

# Standard Operation Procedures for Inspection and Maintenance

## Grass Buffers Swales and Grass (GB-GS)



November 2007

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## **GB-GS-1 BACKGROUND**

Grass Buffers and Grass Swales are common types of Stormwater Management Facilities utilized within the Front Range of Colorado. Grass Buffers and Grass Swales promote filtration, infiltration, and settling to reduce runoff volume.

Grass Buffers are uniformly graded and densely vegetated areas of turf grass. They are designed to accommodate sheet flow rather than concentrated or channelized flow. They are typically located adjacent to impervious areas such as parking lots or along highways and roads. Grass Buffers are designed to evenly distribute runoff across the width of the buffer to achieve uniform sheet-flow conditions. A flow spreader may be incorporated for this purpose. In some cases, grass buffers may have underdrain systems.

Grass Swales are densely vegetated drainageways with low-pitched side slopes that collect and convey runoff. Design of their longitudinal slope and cross section forces the flow to be slow and shallow, thereby facilitating sedimentation while limiting erosion. Berms or check dams may be installed perpendicular to the flow to decrease the slope and slow down the flow. Grass swales are used in open space and landscaped areas to collect and convey overland flows, and can be used as an alternative to curb and gutter to collect and convey street flows. Some grass swales are designed with underdrain systems.

## **GB-GS-2 INSPECTING GRASS BUFFERS AND SWALES (GB-GS)**

### **GB-GS-2.1 Access and Easements**

Inspection and maintenance personnel may utilize the stormwater facility map located in Appendix G containing the locations of the access points and maintenance easements of the GB-GSs within this development.

### **GB-GS-2.2 Stormwater Management Facilities Locations**

Inspection and maintenance personnel may utilize the stormwater facility map located in Appendix G containing the locations of the GB-GSs within this development.

### **GB-GS-2.3 Grass Buffer - Grass Swale (GB-GS) Features**

GB-GSs are unique stormwater quality facilities, in that they are typically viewed as landscaping or ground cover, and are often overlooked as water quality treatment facilities. GB-GSs have a number of features that are designed to serve a particular function. It is important for maintenance personnel to understand the function of each of these features. Below is a list of the common features of a Grass Swale or Grass Buffer and the corresponding maintenance inspection items that can be anticipated:

**Table GB-GS-1  
Typical Inspection & Maintenance Requirements Matrix**

|                                     | <b>Sediment Removal</b> | <b>Mowing Weed control</b> | <b>Trash &amp; Debris Removal</b> | <b>Erosion</b> | <b>Removal/ Replacement</b> | <b>Structural Repair</b> |
|-------------------------------------|-------------------------|----------------------------|-----------------------------------|----------------|-----------------------------|--------------------------|
| <b>Swale Bottom</b>                 | X                       | X                          | X                                 | X              |                             |                          |
| <b>Side Slope</b>                   |                         | X                          | X                                 | X              |                             |                          |
| <b>Buffer Strip</b>                 | X                       | X                          | X                                 | X              |                             |                          |
| <b>Inflows</b>                      | X                       | X                          | X                                 | X              | X                           | X                        |
| <b>Underdrain System</b>            |                         |                            |                                   |                | X                           |                          |
| <b>Grade Control/Level Spreader</b> |                         |                            |                                   | X              |                             | X                        |
| <b>Irrigation System</b>            |                         |                            |                                   |                | X                           |                          |

**GB-GS-2.3.1 Grass Swale Bottom and Side Slopes; Grass Buffer Strips**

Grass Swales and Grass Buffers require general maintenance of the turf grass and repair of any rill or gully development. The bottom and side slopes of grass swales and the area of grass buffer strips should be maintained with dense vegetative cover, and should not be eroded or bare. Inspection over the first few years will help to determine if any problems are developing.

*The typical maintenance items that are required at the side slopes and bottoms of grass swales and within grass buffer areas are as follows:*

*a. Sediment Accumulation* – The purpose of the grass swale or buffer is to slow down flow and allow sedimentation to occur. To prevent a loss in performance of the swale or buffer, sediment that accumulates must be removed on a timely basis.

*b. Vegetation Sparse* – Grass Swales and Buffers rely on a healthy, dense cover of grass to decrease the flow velocities and promote sedimentation and infiltration. Grasses that are diseased, dying or otherwise damaged should be replaced. All bare areas should be reseeded or patched. Causes which contribute to the damaged grass cover, including lack of adequate irrigation, traces of pedestrian or vehicular traffic, uncontrolled weeds etc., should be identified and remedied.

