There are four pillars that make up the program and will be implemented in all Blueprint neighborhoods:

- Green Infrastructure – Rain Gardens/Bump-outs/permeable pav’t
- Roof Water Redirection
- Lateral Lining
- Voluntary Sump Pump Program.
• It rains in Columbus about 140 days per year
• Rain Gardens Porous pavement, known as green infrastructure (GI) are rapidly becoming an important part of the storm sewer system.
• Rain water is routed through the G.I., filtering through layers of stone, before draining into storm sewer that empty into our rivers.
• This natural filtering process slows the release of Stormwater and keeps pollutants and trash out of the system
PRE-CONSTRUCTION

• Understand the scope of work
• Excavate the site as shown in plans
• Perform surveying to verify plans elevations and provide positive drainage.
• Prepare subsurface as shown in the plans
WEISHEIMER INDIAN SPRINGS PROJECT

• Replace existing roadway with water quality basins
• 11,500 CY of excavation
• 19,000 tons of #4’s aggregate base (clean/washed)
• 2,100 tons of 57’s aggregate base
• 7,900 SY of geo-webbing
• 70,800 SF of pervious pavors
• 6,400 LF of curb
• 1000 SY of concrete apron
• 6,100 SF of 4” sidewalk
• 400 LF of 12”-24” storm sewer
• 3000LF of 6” perforated underdrains
• 1,100 LF of 6”-8” waterline and services
Maintenance of Traffic

Notes:
1. Construction along Dominion Boulevard between Shields Place and Sellers Avenue shall be phased using City of Columbus STD DWG 1540 sheets 7, 8 & 9.
2. All construction on Dominion shall be completed within 180 days of the start of construction.
3. Road closures that result in the inability for residents to have vehicular access to their driveways shall be limited to 3 weeks at a time for a maximum of 12 driveways when on-street parking is not available in front of their home or an immediately adjacent home.
4. Vehicular access to residential driveways must be maintained from November 23, 2017 through March 17, 2018.
5. It shall be the Contractor's responsibility to maintain access to all properties within the project limits at all times. When vehicular access is restricted due to construction activities, an ADA accessible pedestrian access route shall be provided. Where permanent walk is not planned, temporary walk shall be provided by the Contractor. All temporary pedestrian access shall conform to the requirements of City of Columbus Item 608 Temporary Asphalt Concrete Walk, As Per Plan, see sheet 16. Installation of temporary walk, removal of temporary walk and restoration of disturbed areas shall be be paid for under Item 614 Maintain Traffic As Per Plan.
6. Work hours shall comply with City of Columbus Noise Ordinance 0544-03.
7. Contractor employee parking shall not be within 300-feet of the nearest closed driveway.
Contractor didn’t want to spend money on utility backfill that would be removed later.
Tailings had to be brought in to maintain drivable surface
Construction Sequencing Suggestions

• Do as much utility work as you can before closing road
• If going with phased construction, don’t let contractor mill off all phases at one time
• Try to find streets with alley access for residents
• Don’t close road during colder months
Subgrade Compaction & Proof Roll

GeoFabric Layers

- Bottom and sides of trench
Tencate Mirafi RS-380i
- Reinforcement in weak soils
- High Infiltration Rate

<table>
<thead>
<tr>
<th>Fabric</th>
<th>Permitivity</th>
<th>Grab Strength</th>
<th>Tear/Tensile Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODOT Type D</td>
<td>0.05 sec⁻¹</td>
<td>800 N</td>
<td>70 lbs</td>
</tr>
<tr>
<td>Mirafi RS-380i</td>
<td>0.9 sec⁻¹</td>
<td>1500 N</td>
<td>180 lbs</td>
</tr>
</tbody>
</table>
Outlets & Underdrains

All Proposed Perforated Underdrain (PUD) shall be per ASTM F758 PVC SDR 26 with 4 holes, 3/8" perforations, every 3" at 90° and 160°, holes to be facing down.

Stormtech DC-780
Easton video

https://youtu.be/2Kbk6-47WVo
LA Abrasion Test

- The standard LA abrasion test subjects a course aggregate sample to abrasion, impact, and grinding in a rotating steel drum containing a specified number of steel spheres.

