AGENDA

• HOW DO YOU IMPLEMENT A STORMWATER STRATEGY IN YOUR COMMUNITY
  • OVERVIEW OF APPROACHES
  • DRIVERS
    • MS4 PERMITS
    • CRS
  • PUBLIC VERSUS PRIVATE INVESTMENT
  • TECHNICAL SUPPORT
    • DESIGN GUIDELINES
    • TRAINING
  • INCENTIVES
    • FEES AND CREDITS
  • MANAGEMENT
    • REVIEW
    • MAINTENANCE
GREEN INFRASTRUCTURE TOOL BOX

- TREE PROGRAM
- STREAMWAYS, GREENWAYS, BLUEWAYS
- LOW IMPACT DEVELOPMENT

http://www.washingtonnature.org/cities/
STREAMWAYS, GREENWAYS, AND BLUEWAYS

Green Infrastructure

Park Systems

Wildlife Habitats and Corridors

Hub and Corridor Design

http://stormwater.wef.org/2014/04/water-wellness/
STREAMWAYS AND STREAM RESTORATION

• Before (February 2008)

• After (May 2015)
TKE PROGRAM

- Help Manage Small Storms
- Cooling – Reduce Heat Island Impacts
- Manage Air Pollution
- Improve walkability and Neighborhood Activity
- Provide Habitat
- Improve Tax Base

Urban Tree Canopy

Trees absorb carbon dioxide, mitigating climate change

Trees shade buildings reducing the need for air conditioning, which reduces fossil fuel consumption

Urban tree canopy improves neighborhood air quality and reduces heart attacks, strokes, and asthma
TREE PROGRAM

• STREET TREES- SHADEWAYS
• RESIDENTIAL TREES
• PARKWAYS

• NOT JUST TREE ORDINANCE...
  • GREEN STREETS
  • TREE PLANTING PROGRAM
  • PLAZA AND PARKING LOT SHADE PROGRAMS
  • TREE GIVEAWAYS

Plant the right tree in the right place
Plant taller trees away from overhead utility lines.

Arbor Day Foundation
arborday.org

Tail trees, such as:
maple, oak, spruce, and pine

Medium trees, such as:
washington hawthorn and goldenrain tree

Small trees, such as:
redbud, dogwood, and crabapple
## Using Trees to Meet Stormwater Credit

<table>
<thead>
<tr>
<th>Location</th>
<th>Document Title</th>
<th>Details</th>
</tr>
</thead>
</table>
| Portland, OR       | 2004 Stormwater Management Manual                   | • Subtract Impervious Cover under trees within 25 feet of impervious cover that meets certain criteria  
                      • Existing Tree = 50% of Existing Canopy, New Trees = 100 to 200 ft² of impervious cover |
| Indianapolis, IN   | 2007 Stormwater Green Infrastructure Supplemental Document | • Credits for new or exiting tree canopy within 20 feet of impervious surfaces.  
                      • 1 tree = 100 ft² of Impervious Cover                                               |
| Pine Lake, GA      | 2003 Ordinance                                      | • Trees count towards site runoff requirements  
                      • Trees = 10 to 20 gallons/in DBH                                                  |
| Minnesota          | Volume, TSS, Phosphorus Credit                       | • Based on interception, evaporation, and infiltration  
                      • Example: Mature Red Maple with infiltration area = 340 cf                        |
| Philadelphia, PA   | 2011 Stormwater Manual                              | • Reduction in impervious area                                                             |
| Washington, DC     | 2013 Guidebook                                      | • Trees receive retention value  
                      • Preserved Trees = 20 ft³; New Trees = 10 ft³                                         |
STORMWATER CONTROLS

- STORMWATER CONTROL MEASURES
- BEST MANAGEMENT PRACTICES
- SUSTAINABLE URBAN DRAINAGE SYSTEMS
- LOW IMPACT DEVELOPMENT
OTHER MANAGEMENT STRATEGIES

• LOCAL FLOODPLAINS
• FLOODPLAIN PROTECTION ORDINANCES
• STREAM BUFFER REQUIREMENTS

https://www.fema.gov/media-library/assets/images/51686
https://www.athensclarkecounty.com/DocumentCenter/View/2211
MASTER PLANNING AS A DRIVING FORCE
PLANNING IN CONTEXT

- Flood Damage Reduction
- Vulnerable Populations Impacted
- Water Quality: Pollutant Reduction (TSS and E. coli)
- Riparian Corridors Protected: Riparian Corridors and Wetlands
- Water Resources: Groundwater Recharge
- Recreation: Improvements in Property Values
DC1 Information

Description of Damage Center
In an area experiencing rapid growth, there is anticipated to be significant increases in flooding. There are relatively few structures currently endangered by the current floodplain, however additional development will increase peak flows and result in higher base elevations.