*c. Erosion Present* – Lack of adequate vegetative cover or excessive flow velocities may result in rill or gully development, and erosion of the swale or buffer strip. Erosion will require maintenance to prevent further damage to the area and to prevent sediment transport.

d. *Standing Water/Boggy Areas* – Grass swales and buffers are generally intended to drain and be dry in between rain events. If areas of standing water are present, the swale or buffer may need to be evaluated for proper grade to ensure drainage. In some cases, where underdrains are used, the underdrains should be inspected to ensure that they are not clogged.

#### GB-GS-2.3.2 Inflow Points

Inflow points are the points of stormwater discharge into the swale or buffer. Inflow points are typically pipe outfalls, other grass swales or buffers, or curb cuts from upstream impervious areas, such as parking lots. Some form of energy dissipation is typically provided immediately downstream of the inflow point into the grass swale or buffer. Energy dissipation devices may include riprap aprons, or flow spreader devices.

*The typical maintenance items that are required at inflow points are as follows:*

a. *Riprap Displaced/Rundown Damaged* – Often, because of the repeated impact/force of water, the riprap can shift and settle. If any portion of the riprap rundown or apron appears to have settled, if soil is present between the riprap, or if the riprap has shifted, maintenance may be required to ensure future erosion is prevented.

b. *Erosion Present/Outfall Undercut* – In some situations, an energy dissipater may have not been provided, or may not have been sized, constructed, or maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure(s) and sediment transport within the facility.

c. *Sediment Accumulation* – Because of the turbulence in the water created by the energy dissipater, sediment often deposits immediately downstream of the inflow point. To prevent a loss in performance, sediment that accumulates in this area must be removed on a timely basis.

#### GB-GS-2.3.3 Underdrain System

Some grass swales and buffers that have a flatter slope or soils which do not allow adequate percolation or are in areas with a continuous base flow may have been installed with an underdrain system. Underdrains typically consist of a layer of geotextile fabric, gravel storage area and perforated PVC pipe. The geotextile fabric is utilized to prevent the filter material from entering the underdrain system. The gravel storage area allows for storage of treated stormwater runoff prior to the discharge of the runoff through the perforated PVC pipe.

*The typical maintenance activities that are required for the underdrain system are as follows:*

With proper maintenance of the grassed areas, there should be a minimum amount of maintenance required on the underdrain system. Generally the only maintenance performed on the underdrain system is jet-vac cleaning in the event that it becomes clogged.

#### GB-GS-2.3.4 Grade Control Level Spreader

Grass swales that are installed in areas with steep longitudinal slopes often necessitate the use of grade control checks or drop structures. Grade control structures are typically either concrete walls or rip rap structures that serve to provide a reinforced drop at specific locations in the channel, reducing the longitudinal slope between the control structures.

Level Spreaders are installed on the upstream of grass buffers to evenly distribute flows along the design length. Level spreaders may consist of slotted curbing, modular block porous pavement, level walls or other spreader devices.

*The typical maintenance activities that are required for grade control structures and level spreaders are as follows:*

*a. Erosion present* – Grade control structures and level spreaders are provided to reduce the potential for erosion of the grassed swale or buffer areas. Erosion within the vicinity of the control structure or level spreader indicates that the structure is not functioning as intended and requires maintenance to prevent future erosion and damage.

*b. Structural damage* – Structural damage can occur at anytime along the life of the facility. Typically, structural damage occurs with the deterioration of concrete, including cracking, spalling or settling and the erosion and deterioration of the riprap structures. Level spreaders may settle unevenly creating low areas, which concentrate the flows.

#### GB-GS-2.3.5 Irrigation

Grass Buffers and Grass Swales depend on healthy, dense turf grass to function, and therefore require an irrigation system, to provide a consistent water supply. Typically, the condition of the grass cover will provide evidence of the effectiveness and maintenance needs of the irrigation system.

*The typical maintenance activities that are required for irrigation systems are as follows:*

Irrigation systems will generally require routine periodic maintenance and adjustment to ensure that proper amounts of water are being applied given the weather conditions, and that they are providing coverage to all areas of the grass to eliminate bare spots.

