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Land Development Issues

• Increase in Amount of Impervious Surfaces
• Increase in Stormwater Runoff Rates
• Municipal Stormwater Regulations – Rate vs. Volume
• Stormwater Detention Facilities
• Land Subdivision Process - Traditional Practice

New Home Construction in United States

• Land Subdivision for Residential Development Continuous Since the 1950’s
• New Home Construction is Currently at its Highest Level Ever
Standard Land Subdivision Process

• Clear Site of Trees
• Scrape Topsoil and Stockpile
• Grade Entire Site
• Build Roads and Infrastructure
• Redistribute Topsoil
• Build Homes

Soil is Compacted Over Entire Site Surface Reducing Rate of Stormwater Infiltration
## Stormwater / Precipitation

<table>
<thead>
<tr>
<th>Precipitation Pre-development</th>
<th>Precipitation Post-development</th>
</tr>
</thead>
<tbody>
<tr>
<td>40% Evaporation</td>
<td>30% Evaporation</td>
</tr>
<tr>
<td>10% Surface Runoff</td>
<td>55% Surface Runoff</td>
</tr>
<tr>
<td>45-50% Soil Recharge</td>
<td>15% Soil Recharge</td>
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Post Development Land Cover

• Pavement
• Rooftops
• Sidewalks
• Yard Area

Yard Areas
Cover the
Largest % of
the Site
Problem?

• Yard Areas Comprise the Majority of Post Development Land Cover

• Soil in Yard Areas is Compacted by Grading Operations Reducing its Infiltration Capacity

Lost Opportunity to Use Yard Areas as Stormwater Infiltration Zones
Goal: Increase Infiltration Rate of Soil in Yard Areas

(Reference Project Site Will be Used for Analysis)

Baseline: Develop Land per Current Standards.

Alternative One: Regulation Requiring Developer to Amend Soil in Yard Areas After Construction is Complete.

Alternative Two: Require Modified Development and Grading Practices such to Avoid Compacting Yard Areas in the First Place.
Baseline Reference Site

• Village of New Albany, Ohio
• +/- 18 Acres
• Currently Forested
• Last Cut in 1942
• Zoned R-2 Residential
• Bounds Stream on the North
Reference Site

• Proposed Development Plan – 2002

• Proposed Plan Will Serve As Baseline Condition
Reference Site

- Current Land Uses

- Future Park Site
  +/− 7 Acres

- Dublin Granville Road

- Rose Run Creek

- Market Street

- Residential Development Site
  +/− 18 acres

- Alpath Road

- Single Family Residential

- New Albany Schools Learning Campus

- Rose Run Park

- Neighborhood Commercial

- Multi-Family Residential

- Ogden Woods Blvd.

- Single Family Residential

- Church / Institutional

- Reference Site

- Rose Run Creek

- Reference
Proposed Site Plan

Site Plan Elements:
Zoning: R-2 Single Family residential.
• 80’ lot frontage
• 15’ front setback
• 7.5’ side setback
• 30’ rear setback
• Forested preserve areas to remain

Utilities / Infrastructure:
• Sanitary Sewer
• Storm Sewer
• Stormwater Detention Basins
• Streets – curb & gutter with 22’ wide asphalt pavement.
• Sidewalks – concrete, 5’ width.
• Municipal Water Lines
• Electric Service
• Natural Gas Service

Reference
Proposed Site Cover

Pervious Elements:
- Forested preserve areas (Minimum)
  3.32 Acres
- Lawn (variable porosity)
  9.89 Acres
- Stormwater Detention Basins (2)
  +/- 0.50 Acres

Impervious Elements:
- Streets – curb & gutter with 22’ wide asphalt pavement.
  0.96 Acres
- Sidewalks – concrete, 5’ width.
  0.37 Acres
- Asphalt Driveways
  0.23 Acres
- Rooftops
  2.73 Acres

Figure 1
**Proposed Site Drainage Plan**

*Note - Q represents the rate of stormwater runoff measured in cubic feet per second.*