Description of Traditional Infrastructure
Regional detention facility that will provide 1,178,000 sq-ft of storage.

Traditional Infrastructure Cost
$30,000,000

Source of Information

Plan Benefits

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<tr>
<th>Description</th>
<th>DC1</th>
<th>All DCs</th>
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<tbody>
<tr>
<td>Recreation</td>
<td>$0</td>
<td>$131.9K</td>
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<tr>
<td>WQ - TSS Removed</td>
<td>4,339 lbs</td>
<td>9,242 lbs</td>
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<tr>
<td>WQ - E.coli Removed</td>
<td>116T</td>
<td>3047T MPN</td>
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<tr>
<td>GW Recharge</td>
<td>59,527 m³</td>
<td>93,428 m³</td>
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<tr>
<td>Habitat - Forest</td>
<td>$91.2K</td>
<td>$130.4K</td>
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<tr>
<td>Habitat - Wetland</td>
<td>$76.6K</td>
<td>$132.7K</td>
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</table>

Flood Damages

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<tr>
<th>Flood Year</th>
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<tr>
<td>2 year flood</td>
<td>$479.4K</td>
<td>$1.1M</td>
</tr>
<tr>
<td>10 year flood</td>
<td>$479.8K</td>
<td>$1.1M</td>
</tr>
<tr>
<td>100 year flood</td>
<td>$384.4K</td>
<td>$16.2K</td>
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</table>

Vulnerable Population (cost)

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<thead>
<tr>
<th>Flood Year</th>
<th>DC1</th>
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</thead>
<tbody>
<tr>
<td>2 year flood</td>
<td>$51.5K</td>
<td>$174.3K</td>
</tr>
<tr>
<td>10 year flood</td>
<td>$51.6K</td>
<td>$187.6K</td>
</tr>
<tr>
<td>100 year flood</td>
<td>$62.8K</td>
<td>$1.2M</td>
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Round 1 Summary

<table>
<thead>
<tr>
<th>DC Name</th>
<th>Trad</th>
<th>Infl</th>
<th>Free</th>
<th>Buyout</th>
<th>Add-On</th>
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<tbody>
<tr>
<td>MC</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC1</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC0</td>
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<tr>
<td>SC1</td>
<td>✓</td>
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<td></td>
<td></td>
<td>✓</td>
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</tbody>
</table>

Description will go here
**MS4 PERMIT REQUIREMENTS**

- “THE PHASE II FINAL RULE REQUIRES AN OPERATOR OF A REGULATED SMALL MS4 TO DEVELOP, IMPLEMENT, AND ENFORCE A PROGRAM TO REDUCE POLLUTANTS IN POST-CONSTRUCTION RUNOFF TO THEIR MS4 FROM NEW DEVELOPMENT AND REDEVELOPMENT PROJECTS THAT RESULT IN THE LAND DISTURBANCE OF GREATER THAN OR EQUAL TO 1 ACRE.”

MS4 PERMITS AS A DRIVER

http://www.epa.ohio.gov/portals/35/cso/wet_weather_flow_graphic.jpg
MS4 PERMIT REQUIREMENTS

• SET A GOAL
  • MUST BE MEASURABLE
  • EXAMPLE: “REDUCE BY X % OF IMPERVIOUS COVER AREA DIRECTLY CONNECTED TO THE STORM SEWER SYSTEM”

• DEVELOP A STRATEGY –
  • BMPS IDENTIFIED IN PLANNING PROCEDURES
    • PROMOTE BMPS IN MASTERPLANS, COMPREHENSIVE PLANS, AND ZONING ORDINANCES

