

# Implementing Better Site Designs at Residential Infill Sites

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# MEASURES TO CONSIDER

- Preference is Gravity Flow to Bioswales
- Locating Swales Off-line
- Use Flow Splitters to Convey Treatment Flows to Off-line Bioswales
- Using Pumps to Convey Flows from Outlying Areas to Bioswales
- Treat Off-site Runoff to Compensate for Untreated Portion of On-site Runoff

# The Development Process

- Site Layout
- Due Diligence
- Tentative Map
- Permitting
- Design
- Design Approvals
- Construction

# The Development Process -

## Constraints

- Profit
- Time
- Implementation

# Hurdles to Successful

## Implementation of BMPs

- Cost
- Grading
- Land Availability
- Utility Design – Vertical Constraints
- Vehicles
- City Acceptance
- Constructability

# The Cost Hurdles

- Cost of Dirt to Create Grades
- Land Cost
- Landscape Coordination
- Time to Develop Mutually Accepted Plan
- Added Improvement Plan Issue that Generates Comments / Revisions

# The Grading Hurdle

- Grading and Compacting Dirt is Expense
  - Bay Mud is Common in Santa Clara County – Differential Settlement Results if Fill is not Relatively Uniform
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# The Land Availability Hurdle

- In-fill Downtown Projects often have no Landscaping
- Small Building Sites want Street Frontage, Landscaping is to Rear, away from Storm Drain Facilities
- Hillside Developments have Steep Streets, with Flat Areas between Buildings

# The Vertical Hurdle

- Including Treatment adds another Constraint to the Design of Gravity Sewer and Storm Drain Systems
- Fall from site to Receiving Water is often Limited.
- Many Cities have Height Ordinances that Restrict Placement of Additional Fill to Allow Gravity Drainage
- Treatment of Runoff that Gravity Flows away from the Site is not Possible

# The Vehicle Hurdle

- Roadway Crossings must be Shallow
- Placement of Utilities in Subgrade of Asphalt Pavement causes Differential Compaction
- Curb Openings along Roadways Present a Driving Hazard
- Water in Treatment Device should be Separated from Pavement Subgrade
- Bioswales Segment Drive Aisles

# The City Acceptance Hurdle

- Shallow Ponding is Seen as a Liability
- Cities do not Want Additional Maintenance
- City Maintenance Crews do not want Small Diameter Pipes because of Clogging Concerns
- City Building Standards are Often Incompatible with On-site Treatment
- When City does not have Design Standards, Approval is Subjective
- Cities have Concerns Regarding Maintenance of Measures Outside City Right-of-Way

# The Constructability Hurdle

- Contractors do not like Non-standard Items
- Field Crews may not Understand Goal of Treatment Device, leading to Improper Installation

# How Cities can Help

- Establish Common Standards and Details among Neighboring Cities
- Establishment of In-Lieu Treatment Areas & Reimbursement Funds to allow Developers to Best Use Available On-site Treatment
- Identify Conflicts in your Standards and Resolve
- Develop Model Maintenance Agreements



