APPENDIX E

MISCELLANEOUS DESIGN DETAILS

E-1: WAYNE COUNTY PARKS – OPTIONAL HEAD WALL DETAIL FOR STORM DRAIN OUTLET ON RIVER COURSES

E-2: RIPRAP SPECIFICATIONS

E-3: EXAMPLE TERRACED SIDE SLOPE DETAIL

E-4: WAYNE COUNTY PARKS DIVISION PERMIT GUIDELINES FOR SITE RESTORATION
APPENDIX E-1

Wayne County Parks
Optional HeadWall Detail For Storm Drain Outlet
On River Courses
NOTES

FOOTINGS TO BE Poured SEPARATE FROM HEADWALL USING 6 REINFORCING RODS FOR ANCHOR DOWELS.

FACE OF HEADWALL SHALL BE LOCATED 1 FT. OUTSIDE THE EDGE OF NORMAL WATER LEVEL.

HEIGHT OF HEADWALL WILL VARY ACCORDING TO THE CHARACTER OF THE BANK AT THE STRUCTURE.

REINFORCE HEADWALL (ABOVE FOOTING) WITH 1" O.C. BARS SPACED AT 16" MAX HORIZONTAL AND VERTICAL, AS SHOWN.

HEADWALL DETAIL - Storm Drain Outlet on River Courses

WAYNE COUNTY OFFICE OF PUBLIC SERVICE
Department of Parks
APPENDIX E-2

Riprap Specifications
Riprap

Definition

Riprap is a permanent cover of rock used to stabilize streambanks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows.

This BMP addresses using riprap to stabilize streambanks, line channels and provide stable outlets. For purposes of this BMP, “rock” can be used interchangeably with “stone”. For information on designing various types of stream liners (including vegetation and riprap), see the Stormwater Conveyance Channel BMP.

All work conducted below the ordinary high water mark of a lake or stream, or in a floodplain or wetland will require permits from the Michigan Department of Environmental Quality, Land and Water Management Division. This includes the placement of riprap. (See Exhibit 1 for a definition of ordinary high water mark).

Other Terms Used to Describe

Armoring
Energy Dissipator

Pollutants Controlled and Impacts

The use of riprap in channels and below concentrated flows protects stream banks and discharge channels from higher erosive flow velocities. This reduces downcutting and lateral cutting, which in turn decreases sediment input to a watercourse.

Application

Land Use
All land uses.

Soil/Topography/Climate
The rock to be used as riprap must be capable of withstanding freezing and thawing and the flow or wave action of the water where it is used. The soil texture on the site and whether seepage is occurring are factors in determining the need and thickness of filters beneath the riprap.

When to Apply
Riprap used at outlets should be in place before the outlet is discharging. Streambank grading should be done when it is most feasible to bring stone to the site. Riprap should be placed as soon after grading as possible.

Where to Apply
Riprap is most often used in streambanks, on slopes, and at outlets.

Relationship With Other BMPs

Riprap is often used in making Stabilized Outlets, in Streambank Stabilization (including bioengineering techniques), and Slope/Shoreline Protection. Filters should be used underneath riprap to
help stabilize the soils.

**Specifications**

**General Considerations:**
Riprap structures should be designed by licensed professional engineers or other persons qualified in the design of such structures.

**Stone Type**
The material used for riprap should be fieldstone or rough unhewn quarry stone. Stone should be hard, angular, and of such quality that it will not disintegrate on exposure to water or weathering. It should also be chemically stable, capable of withstanding freezing and thawing, and suitable in all other respects for the intended use.

Because it is not as aesthetically pleasing as rock, broken concrete is a less favorable riprap alternative. If concrete is used, it should be clean and otherwise meet design criteria. Asphalt should *not* be used as riprap.

**Riprap Size**
Riprap comes in a variety of sizes. The appropriate size to use primarily depends on the intended use of the structure. For example, the size of riprap used to stabilize streambanks depends on the velocity of the water.

Structural design is usually based on the diameter of stone in the mixture for which a percentage, by weight, will be smaller. For example, \(D_{50}\) indicates a mixture of stones in which 50 percent of the stone by size would be larger than the diameter specified, and 50% would be smaller than the stone size specified. In other words, the design is based on the average size of stone in the mixture.

Table 1 lists some typical riprap by weight, spherical diameter and corresponding rectangular dimensions. These stone sizes are based on an assumed specific weight of 165 lbs./ft\(^3\).