• IMPLEMENT WITH ORDINANCE
  • AVOID “TO EXTENT PRACTICABLE” LANGUAGE

• ENSURE MAINTENANCE
COMMUNITY RATING SYSTEM (CRS)

- PROGRAM WITHIN THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP) WHICH ENCOURAGES COMMUNITY ACTION TO MANAGE FLOODPLAINS ABOVE AND BEYOND THE MINIMUM NFIP

Diagram:
- Community Action
- CRS Credits
- Community Classification
- Flood Insurance Premium Discounts
CRS CLASSES AND DISCOUNTS

- 62 CRS COMMUNITIES IN TEXAS

- HIGHEST CLASS
  - CITY OF GRAND PRAIRIE (5)
  - CITY OF HOUSTON (5)
  - CITY OF PASADENA (5)
  - CITY OF PLANO (5)

<table>
<thead>
<tr>
<th>Rate Class</th>
<th>SFHA*</th>
<th>Non-SFHA**</th>
<th>Credit Points Required</th>
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<tr>
<td>1</td>
<td>45%</td>
<td>10%</td>
<td>4,500 +</td>
</tr>
<tr>
<td>2</td>
<td>40%</td>
<td>10%</td>
<td>4,000 - 4,499</td>
</tr>
<tr>
<td>3</td>
<td>35%</td>
<td>10%</td>
<td>3,500 - 3,999</td>
</tr>
<tr>
<td>4</td>
<td>30%</td>
<td>10%</td>
<td>3,000 - 3,499</td>
</tr>
<tr>
<td>5</td>
<td>25%</td>
<td>10%</td>
<td>2,500 - 2,999</td>
</tr>
<tr>
<td>6</td>
<td>20%</td>
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<td>2,000 - 2,499</td>
</tr>
<tr>
<td>7</td>
<td>15%</td>
<td>5%</td>
<td>1,500 - 1,999</td>
</tr>
<tr>
<td>8</td>
<td>10%</td>
<td>5%</td>
<td>1,000 - 1,499</td>
</tr>
<tr>
<td>9</td>
<td>5%</td>
<td>5%</td>
<td>500 - 999</td>
</tr>
<tr>
<td>10</td>
<td>0%</td>
<td>0%</td>
<td>0 - 499</td>
</tr>
</tbody>
</table>
CRS CREDIT FOR ONSITE STORMWATER MANAGEMENT

- PROTECTING NATURAL FLOODPLAIN FUNCTION
  - SECTION 450 – LOW IMPACT DEVELOPMENT (LID)
    - STORMWATER MANAGEMENT REGULATIONS (SMR)
      - REGULATING DEVELOPMENT ON A CASE BY BASE BASIS TO ENSURE THAT THE PEAK FLOW OF STORMWATER RUNOFF FROM EACH SITE WILL NOT EXCEED THE PRE-DEVELOPMENT RUNOFF
        - UP TO 25 POINTS- LID ORDINANCE
    - WATER QUALITY REGULATIONS
      - REGULATIONS THAT IMPROVE STORMWATER RUNOFF THROUGH THE USE OF BEST MANAGEMENT PRACTICES (20 POINTS)

- PARTIAL CREDIT AVAILABLE FOR LID ORDINANCES

“Credit for LID is also provided if the community’s stormwater management ordinance requires the use of “soft” techniques to reduce runoff to the maximum extent possible before using detention. This can be thought of as a requirement to mimic natural hydrologic runoff and minimize the impact of land development on water resources to the maximum extent possible. The developers are required to control the runoff, but detention ponds are discouraged in favor of on-site infiltration.”
IMPLEMENTING LID IN AN ORDINANCE

• EXAMPLE:

  • “SMALL SCALE STORMWATER MANAGEMENT PRACTICES, NON-STRUCTURAL TECHNIQUES, AND BETTER SITE PLANNING TO MIMIC NATURAL HYDROLOGIC RUNOFF CHARACTERISTICS AND MINIMIZE THE IMPACT OF LAND DEVELOPMENT ON WATER RESOURCES MUST BE IMPLEMENTED. ONLY WHEN IT IS ABSOLUTELY NECESSARY IS THE USE OF A STRUCTURAL BMP WARRANTED.” - BERKELEY COUNTY, WEST VIRGINIA
SETTING GOALS