### GB-GS-2.3.6 Miscellaneous

There are a variety of inspection/maintenance issues that may not be attributed to a single feature within the GB-GS. This category on the inspection form is for maintenance items that are commonly found in the GB-GS, but may not be attributed to an individual feature.

*a. Encroachment in Easement Area* – Arapahoe County requires that GB-GS be located in tracts or drainage easements. Property owners may place landscaping, trash, fencing, or other items within the easement area that may affect maintenance or the operation of the facility.

*b. Public Hazards* – Public hazards include items such as containers of unknown/suspicious substances, and exposed metal/jagged concrete on structures. **If any hazard is found within the facility area that poses an immediate threat to public safety, contact the local Sheriff's Office at 911 immediately.**

*c. Burrowing Animals/Pests*– Prairie dogs and other burrowing rodents may cause damage to the GB-GS features and negatively affect the vegetation within the GB-GS.

*d. Other* – Any miscellaneous inspection/maintenance items not contained on the form should be entered here.

### **GB-GS-2.4 Inspection Forms**

GB-GS Inspection forms are located in Appendix D. Inspection forms shall be completed by the person(s) conducting the inspection activities. Each form shall be reviewed and submitted by the property owner or property manager to Arapahoe County per the requirements of the Operations and Maintenance Manual. These inspection forms shall be kept indefinitely and made available to Arapahoe County upon request

## **GB-GS-3 MAINTAINING GRASS BUFFERS & GRASS SWALES (GB-GS)**

### **GB-GS-3.1 Maintenance Personnel**

Maintenance personnel must be experienced to properly maintain GB-GSs. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

### **GB-GS-3.2 Equipment**

It is imperative that the appropriate equipment and tools are taken to the field with the operations crew. The types of equipment/tools will vary depending on the task at hand. Below is a list of tools, equipment, and material(s) that may be necessary to perform maintenance on a GB-GS:

- 1.) Mowing Tractors

- 2.) Trimmers (extra string)
- 3.) Shovels
- 4.) Rakes
- 5.) All Surface Vehicle (ASVs)
- 6.) Engineers Level (laser)
- 7.) Erosion Control Blanket(s)
- 8.) Mulch
- 9.) Sod or Seed
- 10.) Illicit Discharge Cleanup Kits
- 11.) Trash Bags
- 12.) Stormwater Facility Operation and Maintenance Manual

Some of the items identified above may not be needed for every maintenance operation. However, this equipment should be available to the maintenance operations crews should the need arise.

### **GB-GS-3.3 Maintenance Forms**

The GB-GS Maintenance Form provides a record of each maintenance operation performed by maintenance contractors. The GB-GS Maintenance Form shall be filled out in the field after the completion of the maintenance operation. Each form shall be reviewed and submitted by the property owner or property manager to Arapahoe County per the requirements of the Operations and Maintenance Manual. The GB-GS Maintenance form is located in Appendix E.

### **GB-GS-3.4 Maintenance Categories and Activities**

A typical GB-GS Maintenance Program will consist of three broad categories of work: Routine, Minor and Major. Within each category of work, a variety of maintenance activities can be performed on a GB-GS. A maintenance activity can be specific to each feature within the GB-GS, or general to the overall facility. This section of the SOP explains each of the categories and briefly describes the typical maintenance activities for a GB-GS.

A variety of maintenance activities are typical of GB-GSs. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of the GB-GS or underdrain system. Below is a description of each maintenance activity, the objectives, and frequency of actions.

### **GB-GS-3.5 Routine Maintenance Activities**

The majority of this work consists of scheduled mowing, trash and debris pickups and landscape care for the GB-GS during the growing season. It also includes activities such as weed control. These activities normally will be performed numerous times during the year. These items do not require any prior approval by

Arapahoe County, however, completed inspection and maintenance forms shall be submitted to Arapahoe County for each inspection and maintenance period.

The Routine Maintenance Activities are summarized below, and further described in the following sections.