<table>
<thead>
<tr>
<th>Weight (lbs)</th>
<th>Mean Spherical Diameter (in)</th>
<th>Typical Rectangular Shape Length (in)</th>
<th>Width, Height (in)</th>
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</thead>
<tbody>
<tr>
<td>50</td>
<td>10</td>
<td>18</td>
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<td>83</td>
<td>28</td>
</tr>
<tr>
<td>8000</td>
<td>54</td>
<td>90</td>
<td>30</td>
</tr>
</tbody>
</table>

Source: USDA Soil Conservation Service
**Gradation**
Riprap should be composed of a well-graded mixture down to the one-inch size particle such that 50 percent of the mixture by weight is larger than the $D_{50}$ size as determined from the design procedure. For the purposes of this BMP, a well-graded mixture is defined as a mixture composed primarily of the larger stone sizes but with a sufficient mixture of other sizes to fill the progressively smaller voids between the stones. The diameter of the largest stone size in such a mixture should not be more than 1.5 times the $D_{50}$ stone size.

After determining the riprap size that will be stable under the flow conditions, the designer should consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size.

Riprap structures for **streambank stabilization** should be designed to be stable for bank-full flows in the reach of the channel being stabilized.

**Thickness**
For both streambank stabilization and outlets, the minimum thickness of the riprap layer should be 1.5 times the $D_{50}$ diameter, or 6 inches, whichever is greater. **A geotextile or stone filter must be placed under the riprap to prevent water from removing the underlying soil material through the voids in the riprap.** (Removal of the soil material leaves cavities behind the riprap and failure of the riprap may result). The filter may consist of smaller sized stone (usually 2”), a geotextile material, or a combination of both. Stone filters should be a minimum of 6 inches thick, and greater if the area has high seepage pressures. Follow the specifications below.

**Granular (Stone) Filter Blanket.** For dumped riprap, a filter ratio of 5 or less between successive layers will result in a stable condition. The filter ratio is defined as the ratio of $D_{15}$ size of the coarser layer to the $D_{85}$ size of the finer layer. An additional requirement for stability is that the ratio of the $D_{15}$ size of the coarse material to the $D_{15}$ size of the fine material should exceed 5 and be less than 40. A further requirement is that the ratio of the $D_{50}$ size of the coarse material to the $D_{50}$ size of the fine material not exceed 40. These requirements can be stated as follows:

$$\frac{D_{15} \text{(coarser layer)}}{D_{85} \text{(finer layer)}} < 5 < \frac{D_{15} \text{(coarser layer)}}{D_{15} \text{(finer layer)}} < 40$$

$$\frac{D_{15} \text{(coarser layer)}}{D_{50} \text{(finer layer)}} < 40$$

The filter requirements apply between the bank material and the filter blanket, between successive layers of filter blanket material if more than one layer is used, and between the filter blanket and the stone cover.

If a single layer of filter material will not satisfy the filter requirements, one or more additional layers of filter material must be used. In addition to the filter requirements, the grain size curves for the various layers should be approximately parallel to minimize the infiltration of the fine material into the coarser material. Not more than 5 percent of the filter material should pass the No. 200 sieve.

The minimum thickness of each layer of granular filter material shall be 6 inches, or 3 times the $D_{50}$ size of the filter, whichever is greater.

**Synthetic (Geotextile) Filter Fabric.** The Filters BMP includes information on geotextile materials which may be used may be used in place of or in conjunction with granular filters. Always check manufacturer’s specifications to ensure that the filter fabric selected meets the tensile strength and
durability requirements for the determined rock size. Some guidance in selecting filter fabric is given below.
The following particle size relationships must exist:

For filter fabric adjacent to granular materials containing 50 percent or less (by weight) of fine particles (less than 0.075 mm):

a) \[ \frac{D_{50 \, \text{base} \, (\text{mm})}}{\text{EOS* filter fabric (mm)}} > 1 \]

b) Total open area of filter fabric is less than 36 percent.

For filter fabric adjacent to all other soils:

a) EOS less than U.S. Standard Sieve No. 70.

b) Total open area of filter is less than 10 percent.

No filter fabric should be used with less than 4 percent open area or an EOS smaller than U.S. Standard Sieve No. 100.

Stream Bank Protection and Channel Lining

See Exhibit 1 for applications.

General Planning Considerations:

1. Slopes on which riprap is used to stabilize streambanks should be no steeper than 1.5:1.

2. All bare soil on the slope above the riprap should be stabilized with seed and mulch, or sod. See the Vegetative BMPs.

3. When riprap is used in conjunction with other vegetative practices or bioengineering, the riprap should extend 1 foot above the ordinary high water mark. When only riprap is being used for bank stabilization, the top of the riprap should extend 3 feet above the ordinary high water mark. See Exhibit 1 for an explanation of the ordinary high water mark.

4. Determine a means of accessing the site before designing any riprap structure.

5. Determine how the riprap will be placed on the site. If the rock is to be dumped, it must be done in a manner which will not cause separation of the small and large stones. If rock is to be dumped over a bank and placed by hand, it must be done so that it does not create more erosion. Consider using aluminum or wooden shutes to roll rock down a bank to the waters’ edge.