PRECAST CONCRETE  
MODEL 2KR  
SIDE OPENING DROP INLET

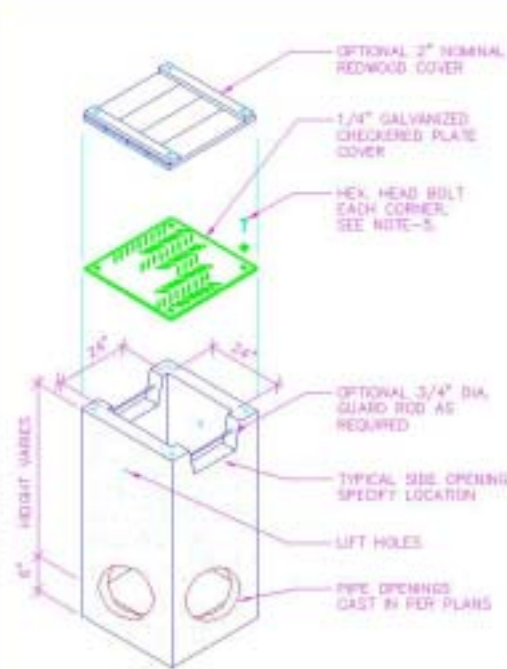
FEB., 1972

2KR

JUNE, 1996

1-11

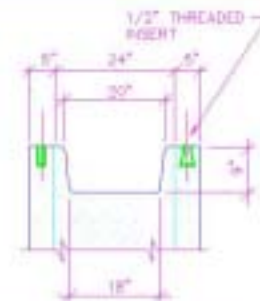
Santa Fe Cast Products Company



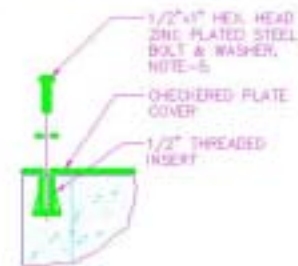
ISOMETRIC

NOTES

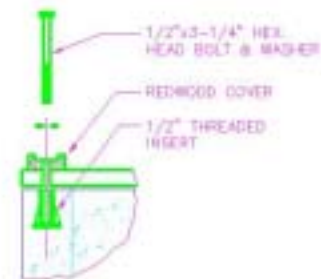
1. SIDE OPENINGS ARE AVAILABLE ONLY IN THE SIZE SHOWN.
2. SIDE OPENINGS CAN BE PROVIDED ON ANY MODEL DROP INLET, PLEASE SEE DWG., PAGE 1-3.
3. WEIGHT OF WALLS PER VERTICAL FOOT = 800 LBS.  
WEIGHT OF 6" FLOOR SLAB = 800 LBS.
4. AREA OF SIDE OPENING IS 1.11 SQ. FT.
5. COUNTERSINK BOLTS AVAILABLE ON REQUEST.



TYPICAL SIDE OPENING



STEEL COVER FASTENING DETAIL



REDWOOD COVER FASTENING DETAIL

# Bioswale Standards

- A Design Standard for Bioswales is Attached
- Design per California Best Management Practices Handbook (<http://www.cabmphandbooks.com/>)
- New Development and Redevelopment
- TC-30 – Vegetated Swale

## Manning's Roughness in a Bioswale

Calculate Velocity \* Radius

where:

Velocity is in feet per second

Hydraulic Radius (= Area / Perimeter) is in feet

Condition	Manning's N
For Depth equal to or less than 5 inches	0.250
For Depth greater than 5 inches	
if $V * R < 0.15$	0.200
if $0.15 < V * R < .4$	0.150
if $0.4 < V * R < .75$	0.100
if $0.75 < V * R < 1$	0.080
if $1 < V * R < 2$	0.060
if $2 < V * R$	0.050

Manning's Roughness for a grass-lined channel / bioswale.

The velocity and Hydraulic Radius vary with roughness. An iterative process is needed to solve for depth and hydraulic roughness.

Valid for grasses 6" high and less. If a grass is used that will grow taller than 6", a higher roughness should be used.

# Bioswale Comments

- On-line Bioswale is Typical
- Off-line Bioswale may Work Best, Especially in Hillside Areas
- For Long Linear Systems, Intermittent Collection Boxes may be Desired to Reduce Total Flow in Bioswale