- SCIENCE BASED CRITERIA
  - STREAM PROTECTION STANDARD
  - WATER QUALITY VOLUME
    - TMDL
    - WATERSHED PROTECTION PLANS
    - PERMITS

- BALANCE PRIVATE BENEFIT AND PUBLIC COST
  - STORMWATER UTILITY COSTS

One-Bay Master Planning
<table>
<thead>
<tr>
<th>Urban Center</th>
<th>Standard(s)</th>
</tr>
</thead>
</table>
| Fort Worth, TX    | • rainfall of 1.5 inches *(85th percentile storm)*  
• Post-development channel velocities cannot be increased by more than 5% above predevelopment velocities  
• Twenty-four hours of extended detention shall be provided for on-site, post-developed runoff generated by the 1-year, **24-hour rainfall** event to protect downstream channels.                                                                                                                                 |
| Austin, TX        | • The minimum volume is the first one-half (0.5) inch of runoff plus an additional one-tenth (0.1) inch for each ten (10) percent increase of impervious cover over twenty (20) percent within the drainage area to the control.                                                                                                                                       |
| Harris County, TX | • First 1” of runoff                                                                                                                                                                                                                                                                                                                        |
| Philadelphia, PA  | • 1” runoff from Impervious Cover for Separate Sewer Areas must be infiltrated  
• 20% of Water Quality Volume must be routed through a BMP  
• Channel Protection- detain and release **1 year 24-hour storm**                                                                                                                                                                                                       |
| Kansas City, KS   | • 90 percent volume of all 24-hour storms on an annual basis- **90th Percentile Storm**                                                                                                                                                                                                                                                     |
| Atlanta, GA       | • 1.2” of Runoff and 80% of Solids  
• 30% Reduction of 100 year Storm  
• 1” must be evaporated/infiltrated/reused                                                                                                                                                                                                                                                                 |
| Chicago, Illinois | • Depth and Flow Rate standards dependent on Impervious Cover Area                                                                                                                                                                                                                                                                                                                                 |
| San Diego, CA     | • discharge rates and durations are mitigated with the flow range of 10 % of the 2-year flow to the 10-year flow  
• 85th percentile water quality design                                                                                                                                                                                                                                                                                                          |
| Los Angeles, CA   | • “Post-development peak storm water runoff discharge rates shall not exceed the estimated pre-development rate” (>0.1”)  
• 85th percentile 24-hour runoff event- **V**  
• flow of runoff = 2* the 85th percentile hourly rainfall intensity-Q                                                                                                                                                                                                                                                                         |
| Denver, CO        | • Standards set by the **Water Quality Capture Volume**                                                                                                                                                                                                                                                                                                                                                   |
INVESTMENT IN STORMWATER MANAGEMENT

Pardon Our Dust!

The San Antonio River Authority (SARA) recently received a grant from the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency that will fund stormwater retrofits at SARA’s main office at 100 E. Guenther and at SARA’s Environmental Center at 600 E. Euclid. Construction of the Low Impact Development (LID) stormwater retrofits will begin this summer and include cisterns, rain gardens and permeable pavement parking stalls.
Our love of the river runs deep, and we are managing our stormwater onsite to protect it.

Untreated rainwater that flows into storm drains and is directed to our creeks and rivers is known as stormwater runoff. In the San Antonio River Watershed, stormwater runoff is the most significant contributor to water quality degradation. To help prevent stormwater pollution from entering the river, SARA is installing Low Impact Development (LID) Best Management Practices (BMPs) designed to capture first-flush stormwater pollutants. LID BMPs capture and treat pollutants before they reach our river.

To learn more about these practices and how you can be Watershed Wise, visit our website at www.sara-tx.org.
DOCUMENTING THE CONSTRUCTION PROCESS

Initial Condition  Excavation  Liner  Gravel Layer

Choke Layer  Gravel Layer  Bedding Layer  Pavers
USING THE SITE TO EDUCATE
USE THE SITE FOR TRAINING

• HARD HAT TOURS DURING CONSTRUCTION
• OPEN HOUSE
• CONTRACTORS WORKSHOP
MONITORING PERFORMANCE
QUICK LESSONS LEARNED
WHAT IS THE DRIVER FOR PRIVATE INVESTMENT?