6. If riprap placement requires re-configuring banks or slopes, the filter should be placed as soon after the banks are prepared as possible. Placement of riprap should follow immediately after the placement of the filter.

7. The finished surface should not have pockets of finer materials which would flush out and

RIP-4
8. Riprap used both at the outlet of storm sewers and to protect an eroding bank, should be designed to accommodate both uses. Riprap used as outlet protection should be constructed before the pipe or channel begins to operate.

Design:

Stone Size Selection for Streambank Stabilization:
The design method described below is adapted from Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15 of the Federal Highway Administration. It is applicable to both straight and curved sections of channel where the flow is not perpendicular to the bank of the channel.

A. Straight Sections of Channel.
This design method determines a stable rock size for straight and curved sections of channels. It is assumed that the shape, depth of flow, and slope of the channel are known. A stone size is chosen for the maximum depth of flow. If the sides of the channel are steeper than 3:1, the stone size must be increased accordingly. The final design size will be stable on both sides of the channel and the bottom.

1. Enter Exhibit 3 with the maximum depth of flow (feet) and channel slope (feet/foot). Where the two lines intersect, choose the d₅₀ size of stone.

2. If channel side slopes (z) are steeper than 3:1, continue with step 3, if not, the procedure is complete.

3. Enter Exhibit 4, with the side slope and the base width to maximum depth ratio (B/d). Where the two lines intersect, move horizontally left to K1. Record K1.

4. Determine from Exhibit 5, the angle of repose (Ar) for the d₅₀ size of stone. The angle of repose is the angle in which the rocks will lay in relation to the bank. Banks should be designed so that the natural angle of repose of the stone mixture is greater than the slope of the bank being stabilized. (Use Ar=42° for d₅₀ greater than 1.0 ft. Do not use riprap on slopes steeper than the angle of repose for the size of stone.)

5. Enter Exhibit 6, with the side slope (z) of the channel and the angle of repose (Ar) for the d₅₀ size of stone. Where the two lines intersect, move vertically down to read K2. Record K2.

6. Compute d’₅₀ = d₅₀ x K1/K2, where d’₅₀ is to determine the correct size stone for the bottom and side slopes of straight sections of channel.

B. Curved Sections of Channel
1. Compute the radius of the curve (Ro), measured at the outside edge of the bottom.

2. Compute the ratio of the top width of the water surface (Bs) to the radius of the curve (Ro), Bs/Ro.

3. Enter Exhibit 7, with the ratio Bs/Ro. Move vertically until the curve is intersected.
4. Compute \( d_{50c} = d'_{50} \times K3 \), where \( d_{50c} \) is the correct size stone for bottom and side slopes of curved sections of channel.

C. Design Example Problems:

**Problem #1**
**Given:** A trapezoidal channel 3 feet deep \( (d) \), with an 8-foot bottom \( (B) \), 2:1 side slopes \( (z) \), and a 2 percent slope. **Calculate:** A stable riprap size for the bottom \( (B) \) and side slopes \( (z) \) of the channel.

![Diagram of trapezoidal channel](image)

**Solution:**
1. From Exhibit 3, for a 3-foot deep channel on a 2 percent grade: \( d_{50} = 0.75 \) feet or 9 inches.
2. Since the side slopes \( (z) \) are steeper than 3:1, continue with Step 3.
3. From Exhibit 4 for \( B/d = 2.67 \) and \( z = 2 \); \( K1 = 0.8 \)
4. From Exhibit 5 for \( d_{50} = 9 \) inches; \( Ar = 41^\circ \)
5. From Exhibit 6 for \( z = 2 \) and \( Ar = 41^\circ \); \( K2 = 0.75 \)
6. \( d'_{50} = d_{50} \times K1/K2 = 0.75 \times 0.8/0.75 = 0.8 \) feet
   \[ 0.8 \text{ ft} \times 12 \text{ inches} = 9.6 \text{ inches} \]
   Use \( d'_{50} = 10 \) inches

**Problem #2**
**Given:** The preceding channel in Problem #1 has a curved section with a radius of 50 feet at the outside edge of the bottom. **Calculate:** A stable riprap size for the bottom and side slopes of the curved section of channel.

**Solution:**
1. Radius of curvature, \( Ro = 50 \) feet
2. Top width at water surface,
   \[ Bs = 8 + (2 \times 3 \times 2) = 20 \text{ feet} \]
   \[ Bs/Ro = 20/50 = 0.40 \]
3. From Exhibit 7 for Bs/Ro = 0.40; K3 = 1.1

4. \( d_{50c} = d'_{50} \times K3 = 0.84 \times 1.1 = 0.92 \) feet

Use \( d_{50c} = 1.0 \) ft = 12 inches

Length/Thickness/Height of Streambank Area to be Riprapped
Refer back to page RIP-3 for specifications on the proper thickness.

