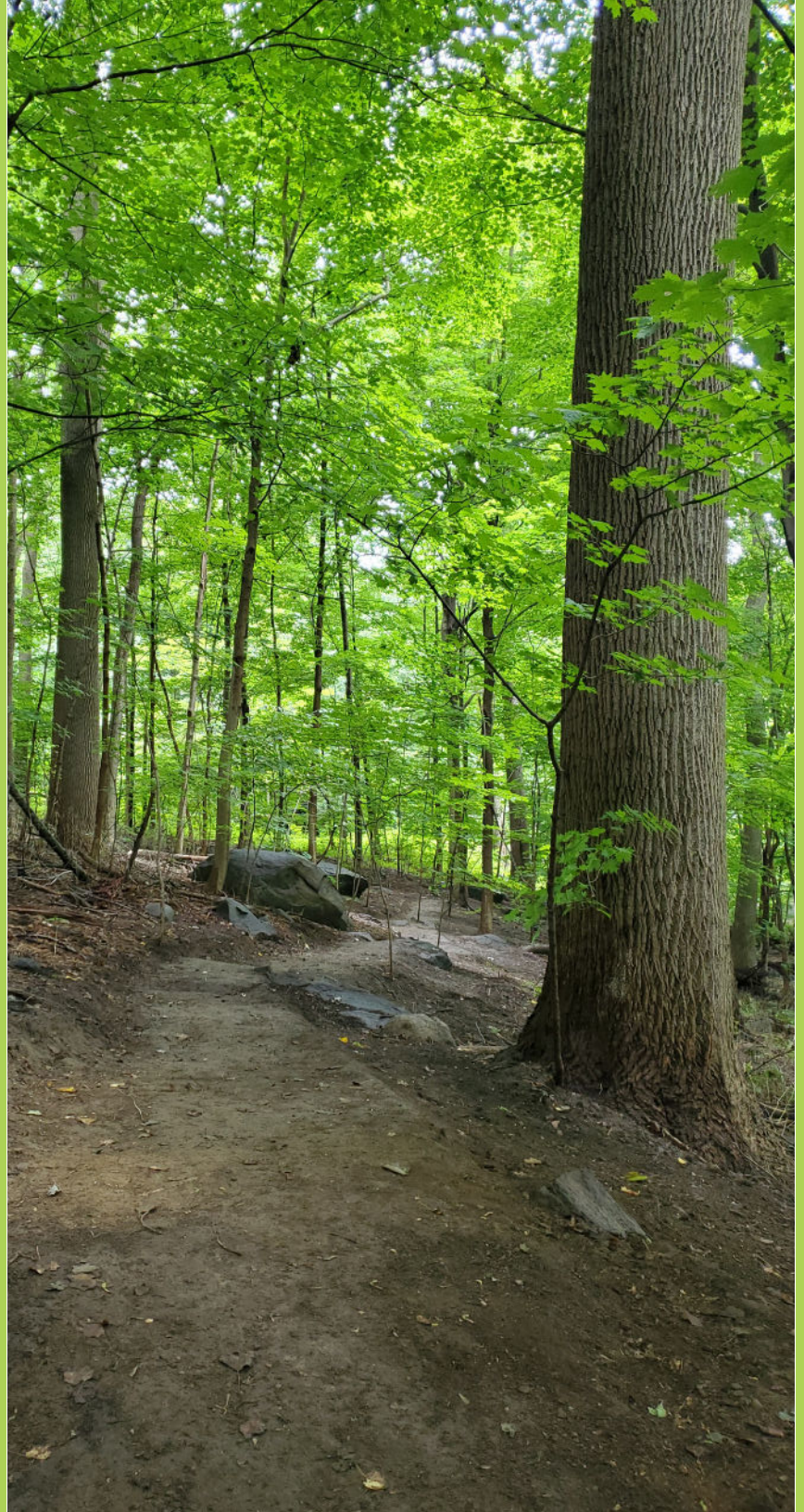
Trail Design Guidelines

Natural Areas Conservancy

Introduction

The Natural Areas Conservancy's Trail Design Guidelines were developed to guide and support the work of New York City trail practitioners. These design guidelines include design details and accompanying narratives, which provide an overview of best practices in construction of common trail structures.

This set of Design Guidelines includes updates and more in-depth information related to trail structures, as well as new details developed in partnership with the New York City Department of Parks & Recreation as a continuation of the original design guidelines included in the NYC Strategic Trails Plan.



Who we are

The NAC is the non-profit partner to NYC Parks, helping to manage and restore 10,000 acres of forests and wetlands since 2012.

Since 2017, we've worked in partnership with NYC Parks on the Citywide Trails Team to formalize a trail network of over 250 miles in nearly 70 parks in NYC.

Since 2019, in partnership with NYC Parks, we have developed an advanced volunteer program called the Super Steward: Trail Maintainer Program.

In 2021, we released the Strategic Trails Plan for NYC, which provided recommendations for long-term management and activation of trails.

Trail Terminology

Bench cut
Excavation into and along a hillside to reduce erosion.

Cross Slope
The percentage of rise to length ("run") when measuring the trail tread from edge to edge perpendicular to the direction of travel.

Trail Grade
The ascent or descent of a trail segment expressed as a percentage of its length.

Linear Grade
The trail grade that is determined to be appropriate to accommodate the managed uses of a trail.

Outslope
The slope in the downhill direction of the trail. A sustainable outslope has a typical grade of 5% to shed water off of the trail.

Running Slope
The percentage of rise to length ("run") when measuring the trail tread from edge to edge parallel to the direction of travel.

Sheet flow
Water flowing across the trail from uphill.

Trail Corridor
The tread and area above and to the sides of it, customarily 2 ft wide and 8 ft high for nature trails. Corridor dimensions range depending upon intended usage.

Trail Restoration
Naturalization of informal trails through decompaction of tread and invasive management along edges. These efforts sometimes culminate in planting of native trees and shrubs to restore the forest.

Tread
Trail walking surface.

Trail Structures

Check Step
Check steps function to stabilize the trail tread from erosion while offering support for hikers on an incline. To prevent erosion, they are intended to slow and hold surface water long enough to deposit transported sediment.

Drainage Dip
Earthen barrier consisting of a rolling grade and apron or drainage ditch that diverts water onto the adjacent forest floor.

Puncheon
In areas that are difficult to drain, puncheons can be used to elevate the walking surface to provide crossings over wet areas. Puncheons typically consist of lumber constructed in the form of low lying footbridges for muddy/partially flooded areas or larger footbridges that allow access through stream crossings/heavily flooded areas.

Water Bar
Water bars are barriers embedded in the trail to divert water onto the adjacent forest floor. The barriers can be large rocks, logs, or treated timber

Turnpike
In areas with poor drainage, turnpikes can be utilized to raise the tread surface material and provide an even, dry walking surface. Turnpikes typically consist of lumber that is spaced the length of the trail then filled with earthen materials, such as gravel or crushed stone, then capped with mineral soil. In some cases, trenches are dug alongside the structure to improve drainage.

Individual Rock Step

Surveying and site layout

Prior to installation, survey the project location to calculate rise over run to determine the number of steps needed for the project. This can be completed through the use of a Clinometer to calculate the trail grade or through the use of a string line, level and tape measure to measure out total rise over run. To calculate the estimated number of steps, divide the total rise by the projected rise per step. To calculate the number of landing platforms and spacing needed for each, divide total run by number of steps. Flag out the excavation area using the approximate length and width of the rock to help ensure that the area is not over-excavated. Assess the work for potential impacts to trees, shrubs and roots. Occasionally, the installation location needs to be adjusted to mitigate negative impacts to native trees and shrubs.

Installation

Excavate area for a base step which is installed at the existing trail grade and serves as a foundation for the remaining steps. Always use a basestep at the bottom of each set of rock steps which will stabilize the structure and counteract weathering. Excavate the top layer of duff and organic soil until mineral soil is reached. Move the rock, place it into the hole and check there are good points of contact between the rock. Use a digital level or a large traditional level to check the cross slope and the running slope with the goal of getting down to approximately 1 degree. Repeat this step as many times as needed until sufficiently excavated. Use the “wiggle test” to check how the rock fits in the hole by standing on top of the rock and rocking back and forth. If the rock moves, reset as needed and make final adjustments to the excavated hole until you have a snug fit. To finish, backfill the edges surrounding the base step with crushed stone and mineral soil. Use McLeods to tamp down the area around the rock in 6” increments until secured.