**Area A**
1.49 Acres
Offsite Drainage
Q₂ – 0.36 CFS
Q₁₀₀ – 0.94 CFS

**Area B**
0.69 Acres
Offsite Drainage
Q₂ – 0.43 CFS
Q₁₀₀ – 1.08 CFS

**Area C1 & C4**
6.3 Acres
Storm sewer to Pond 1 and Rose Run
Q₂ – 12.4 CFS
Q₁₀₀ – 21.15 CFS

**Area C2**
0.61 Acres
Sheet flow to Rose Run
Q₂ – 0.54 CFS
Q₁₀₀ – 0.83 CFS

**Area C3**
2.69 Acres
Sheet flow to Rose Run
Q₂ – 3.02 CFS
Q₁₀₀ – 5.03 CFS

**Area D1**
2.04 Acres
Offsite Drainage
Q₂ – 2.89 CFS
Q₁₀₀ – 4.52 CFS

**Area D2, D3, D4 & D5**
3.66 Acres
Storm sewer to Pond 2 and Rose Run
Q₂ – 7.82 CFS
Q₁₀₀ – 13.75 CFS

**Pre Development:**
Of f Site Surface Runoff Totals
Q₂ – 3.39 CFS
Q₁₀₀ – 8.72 CFS
To-Stream Runoff Totals
Q₂ – 7.11 CFS
Q₁₀₀ – 18.18 CFS

**Post Development:**
Of f Site Surface Runoff Totals
Q₂ – 0.79 CFS
Q₁₀₀ – 2.02 CFS
To-Stream Runoff Totals
Q₂ – 26.71 CFS
Q₁₀₀ – 45.28 CFS

**Storage Requirements:**
Store 100YR post development storm at 2YR pre development release rate.
Q₂pre site total – 10.5 CFS
Q₁₀₀post site total – 47.3 CFS
Baseline Conditions

• Total Lawn Area is 9.89 Acres: +/-50% of Developed Acres

• Stormwater Regulations

**Storage Requirements:**
Store 100YR post development storm at 2YR pre development release rate.
- $Q_{2 \text{pre site total}} = 10.5 \text{ CFS}$
- $Q_{100 \text{post site total}} = 47.3 \text{ CFS}$

• Stormwater Detention is Required

• Traditional Land Subdivision Process
Alternative One - Post Construction Amendment of Soil in Yard Areas

This alternative would be implemented after all construction had been completed and would be an amendment to the development/stormwater ordinance. It would consist of the following steps:

1. The subsoil surface of all yard areas would be scarified (tilled) to a depth of 12 to 18 inches.

2. A blend of stockpiled topsoil, organic compost and sand would be spread over the yard areas to a depth of 2 inches.

3. Soil surface will be fine tilled to a depth of 6 inches and the surface smoothed.
Alternative One - Assumptions

1. Amendment materials are available within a reasonable distance from the site.
2. Market values for compost and sand material remain stable.
3. Local housing market remains stable or expands
Alternative One - Costs

The costs of this alternative would be immediate and include:

- Acquisition of compost and sand material
- Blending of the soil materials
- Spreading Amendment
- Soil tilling

The stockpiled topsoil would already be available on site. However, there may be costs to the municipality through required changes in ordinances and specialized knowledge needed for enforcement.
Alternative One - Costs

• Amendment Material – Delivered Cost
  2 inch layer over 9.89 Acres = 72658 Cubic Yards (CY)
  72658 Cubic Yards x $20/CY = $53,164.94

• Spread Amendment – Equipment and Labor
  9.89 acres = 47867 Square Yards (SY) x $1/SY = $47,867.00

• Tilling Soil to 12” Depth
  47867 SY x $1/SY = $47,867.00

Total Amendment Operation Cost = $148,899.00

• Costs to Municipality via Specialized Knowledge Needed for Construction and Material Inspection = $10,000 - $20,000
Alternative One - Benefits

Short Term:

Reduces the need for additional costly stormwater infrastructure to be paid for by the developer and maintained by the municipality.

- Traditional yard areas have low infiltration rates – 0.16 to 0.47 inches per hour
- Amended yard areas have higher infiltration rates – 2.0 to 3.86 inches per hour

Method
1. Calculate reduced runoff rate (Q) over the 9.89 acres of Yard Area.
2. Calculate effect of reduced Q on stormwater management infrastructure (savings).
   - Reduced pipe sizes
   - Reduced length of system
   - Reduced size of stormwater detention facilities
   - Reduced need for stormwater detention facilities

Analysis
Alternative One - Benefits

The benefits of soil amendment: long and short term:

Short Term – Easier to Monetize

• Reduction in storm sewer pipe size required throughout project = $6000
• Reduced excavation of detention basins due to reduced runoff volumes = $189,000

Long Term – Difficult to Monetize

• Protection of water quality by promoting infiltration versus runoff. Reduces the risk of enforcement actions from Ohio EPA.
• Reducing long term erosion impacts on stream channels thus reducing maintenance required by the municipality to reinforce stream banks and repair existing infrastructure.
• Reduction in the lowering of regional water tables which keeps water supply consistent for those residents neighboring the village who rely on wells.
• Protection of municipal drinking water sources downstream, thus reducing the possibility of litigation against the municipality.
• Reduces flood potential, protecting municipal and private interests.