Length: The appropriate length of channel in which rock should be placed should be at least the entire eroded section that is being protected, plus a minimum of 10 feet upstream and downstream of the eroded area. Be sure that the stone on the upstream and downstream ends are trenched in to prevent dislodging.

Where riprap is used only for slope or bank protection and does not extend across the bottom at the channel, riprap should be “keyed in” as shown in Exhibit 2.

Height: Install riprap to a height of three feet above the ordinary high water mark, or 1 foot above the ordinary high water mark if used in conjunction with bioengineering techniques. All exposed soil above the riprap should be stabilized according to the vegetative BMPs.

Design Example Problem:
A streambank has an ordinary high water mark of 3 feet, an 8 foot bottom width, 2:1 side slopes and a two percent slope. There is a 75 foot long curved bank that is eroding. Determine the proper rock size, appropriate stone gradation, and dimensions of the riprap.

1. Refer to example Problems #2 to solve for the proper stone size. Use a \( D_{50} \) stone size of 12 inches.

2. This riprap will be placed to a height of 6 feet (3 feet above the ordinary high water mark). The depth will be 24 inches: \( [1.5 \times (\text{stone size of 12 inches}) = 18 \text{ inches} + 0.5 \text{ foot granular stone} = \text{total of 24 inches}] \).

3. The length of area covered with riprap will be the eroded area (75 feet) + 10 feet upstream and downstream = 95 feet.

4. A geotextile fabric will be installed beneath the riprap.

Construction:
1. Where grading is required, grade the site according to the grading plan. Grade only when stone is ready to be placed.

2. Compact gravel subgrades according to design. Any fill that is used should be compacted to a density approximating that of the surrounding undisturbed area.

3. Install geotextile filter fabrics according to the manufacturer’s specification. Always bury both the upper-most and toe of the geotextile fabric to prevent unravelling. (Basic installa-
tion techniques are discussed in the Filters BMP. Spread granular filters in uniform layers according to the design.

4. Install riprap. If riprap is dumped, hand place any rocks that need to be moved to fit the design.

**Maintenance of Riprap on Stream Banks**

Inspections should be made of all sites immediately after the first rainfall following installation of riprap. This is particularly important in areas where riprap that is displaced during the storm would impact culverts. Thereafter, riprapped sites should be checked following large storms, especially those which are near or exceed the storm frequency used in the design. Displaced riprap should be removed from its downstream location and new riprap placed according to the specifications above.

**Outlets**

**General Considerations for Outlets**

1. How and when to use a riprapped outlet should be made based on criteria given in the Stabilized Outlets BMP.

2. The outlet structure should be designed in conjunction with the conveyance system (i.e. pipe, outlet of a Sediment Basin, etc.) from which the water is outletted. There should be no overfall from the end of the pipe/outlet to the outlet structure (i.e. the pipe/outlet should not be suspended above the outlet structure).

3. The outlet structure should be in place before water is released from the conveyance system.

4. Additional protection may be required on the opposite bank or downstream to prevent in-stream erosion.

5. There should be no overfall from the end of the apron to the receiving channel streambed.

**Stone Size Selection for Outlets**

1. The median stone diameter, \( d_{50} \), in feet, shall be determined from the formula:

\[
d_{50} = \frac{0.02 \cdot Q^{4/3}}{TW \cdot D_o}
\]

Where TW is tailwater depth above the invert of the culvert in feet,
Q is the pipe discharge in cfs for the conduit design storm, or the 25-year storm, whichever is greater, and

\[ D_o \] is the maximum inside culvert width in feet.

2. Fifty percent by size of the riprap mixture should be larger than the median size stone designated as \( d_{50} \) and 50% should be smaller. The largest stone size in the mixture should be 1.5 times the \( d_{50} \) size. The riprap should be reasonably well-graded.

Outlet Dimensions
Refer to Exhibit 8.

1. **Length**: The length of the apron, \( L_a \), should be determined using the following formula:

   \[ L_a = \frac{1.7Q + 8D_o}{D_o^{3/2}} \] for culverts flowing up to 1/2 full.

   \[ L_a = \frac{3.0Q}{D_o^{3/2}} \] for culverts flowing at or above 1/2 full

   Where \( Q \) and \( D_o \) are as described above.

2. **Width**: Where there is a well-defined channel downstream of the apron, the bottom width of the apron should be at least equal to the bottom width of the channel. The structural lining should extend at least one foot above the tailwater elevation, but no lower than two-thirds of the vertical conduit dimension above the conduit invert.

   Where there is no well-defined channel immediately downstream of the apron (i.e. as may apply to **Sediment Basins**) width, \( W \), of the outlet end of the apron should be as follows:

   For tailwater elevation greater than or equal to the elevation of the center of the pipe:
   \[ W = 3D_o + 0.4L_a \]

   For tailwater elevation less than the elevation of the center of the pipe:
   \[ W = 3D_o + L_a \]

   Where \( L_a \) is the length of the apron determined from the formula above and \( D_o \) is the culvert width.