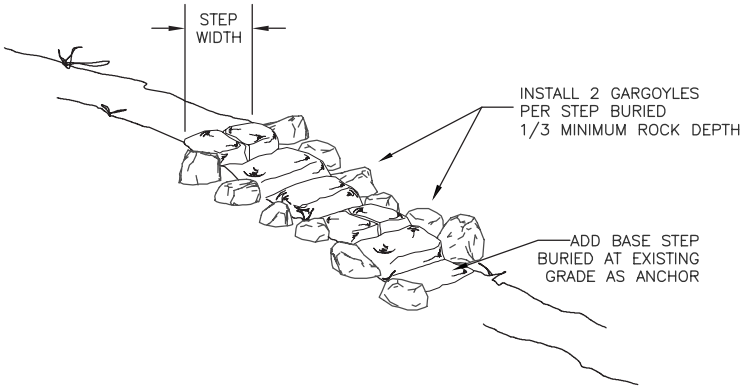
For the first step, repeat the excavation and setting process from the base step above and plan installation directly against the back edge of the base step. Excavate the area at a minimum of 1/3 the vertical dimension of the rock. Be sure that the final height of the rock has a maximum step rise of 8” and a minimum of 12” step run. To finish, backfill the edges surrounding the base step with crushed stone and mineral soil. Next, install 1 gargoyle on each side of the rock step. Gargoyles are intended to frame the rock staircase and encourage park users to stay on the trail. Use 50-75 LBS rocks with irregular or jagged edges. The final gargoyle height should sit a few inches above the rock step. See above for setting the rocks. Naturalize the site with coarse woody debris and leaf litter.

Individual Rock Step

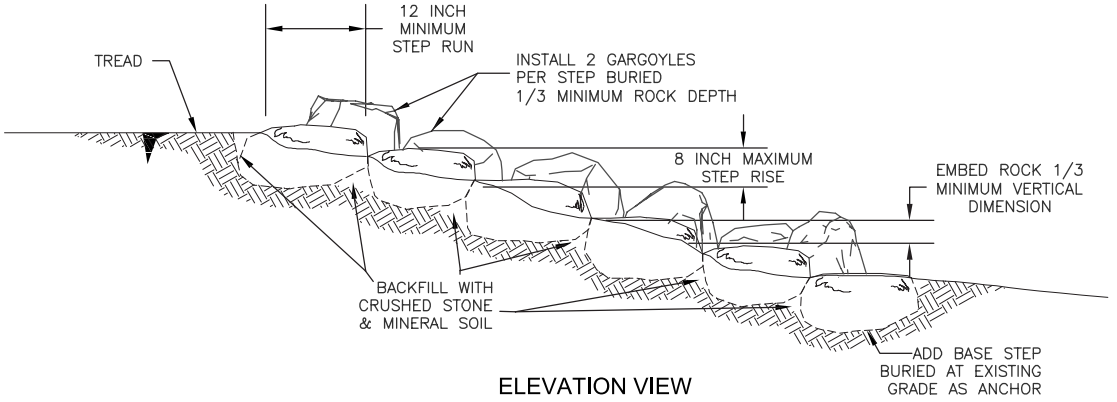
INDIVIDUAL ROCK STEP

TYPICAL ID	STEP WIDTH	STEP RUN	STEP RISE	MINIMUM ROCK WEIGHT	COMMENTS
	X	X	X	200 LBS	X

EXAMPLE



PERSPECTIVE VIEW



ELEVATION VIEW

ROCK RISER STAIRWAY

NOTES:

1. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
2. REMOVE AND DISPOSE OF DUFF AND TOP ORGANIC LAYERS DOWN TO MINERAL SOIL.
3. INSTALL GARGOYLES A FEW INCHES ABOVE STEP HEIGHT.

Individual Timber Pinned Check Step

Surveying and site layout

Calculate rise over run to determine the number of steps needed for the project. Use a Clinometer to calculate the trail grade or string line, level and tape measure to find total rise over run. Divide the total rise by the projected rise per step to calculate the number of steps needed. Flag out the site to delineate the excavation area. Use measuring tape to flag out the width of the check step and use 1 flag per corner of the check step (4 total). This helps ensure that the check step is not over-excavated. Assess the site for potential impacts to trees, shrubs and roots. Occasionally, the site needs to be adjusted to mitigate negative impacts to native trees and shrubs.

Installation

When installing multiple check steps, always start at the bottom and proceed to move up the slope. This ensures steps are spaced appropriately so the structural integrity doesn't get compromised over time. Excavate the area using grub hoes, pick mattocks and shovels. Excavate to a depth of at least 1/4 the vertical dimension of the timber. At least 1 FT of each end of the check step should be buried into the banks of the trail corridor. Place the timber into the trench and make any necessary adjustments to ensure a snug fit. Use a level to check the cross slope and the running slope to assess how it sits on the trail. The goal is to get down to approximately 1 degree for the cross slope and running slope. Repeat as many times as needed until sufficiently excavated.

Secure the structure using one of the following methods based on the overall site conditions and availability of materials:

- **Buried in the bank**
  Wedge large 2-4" rocks around the edges of the check step with a special emphasis on the section that extends into the banks of the trail edge. Choose longer rocks with sharper edges that can pin the structure in place. Set the rocks around the structure with single jacks until the structure is secure.

- **Pinned with larger rocks**
  For additional structural integrity in high erosion areas, use the "buried in bank" method and finish by adding in large rocks (50-75 LBS) in size with a special emphasis on the downhill side of the check step. The rocks should be buried at least 1/3 vertical dimension of the rock.

- **Buried with added rebar**
  Drill (2) 1/2 in diameter pilot holes through the entire timber where the check step hits the edge of the banks. Pound rebar through holes and into the ground so that the upper end of rebar sits flush with the top timber face.

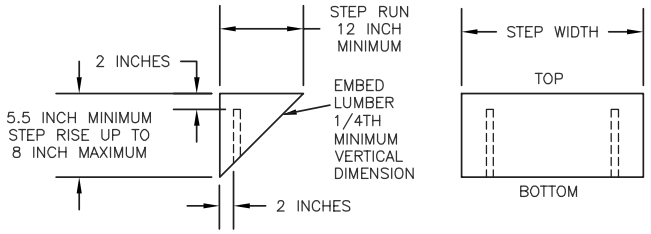
To finish structure - backfill the area around the structure in a bed of crush and mineral soil. Tamp the area around the check steps in 6" sections with McLeods until there is no visual displacement. Naturalize the area around the check step with coarse woody debris and leaf litter.

Individual Timber Pinned Check Step

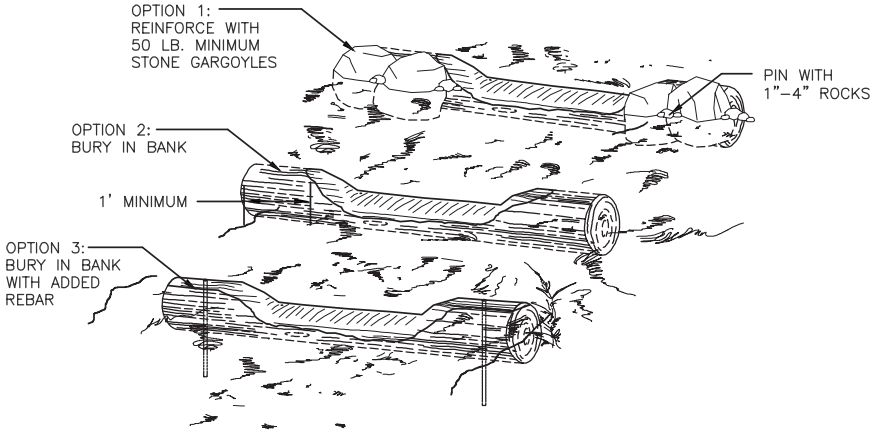
INDIVIDUAL TIMBER PINNED STEP

TYPICAL ID	MORTAR/ RESISTANT MATERIAL	STEP WIDTH	STEP RISE	STEP RUN	MATERIAL TYPE	SPECIES	EPOXY TYPE	PRESERV. TYPE	COMMENTS
	X	X	X	X	X	X	X	PX	X

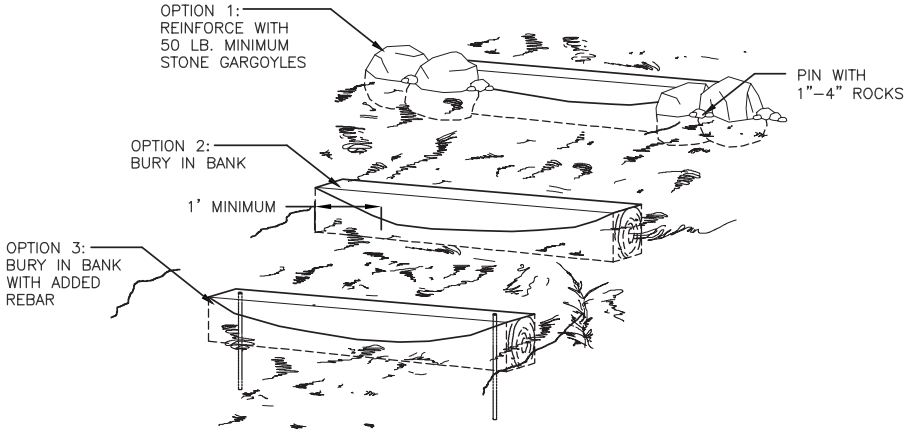
N/A WHEN NOT APPLICABLE



STEP



PERSPECTIVE VIEW
(LOG)



PERSPECTIVE VIEW
(DIMENSIONAL LUMBER)

