pollution, please call our 24-hour pollution hotline at 512-974-2550. There's more contact information on our About page.

RECENT NEWS

- November 5, 2012
  Changes on the way for Eliza Spring to benefit Barton Springs Salamander

- November 5, 2012
  Sterile Asian Grass Carp To Be Released In Lake Austin for Hydrilla Control

- October 13, 2012
  Lake Austin Task Force calls public hearing

- September 27, 2012
  Barton Springs Pool bypass tunnel to be repaired

- September 26, 2012
  Construction continues on the Waller Creek Tunnel outlet facility

See All News

VIDEO

WhatHow much is expected on the project’s end.

Mid-December until the project’s end.
(Schedule subject to change.)

Share

Top Content

- Grow Green
- Landscape Design
- Grow Green Resources
- Plants
- Scoop the Poop

Upcoming Events

- Public Meeting – Reducing Bacteria in Four Creeks
  Nov. 28, 2012
- Volunteer for Dobie Middle School Rain Garden
  Dec. 01, 2012
- Shoal Creek Peninsula Stabilization Project
  Meet the Contractor Meeting
  Dec. 05, 2012
- Volunteer Lady Bird Lake Cleanup
  Dec. 08, 2012
- Watershed Protection Ordinance: Presentation of Draft ordinance
  Dec. 14, 2012

More Events

Find Watershed on Facebook

Find us on Twitter

State of Our Environment

Watershed Data Portal
As a creekside neighbor, there are several things you can do to improve water quality as well as increase the beauty and value of your property.

Why Should I Do This?

When we build along a waterway, we take away the benefits of the native stream side landscape. Our houses and streets cover the land and prevent rainwater from soaking into the ground. Without this underground flow of water, our creeks are more apt to dry out when there is little rain.

If we also change the natural look of the stream by removing vegetation and planting turf down to the water, we take away the benefits of native plants. These deep-rooted plants can help prevent erosion and filter pollutants that might run off the yard during rainfall. Planting trees also provides shade that keeps the water cooler and prevents evaporation. This makes the creek a healthier place for aquatic life and wildlife as well as a more attractive place for you to view and enjoy.

How Can You Help?

The best answer is the simple answer – return the creek to its natural state.

1. Plant
   - Plant trees, both tall and short, near the stream but out of the flood zone
   - Plant shrubs and deep-rooted native grasses to help stabilize the creek-bank and prevent erosion

2. Maintain
   - Avoid mowing near the water. Giving plants the opportunity to grow a minimum of 12” helps native grasses become established and allows for a more diverse mix of groundcover

   - Use pesticides and fertilizers as a last resort (see www.growgreen.org for additional earthwise gardening tips)

3. Keep water on the land to prevent erosion, feed the creek naturally and save money on watering:
   - Use rainbarrels or larger storage tanks to capture rain from your gutters
   - Consider planting a rain garden (a plant bed that is sunken and captures rainwater)
   www.cityofaustin.org/growgreen/plants.htm
**Light:**
Sun/ Part Shade

**Soil Needs:**
- Amend existing soil with 2-3” of compost
- Be sure that your total soil base is 6-8” deep
- If additional soil is needed, use a good quality soil mix (approximately 25% compost, 65% loam and 10% sand)

**Water Needs:**
Once established, these plants require little to no water. If plants look wilted, however, water thoroughly every 3-4 weeks if there is no rainfall.

**Irrigation:**
- Hand-watering is recommended
- If you must use an irrigation system, use bubblers for the beds

**Turf:**
Not recommended next to the creek

**Gardening Tips:**
- Do not plant trees or shrubs in the stream channel
- If planting the garden in phases, start with the trees. They will be the slowest growing vegetation and play an important role in shading the creek from the hot Texas sun
- Allowing the vegetation that is closest to the stream to go fully wild is beneficial and will become more tame as the tree canopy develops