   The width of the apron at the culvert outlet should be at least three times the culvert width.

3. The side slopes should be 2:1 or flatter.

4. The bottom grade should be level (0.0%).

5. There should be no overfall from the end of the apron to the receiving channel streambed.
6. There should be no overfall at the end of the apron or at the end of the culvert.

7. There should be no bends or curves at the intersection of the conduit and apron.

**Stone Size and Gradation**

1. The median stone diameter, $D_{50}$, in feet shall be determined from the formula,

\[ D_{50} = \frac{0.02}{TW} \left( \frac{Q}{D_o} \right)^{4/3} \]

Where $Q$ and $D_o$ are as defined under apron dimensions and TW is tailwater depth above the invert of culvert in feet.

2. The largest stone size in the mixture shall be 1.5 times the $D_{50}$ size. The riprap shall be reasonably well graded.

3. Gabions or precast cellular blocks may be substituted for riprap if the $D_{50}$ size calculated above is less than or equal to the thickness of the gabions or concrete revetment blocks. See the Shoreline/Slope Stabilization BMP.

**Design Example Problem:**

Given: a maximum inside culvert width, $D_o$ of 1.5 ft., a flow ($Q$) of 14/5 cfs, and a tailwater elevation, TW, of 0.7 feet, determine the appropriate design dimensions of the apron ($h_a$ and $W$), and the $D_{50}$ stone size.

**Solution:**

Using \[ L_a = \frac{1.7Q}{D_o^{3/2}} + 8D_o \]

\[ L_a = \frac{1.7(14.5)}{(1.5)^{3/2}} + 8(1.5) \]

\[ L_a = 25.4 \text{ feet, rounded up = 26 feet} \]

Since $TW < 0.5D_o$, use \[ W = 3D_o + L_a \]

\[ W = 3(1.5) + 26 \]

\[ W = 30.5 \text{ feet, rounded up = 31 feet} \]

Using \[ D_{50} = \frac{0.02}{TW} \left( \frac{Q}{D_o} \right)^{4/3} \]

\[ D_{50} = \frac{0.02}{0.7} \left( \frac{14.5}{1.5} \right)^{4/3} \]

\[ D_{50} = 0.58 \text{ feet, converted and rounded = 7 inches} \]

RIP-10
Maintenance

Inspections should be made of all sites immediately after the first rainfall following installation of riprap. This is particularly important in areas where riprap that is displaced during the storm would impact culverts. Thereafter, riprapped sites should be checked following large storms, especially those which are near or exceed the storm frequency used in the design. Displaced riprap should be removed from its downstream location and new riprap placed according to the specifications above.

Exhibits

Formulas included in this BMP were taken from the Rhode Island Soil Erosion and Sediment Control Handbook, Rhode Island Dept. of Env. Mgt., 1989.


Exhibit 2: Length and Height of Riprap. MDEQ, Surface Water Quality Division.


Exhibit 8: Configuration of Conduit Outlet Protection where there is no well defined channel downstream. Standards for Soil Erosion and Sediment Control in New Jersey, New Jersey Soil Conservation Committee, 1980.
Exhibit 1

Ordinary High Water Mark

All raw soil above permanent riprap should be covered with riprap, sod or seeded and mulched.

The ordinary high water mark is the normal water level, which on a river is where the grass stops and the bare soil starts.

All raw soil above permanent riprap should be covered with riprap, sod or seeded and mulched.

No stream banks should be unprotected for 5 days or more

Exhibit 2
Riprap Placement: Length, Thickness, Height

Length to stabilize: cut bank, plus a minimum of 10 feet on both sides.

Height to stabilize: usually three feet above the Ordinary High Water Mark; can be less on hydrologically stable streams.

"Keying in"

Use geotextile (filter) fabric to prevent erosion caused by seepage

T = Thickness = 1.5 times the maximum stone diameter, but no less than 6 inches
Z = Side Slope

Exhibit 3

Maximum Depth of Flow for Riprap-Lined Channels

Exhibit 4
Distribution of Boundary Sheer Around Wetted Perimeter of Trapezoidal Channels


Exhibit 5
Angle of Repose for Riprap Stones

Exhibit 6
Ratio of Critical Shear on Sides to Critical Shear on Bottom


Exhibit 7
Ratio of Maximum Boundary Shear in Bends to Maximum Bottom Shear in Straight Reaches

Exhibit 8
Configuration of Conduit Outlet Protection Where There is no Well-Defined Channel Downstream


RIP-17
APPENDIX E-3

Example Terraced Side Slope Detail
ALL TERRACING MATERIALS MUST BE APPROVED BY THE LOCAL COMMUNITY