PRESERVATIVE TREATMENT – (REFER TO AWPA USE CATEGORY SYSTEM)			
PRESERVATIVE TYPE	TREATMENT TYPE	USE CATEGORY	COMMENTS
P1	WB	UC4A	X
P2	WB	UC3B	
P3	XX	XXXX	

TREATMENT TYPE

WB = WATERBORNE
OT = OIL–BORNE

USE CATEGORY

UC3B = ABOVE GROUND – EXPOSED
UC4A = GROUND CONTACT – GENERAL USE
UC4B = GROUND CONTACT – HEAVY DUTY

NOTES:

1. PRE–DRILL HOLES FOR REBAR TO PREVENT SPLITTING OF TIMBER.
2. REMOVE AND DISPOSE OF DUFF AND TOP ORGANIC LAYERS DOWN TO MINERAL SOIL.
3. MAXIMUM DIMENSIONAL LUMBER SIZE NOT TO EXCEED 10" X 10" IN WIDTH/HEIGHT

Standard Puncheon

Surveying and site layout

Survey the project site with a measuring wheel to determine the number of puncheons needed to address the flooding, stream crossing or muddy trail. Assess the work site for potential impacts to trees, shrubs and roots. Occasionally, the installation location needs to be adjusted to mitigate negative impacts to native vegetation. Use a McLeod or a hard rake to remove duff or coarse woody debris from the site. For one 8 FT puncheon, measure out the installation location for three dimensional timber sills at 0 FT, 4FT and 8FT. Place flags to demarcate each corner of the sill to prevent over excavation.

Installation

For an 8 FT puncheon, cut all timber to the following quantities and sizes:

- 3 32" sills using 6x6x8' timber
- 13 32" decking boards cut from 2x8x8' timber
- 2 6x6x8' dimensional timber stringers left whole

Excavate the sill area using grub hoes, pick mattocks and small shovels. Grub hoes are great to begin excavation since they are a similar width to the timber. For rockier areas, use pick mattocks to pick and pry out rocks. Clear out organic soil and excavate down to the mineral soil. If it is not possible to excavate down to mineral soil, use crushed rock and mineral soil to backfill and tamp down with a McLeod to create a firm foundation. Be mindful of roots that may appear. Smaller roots under 1" diameter can be cut with loppers or hand pruners. Avoid cutting any roots larger than 1" to reduce negative impacts to trees or shrubs. If encountering a root between 1-2" and it's not possible to adjust the location for the dimensional timber, a certified ISA arborist should be consulted to assess whether the root can be removed.

Place the sills on the ground and make adjustments as needed. Final placement should be installed at least 1/2 vertical dimension of the sill. Use a level to check the cross slope and the running slope. The goal is to get down to approximately 1 degree for the cross slope and running slope. If rock is available on site, fill in the edges of the sill with crushed rock and mineral soil and tamp down with a McLeod. If site conditions are particularly boggy and rocks aren't readily available, rebar can be used for extra stability. Place the two 6x6x8' stringers on top of the sills flush against the outside edge of the sills. Drill two (2) timber bolts for each end, placed 2-3 inches apart (6 per stringer) until the timber bolt head is slightly recessed below the top of the stringer. Place decking boards to sit perpendicular atop stringers, beginning at the edge of stringer and leaving a gap of no more than 1/2 inch between each decking board. Drive (2) decking screws into each end of decking boards to attach to the stringers.

Standard Puncheon

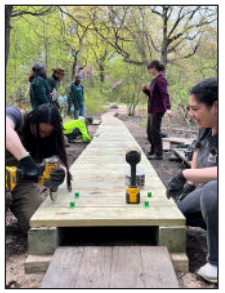
STANDARD PUNCHEON

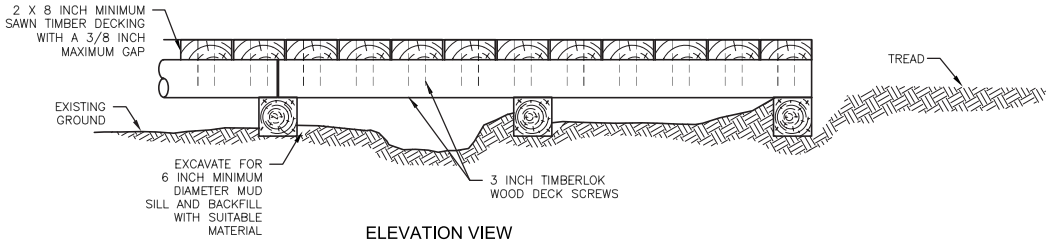
	STRINGER/MUD SILL				DECK				CURB			WEARING SURFACE				
TYPICAL ID	SIZE	SPECIES	NUMBER	PRESERV. TYPE	TYPE	SIZE	SPECIES	PRESERV. TYPE	SIZE	SPECIES	PRESERV. TYPE	TYPE	SIZE	SPECIES	PRESERV. TYPE	COMMENTS
	X	X	X	PX	X	X	X	PX	X	X	PX	X	X	X	PX	X

N/A WHEN NOT APPLICABLE

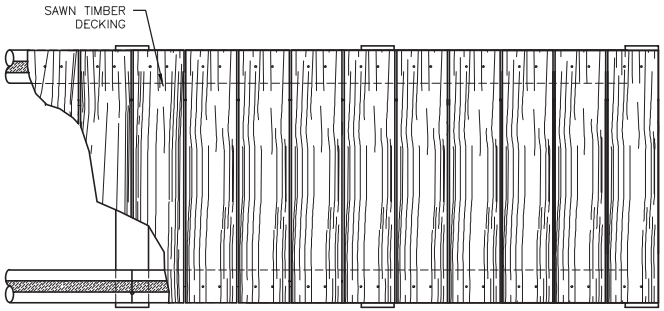
EXAMPLE 1

EXAMPLE 2

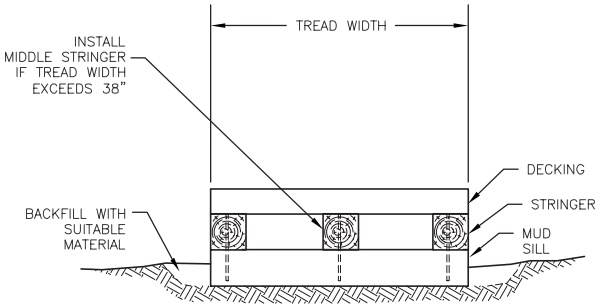




ELEVATION VIEW



PLAN VIEW



TYPICAL SECTION

PRESERVATIVE TREATMENT – (REFER TO AWPA USE CATEGORY SYSTEM)			
PRESERVATIVE TYPE	TREATMENT TYPE	USE CATEGORY	COMMENTS
P1	WB	UC4A	X
P2	WB	UC3B	
P3	XX	XXXX	

TREATMENT TYPE

WB = WATERBORNE
OT = OIL–BORNE

USE CATEGORY

UC3B = ABOVE GROUND – EXPOSED
UC4A = GROUND CONTACT – GENERAL USE
UC4B = GROUND CONTACT – HEAVY DUTY

NOTES:

1. PRE–DRILL HOLES WHEN REBAR IS NEEDED TO PREVENT SPLITTING OF LOGS OR SAWN TIMBERS.
2. RECESS END OF REBAR 1/2 INCH BELOW TOP OF STRINGERS.
3. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
4. FINAL DECK ELEVATION FOR RUNNING PLANKS OR DECKING SHALL BE NO MORE THAN 1/2 INCH DIFFERENCE IN ELEVATION.
5. USE 3 INCH HEX SCREWS FOR BOARDS AND 10 INCH TIMBERLOKS TO FASTEN STRINGERS TO MUD SILLS.
6. CURB IS OPTIONAL PENDING CLEARING HEIGHT ABOVE GROUND. IMPROVED ACCESS PUNCHEON REQUIRES CURB.
7. FOR A SINGLE STANDARD PUNCHEON, MUD SILL SHOULD BE FLUSH TO BEGINNING AND END OF STRUCTURE.
8. FOR INTERCONNECTED PUNCHEONS, EXTEND FINAL MUD SILL 1/2 WIDTH PAST PREVIOUS PUNCHEON TO SET UP NEXT PUNCHEON SECTION.
9. USE TWO STRINGERS FOR STANDARD 32" WIDE PUNCHEON. FOR PUNCHEONS 36"–48" WIDE USE 3 STRINGERS.
10. SPACING BETWEEN DECKING BOARDS SHALL NOT EXCEED ½ INCH WIDE TO PREVENT HAZARD

Universal Access Puncheon

Surveying and site layout

See *Standard Puncheon* surveying and site layout section for pertinent information related to the surveying and site layout of this structure.