**Table GB-GS-2  
Summary of Routine Maintenance Activities**

| <b>Maintenance Activity</b>               | <b>Minimum Frequency</b>                                | <b>Indication Action is Needed:</b>                               | <b>Maintenance Action</b>  |
|---|---|---|--|
| <b>Trash/Debris Removal</b>               | Twice annual and before mowing                          | Trash & debris in GB-GS   | Remove and properly dispose of trash and debris  |
| <b>Mowing</b>                             | Routine – as necessary to maintain 2” – 4” grass height | Excessive grass height/aesthetics                                 | 2”-4” grass height for turf grass; 4” to 6” for native grass   |
| <b>Irrigation (Automatic)</b>             | Three times annually                                    | Areas of insufficient or excess watering; broken or missing parts | SPRING: start up system; test for even coverage and correct timer settings<br>SUMMER: test for even coverage and correct timer settings<br>FALL: drain and winterized system (follow watering regulations) |
| <b>Irrigation (Not Automatic)</b>         | As needed to maintain healthy grass                     | Areas of insufficient or excess watering                          | Water as needed to maintain healthy grass; (follow watering regulations)   |
| <b>Weed Control</b>                       | Minimum twice annually                                  | Noxious weeds; Unwanted vegetation                                | Treat w/herbicide or hand pull; consult a local Weed Inspector   |
| <b>Mosquito Treatment</b>                 | As needed, based upon inspections                       | Standing water/ mosquito habitat                                  | Perform maintenance to eliminate standing water; Treat w/ EPA approved chemicals   |
| <b>Level Spreader (Grass Buffer only)</b> | As needed, based upon inspections                       | Evidence of uneven flow/localized erosion                         | Look for cause; repair, fill or revegetate areas of erosion  |
| <b>Rodent Damage</b>                      | As needed, based upon inspections                       | Holes, small piles of dirt, raised burrows                        | Evaluate damage; contact Parks Dept. or Division of Wildlife for guidance  |

**GB-GS-3.5.1 Trash/Debris Removal**

Trash and debris must be removed from the GB-GS area to allow for proper functioning and to improve aesthetics. This activity must be performed prior to mowing operations.

*Frequency* – Routine – Prior to mowing operations and a minimum of twice annually.

**GB-GS-3.5.2 Mowing**

Routine mowing of the turf grass embankments is necessary to maintain an appropriate grass height and to improve the overall appearance of the GB-GS.

Turf grass should be mowed to a height of 2 to 4- inches (4 – 6- inches for native grass) and shall be bagged to prevent potential contamination of the filter media.

*Frequency* – Routine – as necessary to maintain grass height.

#### GB-GS-3.5.3 Irrigation

Irrigation systems should be maintained in proper working order to provide an adequate water supply to support the grass cover. When automatic irrigation systems are not available, alternate methods for providing a water supply during times of drought must be provided.

Automatic irrigation systems should be maintained routinely throughout the growing season to ensure that they are providing the appropriate amounts of water, and are providing complete coverage of the area. Sprinkler heads should be adjusted as necessary, and checked for broken or missing parts.

*Frequency* - Routine as needed throughout the growing season, plus the following:

SPRING: Start up the system and test for even coverage and correct timer settings.

SUMMER: Test for even coverage and correct timer settings.

FALL: Drain and winterize the system.

#### GB-GS-3.5.4 Weed Control

Noxious weeds and other unwanted vegetation must be treated as needed throughout the GB-GS. This activity can be performed either through mechanical means (mowing/pulling) or with herbicide. Consultation with a local Weed Inspector is highly recommended prior to the use of herbicide. Herbicides should be utilized sparingly and as a last resort. All herbicide applications should be in accordance with the manufacturer's recommendations.

*Frequency* – Routine – As needed based upon inspections.

#### GB-GS-3.5.5 Mosquito Treatment

GB-GS facilities are intended to drain, and should not have areas of standing water which creates mosquito habitat. Causes of the standing water or boggy conditions should be investigated and remediated as necessary to eliminate the standing water. Only EPA approved chemicals should be applied in accordance with the recommendations of the manufacturer.

*Frequency* – As needed based upon inspections.

#### GB-GS-3.5.6 Level Spreader (Grass Buffer only)

Evidence of uneven flow and localized erosion downstream of the level spreader indicate that the flow is not evenly distributed along the length of the spreader.

Areas of erosion should be repaired, filled and revegetated. Causes for the erosion should be investigated and repaired.

*Frequency* – As needed based upon inspections.

**GB-GS-3.5.7 Rodent Damage**

Small holes, piles of dirt, and raised burrows are evidence of rodent damage. Damaged areas should be repaired and revegetated. Consultation with an animal control specialist or the Division of Wildlife may be required for persistent problems.

*Frequency* – As needed based on inspections.