EXAMPLE OF TERRACING DETAIL
NOT TO SCALE
WAYNE COUNTY DEPARTMENT OF PUBLIC SERVICES
PARKS DIVISION

PERMIT GUIDELINES FOR SITE RESTORATION
Revised: 1 July 2015

General Guidelines:
1. The Contractor shall be responsible at no expense to the Owner, for any damage to Park property, including but not limited to; athletic fields, boardwalks, bridges, comfort stations, fences, lawns, paved pathways, picnic shelters, planting material, playground structures, signs and site furnishings.
2. The Contractor shall provide and maintain a safe and adequate travel route at all times for Park visitors throughout the duration of the Project. All equipment shall be stored in a manner that is safe to Park visitors and approved by the Wayne County Parks Design Staff.
3. The Contractor shall be responsible for contacting and coordinating with all pertinent utility companies at least 72 hours in advance of any digging to familiarize themselves with all underground utilities, pipes and structures. The Contractor shall assume sole responsibility for any cost incurred due to damage of any utilities.
4. The Contractor shall not willfully proceed with the construction as designed when it is obvious that unknown obstructions and/or grade differences exist. Such conditions shall be immediately brought to the attention of the Wayne County Parks Design Staff. The Contractor shall assume full responsibility for all necessary revisions due to failure to give proper notification.
5. Any discrepancies between dimensioned layout and actual field conditions shall be immediately brought to the attention of the Wayne County Parks Design Staff. The Contractor shall assume full responsibility for all necessary revisions due to failure to give proper notification.
6. The Contractor shall be responsible for any coordination with subcontractors as required to accomplish installation operations.
7. The Contractor shall provide and maintain positive surface drainage.

Lawn Restoration
1. All lawn that is disturbed due to construction activities shall be restored to its original state by the Contractor at no expense to the Owner.
2. Remove diseased or unsatisfactory lawn growth. Do not bury into soil. Remove topsoil containing foreign materials, including oil drippings, stone, gravel, and construction materials.
3. All disturbed areas shall be rough graded to meet the existing adjoining grades and any extraneous materials, i.e. rocks, wood, construction debris or equipment shall be removed and disposed of in a legal manner.
4. After rough grade is met, all disturbed lawn areas shall receive a minimum of 4" of clean, fertile, friable, topsoil of sandy loam character, free of any extraneous material. It will be the Contractor’s responsibility to supplement any salvaged topsoil supply to meet the minimum 4" depth.

5. Following the installation of topsoil, the approval of final grade by the Wayne County Parks Design Staff shall be required prior to reseeding of disturbed areas.

6. Apply a starter fertilizer (15-30-15) at a rate of 5lbs. per 1,000 sf thoroughly and evenly via a mechanical rotary or drop type spreader.

7. Perform seeding operations immediately after preparation of disturbed areas and when soil is dry and winds do not exceed 5 m.p.h. Apply recommended seed via a mechanical rotary or drop type spreader. After seeding, rake or drag surface of soil lightly to incorporate seed into top of soil. Areas that are identified to be seeded prior to construction shall be designated on drawings. The following seed mix is recommended, however alternates can be submitted Wayne County Parks Design Staff for review.

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<th>Seed</th>
<th>Purity</th>
<th>Germination</th>
<th>Mixture %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky Bluegrass</td>
<td>99%</td>
<td>85%</td>
<td>10%</td>
</tr>
<tr>
<td>Turf-Type Perennial Ryegrass</td>
<td>99%</td>
<td>85%</td>
<td>15%</td>
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<tr>
<td>Creeping Red Fescue</td>
<td>98%</td>
<td>85%</td>
<td>20%</td>
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<tr>
<td>Hard Fescue</td>
<td>97%</td>
<td>85%</td>
<td>20%</td>
</tr>
<tr>
<td>Turf-Type Tall Fescue</td>
<td>98%</td>
<td>85%</td>
<td>35%</td>
</tr>
</tbody>
</table>

Seeding application rate: 7lbs. per 1,000 sf.

8. Immediately following seeding operations, the Contractor shall install straw mulch in a uniform manner with continuous coverage over all seeded areas. Anchor straw by mechanical means or with a liquid tackifier at a rate of 60 gals. per acre.

9. Hydroseeding applications may be utilized for establishing new lawns using a mixture of specified fertilizer, tackifier at a rate of 60 gals. per acre, wood cellulose fiber mulch at a rate of 2,000 lbs. per acre and specified seed mix.

10. Water newly seeded areas. The Contractor shall maintain adequate soil moisture until new grass is established.

**Grow Zones Restoration**
1. All “Grow Zones” that are disturbed due to construction activities shall be restored to their original state.
2. “Grow Zones” shall be located in the field prior to construction by the Contractor and the Wayne County Parks Design Staff.
3. The Contractor shall consult with the Wayne County Parks Design Staff prior to restoration for the recommended Seed Mix and application method(s).