# Getting Flow to Bioswale

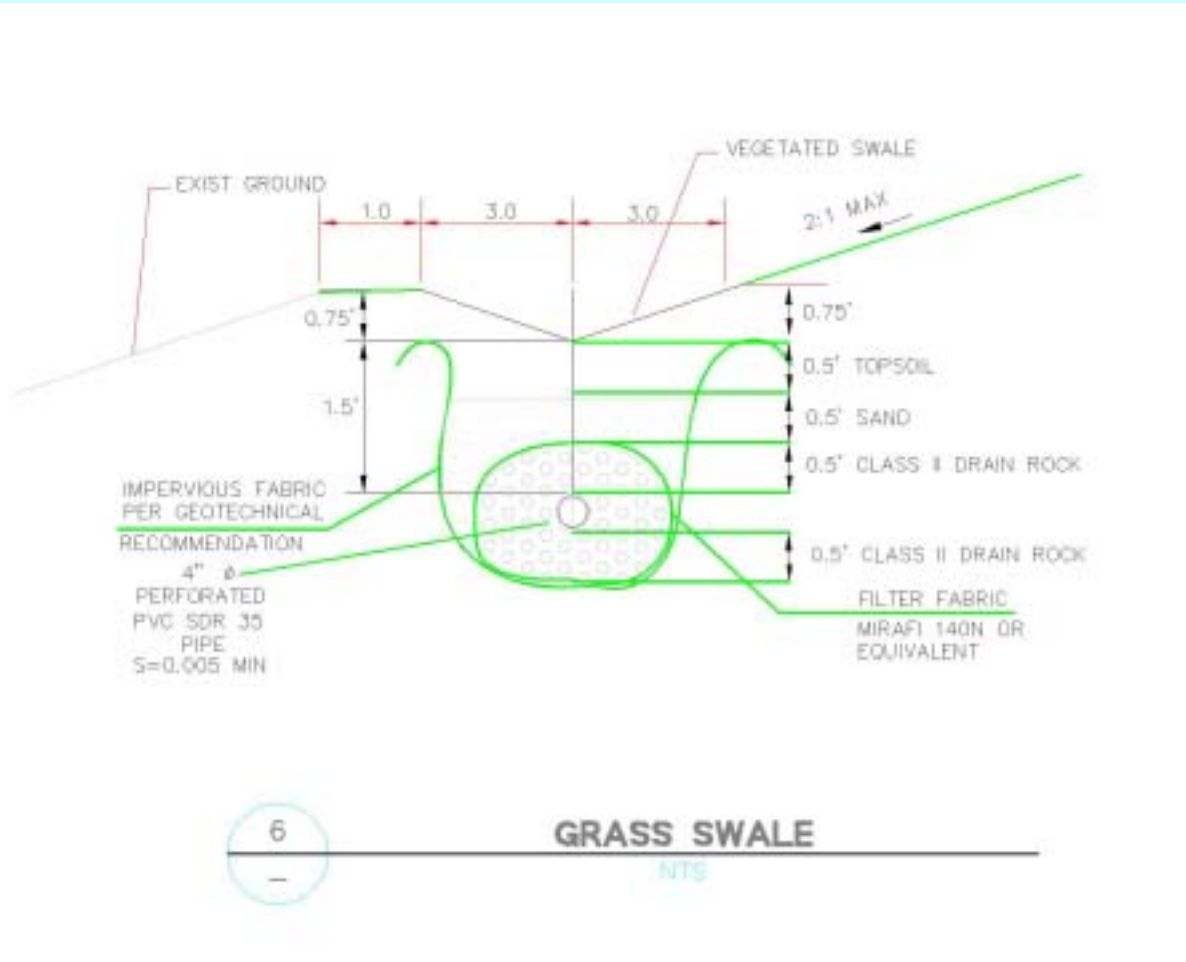
- Gravity as Overland Flow
- Gravity as Storm Drain Discharge
- Gravity as Discharge through Flow Splitter
- Pump Low Flows
- Pump All Flows



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**MASTER UTILITY PLAN**

DATE	DESCRIPTION
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# Gravity Flow to Bioswale (Preferred)

- Overland Flow across Concrete Mow Strip, where Mow Strip Separates Bioswale from Asphalt Subgrade
- Bumper Stops
- Curb Openings
- Shallow Pipes versus Deep Bioswales?
- Manhole Flow Splitters (See Detail)
- Treat Off-site Flows In-lieu of On-site Flows



# Pumped Flow to Bioswale Why?

- In Viewing All Costs, Pumping May be Less Expensive than “Tweaks” Necessary to Make Gravity Flow Work
- Allows Placement of Bioswale or Storage Area at Site’s Best Aesthetic Site versus at Site’s Low Point
- Reliability and Removals should be Compared with Mechanical Treatment

# Pumped Flow to Bioswale Considerations (page 1):

- Pump Size: 1 acre to Pump, Runoff Coefficient 0.5, 0.2 inch/hour Rainfall = .1 cfs or about 50 gpm
- A 0.5 Horsepower Pumping Unit Capable of Passing 2-inch Solids Pumps 90 gpm at 20 feet of Head
- Pump Purchase/Replacement Cost is Less than \$1,000
- Operating 10% of the Time, at 0.15 \$/kW-hr, Annual Energy Cost is \$50.

# Pumped Flow to Bioswale Considerations (page 2):

- Stepped Manholes may be Possible at Pump Locations, Allowing Invert of Downstream Storm Drain to be Raised
- If Stepped Manhole Used on a Flat Sites, a Pumping Unit Allows for Steeper Pipe Slopes

# Conclusions

- Gravity Flow to a Bioswale is Preferred
- Locating Bioswales Off-line Typically Works Better within Site Constraints
- Mechanical Treatment Devices can be used to Supplement Bioswales, but Cost should be compared with Cost of Pumping to Bioswale
- Energy Cost should be Compared with Cost of Cleaning Mechanical Treatment Devices and Disposing of Wastes