Analysis
Alternative One - Summary

**Costs**
- Total Amendment Operation Cost = $148,899.00
- Costs to Municipality via Specialized Knowledge Needed for Construction and Material Inspection = $10,000 - $20,000

**Benefits**

**Monetized**
- Reduced Infrastructure Costs – Storm Sewer Costs Average $60 to $80 per Linear Foot (LF). = $6000

Note: Cost of Pipe Increases Approximately $3.00/LF for Every 3 Inch Increase in Pipe Diameter (project contains over 2000 LF of Pipe)
- Reduced excavation of detention basins due to reduced runoff volumes = $189,000

**Non-Monetized** (Previous Slide)
Alternative Two - Modified Construction Methods / Avoid Compaction of Yard Areas

Alternative two would be based on the municipality providing developers with the option of employing alternative site grading and development techniques in-lieu of tax breaks or streamlined plan approval. The goal of this alternative is to reduce the amount of soil compaction of future yard areas during construction.

This would require the developer to:

1. Design a plan layout that works with existing stormwater drainage patterns, removing the need for mass clearing and grading operations.

2. Guarantee construction access is limited throughout site, primarily in future yard areas, to reduce the rate of soil compaction.
Alternative Two - Assumptions

- Machinery is available that can “tread lightly” enough as to not inadvertently compact the existing soils.

- Site construction traffic can be adequately monitored and controlled.

- Infiltration rate of native soils is two to four times higher when not compacted by construction activities.

- Local housing market remains stable or expands.
Alternative Two - Costs

• Additional time and expertise required to design a plan layout that works with existing stormwater drainage patterns, removing the need for mass clearing and grading operations.

• Modify construction sequence such that heavy equipment access is limited throughout site, primarily in future yard areas, to reduce the rate of soil compaction.

Notes:

- change to the standard approach to site design

- would not require new materials or machinery.

- costs incurred because the model for purchase, zoning, design and construction of property is guided by a standardized economic model.
Alternative Two - Costs

- Cost to Developer of Changing Site Design Approach (Additional Consultant Fees) = $100,000 to $150,000

- Cost to Developer of Modified Development/construction Procedures (Time and Specialized Knowledge) = $500,000

- Possible Loss of Site Development Density (Number of Homes per Acre) = $50,000 to $300,000
Alternative Two - Benefits

• The benefits of Alternative two are much the same as Alternative one.

Additional Benefits

• Reduced costs of site clearing and grading

• Health of adjacent vegetated and forested areas. With less modification of the quality and flow of ground water (via less soil compaction), the existing vegetation will suffer lower stress caused by the adjacent construction.
Alternative Two - Benefits

Monetized

• Reduction in grading and clearing operations required throughout project = $600,000

• Reduced excavation of detention basins due to reduced runoff volumes = $189,000

• Reduction in storm sewer pipe size required throughout project = $6000

Non-Monetized

• Tax break for property over a specified time period.

• Improved Health of Adjacent Forested/Undeveloped Areas.

• Long Term Benefits Described for Alternative 1.
Alternative Two – Risks and Uncertainties

• Difficult to Calculate Infiltration Rate in Native Undisturbed Soil

• Difficult to Monitor Site-By-Site Clearing and Construction Operations.

• Availability of Machinery that can “Tread Lightly” Enough as to Not Inadvertently Compact Soils

• Ripple Effect is to Associated Industries and the Reflection of Increased Costs is Unknown.
**Recommendation – Alternative Two**

• The Two Alternatives Have Many of the Same Benefits.

• Both Alternative One and two Offer the Possibility of Balancing Monetary Costs and Benefits to the Developer. This Reduces the Need to Accurately Monetize Long Term Environmental Benefits via Discounting.

• Alternative Two attempts to improve the problem of increased stormwater runoff created by soil compaction by not creating the problem in the first place.