**Tree Inventory Plan**
1. Any person wishing to perform land clearing or grubbing activities, remove or transplant trees of any D.B.H. within Park Property of Wayne County shall not do so until they have received approval from the Permits office.
2. Applicant shall submit a Tree Inventory Plan that is performed by a registered land surveyor or certified arborist and includes the following:
   a. Topographic information delineating both existing and proposed contours.
b. Existing and proposed structures, utilities and pavement.
c. Property lines, R.O.W. and easements that are applicable.
d. The location and approximate drip line of all existing deciduous trees 6” D.B.H. or
greater and existing evergreen trees 10’ height or greater.
   i. These trees shall be tagged in the field by identifying numbers using non-
corrosive metal tags and shown on the plan with their respective number.
e. All existing deciduous trees 6” D.B.H. or greater and existing evergreen trees 10’
height or greater shall also be identified on a list using both their common and
botanical names with their corresponding number. Please also indicate size and
condition. Those trees that meet the Landmark Tree Requirements below shall also
be identified.
f. Identify clearly all existing deciduous trees 6” D.B.H. or greater, existing evergreen
trees 10’ height or greater and any Landmark Trees that are proposed to be
removed.
g. The location of all replacement trees according to the Tree Replacement Standards
below. Applicant shall also furnish a plant list that includes quantities, common and
botanical names, size, root type and spacing.
h. A table including the total number of deciduous trees 6” D.B.H. or greater, evergreen
trees 10’ height or greater on site, landmark trees, total number of trees proposed to
be removed and the total number of replacement trees required.
i. The location of tree protection fence and associated details per Wayne County Parks
Standards shall also be included on the plan.

3. Landmark Trees are any existing tree in good condition that are 24” D.B.H. or greater or is
of a type and D.B.H. equal to or greater than those shown on the list below.

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>Landmark D.B.H. (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies species</td>
<td>Fir</td>
<td>18</td>
</tr>
<tr>
<td>Acer species</td>
<td>Maple</td>
<td>18</td>
</tr>
<tr>
<td>Aesculus carnea</td>
<td>Horse Chestnut</td>
<td>18</td>
</tr>
<tr>
<td>Aesculus glabra</td>
<td>Buckeye</td>
<td>18</td>
</tr>
<tr>
<td>Alnus glutinosa</td>
<td>Black Alder</td>
<td>12</td>
</tr>
<tr>
<td>Asimina triloba</td>
<td>Pawpaw</td>
<td>8</td>
</tr>
<tr>
<td>Betula species</td>
<td>Birch</td>
<td>18</td>
</tr>
<tr>
<td>Carpinus species</td>
<td>Hornbeam</td>
<td>8</td>
</tr>
<tr>
<td>Carya species</td>
<td>Hickory</td>
<td>18</td>
</tr>
<tr>
<td>Castanea dentata</td>
<td>American Chestnut</td>
<td>8</td>
</tr>
<tr>
<td>Catalpa species</td>
<td>Catalpa</td>
<td>18</td>
</tr>
<tr>
<td>Cercis canadensis</td>
<td>Redbud</td>
<td>8</td>
</tr>
<tr>
<td>Cladrastis lutea</td>
<td>Yellowwood</td>
<td>12</td>
</tr>
<tr>
<td>Cornus florida</td>
<td>Flowering Dogwood</td>
<td>8</td>
</tr>
<tr>
<td>Crataegus species</td>
<td>Hawthorn</td>
<td>12</td>
</tr>
<tr>
<td>Diospyros virginiana</td>
<td>Persimmon</td>
<td>12</td>
</tr>
<tr>
<td>Fagus grandifolia</td>
<td>American Beech</td>
<td>18</td>
</tr>
<tr>
<td>Ginkgo biloba</td>
<td>Ginkgo</td>
<td>12</td>
</tr>
<tr>
<td>Gymnocladus dioicus</td>
<td>Kentucky Coffeetree</td>
<td>16</td>
</tr>
<tr>
<td>Juglans nigra</td>
<td>Black Walnut</td>
<td>18</td>
</tr>
<tr>
<td>Juniperus species</td>
<td>Cedar</td>
<td>12</td>
</tr>
<tr>
<td>Larix laricina</td>
<td>Larch/Tamarack</td>
<td>12</td>
</tr>
<tr>
<td>Liquidambar styaciflua</td>
<td>Sweetgum</td>
<td>12</td>
</tr>
<tr>
<td>Liriodendron tulipifera</td>
<td>Tuliptree</td>
<td>12</td>
</tr>
<tr>
<td>Botanical Name</td>
<td>Common Name</td>
<td>Landmark D.B.H. (inches)</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Malus species</td>
<td>Crabapple</td>
<td>12</td>
</tr>
<tr>
<td>Metasequoia glyptostroboides</td>
<td>Dawn Redwood</td>
<td>16</td>
</tr>
<tr>
<td>Nyssa sylvatica</td>
<td>Blackgum</td>
<td>16</td>
</tr>
<tr>
<td>Ostrya virginiana</td>
<td>Ironwood</td>
<td>8</td>
</tr>
<tr>
<td>Picea species</td>
<td>Spruce</td>
<td>18</td>
</tr>
<tr>
<td>Pinus species</td>
<td>Pine</td>
<td>18</td>
</tr>
<tr>
<td>Platanus species</td>
<td>London Plane/Sycamore</td>
<td>18</td>
</tr>
<tr>
<td>Prunus species</td>
<td>Cherry</td>
<td>18</td>
</tr>
<tr>
<td>Pseudotsuga menziesii</td>
<td>Douglas Fir</td>
<td>18</td>
</tr>
<tr>
<td>Quercus species</td>
<td>Oak</td>
<td>16</td>
</tr>
<tr>
<td>Sassafras albidum</td>
<td>Sassafras</td>
<td>14</td>
</tr>
<tr>
<td>Taxodium distichum</td>
<td>Bald Cypress</td>
<td>12</td>
</tr>
<tr>
<td>Tilia americana</td>
<td>Basswood</td>
<td>18</td>
</tr>
<tr>
<td>Tsuga canadensis</td>
<td>Eastern Hemlock</td>
<td>12</td>
</tr>
<tr>
<td>Ulmus americana</td>
<td>American Elm</td>
<td>18</td>
</tr>
</tbody>
</table>

