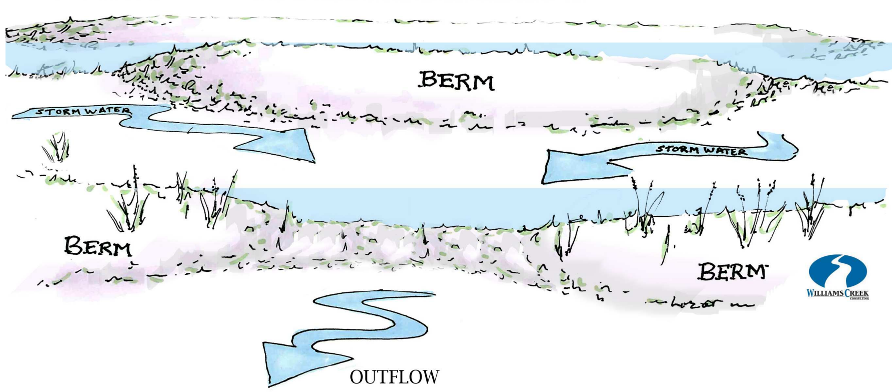
4.6. *Low Impact and Retentive Grading*

Low Impact Grading techniques focus on utilizing existing topography during Site layout to minimize cost. Proposing structures, roads, and other impervious surfaces along existing high ground will allow for storm water to drain onto adjacent storm water utilities with a minimum of earthwork required. In doing so, low impact grading can promote the use of existing drainage patterns on-site, minimizing the impact to downstream receiving bodies. The advantages associated with low impact grading are maximized when the existing topography is exceedingly flat, and slope and cover requirements of conventional pipe networks are at a premium. If storm water is kept out of traditional piping infrastructure and conveyed via swale or pond, water quality benefits will be maximized while earthwork and infrastructure costs are minimized. Storage observed en route to primary detention will decrease primary detention requirements further separating Low Impact Grading from traditional development on an economic scale.

Retentive Grading techniques, alternatively, can be utilized on Sites in which the vertical fall from Development to the storm water outlet is high. If topographic variation is plentiful on site, retentive grading can be an effective method of slowing velocities in open channels, preventing scour, encouraging infiltration, and increasing site retention in route to primary storm water detention facilities. The use of retentive grading can therefore decrease the potential size of primary facilities. If retentive grading is utilized on adequately infiltrating soils, the volume of storm water impounded upstream of the berm may be removed from the storm water treatment system, and support ground water recharge. If adequately infiltrating soils are not present on the Site, underdrains placed below amended soils can help to delay and spread out the inflow hydrograph to primary detention facilities, thereby decreasing the required storage capacity of primary facilities. The filtering of storm water to underdrains will facilitate removal of Total Suspended Solids (TSS), when properly designed. The use of organic soil amendments can facilitate uptake of excess nutrients and provide a medium for the sorption of fecal coliforms. Berms and retentive grading systems may function alone in grassy areas or may be incorporated into the design of other storm water control facilities such as bioretention and constructed wetlands. When adequate freeboard exists to intermittently stage storm water en route, the cost of conventional storm water facilities may be decreased.



Low Impact and Retentive grading key elements:

- High quality topsoil in outer layer of berm that provides growing medium for plants (minimum 4 inches).
- Inner layer of berm constructed of a stable fill material.
- Established vegetation to prevent erosion and improve appearance.
- An overflow weir or runoff bypass mechanism.
- Soil amendments and underdrain placement at designer discretion.

Table 4.6.1: Low Impact and Retentive Grading Potential Application and Storm Water Regulation

Potential applications			Storm water regulations		
				Infiltration	No Infiltration
Residential Subdivision:	Yes		Water Quality Benefit	Yes	Yes
Commercial:	Yes		Volume Reduction	Yes	No
Ultra Urban:	Limited		Attenuation Benefit	Yes	Yes
Industrial:	Yes				
Retrofit:	Yes				
Highway Road:	Yes				

Acceptable forms of pre-treatment

- Sediment forebays
- Filter strips
- Vegetated swales
- Bioretention gardens
- Wetlands
- General Disconnection of impervious areas from detention facilities

Berms and Retentive Grading Techniques in the Urban Landscape

Berms and retentive grading can provide an efficient method of reusing soil on site to manage storm water, by moving structural soil small distances and creating storage. In addition, appropriate soils upstream of the berm may be excavated to provide structural fill, and subsequently provide a location to deposit top soil removed from other parts of the Site. Addition of topsoil to berm excavations can help to support a healthy vegetative system and increased infiltration potential.

Pretreatment for other Facilities

A berm and small depression can act as a sediment forebay before storm water enters a bioretention basin, subsurface infiltration facility, or other facility.