Installation

See *Standard Puncheon* installation section for additional pertinent information.
related to installation of this structure. Use for an 8 FT puncheon, cut all timber to the following quantities and sizes:

Puncheon

- 3 48" sills using 6x6x8' timber
- 13 48" decking boards cut from 2x8x8' timber
- 3 6x6x8' dimensional timber stringers left whole
- 2 2x2x8' minimum curbs

Ramps

- 6 2x6x8" stringers left whole
- 26 48" decking boards cut from 2x8x8' timber
- 4 2x2x8' curbs

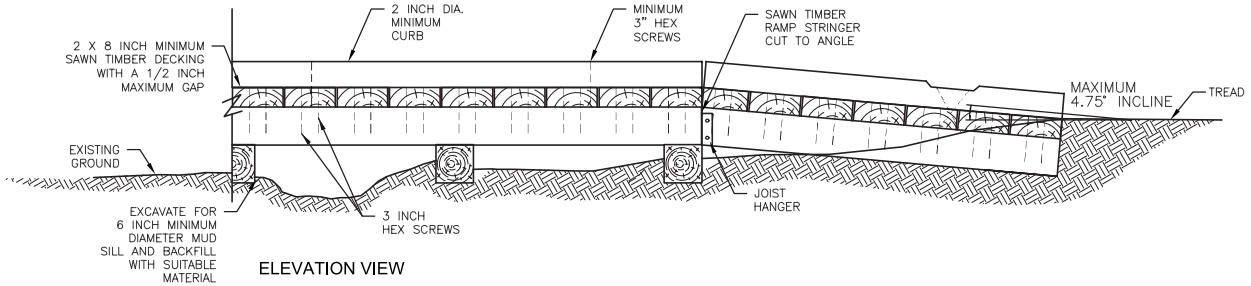
Once the puncheon is installed, ramp installation can begin. For ramp installation, cut one end of each 2x6x8' stringer at 5 degrees so it sits flush against the puncheon. Install 1 joist hanger at the center of each puncheon stringer and screw into place. Set each ramp stringer on the joists and flag out the area to be excavated. Excavate site with a pick mattock until the ramp stringer is flush on the joist hanger and below grade. Screw them into the joist hangers. Fill in the stringer edges with crushed rock, mineral soil and tamp down with a McLeod. Place decking boards perpendicular atop stringers and leave no more than a 1/2 inch gap between each board. Drive (2) decking screws into each end of the boards. Set 3 2x2" wood squares at 0, 4 and 8 FT on the edge of both the puncheons and the ramp. Place 6 2x2x8' curbs on the ramps as well as the puncheon and secure them in place using 2 decking screws per wood square.

Universal Access Puncheon

UNIVERSAL ACCESS PUNCHEON

	STRINGER/MUD SILL				DECK/BACKWALL				CURB			WEARING SURFACE				
TYPICAL ID	SIZE	SPECIES	NUMBER	PRESERV. TYPE	TYPE	SIZE	SPECIES	PRESERV. TYPE	SIZE	SPECIES	PRESERV. TYPE	TYPE	SIZE	SPECIES	PRESERV. TYPE	COMMENTS
	X	X	X	PX	X	X	X	PX	X	X	PX	X	X	X	PX	X

N/A WHEN NOT APPLICABLE



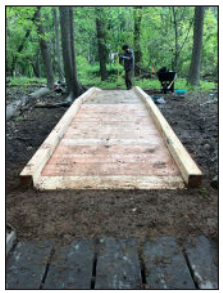
ELEVATION VIEW

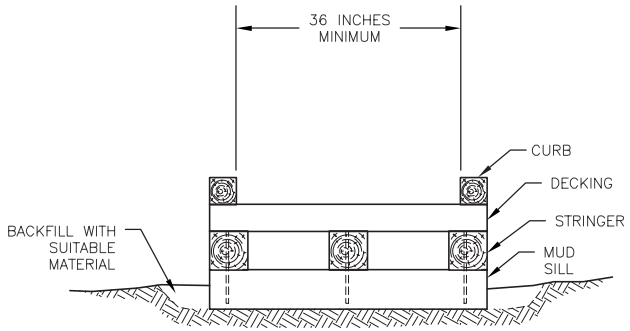
NOTES:

1. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
2. FINAL DECK ELEVATION FOR RUNNING PLANKS OR DECKING SHALL BE NO MORE THAN 1/2 INCH DIFFERENCE IN ELEVATION.
3. USE 3 INCH HEX SCREWS FOR BOARDS AND 10 INCH TIMBERLOKS TO FASTEN STRINGERS TO MUD SILLS.
4. IMPROVED ACCESS PUNCHEONS REQUIRE CURB.
5. FOR INTERCONNECTED PUNCHEONS, EXTEND FINAL MUD SILL 1/2 WIDTH PAST PREVIOUS PUNCHEON TO SET UP NEXT PUNCHEON SECTION.
6. 36 INCH WIDE MINIMUM DECKING FOR IMPROVED ACCESS PUNCHEONS NOT INCLUDING SPACE FOR CURBS
7. USE THREE STRINGERS INSTEAD OF 2 FOR ADDITIONAL STRUCTURAL SUPPORT
8. FASTEN RAMP HARDWARE TO STRINGERS CENTERED ON STRINGER. FOR RAMP STRINGERS, USE 3 2X6 INCH BOARDS.
9. RAMP STRINGERS SHOULD EXTEND UNTIL END IS FULLY BURIED INTO THE GROUND.
10. SPACING BETWEEN DECKING BOARDS SHALL NOT EXCEED ½ INCH WIDE TO PREVENT HAZARD
11. REBAR IS OPTIONAL.
12. PRE–DRILL HOLES WHEN REBAR IS NEEDED TO PREVENT SPLITTING OF LOGS OR SAWN TIMBERS.
13. RECESS END OF REBAR 1/2 INCH BELOW TOP OF STRINGERS.

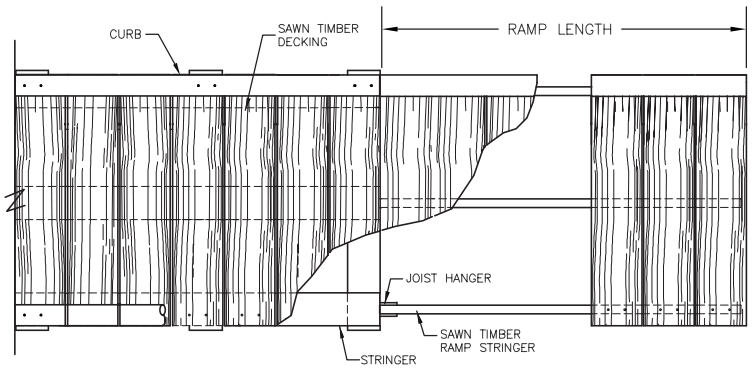
EXAMPLE 1

EXAMPLE 2





TYPICAL SECTION



PLAN VIEW

PRESERVATIVE TREATMENT – (REFER TO AWPA USE CATEGORY SYSTEM)			
PRESERVATIVE TYPE	TREATMENT TYPE	USE CATEGORY	COMMENTS
P1	WB	UC4A	X
P2	WB	UC3B	
P3	XX	XXXX	

TREATMENT TYPE

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OT = OIL–BORNE

USE CATEGORY

UC3B = ABOVE GROUND – EXPOSED
UC4A = GROUND CONTACT – GENERAL USE
UC4B = GROUND CONTACT – HEAVY DUTY

Puncheon Without Decking

Surveying and site layout

Survey the project site with a measuring wheel to determine the number of puncheons needed to address the flooding, stream crossing or muddy trail. Assess the work site for potential impacts to trees, shrubs and roots. Occasionally, the installation location needs to be adjusted to mitigate negative impacts to native vegetation. Use a McLeod or a hard rake to remove duff or coarse woody debris from the site. For one 8 FT puncheon, measure out the installation location for three dimensional timber sills at 0 FT, 4FT and 8FT. Place flags to demarcate each corner of the sill to prevent over excavation.

Installation

For an 8 FT puncheon, cut all timber to the following quantities and sizes:

- 3 32" sills using 6x6x8' timber
- 3 2x8x8" minimum sawn timber

Excavate the sill area using grub hoes, pick mattocks and small shovels. Grub hoes are great to begin excavation since they are a similar width to the timber. For rockier areas, use pick mattocks to pick and pry out rocks. Clear out organic soil and excavate down to the mineral soil. If it is not possible to excavate down to mineral soil, use crushed rock and mineral soil to backfill and tamp down with a McLeod to create a firm foundation. Be mindful of roots that may appear. Smaller roots under 1" diameter can be cut with loppers or hand pruners. Avoid cutting any roots larger than 1" to reduce negative impacts to trees or shrubs. If encountering a root between 1-2" and it's not possible to adjust the location for the dimensional timber, a certified ISA arborist should be consulted to assess whether the root can be removed.

Place the sills on the ground and make adjustments as needed. Final placement should be installed at least 1/2 vertical dimension of the sill. Use a level to check the cross slope and the running slope. The goal is to get down to approximately 1 degree for the cross slope and running slope. If rock is available on site, fill in the edges of the sill with crushed rock and mineral soil and tamp down with a McLeod. If site conditions are particularly boggy and rocks aren't readily available, rebar can be used for extra stability.