**Tree Replacement**

1. Any person wishing to remove trees that are in good condition shall do so in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Size of Removed Tree</th>
<th>Number of replacement trees to removed tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous Tree 6” D.B.H. or greater =</td>
<td>3:1 (minimum 2.5” caliper)</td>
</tr>
<tr>
<td>Evergreen Tree 10’ height or greater =</td>
<td>3:1 (minimum 8’ height)</td>
</tr>
<tr>
<td>Landmark Tree (see list) =</td>
<td>1:1 (number of caliper inches = D.B.H. inches)</td>
</tr>
</tbody>
</table>

2. All replacement trees shall be of similar species to those being removed. Replacement trees shall be nursery grown and comply with ANSI Z60. Species, proposed size and any substitutions must be approved by the Wayne County Parks Design Staff prior to shipment or installation. Installation shall be per Wayne County Parks Standards. The suggested plant list is indicated below.

**Replacement Plant suggestions:**

**Canopy Trees**
- Acer rubrum – Red Maple
- Acer saccharum – Sugar Maple
- Carya ovata – Shagbark Hickory
- Fagus grandifolia – American Beech
- Lirodendron tulipifera – Tulip Tree
- Nyssa sylvatica – Black Gum
- Ostrya virginiana – Ironwood
- Platanus occidentalis – Sycamore
- Quercus bicolor – Swamp White Oak
- Quercus imbricaria – Shingle Oak
- Quercus macrocarpa – Bur Oak
- Quercus rubra – Red Oak
- Tilia americana - Basswood

**Evergreen Trees**
- Abies concolor – White Fir
- Picea glauca – White Spruce
- Picea pungens – Colorado Spruce
- Pinus Strobus – White Pine
- Taxodium distichum – Bald Cypress
- Tsuga Canadensis – Eastern Hemlock

**Flowering Trees**
- Amelanchier canadensis – Serviceberry
- Cercis canadensis – Eastern Redbud
- Cornus florida – Flowering Dogwood
- Crataegus crus-galli inermis ‘Crusader’
- Malus species – Crab Apple
**Bike Paths**
1. All County Bike Paths within or in close proximity of construction limits shall be adequately barricaded for the duration of construction. Appropriate signage shall be installed where necessary to adequately inform visitors of the construction zone and directions for an alternative route.
2. All Bike Paths removed or damaged as a result of construction shall be replaced with 3.5" depth bituminous pavement. The section of pavement shall include an 8" depth 21AA aggregate base compacted per current MDOT standards, 2" depth 13A leveling course, tack coat and a 1.5" depth 36A wearing course. The bituminous pavement shall be installed per current MDOT installation methods.

**Road Shoulders**
1. All Road shoulders shall be restored with 4” of topsoil and seeded as specified. No gravel will be allowed beyond the asphalt shoulder. Shoulder restoration shall meet all current MDOT standards.

**Park Drives**
1. All Park Drives that are within or in close proximity to construction limits shall be replaced and restored to their original state. Construction applications shall meet all current MDOT standards and project specifics should be taken into consideration prior to commencement of restoration.
2. All construction equipment and materials remaining on site following construction period shall be removed and disposed of off site.

Through the Permits Office, the Wayne County Parks Design Staff shall review all construction permits within or in close proximity to Park property prior to issuance of a permit.

Please contact: Elizabeth Iszler, Chief of Planning and Design: (734) 261-4312