### Good Plant Choices:

<table>
<thead>
<tr>
<th>Large Trees</th>
<th>Small Trees</th>
<th>Perennials</th>
<th>Ground Covers</th>
<th>Ornamental Grasses</th>
<th>Aquatic and Semi-Aquatic Plants (for raingardens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bald Cypress</td>
<td>Carolina Buckthorn</td>
<td>Blue Mistflower</td>
<td>Big Muhly</td>
<td>Indian Grass</td>
<td>Obedient Plant</td>
</tr>
<tr>
<td>Bur Oak</td>
<td>Mexican Plum</td>
<td>Columbine</td>
<td>Frog Fruit</td>
<td>Inland Sea Oats</td>
<td>Bushy Bluestem</td>
</tr>
<tr>
<td>Chinquapin Oak</td>
<td>Possumhaw Holly</td>
<td>Turk’s Cap</td>
<td>Horseherb</td>
<td>Switchgrass</td>
<td>Wood Fern</td>
</tr>
<tr>
<td>Live Oak</td>
<td>Roughleaf Dogwood</td>
<td></td>
<td></td>
<td>Meadow Sedge</td>
<td>Spike Sedge</td>
</tr>
<tr>
<td>Sycamore</td>
<td>Redbud</td>
<td></td>
<td></td>
<td>Canada Wild Rye</td>
<td></td>
</tr>
</tbody>
</table>

**Shrubs**
- Coralberry
- Buttonbush
- Eve’s Necklace
- Chili Pequin
- Dwarf Palmetto

**Ground Covers**
- Big Muhly
- Frog Fruit
- Horseherb

**Ornamental Grasses**
- Indian Grass
- Inland Sea Oats
- Switchgrass
- Meadow Sedge
- Canada Wild Rye
- Eastern Gama Grass

For more earth-wise gardening tips, visit [www.growgreen.org](http://www.growgreen.org)

For water conserving tips and rebates, visit [www.waterwiseaustin.org](http://www.waterwiseaustin.org)

[www.cityofaustin.org/growgreen/designs.htm](http://www.cityofaustin.org/growgreen/designs.htm)
Yard Drainage and Flooding

On this Page...
Overview
Proper Yard Grading
Your Yard’s Role in the Stormwater Management System
Grading and Drainage Changes
How Residents Can Help

Overview

Your yard plays an important role in protecting your home from flooding. A properly graded yard can minimize minor drainage problems and prevent more serious flooding conditions.

Before most homes in Naperville were built, a detailed plan for how the yard would be graded to provide proper drainage of stormwater was developed by the builder and their engineer. The grading plan for your property may also have been part of an overall stormwater plan for your subdivision.

Proper Yard Grading

In general, a properly graded yard will have some or all of the following characteristics:

- **Ground sloping away from the house** – the ground surrounding your home should be graded away from your house’s foundation to ensure that stormwater flows away from the house and not towards it.

- **Pavement sloping away from the house** – driveways, sidewalks and patios should be graded away from your house’s foundation to ensure that the stormwater flows away from the house and not towards it.

- **Drainage path towards the city’s Stormwater Management System** – stormwater runoff from your yard should have an unobstructed path towards the city’s system. Many residential properties have swales in the side and rear yards which carry water towards inlets within the yard, a neighboring yard, or the street. Some properties are graded such that the stormwater can flow directly into a creek, ditch or basin.

Your Yard’s Role in the Stormwater Management System

All yards are a part of the city’s Stormwater Management System. In most locations, stormwater from one yard is intended to flow onto and through another yard, either down slopes or within swales and ditches, to reach other features within the system, such as storm sewers or basins.

While all yards are a part of the system, some yards have key features which play a critical role in the Stormwater Management System. The components of the city’s system described below are often present on residential

Contact Information:
City of Naperville
Department of Public Works
180 Fort Hill Drive
Naperville, IL 60540
(630) 420-6095
Contact Us

Related Links:
Stormwater
Stormwater Overview
Street Drainage System and Roadway Flooding
Home or Structure Flooding
Sump Pumps

Page Credits
Content Contributor
Jennifer Louden

Content Manager
Jennifer Runestad
property, sometimes unbeknownst to the homeowner. These features are typically located within a dedicated easement.

- **Storm Sewers** – Many residential properties have an inlet on the surface covered by a grate that empties into a storm sewer pipe below ground which transports the water away. Yard inlets are typically intended to collect the stormwater from not only the yard where it is located, but also from the adjacent properties.