After the puncheon sills are set, place the 3 2x8x8' sawn timber boards on top of the sills. Adjust the sawn timber until it sits centered on the sills and leave a gap of no more than 1/2 inch between each of the sawn timbers to accommodate future expansion and contraction due to weathering. Final placement of sawn timbers should leave approximately 5" of space on either side of the sills which allow for increased stability of the structure. Drive (2) decking screws into each end of the sawn timber (6 per board) to attach to the sills to finish the puncheon.

Puncheon Without Decking

PUNCHEON WITHOUT DECKING

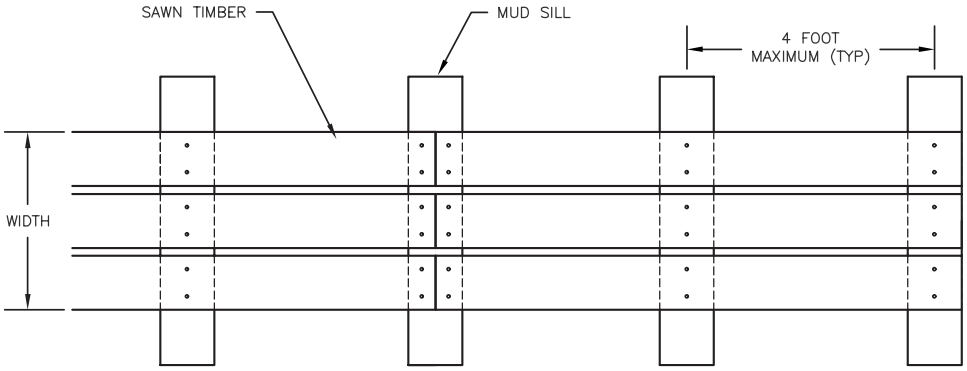
TYPICAL ID	WIDTH	MUD SILL		STRINGER			COMMENTS
		SPECIES	PRESERV. TYPE	TYPE	SIZE	PRESERV. TYPE	
	X	X	P X	X	X	X	X

N/A WHEN NOT APPLICABLE

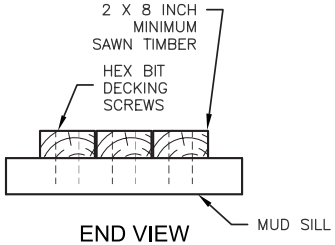
NOTES:

1. PRE–DRILL HOLES FOR FASTENERS TO PREVENT SPLITTING OF LOGS OR SAWN TIMBERS.
2. RECESS END OF REBAR 1/2 INCH BELOW TOP OF STRINGERS.
3. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
4. ALL FIELD DRILLED HOLES AND CUTS SHALL BE FIELD TREATED.
5. FINAL DECK ELEVATION FOR RUNNING PLANKS OR DECKING SHALL BE NO MORE THAN 1/2 INCH DIFFERENCE IN ELEVATION.
6. FOR INTERCONNECTED PUNCHEONS, EXTEND FINAL MUD SILL 1/2 WIDTH PAST PREVIOUS PUNCHEON TO SET UP NEXT SECTION.

EXAMPLE 1



PLAN VIEW

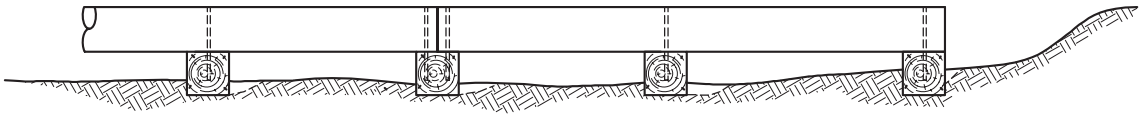


END VIEW

SAWN TIMBER STRINGER

PLACE SAWN TIMBER STRINGERS WITH A MAXIMUM GAP OF 3/8 INCH

EXAMPLE 2



ELEVATION VIEW

PRESERVATIVE TREATMENT – (REFER TO AWPA USE CATEGORY SYSTEM)			
PRESERVATIVE TYPE	TREATMENT TYPE	USE CATEGORY	COMMENTS
P1	WB	UC4A	X
P2	WB	UC3B	
P3	XX	XXXX	

TREATMENT TYPE

WB = WATERBORNE
OT = OIL–BORNE

USE CATEGORY

UC3B = ABOVE GROUND – EXPOSED
UC4A = GROUND CONTACT – GENERAL USE
UC4B = GROUND CONTACT – HEAVY DUTY

Log or Treated Timber Water Bar

Surveying and site layout

Survey the project location using a clinometer or string line level and tape measure, to calculate the grade. The grade will determine at which angle, perpendicular to the trail, the water bar will be set (reference the *SKEW* table for degree of angle relative to grade). The angle should always be wider towards the outslope. While surveying, seek out a location for the structure where the timber will not be obstructed by large rocks or roots. This is also a good time to survey the area for rocks that can be used to set the structure.

Once surveying is complete, brush all debris from the work site and flag location(s) to delineate the area to be excavated. The timber should be set a foot into the backslope of the trail and extend a foot into the outslope. Once location is determined, use 1 flag to demarcate each corner of the timber. This helps ensure the area is not over-excavated, which would make it more difficult to set the timber. Assess the work site for potential impacts to trees, shrubs and roots. Occasionally, the location may need to be adjusted to mitigate negative impacts to native vegetation or avoid large rocks that cannot be removed.

Installation

Begin installation by clearing out darker organic soil and excavate down to the lighter mineral soil. For rockier areas, pick mattocks are best used to pick and pry out rocks. As excavation progresses, be mindful of roots that may appear. Roots under 1" diameter can be cut; avoid cutting any roots larger than 1" to reduce negative localized impacts to the natural area. If encountering a root between 1-2" and it's not possible to adjust the location of the timber, a certified ISA arborist should be consulted for an assessment to determine whether or not the root can be removed. Be mindful not to over excavate sediment to ensure structural integrity and longevity. The depth of the hole will be determined by the size of the timber, which should have 1-2" max exposure at the tread surface.

Once the area is excavated, place the timber into the hole. Inspect the excavated area and make any necessary adjustments. Pay particular attention to all sides of the excavated area, as well as underneath the timber to see if more material needs to be removed or backfilled. Use a level to check the cross slope and the running slope to assess how it sits on the trail. Repeat this step as many times as needed until sufficiently set. If it is not possible to excavate down to mineral soil, use crushed rock and mineral soil backfill and tamp down to create a firm foundation for the timber. If rock is available on site, set large rock (50lbs minimum) on the downslope edges of the timber to anchor the structure. Fill in the area around the rock and timber with crushed rock (1"-4" in size) and mineral soil and tamp down.

After the timber is set, begin construction of the drainage dip on the downgrade of the tread leading towards the timber. The timber is intended to reinforce this dip, which is the most important feature of this structure. See *Drainage Dip* section for additional guidelines.

Log or Treated Timber Water Bar

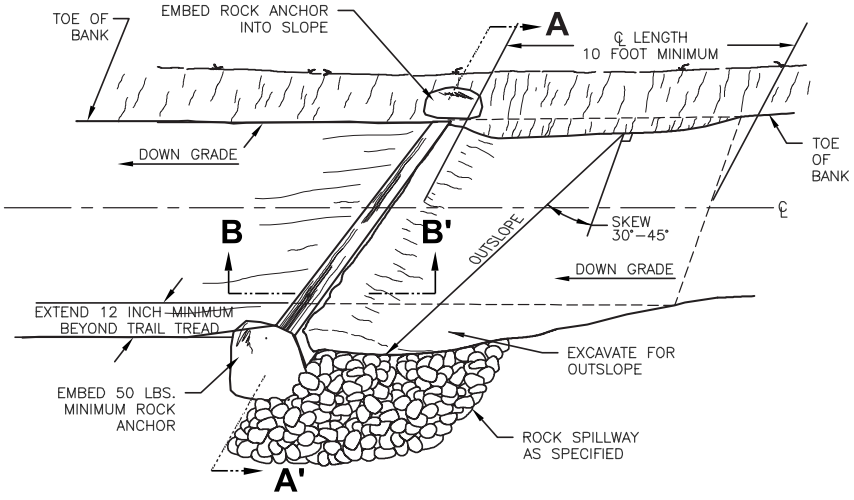
LOG OR TREATED TIMBER WATERBAR

TYPICAL ID	MATERIAL TYPE	ANCHOR SECTION TYPE	SPECIES	PRESERV. TYPE	OUTSLOPE	℄ LENGTH	ROCK SPILLWAY***	COMMENTS
	M X	X	X	P X	X	X	X	X