- Market Forces (Public Demand)
  - Greater Lot Utilization
  - Higher Price Point
- Public Incentives
  - Financing Support / Credits
  - Review Acceleration
- Regulatory Driver
  - Ordinances / Permits

What is the impetus for private developers to implement stormwater controls?
WHAT ARE THE CONCERNS OF THE DESIGN COMMUNITY WHEN ADVOCATING FOR LID WITH THEIR CLIENTS?
50% of government staff reported to have concerns regarding on-site stormwater management...

- 34% - Cost
- 34% - Staffing
- 16% - Institutional willingness to embrace change
DESIGN GUIDELINES

- CLEAR DESIGN OBJECTIVES
- DESIGN GUIDANCE
- STANDARD DETAILS AND SPECIFICATIONS
- PERIODIC TRAINING

DESIGN MANUALS

Design Professionals
- Site Design
- BMP Design

Government
- Implementing Ordinance
- Reviewing Design
- Staffing/Resources

Construction and Maintenance
- Certification
- Material Development
CHECKING IN WITH THE COMMUNITY AFTER TRAINING

50% of government staff reported having Fewer Concerns about LID after technical and management training.
INCENTIVES

- DEVELOPMENT REQUIREMENT WAIVERS
  - SET BACKS
  - LANDSCAPE REQUIREMENTS
- IMPERVIOUS COVER CREDITS
- FEE WAIVERS
- CREDIT TO MS4 UTILITY ANNUAL FEES
- BELOW-MARKET-RATE LOAN PROGRAMS
- GRANT PROGRAMS
REVIEW - MAINTAINING STANDARDS

• WHO WILL BE CONDUCTING REVIEW?
  • WHAT QUALIFICATION OR TRAINING DO THEY NEED?

• WHAT IS THE REVIEW PROCESS AND WHERE DOES IT FIT IN WITH YOUR CURRENT REVIEW PROCESS?

• HOW DO YOU SIMPLIFY REVIEW?
  • COMPONENTIZED DESIGN WITH STANDARD DETAILS
  • DESIGN WORKSHEETS

Bioretention Review Process
- Is the watershed delineated correctly (<5 acres)?
- Are the runoff generating characteristics accurately defined (Tc, imp. %, soil)?
- Is the treatment volume calculated correctly?
- Do the media storage capacity and ponding depth meet the required volume?
- Does the soil media meet the design guidance? If proprietary is the claimed flow rate too high (< 30 in/hr)?
- Is the bioretention area properly sized and configured on the site plan?
- Will the BMP use infiltration? Is there technical data to support an adequate infiltration rate (>0.5 in/hr)?
- Does the inlet configuration assure flow capture? Is there enough head difference? Is the inlet big enough to resist plugging?
- Is the inlet transition designed to reduce erosion (cobble, drop basin)?
- Is a forebay or other pretreatment BMP provided to capture sediment?
- Is the BMP configured with an overflow or bypass? Is it sized correctly?
- If infiltrating BMP, are lateral flows restricted if necessary to prevent pavement or foundation damage?
- Are ancillary benefits (e.g., habitat, education, shade) maximized?
- Does the vegetation meet the aesthetic, seasonal, sun exposure, and maintenance needs of the site?
- Are there physical hazards to pedestrian, cyclists, or traffic with the design?

Figure 5-3. Review process for bioretention.
TRAINING YOUR REVIEWERS

• NEEDS TO COVER
  • GENERAL CONCEPTS OVERVIEW
    • WHAT AND WHY
  • SITE DESIGN
    • CHANGE IN THOUGHT PROCESS
  • BMP DESIGN
  • CONSTRUCTION TOURS
  • SITE TOURS
DEALING WITH VARIANCES

• DOES YOUR CONTROLLING ORDINANCE ALLOW FOR VARIANCES?

• DOES THE NEW ORDINANCE CONFLICT WITH EXISTING ORDINANCE?