- LA abrasion of 40 means 40% of the original sample passed through the No. 12 sieve (1.70 mm).
No. 2, 3, or 4 Stone

• Testing Requirements
  • LA Abrasion Test <40 as per ASTM C-131
  • Angular particles >90% (no rounded river gravel)
  • Less than 2% passing No. 200 sieve
  • CBR >80%

• Recycled Concrete Typically Can’t pass the LA abrasion test
Tech South
-Soft rock or contaminated material?
GeoWeb – Increases Strength

Doubles Layer Coefficient of the Stone Layer it Confines

<table>
<thead>
<tr>
<th>Relative Size</th>
<th>GW20V</th>
<th>GW30V</th>
<th>GW40V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>GW20V (small cell)</td>
<td>GW30V (mid cell)</td>
<td>GW40V (large cell)</td>
</tr>
<tr>
<td>Nominal Length x Width</td>
<td>8.8 x 10.2 in (224 x 259 mm)</td>
<td>11.3 x 12.6 in (287 x 320 mm)</td>
<td>10.5 x 13.0 in (267 x 330 mm)</td>
</tr>
<tr>
<td>Nominal Area</td>
<td>44.6 in² (289 cm²)</td>
<td>71.3 in² (460 cm²)</td>
<td>66.3 in² (440 cm²)</td>
</tr>
<tr>
<td>Cells per yd² (m²)</td>
<td>28.9 (34.6)</td>
<td>18.2 (21.7)</td>
<td>N/A</td>
</tr>
<tr>
<td>Nominal Depths</td>
<td>3 in (75 mm), 4 in (100 mm), 6 in (150 mm), and 8 in (200 mm) for all cells</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. All details and dimensions are nominal and subject to manufacturing tolerances.
2. Cell area will vary only ± 3% through the recommended expansion range.
3. Cell sizes are for Class VI; seismic areas are fixed and not variable in nature.
No. 57 Stone

- Testing Requirements
  - LA Abrasion <40
  - Angular particles >90% (no rounded river gravel)
  - Less than 2% passing No. 200 sieve
  - CBR >80%
No. 57 Layer
Compaction Equipment

10-12 Ton Roller
No. 8 Setting Bed

• Testing requirements
  • LA Abrasion Test <40 as per ASTM C-131
  • Angular particles >90% (no rounded river gravel)
  • Less than 2% passing No. 200 sieve
  • CBR >80%
Compaction of Stone Layers

- Roll (2) Vibratory Mode
- Roll (2) Static Mode
- Test w/Light Weight Deflectometer
  - 1.0 mm for No. 2, 3, or 4 stone
  - 0.5 or less for No. 57 stone
- Fail Test, re-roll until it passes
- Cannot test for density
Deflectometer Testing

**Procedure**
1. (3) Drops to Seat plate
2. (3) More Drops record readings
3. Take average of last (3) readings

<table>
<thead>
<tr>
<th>Material</th>
<th>Maximum Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 2, 3, or 4 Stone</td>
<td>1 mm</td>
</tr>
<tr>
<td>No. 57 Stone</td>
<td>0.5 mm</td>
</tr>
</tbody>
</table>

**Note**
1. First lift of base stone may have high readings because the native subgrade will deflect and elevate the readings
2. Can only test to a depth equal to plate diameter = 12”
Light Weight Deflectometer

- Purchased by CTL
  - $6000
- Easy to use
- Good form of QA/QC between contractor and inspector
- Most tests passed, few small areas had to be re-rolled
Poor Stone Compaction
Lift Thickness

- 12” or less
Poor Stone Compaction?
Poor Stone Compaction
Erosion Control?
Site Stabilization

- Use Sod
- No grass seed
Concrete bands

- 18”x6” straight curb
- 12”x12” flush band
Eco-Priora vs. Eco-Optilok
Third Street New Albany
Pine Hall Brick – Iron Spot (2 ¾”)

Third Street, New Albany, OH
## Paver Material & Install Prices

<table>
<thead>
<tr>
<th>Material</th>
<th>Price</th>
<th>Delivery Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilock Endura Color</td>
<td>$4.50/SF delivered</td>
<td></td>
</tr>
<tr>
<td>Unilock Standard Color</td>
<td>$2.60/SF delivered</td>
<td></td>
</tr>
<tr>
<td>Pine Hall Clay</td>
<td>$4.50/SF delivered</td>
<td></td>
</tr>
<tr>
<td>Machine Install Price</td>
<td>$2.00/SF (includes setting bed &amp; chips)</td>
<td></td>
</tr>
<tr>
<td>Hand Install Price</td>
<td>$5.00/SF (includes setting bed &amp; chips)</td>
<td></td>
</tr>
</tbody>
</table>
Clay Paver Parking Stall Installation