Retention and Increased Capacity for other Facilities

A berm placed on the down slope side of a bioretention basin or other facility built on a mild slope can help retain storm water in that facility and increase its capacity without additional excavation.

Retention and Infiltration in a Shallow Depression

A shallow depression can be created behind a berm to provide an infiltration area without the need for a more complex storm water facility.

Flow Diversion

A berm can be placed across a slope to divert low or high flow water to a nearby channel or facility.

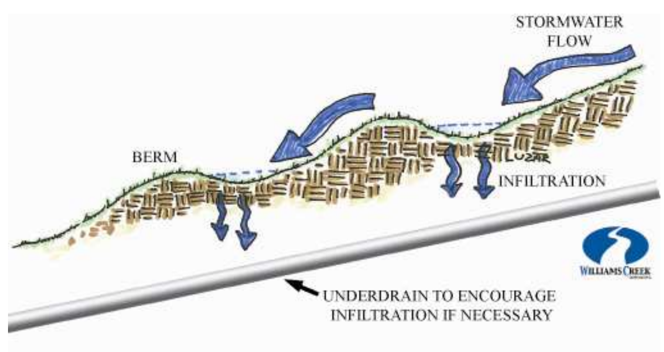
Berms in Series

A series of small berms and depressions can be placed along a slope within any surface- based conveyance system, to provide infiltration and detention while stabilizing the slope.

Components of Berms and Retentive Grading Techniques

Berms and retentive grading systems may be designed to convey and infiltrate all of the storm water they receive in small storms. These systems often include the following components:

- Topsoil
- Fill
- Vegetation
- Weir or Bypass Mechanism



RETENTIVE GRADING
CONVEYANCE, STORAGE AND TREATMENT

Topsoil

The outer portion of the berm consists of high quality topsoil to provide a growing medium for plants. A topsoil containing 30% organic material by weight can be expected to support plant growth, aid in regulation of soil nutrients, and provide a medium for adsorption of pathogens. A berm may consist entirely of high quality topsoil. To reduce cost, only the top 4 to 8 inches needs to consist of high quality topsoil, with well-drained soil, or an underdrain system making up the remainder of the berm.

Fill

A berm may consist entirely of high quality topsoil. However, cost may be reduced by constructing the inner portion of the berm of a stable fill material. In many cases, soil may be reused from elsewhere on the site.

Vegetation

Vegetation stabilizes and prevents erosion of the soil layer. Native trees and grasses are encouraged for aesthetic reasons and because of their deeper root systems which preserve long-term infiltration potentials, but turf is acceptable.

Weir or Bypass Mechanism

The berm may not be able to retain all flow during large events. An overflow weir may be designed to allow flow to overtop the berm without causing erosion. In other cases, the contours of the site may allow excess flow to bypass around the end of the berm.

Recommended Design Procedure

- Water quality-and quantity requirements must be designed within parameters required by the Storm Water Design and Specification Manual.
- Create a Conceptual Site Plan for the entire site, and determine what portion of the sizing requirements berms and retentive grading can help meet. Determine the general location of these features and the role they will play on the site. These techniques can be applied anywhere in advance of Site discharge so long as the storm water is kept on the surface of the Site and not discharged to a pie.
- Create a conceptual design for the berm (or berms), including height of berm and depth of depression.

Table 4.6.2: Starting Design Values for Berm Areas and Depths	
Area (surface area and infiltration area)	Largest feasible on site (Minimum of 1 square foot of infiltration area for every 5 square feet of contributing DCIA recommended.)
Average Ponding Depth	6 -12 inches
Berm Height	6 - 24 inches

- For a berm-depression system intended to promote infiltration, investigate the feasibility of infiltration in the proposed location. The NRCS soil surveys can provide guidance as to where adequately infiltrating soils are likely to be found. However, Infiltration testing should be performed within 25 feet of the infiltration footprint. In addition infiltration characteristics should be based upon the post-construction condition of the soil.

- Estimate runoff reaching the system during the design storm and the maximum water level reached at the berm.

- Using infiltration area and the saturated vertical infiltration rate of the native soil, estimate how long the surface ponding will take to drain. If storage does not drain within the expected time interval between design storms, credit for volume reductions may not be allowed, due to inability to accommodate back to back storm events. The designer may adjust the design until the volume and drainage time constraints are met.

- Design an overflow or bypass mechanism for large storms.

- Consider maintenance activities when choosing berm materials and shape. For example, providing more storage than taken credit for in quantity calculations will allow for long-term sediment accrual without maintenance requirements. If native plantings are designed to develop over time into a diverse ecosystem within the depressional area, the aesthetic and ecological value of the systems will be enhanced.