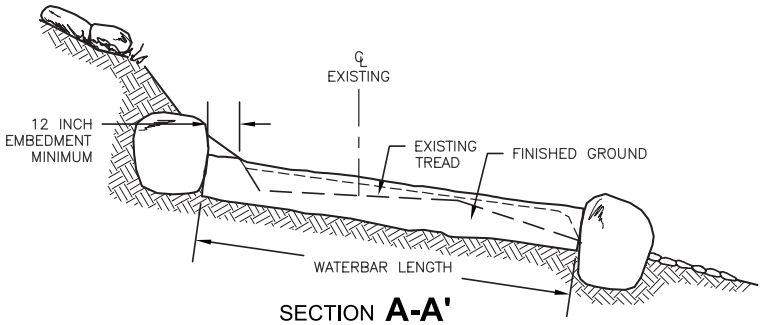
N/A WHFN NOT APPLICABLF

MATERIAL TYPE

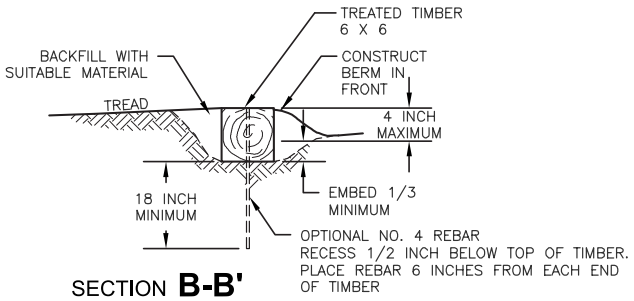
TYPE	MATERIAL	SIZE	COMMENTS
M1	LOG	X	X
M2	SAWN TIMBER		
M3	X		



PERSPECTIVE VIEW



SECTION **A-A'**



SECTION **B-B'**

SKEW

TRAIL GRADE	SKEW ANGLE
<5%	45° MAX
>5%	30° MIN

EXAMPLE 1

EXAMPLE 2

PRESERVATIVE TREATMENT – (REFER TO AWPA USE CATEGORY SYSTEM)			
PRESERVATIVE TYPE	TREATMENT TYPE	USE CATEGORY	COMMENTS
P1	WB	UC4A	X
P2	WB	UC3B	
P3	XX	XXXX	

TREATMENT TYPE

WB = WATERBORNE
OT = OIL–BORNE

USE CATEGORY

UC3B = ABOVE GROUND – EXPOSED
UC4A = GROUND CONTACT – GENERAL USE
UC4B = GROUND CONTACT – HEAVY DUTY

NOTES:

1. SET 1"–4" ROCKS BETWEEN WATER BAR AND EXCAVATED FOUNDATION TO SECURELY ANCHOR STRUCTURE IN GROUND. USE SMALLER ROCKS TO FILL BETWEEN LARGER ROCKS.
2. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
3. NO. 4 REBAR IN SAWN TIMBER OPTIONAL.
4. IF USING REBAR, PRE–DRILL HOLES TO PREVENT SPLITTING OF LOGS OR SAWN TIMBER.

Rock Water Bar

Surveying and site layout

See *Log or Treated Timber Water Bar* surveying and layout section for additional pertinent information related to surveying of this structure. This section will include additional information specific to working with rock.

During surveying of the project area, extra attention should be paid to whether the appropriate rocks (large rocks no less than 100lbs) for this structure are available on site. Once rocks have been identified, consider their location in relation to the project site in order to assess how the rock will be moved. If nearby the site the rock can potentially be moved utilizing rock bars, if further from the site or uphill, a pulley system should be considered. If the ideal rock for this project is on-site, but might be too large to move, rocks can be split using a rock drill, feathers, wedges and a single jack. If rock is unavailable, the project will either require rock sourced from another location or utilization of timber.

Installation

Included here is information specific to installation of a rock water bar. Please, see *Log or Treated Timber* installation section for additional pertinent information related to installation of this structure.

Once the location for the water bar has been determined, flagged out and the rocks that will be utilized have been identified, the first rock will need to be moved to the project site. Each rock will require excavation based on its size, with a minimum of 2/3 of the rock set into the ground. Rocks will be set overlapping one another. Identifying best points of contact between adjoining rocks will inform in which position to best to set them in the ground. For rocks that will be set within the tread it is best to avoid jagged or pointed obstructions. If obstructions are unavoidable, the rock can be shaped with a rock chisel. Use the “wiggle test” to check how the rock fits in the hole by standing on top of the rock and rocking back and forth. If the rock moves, reset as needed and make final adjustments to the excavated hole until you have a snug fit. The amount of rocks required will depend upon the width of the tread being improved, as well as the size of rock installed. Once all rocks have been set in place, the outslope should be set with a gargoyle, which will encourage hikers to remain on the trail.

After the rocks are set, begin construction of the drainage dip on the downgrade of the tread leading towards the rock. The waterbar is intended to reinforce this dip, which is the most important feature of this structure. See *Drainage Dip* section for additional guidelines.

Rock Water Bar

ROCK WATERBAR

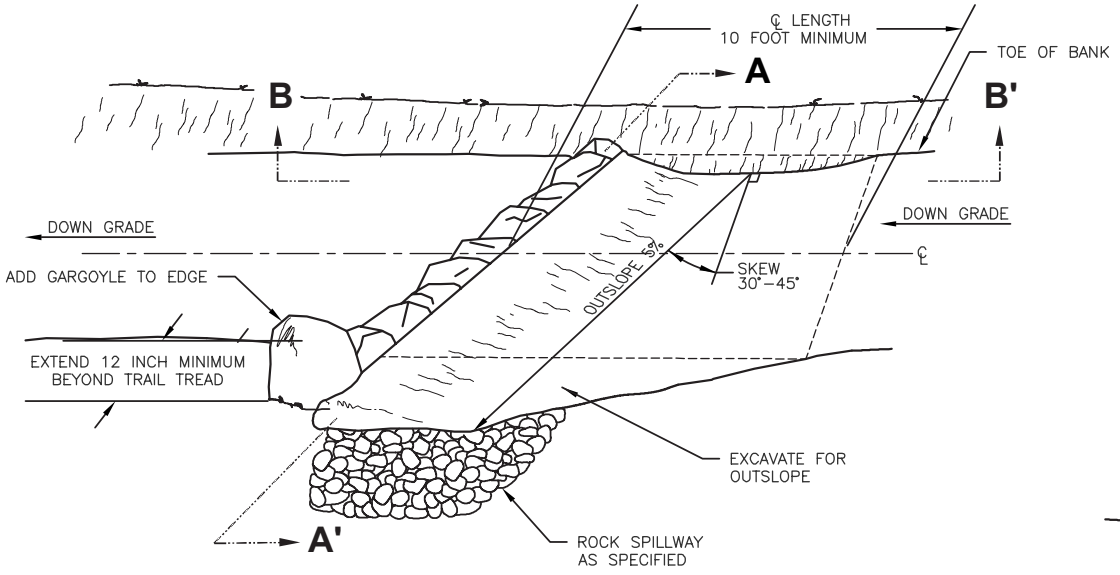
TYPICAL ID	MINIMUM ROCK SIZE (LBS)	OUTSLOPE	℄ LENGTH	ROCK*** SPILLWAY	COMMENTS
	100	X	X	X	X

N/A WHEN NOT APPLICABLE

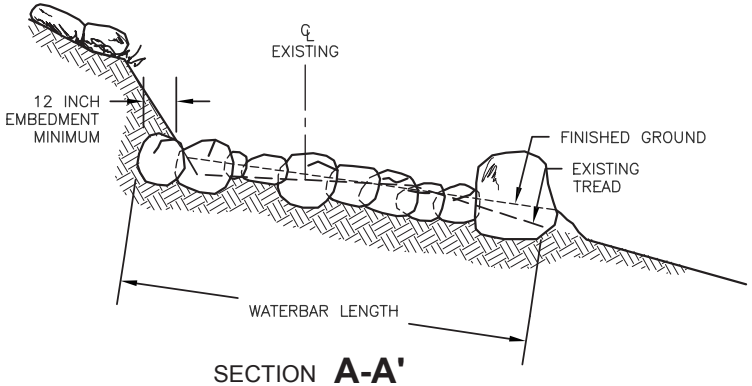
SKEW

TRAIL GRADE	SKEW ANGLE
<5%	45° MAX
>5%	30° MIN

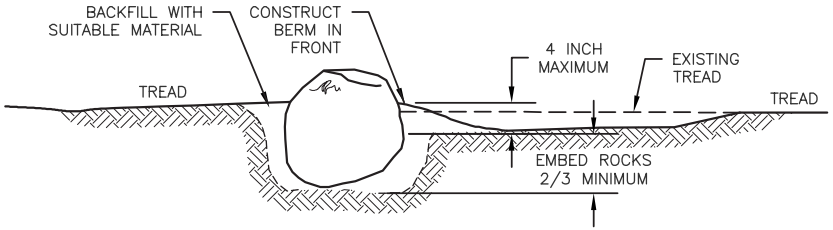
EXAMPLE



PERSPECTIVE VIEW



SECTION **A-A'**



SECTION **B-B'**

NOTE:

1. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
2. ALL EXCAVATED SECTIONS FOR WATERBARS SHALL BE OUTSLOPED TO DAYLIGHT.
3. INSTALL GARGOYLES A FEW INCHES ABOVE STEP HEIGHT.

Drainage Dip

Surveying and site layout

Prior to installation, survey the project location to determine the location of the drainage dip. If setting a series of drainage dips, spacing should be determined by the grade of the slope: 2% spaced approx. 350' apart, 4% spaced approx. 150', 6% spaced approx. 100' 8% spaced approx. 75' and 10% spaced 50'. The grade will determine at which angle, perpendicular to the trail, the drainage dip will be constructed (reference the *SKEW* table for degree of angle relative to grade). For grades that exceed 10% a water bar should be considered.