• SET PROCEDURES FOR EVALUATING AND DECISION PROCESS FOR VARIANCES AND APPEALS

• MINIMIZE VARIANCES WITH GOOD LANGUAGE REQUIRING FUNCTION AND MINIMIZING PRESCRIPTION

http://swamplot.com/tag/variances/page/4/
PLAN REVIEW- LEARN FROM OTHER COMMUNITIES

- NORTH CAROLINA STATE
  - REVIEWER CERTIFICATION AND TRAINING

- DENVER
  - DESIGN WORKSHEETS

- PHILADELPHIA
  - STANDARD BMP COMPONENTS, WORKSHEETS, CHECKLISTS

- COLUMBUS, OHIO
  - ONLINE LIBRARY OF STANDARD SPECIFICATIONS

- PORTLAND, OR
  - DECISION MATRIX TO GUIDE DESIGN, WORKSHEETS

- NASHVILLE, TN
  - AS-BUILT SUBMITTAL
MANAGEMENT STRATEGIES

- IN-HOUSE INSPECTION PROGRAM
- REQUIRE ANNUAL CERTIFICATION BY LICENCED PE/LA
- CROWD SOURCED ALERTING

https://www.mapistry.com/stormwater-bmp-inspection-forms
MAINTENANCE STRATEGIES

- PRIVATE BMPS —
  - REQUIRE A CONTRACT WITH CERTIFIED MAINTENANCE COMPANY
  - REQUIRE ANNUAL INSPECTION

- PUBLIC BMPS —
  - INCORPORATE BMPS INTO PARKS MAINTENANCE (WORKS BEST WHEN BMPS ARE LINKED WITH GREENWAYS AND PARKS)
  - INCORPORATE MAINTENANCE INTO PUBLIC WORKS MAINTENANCE
MAINTENANCE TRAINING - FIELD CREWS

- NEED QUALIFIED PERSONNEL TO INSPECT AND MAINTAIN STORMWATER BMPS
  - MS4 PERMIT COMPLIANCE REQUIREMENT
- TRAINING PROGRAM
  - REGISTRATION/CERTIFICATION
    - CHESAPEAKE BAY
    - NORTH CAROLINA
    - SAN ANTONIO RIVER AUTHORITY
MAINTENANCE- BUSINESS/LANDOWNER OUTREACH

• CHALLENGE: WHEN PROPERTY CHANGES HANDS, THE NEW OWNERS MAY NOT BE AWARE THAT THEY OWN STORMWATER INFRASTRUCTURE

• POTENTIAL SOLUTIONS:
  • DEED RECORD
  • REALTOR EDUCATION
  • MAINTENANCE AGREEMENT RENEWAL TIED WITH INCENTIVES
  • ANNUAL CERTIFICATION BY PE
MAINTENANCE- COTTAGE INDUSTRY

• DEMAND CREATES SERVICE SECTOR FOR MAINTENANCE AND RETROFIT CONTRACTORS

• MATERIALS VENDORS
MAINTENANCE - INNOVATIVE APPROACHES

• CROWD SOURCING – MAINTENANCE CONCERNS
  • ONLINE MAPPING / 311 CALL SYSTEM

• HOA PROGRAM
  • LAKE COUNTY, VIRGINIA  HOW TO IDENTIFY AND MANAGE COMMUNITY BMPS

• INSPECTION WORKSHEETS AND AUTOMATED SUBMITTAL WITH PHOTOS
  • ST. LOUIS, MO
  • ENCINITAS, CA

• LIST OF REGISTERED STORMWATER MAINTENANCE CONTRACTORS
  • WASHINGTON, DC
LID MAINTENANCE – RESOURCES

- CENTER FOR WATERSHED PROTECTION - YOU TUBE HOW TO VIDEO
  - HTTPS://WWW.YOUTUBE.COM/WATCH?V=COFBDMB-Q0U

- WASHINGTON
  - HTTP://WWW.ECY.WA.GOV/PROGRAMS/WQ/STORMWATER/MUNICIPAL/LID/TRAINING/LIDO&MGUIDANCEDOCUMENT.PDF

- CHESAPEAKE BAY
  - HTTP://CHESAPEAKESTORMWATER.NET/TRAINING-LIBRARY/STORMWATER-BMP-MAINTENANCE/

- SAN ANTONIO RIVER AUTHORITY
  - REGISTRATION PROGRAM