**GB-GS-3.6 Minor Maintenance Activities**

This work consists of a variety of isolated or small-scale maintenance/operational problems. Most of this work can be completed by a small crew, hand tools, and small equipment. These items require approval by Arapahoe County. Completed inspection and maintenance forms shall be submitted to Arapahoe County for each inspection and maintenance activity.

**Table GB-GS-3  
Summary of Minor Maintenance Activities**

| <b>Maintenance Activity</b>               | <b>Minimum Frequency</b>          | <b>Indication Action is Needed:</b>  | <b>Maintenance Action</b>                                 |
|---|-----------------------------------|--|---|
| <b>Sediment Removal</b>                   | As needed.                        | Sediment build-up.   | Remove and properly dispose of sediment                   |
| <b>Erosion Repair</b>                     | As needed, based upon inspection  | Rills and gullies forming on slopes and other areas                                | Repair eroded areas & revegetate; address cause           |
| <b>Vegetation Removal</b>                 | As needed, based upon inspection  | Trees, willows, shrubs impeding flow   | Remove vegetation; restore correct grade and surface flow |
| <b>Revegetation</b>                       | As needed, based upon inspection  | Areas without grass  | Replace grass by sodding or seeding                       |
| <b>Irrigation (Automatic)</b>             | As needed, based upon inspection. | Evidence of broken or missing parts  | Replace parts and test system                             |
| <b>Level Spreader (Grass Buffer Only)</b> | As needed, based upon inspection. | Evidence of uneven flow; erosion; or rills/gullies                                 | Repair sections of level spreader and address cause       |
| <b>Fertilization or Soil Amendment</b>    | As needed, minimize fertilization | Grass with pale color; areas with poor grass growth not due to irrigation problems | Consult with turf specialist; Test soil                   |
| <b>Vehicle Tracks (Along Roadways)</b>    | As needed, based upon inspection  | Depressions from vehicle tracks; vegetation damage                                 | Repair and fill depressions; sod or seed damaged areas    |

#### GB-GS-3.6.1 Sediment Removal

Sediment removal is necessary to ensure proper function of the grass swale or buffer. Care should be taken when removing sediment to prevent damage to the turf grass and surrounding areas. Excessive amounts of sediment are an indication of upstream erosion or lack of adequate BMPs during construction activities. Causes for contributions of excess sediment should be investigated and addressed.

*Frequency* – As needed based upon inspections.

#### GB-GS-3.6.2 Erosion Repair

The repair of eroded areas is necessary to ensure the proper functioning of the GB-GS, to minimize sediment transport, and to reduce potential impacts to other features. Erosion can vary in magnitude from minor repairs to vegetation and embankments, to rills and gullies in the embankments and inflow points. The repair of eroded areas may require the use of excavators, riprap, concrete, and sod. Extreme care should be taken when utilizing motorized or heavy equipment to ensure damage to the underdrain system does not occur. Major erosion in a GS-GB is generally the result of excessive velocities caused by steep slopes. It may be necessary to make design improvements to the swale or buffer when erosion becomes a major maintenance item.

*Frequency* – As necessary, based upon inspections.

#### GB-GS-3.6.3 Vegetation Removal

Weeds, Shrubs, Willows and other unwanted vegetation that develops in the grass swale or buffer area may impede the flow and cause standing water or back flow problems. It is necessary to remove unwanted vegetation as soon as it appears. Remove the unwanted vegetation, and restore the correct grade. Revegetate with seed or sod.

*Frequency* – As necessary, based upon inspections.

#### GB-GS -3.6.4 Revegetation

Bare areas should be repaired as soon as possible. Repair bare areas with grass or sod. Causes of the problem, such as inadequate water supply or diseased grasses, should be investigated and resolved.

*Frequency* – As necessary, based upon inspections.

#### GB-GS-3.6.5 Irrigation (Automatic)

Irrigation systems require routine maintenance in accordance with the manufacturer's recommendations (valves, timer, etc.), and maintenance of the pipe and heads to ensure that even coverage is being applied, and that there are no missing or broken parts. Timing systems should be checked to verify that the correct amount of water is being applied to the grassed areas for the seasonal conditions.

*Frequency* – As necessary, based upon inspections.

#### GB-GS-3.6.6 Level Spreader

Level Spreaders that are no longer level, or have developed damaged areas of cracking or spalling, allow flows to concentrate in these depressed areas instead of being distributed over the length of the structure. Also, build up of grasses along the edge of the spreader may create an uneven flow distribution. Rills, gullies and other erosion that develops downstream of level spreaders should be repaired and reseeded or sodded. Causes of the erosion should be investigated and addressed.