Once the surveying work is completed, flag out the work site to delineate the area to be shaped for the drainage dip and outlet drain. Assess the work site for potential impacts to trees, shrubs and roots. Occasionally, the installation location needs to be adjusted to mitigate negative impacts to native vegetation. Be sure the structure will not impact any trail downgrade.

Installation

For site preparation, use a McLeod or a hard rake to remove duff and/or coarse woody debris. For shaping of the drainage dip and outlet drain, use a combination of McLeods, grub hoes, pick mattocks and small shovels. McLeods are great tools for construction of drainage dips since they are effective in both shaping and tamping the tread. For rockier areas, pick mattocks are best used to pick and pry out rocks that are in the project site. Clear out darker, organic soil and excavate down to the lighter mineral soil. Once the site is clear, begin shaping the tread to create a teardrop shape which will narrow towards the outslope. A berm is to be constructed at the location where flagging indicates location of the structure on the tread. The berm should be level. The tread in front of the berm should gradually decrease in grade leading to the outslope where the outlet drain will be constructed.

As the excavation progresses, be mindful of roots that may appear. Roots under 1" diameter can be cut with loppers or hand pruners. Avoid cutting any roots larger than 1" to reduce negative localized impacts to the natural area. If encountering a root between 1-2" and it's not possible to adjust the location for the drainage dip, a certified ISA arborist should be consulted to do an assessment to determine whether or not the root can be removed.

Once the drainage dip is shaped, begin excavation of the outlet drain. The outlet drain should continue to decrease in grade and fan out to disperse water along the downslope. Depending on design parameters, a rock spillway can be included in construction. This will armor the outlet drain to prevent erosion. Rocks set in the spillway should be set at least 2/3 in the ground to ensure structural integrity.

Drainage Dip

DRAINAGE DIP

TYPICAL ID	MATERIAL TYPE	OUTSLOPE	℄ LENGTH	ROCK SPILLWAY***	COMMENTS
	M X	X	X	X	X

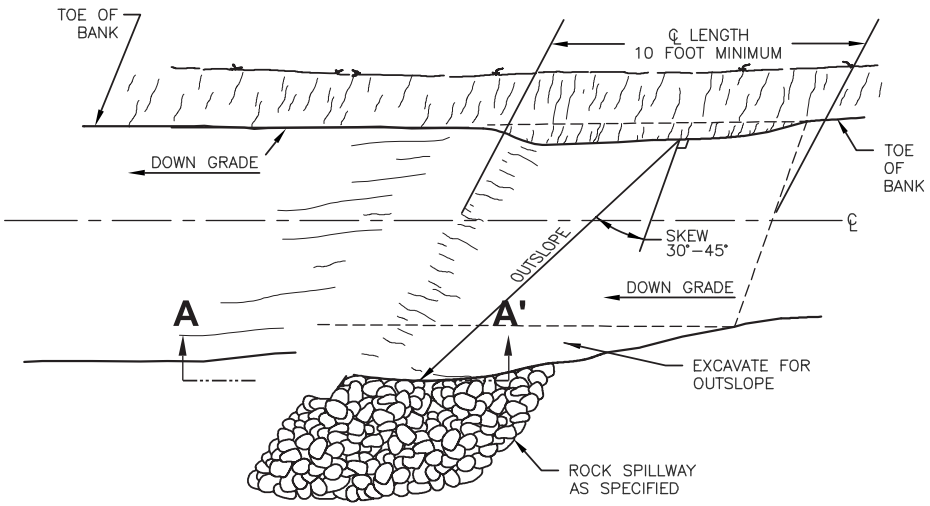
N/A WHEN NOT APPLICABLE

SKEW

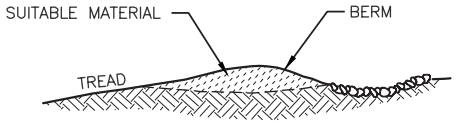
TRAIL GRADE	SKEW ANGLE
<5%	45° MAX
>5%	30° MIN

NOTES:

1. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.



PERSPECTIVE VIEW



SECTION **A-A'**

Check Dam

Surveying and site layout

Prior to installation, survey the project location to calculate the grade. The grade will determine check dam placement (see *Check Dam Spacing* table in design detail). This can be completed through the use of a Clinometer to calculate the trail grade or through the use of a string line level and tape measure. Flag out the excavation area, spacing as needed per measurements. Assess the work site for potential impacts to trees, shrubs and roots. Occasionally, the installation location needs to be adjusted to mitigate negative impacts to native trees and shrubs. Since this structure is intended to restore a decommissioned trail, extra care should be given to supporting established vegetation.

Installation

When installing multiple check dams, always start at the bottom and proceed to move up the slope. This ensures structures are spaced appropriately so they are effectively retaining sediment and their structural integrity doesn't get compromised over time. Excavate to a depth of at least 1/4 the vertical dimension of the timber. At least 1 FT of each end of the check dam should be buried into the banks on either side of the tread. Place the timber into the trench and make any necessary adjustments to ensure a snug fit. Use a level to check the cross slope and the running slope to assess how it sits on the trail. The goal is to get down to approximately 1 degree for the cross slope and running slope. Repeat as many times as needed until sufficiently excavated. Secure the structure using one of the following methods based on the overall site conditions and availability of materials:

- **Buried in the bank**
  Wedge large 2-4" rocks around the edges of the check dam with a special emphasis on the section that extends into the banks of the trail edge. Choose longer rocks with sharper edges that can pin the structure in place. Set the rocks around the structure with single or double jacks until the structure is secure.
- **Pinned with larger rocks**
  For additional structural integrity in high erosion areas, use the "buried in bank" method and finish by adding in large rocks (50-75 LBS) in size with a special emphasis on the downhill side of the check step. The rocks should be buried at least 1/3 vertical dimension of the rock.

Once timber has been installed, decompact tread along decommissioned trail and naturalize the surface through placement of leaves and large woody debris.

Check Dam

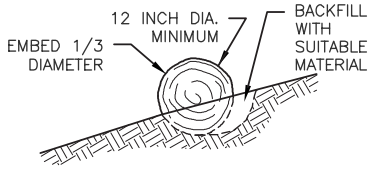
CHECK DAM

TYPICAL ID	CHECK DAM SPACING (FEET)	NO. OF CHECK DAMS	COMMENTS
	X	X	X

N/A WHEN NOT APPLICABLE

CHECK DAM SPACING

GRADE %	SPACING (FEET)
5–10	OCCASIONAL
10–15	20
15–20	15
20+	10



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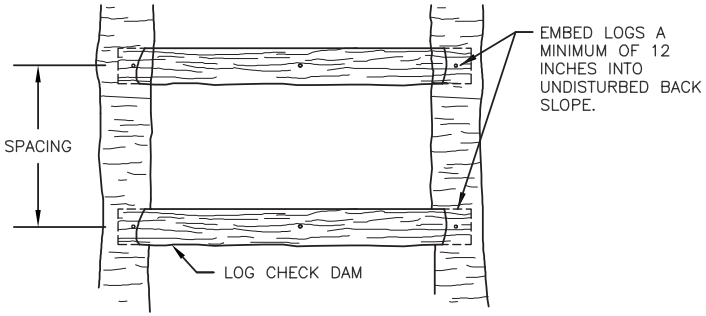
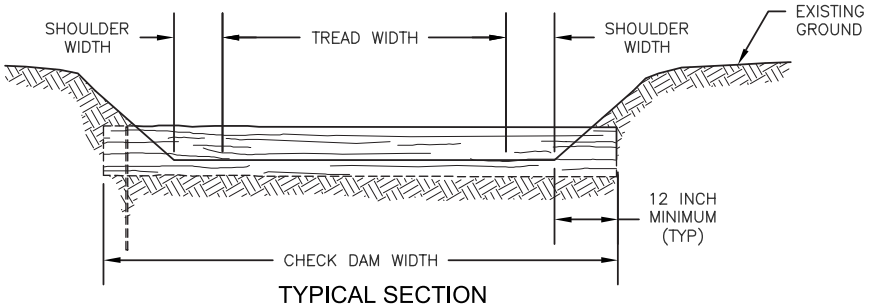


PLAN VIEW



TYPICAL SECTION

SPECIES TYPE

MATERIAL	SIZE	SPECIES/ GRADE	PRESERV. TYPE	COMMENTS
LOG	X	X	X	X

NOTES:

1. SET 1"–4" ROCKS BETWEEN CHECK DAM AND EXCAVATED FOUNDATION TO SECURELY ANCHOR STRUCTURE IN GROUND. USE SMALLER ROCKS TO FILL BETWEEN LARGER ROCKS.

2. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.

Standard Turnpike with Foundation

Surveying and site layout

Prior to installation, survey the project location to determine the length of turnpike needed for the project. This can be completed through the use of a measuring wheel to identify the extent of the flooding or saturated/muddy section of trail.