- If a berm is to be mowed, the slope should not exceed a 4:1 ratio (horizontal to vertical) in order to avoid "scalping" by mower blades. If trees are to be planted on berms, the slope should not exceed a 5:1 to 7:1 ratio. Other herbaceous plants, which do not require mowing, can tolerate slopes of 3:1, though this may promote increased runoff rate and erosive conditions. If underdrains are installed to simulate the water quality and flowrate benefits of infiltration, woody vegetation is not recommended per the long term health of the underdrain system. Berm side slopes should never exceed a 2:1 ratio.

- To minimize cost, check the volume of cut and fill material. Berm height and depression depth may be adjusted to more closely balance the two.

Materials

Soil

- Topsoil stripped and stockpiled on the site should be used for fine grading. Topsoil is defined as the top layer of earth on the site, which produces heavy growths of crops, grass or other vegetation. Top soil is typically high in organic content making it unsuitable for structural fill but advantageous for promoting infiltration, nutrient transformation, and fecal coliform sorbtion.

- Soils excavated from on-site may be used for berm construction provided they are deemed satisfactory as per the above recommendations or by a soil scientist.

Vegetation

- It is critical that plant materials are appropriate for soil, hydrologic, light, and other site conditions. Native trees and grasses are strongly recommended but turf grass is acceptable. Select plants from Chapter 5: Storm Water Landscape Guidance. Take ponding depth, drain down time, sunlight, and other conditions into consideration when selecting plants from this list. Although plants will be subject to ponding, they may also be subject to drought.

- Trees and shrubs shall be freshly dug and planted in accordance with standard nursery practice.

- Perennials, grass-like plants, and groundcover plants shall be healthy, well-rooted specimens.

- Plantings shall be designed to minimize the need for mowing, pruning, and irrigation.

- A native grass/wildflower seed mix can be used as an alternative to groundcover planting. Seed mix shall be free of weed seeds.

Construction Guidelines

- Clearly marking areas for infiltration berms before any site work begins can discourage soil disturbance and compaction during construction and preserve the existing infiltration characteristics of the underlying soil.

- Provide erosion and sedimentation control protection on the site such that construction runoff is directly away from the proposed infiltration berm location. Alternatively, ensure that any sediment accrual associated with construction activities is removed to design grade before the cessation of construction activities.

- Complete site elevation grading and stabilize the soil disturbed within the limit of disturbance. Do not finalize berm excavation and construction until the drainage area is fully stabilized.

- Manually scarify the existing soil surfaces of the proposed infiltration berm locations. Do not compact in-situ soils. Heavy equipment shall not be used within the berm area.

- Backfill the excavated area as soon as the subgrade preparation is complete to avoid accumulation of debris. Place berm soil in 8 inch lifts and compact after each lift is added according to design specification. Grade berm area as fill is added.

- Protect the surface ponding area at the base of the berm from compaction. If compaction occurs scarify soil to a depth of at least 8 inches.

- After allowing for settlement, complete final grading within 2 inches of proposed design elevations. The crest and base of the berm should be level along the contour.

- Seed and plant vegetation as indicated on the plans and specifications.

- Place mulch to prevent erosion and protect establishing vegetation and manually grade to final elevations.

- Water vegetation at the end of each day for two weeks after planting is completed.

Maintenance Guidelines

Berms have low to moderate maintenance requirements, depending on the design.

Table 4.6.3: Berm & Grading Maintenance Guidelines		
	Activity	Schedule
	Remove trash and debris Remove invasive plants. If desired, mow grass to maintain 2 -4 inch height.	As needed
	Inspect soil for erosion and repair eroded areas.	Monthly
	Maintain records of all inspections and maintenance activity concurrent with post-construction requirements listed in *City of Fort Wayne Storm Water Specifications Manual.*	Ongoing

Note:

Design of berms and grading techniques are not limited to the examples shown within this text. Successful storm water management plans will combine appropriate materials and designs specific to each site. Berms may be used within larger basins (e.g., wetlands, wet ponds) to lengthen flow paths; these applications are discussed in various LID literature.

4.6.1. Low Impact and Retentive Grading Designer/Reviewer Checklist

Item	Yes	No	N/A	Notes
Appropriate areas of the site evaluated?				
Infiltration rates measured?				
Runoff bypass or weir provided?				
Soil permeability acceptable?				
Appropriate slope for vegetation type and mowing requirements?				
Natural, uncompacted soils?				
Hotspots/pretreatment considered?				
Ponding depth limited to 12 inches?				
Berm Height limited to 24 inches?				
Positive overflow from system?				
Erosion and Sedimentation control?				
Feasible construction process and sequence?				
Entering flow velocities non-erosive or erosion control devices?				
Acceptable planting soil specified?				
Appropriate plants selected?				
Maintenance accounted for and plan provided?				
Review of treatment volume?				
Review of calculations?				
Appropriate soil composition?				

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