To Small of an area for machine installation, use hand setting prices
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Total</th>
<th>Unit</th>
<th>Low Bid</th>
<th>Total Cost</th>
<th>Contractor Suggested Change</th>
<th>New Bid Cost</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>203</td>
<td>EXCAVATION</td>
<td>11,411</td>
<td>CY</td>
<td>$20.00</td>
<td>$228,220.00</td>
<td>$5.00</td>
<td>$25.00</td>
<td>hard to work in existing streets</td>
</tr>
<tr>
<td>605</td>
<td>6&quot; PVC PIPE UNDERDRAIN PERFORATED, AS PER PLAN</td>
<td>2925</td>
<td>LF</td>
<td>$15.00</td>
<td>$43,875.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>660</td>
<td>SODDING, UNSTAKED</td>
<td>1,912</td>
<td>SY</td>
<td>$12.00</td>
<td>$22,944.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEC</td>
<td>PRESTO GEOWEB GW20V (3-inch), OR EQUAL</td>
<td>7,888</td>
<td>SY</td>
<td>$8.00</td>
<td>$63,104.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEC</td>
<td>PERVERVIOUS CONCRETE PAVERS (T=3 1/8&quot;)</td>
<td>70,794</td>
<td>SF</td>
<td>$7.50</td>
<td>$530,955.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEC</td>
<td>AGGREGATE BASE, AS PER PLAN NO. 57 STONE (T=4&quot;)</td>
<td>1,033</td>
<td>CY</td>
<td>$51.00</td>
<td>$52,683.00</td>
<td>$5.00</td>
<td>$56.00</td>
<td>more work to get to grade than anticipated</td>
</tr>
<tr>
<td>SPEC</td>
<td>AGGREGATE BASE, AS PER PLAN (NO. 2, 3, OR 4 STONE)</td>
<td>9,529</td>
<td>CY</td>
<td>$39.00</td>
<td>$371,631.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEC</td>
<td>WOVEN GEOSYNTHETIC Mifafi RS380i or EQUIVALENT</td>
<td>9,801</td>
<td>SY</td>
<td>$5.30</td>
<td>$51,945.30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Bid Prices** (70,794 SF pervious pavement)

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Igel</td>
<td>$3.6 million</td>
</tr>
<tr>
<td>Shelly &amp; Sands</td>
<td>$3.8 million</td>
</tr>
<tr>
<td>Conie Construction</td>
<td>$4.1 million</td>
</tr>
<tr>
<td>Facemeyer</td>
<td>$4.2 million</td>
</tr>
<tr>
<td><strong>Estimate</strong></td>
<td><strong>$4.6 million</strong></td>
</tr>
</tbody>
</table>

**Includes**
- 20% Force Account
- $405,000 street sweeper
- $129,000 contingency items

**Cost Per SF (Complete street rehab.)**
Low bid (w/o force account, contingency, and sweeper) = $34.60/SF
Paver Installation Contractor

• Most Knowledgeable
• Minimum Responsibilities
  • No. 8 Setting Bed
  • Set Pavers
  • Sweep in Chips
  • Plate Compact Finished Pavers
  • Replace Cracked or Chipped Bricks
  • Re-joint with Aggregate as needed until end of 2-year Warranty Period
• Laying patterns
  • Soldier Course
  • Herringbone
  • Stagger lines
  • Swap pavers
  • Special Patterns
Paving contractor

- Screed machine
  - Much slower if done by hand
- Saw cutting is very loud
- Pavers will look dirty for awhile with all the concrete dust & chip dust
Soldier Course Prep
Plate Compactor

• Use in areas not reachable by roller
• Minimum Force of 13,500 lbf for Stone
• Minimum Force of 5,000 lbf for Pavers
Swap ½ Pieces to Break Up Lines
Provide Laying Details Around Catch Basins and Manholes – Low Volume Streets
Provide Laying Details Around Catch Basins and Manholes – Higher Volume Streets
Warranty and As-Built Tolerances

Warranty Covers
- Creep
- Cracked pavers
- Loss of Joint material

Warranty Does not Cover
- Sediment removal

As-built Tolerances
- Final elevations not deviate more than 3/8” over 10-feet
- Lippage shall be no greater than 1/8” between pavers
- Bond lines shall be +/-1/2” over a 50-ft string line
- Top of pavers may be 1/8” to ¼” above adjacent structures for possible minor settling
Design Engineer

• Construction Observation Contract with City
• Answered a lot of Questions in Field
  • Contractor
  • Inspector
  • Residents
• Light Weight Deflectometer Training
• Attended Monthly Project Meetings
References

- City of Columbus
  - Supplement Spec 1525 – Permeable Pavement
  - Standard Details
    - Typical Section
    - Concrete Band Detail
    - Castings Detail
    - Laying Patterns
  - Green Infrastructure Design Manual Update
East Dominion After
Permeable Pavement - Lessons learned

• 2 week look ahead schedule
• Investigate the site before excavating the roadway
• Perform a walk through of the site with city arborist
• Perform utility and tree survey
• Pay item for root barrier for tree and shrub
• #2’s & 4’s aggregate are washed and wet when delivered to the site
• Replace sanitary lateral and downspout as part of the contract
• Field staff must have strong communication skills
• Emergency contact number for water division
• Inform the city immediately when you encounter a lead waterline service
• Safety-
QUESTIONS?