- **Detention Basin** – A detention basin is an area where stormwater may be quickly collected but slowly released to minimize the impact to the surrounding area. When located on residential property, detention basins are not typically located solely on one property but rather on a portion of each of several adjoining properties, usually in the rear yards. These basins are typically a depressed turf area.

- **Overflow Routes** – During an unusually long or heavy storm event, the amount of stormwater runoff may exceed what the swales and ditches, storm sewers and detention basins can accept. A network of overflow routes including residential side and rear yards has been established to allow the excess runoff to reach creeks, streams and the river without damaging structures.

### Grading and Drainage Changes

Proper maintenance of the grading of your yard can minimize minor drainage problems and prevent more serious flooding conditions. The homeowner is responsible for maintaining the grading of their yard, including any features of the Stormwater Management System located within the yard.

Yard grading often changes over time due to both natural and man-made causes. The following situations can impact yard drainage by changing the grading or obstructing the intended stormwater drainage path:

- **Natural Changes**
  - *Ground Settlement* – The ground surrounding your home, particularly the area close to the house’s foundation, may settle overtime. This could cause the ground or any pavements to slope and direct stormwater towards your home. Settlement could also result in isolated low spots throughout your yard where water may collect.
  - *Erosion* – Heavy rainfall or sump pump and downspout discharge could cause soil erosion resulting in isolated low spots where water may collect.

- **Man-made Changes**
  - *Landscaping* – The installation of landscaping, including planting beds, berms, and retaining walls, is the most common man-made change to yard grading and drainage. All of these activities could change the yard grading and potentially obstruct the intended path for drainage of stormwater from within the yard and from adjacent yards.
  - *Home and Yard Improvements* – Many common home and yard improvements could change yard grading and potentially create obstructions to the intended stormwater drainage path. Examples of common improvements that could impact yard grading and drainage include:
    - House Additions
    - Patios or Decks
    - Fences
    - Sand Boxes or Swing Sets
    - Sheds or Gazebos
    - Pools

### How Residents Can Help

**Know Your Yard**

Homeowners should know and understand how stormwater drains within their yard and if their yard is intended to drain onto or through a neighbor’s
yard or if adjacent yards are intended to drain towards their yard. Homeowners should also know what features of the city’s Stormwater Management System are present on their property. Key features, such as storm sewers, overflow routes, and basins, are typically located within dedicated stormwater management easements. The property's plat is a good place to check if any of these easements have been dedicated on the property.

**Consider Stormwater When Making Improvements**

When planning a home or yard improvement project, consider how the grading of your yard and the drainage of stormwater may be impacted not only for your yard, but for your neighbors' yards as well. Obtain any required permits and be careful not to alter the grading or create obstructions within swales, overflow routes or detention basins.

**Keep it Clear**

Ponding of stormwater within a yard often occurs due to clogged storm sewer inlets. If there is an inlet in your yard, residents are asked to keep this drain clear of all obstructions including, leaves, grass and debris. Debris at storm sewer inlets also build-up after a storm event, which is a good time to check the inlet to make sure that the system will work well in the next storm. If you cannot clear the debris yourself, please contact (630) 420-6095 to report the location.

**Never Dump Into a Storm Sewer Inlet**

It is important to never dump any debris, including but not limited to landscape waste, garbage or chemicals into a storm sewer inlet. While bulky materials can cause flooding, chemicals and other wastes that are dumped into a storm sewer eventually drain into the river, which threatens fish and wildlife and pollutes the water. If you observe this violation, or to find out how to properly dispose of waste products, please contact (630) 420-6095.

**Be Patient After Rain Events**

Following any rain event, stormwater may collect and form ponds in swales and low spots within yards. This can be a concern for many residents as it makes these areas of their yards unusable or they become concerned about the grass. Typically, water can pond over grass for 72 hours before impacting the health of the grass. If your yard has ponding that lasts for longer than 72 hours after most rain events, you can call (630) 420-6095 to request that a city staff member provide guidance and recommendations on how to improve the grading in your yard.