*Frequency* – As necessary, based upon inspections.

#### GB-GS-3.6.7 Fertilization/Soil Amendment

Grass Buffers and Swales rely on healthy, dense turf in order to function properly. Grasses that appear to be diseased, dying or unhealthy may require amendments. Fertilizers should be applied in the minimum amounts recommended by the manufacturer.

*Frequency* – As necessary, based upon inspections.

#### GB-GS-3.6.8 Vehicle Tracks

GB-GSs that are adjacent to roadway sections may be damaged by vehicle tracks. Rutted areas should be filled in and revegetated as soon as possible. Frequent problems associated with vehicle traffic (such as around corners) may require a barrier or sign to avoid vehicular traffic within the grassed areas.

*Frequency* – As necessary, based upon inspections.

### **GB-GB-3.7 Major Maintenance Activities**

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. All of this work requires consultation with Arapahoe County Engineering to ensure the proper maintenance is performed. This work requires that Arapahoe County Engineering Staff review the original design and

construction drawings to assess the situation and assign the necessary maintenance. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.

**Table GB-GS-4  
Summary of Major Maintenance Activities**

| <b>Maintenance Activity</b>             | <b>Minimum Frequency</b>                     | <b>Look for:</b>   | <b>Maintenance Action</b>  |
|---|--|--|--|
| <b>Major Sediment/Pollutant Removal</b> | As needed – based upon scheduled inspections | Large quantities of sediment   | Remove and dispose of sediment. Repair vegetation as needed                |
| <b>Major Erosion Repair</b>             | As needed – based upon scheduled inspections | Severe erosion including gullies, excessive soil displacement, areas of settlement, holes  | Repair erosion – find cause of problem and address to avoid future erosion |
| <b>Structural Repair</b>                | As needed – based upon scheduled inspections | Deterioration and/or damage to structural components – level spreader, grade control structures, irrigation components, and ponding water. | Structural repair to restore the structure to its original design          |
| <b>GB-GS Rebuild</b>                    | As needed – due to complete failure of PLD   | Removal of filter media and underdrain system  | Contact Arapahoe County Engineering  |

**GB-GS-3.7.1      Major Sediment/Pollutant Removal**

Major sediment removal consists of removal of large quantities of pollutants/sediment /landscaping material. Stormwater sediments removed from GB-GSs do not meet the regulatory definition of “hazardous waste”. However, these sediments can be contaminated with a wide array of organic and inorganic pollutants and handling must be done with care to insure proper removal and disposal. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a licensed landfill for proper disposal. Should a spill occur during transportation, prompt and thorough cleanup and disposal is imperative. Vegetated areas need special care to ensure design volumes and grades are preserved or may need to be replaced due to the removal activities.

*Frequency* – Non-routine – Repair as needed, based upon inspections.

GB-GS-3.7.2            Major Erosion Repair

Major erosion repair consists of filling and revegetating areas of severe erosion. Determining the cause of the erosion as well as correcting the condition that caused the erosion should also be part of the erosion repair. Care should be given to ensure design grades and volumes are preserved.

*Frequency* – Non-routine – Repair as needed, based upon inspections.

GB-GS-3.7.3            Structural Repair

A GB-GS generally includes level spreader and grade control structure that can deteriorate or be damaged during the service life of the facility. These structures are constructed of steel and concrete that can degrade or be damaged and may need to be repaired or re-constructed from time to time. Major repairs to structures may require input from a structural engineer and specialized contractors. Consultation with Arapahoe County Engineering Staff shall take place prior to all structural repairs.

*Frequency* – Non-routine – Repair as needed, based upon inspections.

GB-GS-3.7.4            GB-GS Rebuild

In very rare cases, a GB-GS may need to be rebuilt. Generally, the need for a complete rebuild is a result of improper construction, improper maintenance resulting in structural damage to the underdrain system, or extensive contamination of the GB-GS. Consultation with Arapahoe County Engineering Staff shall take place prior to any rebuild project.

*Frequency* – Non-routine – As needed based upon inspections.

**Reference:**

This Manual is adapted from the Douglas County, Colorado, Standard Operating Procedure for Extended Detention Basin (EDB) Inspection and Maintenance, July 2005