Once the surveying work is completed, flag out the work site to delineate the area to be excavated for the timber which will serve as the frame for the turnpike. Use measuring tape to flag out the dimensions of the structure based on the design parameters and use 1 flag to demarcate each corner and side of the structure (typical width is 4ft). This helps ensure that the area is not over-excavated which makes it more difficult to set the timber. Assess the work site for potential impacts to trees, shrubs and roots. Occasionally, the installation location needs to be adjusted to mitigate negative impacts to native vegetation.

Installation

Begin site preparation by removing duff and/or coarse woody debris. Once the site is prepped, begin to dig trenches by clearing out darker, organic soil and excavate down to the lighter mineral soil. As the excavation progresses, be mindful of roots that may appear. See *Log or Treated Timber Detail* for what to do if encountering roots larger than 1". Be mindful of the excavation area to ensure that the trench is not too large or over-excavated since it can blow out the hole and compromise the stability of the turnpike.

Once the area is excavated, place the first section of timber into the hole. Inspect the excavated area and make any necessary adjustments. Pay particular attention to all sides of the excavated area, as well as underneath the timber to see if more material needs to be removed or backfilled. Final placement of the timber should be installed at least 1/2 it's vertical dimension. Use a level to check the cross slope and the running slope to assess how it sits on the trail. The goal is to get the timber down to approximately 1 degree for the cross slope and running slope. Repeat this step as many times as needed until sufficiently set. This process should be repeated for all timber set for the turnpike, which should all be set flush with one another. If it is not possible to excavate down to mineral soil, use crushed rock and mineral soil backfill and tamp down with a McLeod to create a firm foundation for the frame. Make any final adjustments until the structure is relatively level (within approximately 1 degree). If rock is available on site, fill in the edges of the sill with crushed rock and mineral soil and tamp down with a McLeod. If site conditions are particularly boggy and rocks aren't readily available, rebar can be used for extra stability.

After the timber is set, excavate until the bottom of timber has been reached (depth will depend on size of timber utilized). Fill in space with foundation stone 2"-3", then coarse rock 1 1/2", then 3/4" aggregate. Once stone is placed, tamp, then place mineral soil. Mineral soil should be tamped and capped, with the center point of the tread a minimum of 2" above the prevailing grade. Pending site conditions and design parameters, a drainage gully can be constructed on both sides of the structure, running parallel, in order to ensure water remains beneath the newly constructed tread.

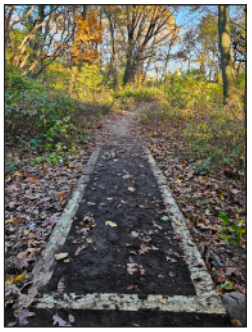
Standard Turnpike with Foundation

TYPE 2 - STANDARD TURNPIKE WITH FOUNDATION

TYPICAL ID	DITCH			FOUNDATION	COMMENTS
	TYPE	LOCATION		TYPE	
		LT	RT		
	X	X	X	FD X	X

N/A WHEN NOT APPLICABLE

EXAMPLE

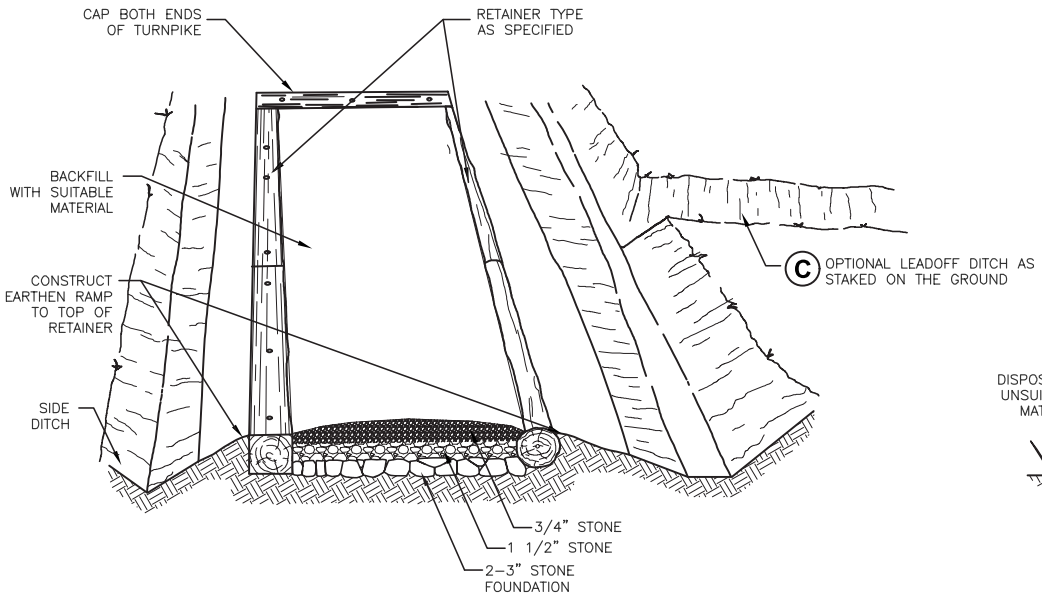


NOTES:

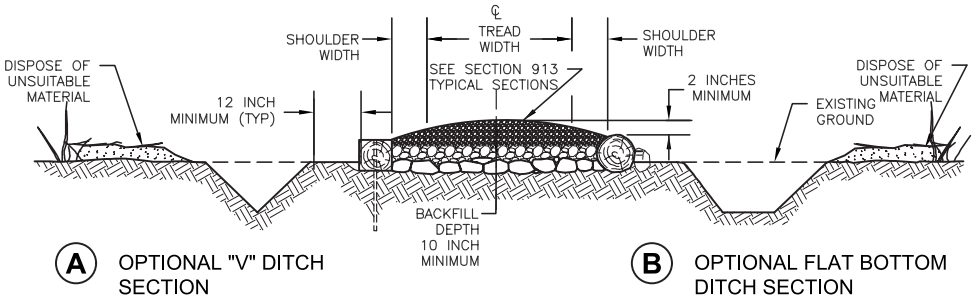
1. COMPACT BACKFILL IN 6 INCH LIFTS UNTIL NO VISUAL DISPLACEMENT.
2. REMOVE AND DISPOSE OF DUFF AND TOP ORGANIC LAYERS DOWN TO MINERAL SOIL.
3. LEADOFF DITCH TO BE CONSTRUCTED THE SAME AS SIDE DITCHES.
4. LEAD–OFF DITCH TO DRAIN TO DAYLIGHT, WHEN THERE IS SUITABLE CROSS SLOPE ON DOWNHILL SIDE OF TRAIL.

IN-FILL MATERIAL TYPE

TYPE	MATERIAL	ROCK SIZE	GRADATION %	COMMENTS
FD1	AGGREGATE	3/4"	X	X
FD2	COARSE ROCK	1 1/2"	X	
FD3	FOUNDATION STONE	2–3"	X	
FD4	X			



PLAN VIEW



TYPICAL CROSS SECTION

Grade Reversal

Surveying and site layout

Prior to installation, survey the project location to determine the overall grade of the segment(s) of trail being improved. Please note, this feature is typically included in the planning and development of new trail and therefore may require adjustments that affect a larger portion of the trail, similar to a reroute, if constructed retroactively.

The grade of the trail will be reversed for about 10-15ft, then return to meet with the descending grade. These reversals should occur every 20-50 ft depending on the overall grade of the segment being improved. Flagging should be placed at each location where a reversal is to be constructed.

Installation

For site preparation, use a McLeod or a hard rake to remove duff and/or coarse woody debris. For shaping of the tread and outlet drain, use a combination of McLeods, grub hoes, pick mattocks and small shovels. McLeods are great tools to use for grade reversals as they are effective in both shaping and tamping the tread. For rockier areas, pick mattocks are best used to pick and pry out rocks that are in the project site. Clear out darker, organic soil and excavate down to the lighter mineral soil. Once the site is clear, begin shaping the tread to achieve a gradual outslope of about 5%. As the excavation progresses, be mindful of roots that may appear. Smaller roots under 1" diameter can be cut with loppers or hand pruners. Avoid cutting any roots larger than 1" to reduce negative localized impacts to the natural area. If encountering a root between 1-2" and it's not possible to adjust the location for the dimensional lumber, a certified ISA arborist should be consulted to do an assessment to determine whether or not the root can be removed.

There may be instances where a bench cut may have to be constructed to establish new tread. A bench cut includes a excavation and tamping of soil at about a 45* angle to prevent erosion of the surrounding slope and tread. Once the grade reversal is shaped, an outlet drain may need to be constructed, pending design parameters.

Grade Reversal

GRADE REVERSAL

TYPICAL ID	DRAIN DIP TYPE	SKEW	SURFACE COURSE TYPE	SURFACE COURSE DEPTH	ROCK SPILLWAY***	COMMENTS
	DDX	X	SX	X	X	X

N/A WHEN NOT APPLICABLE
***FOR ROCK SPILLWAY SEE SHEET STD_923-10-01

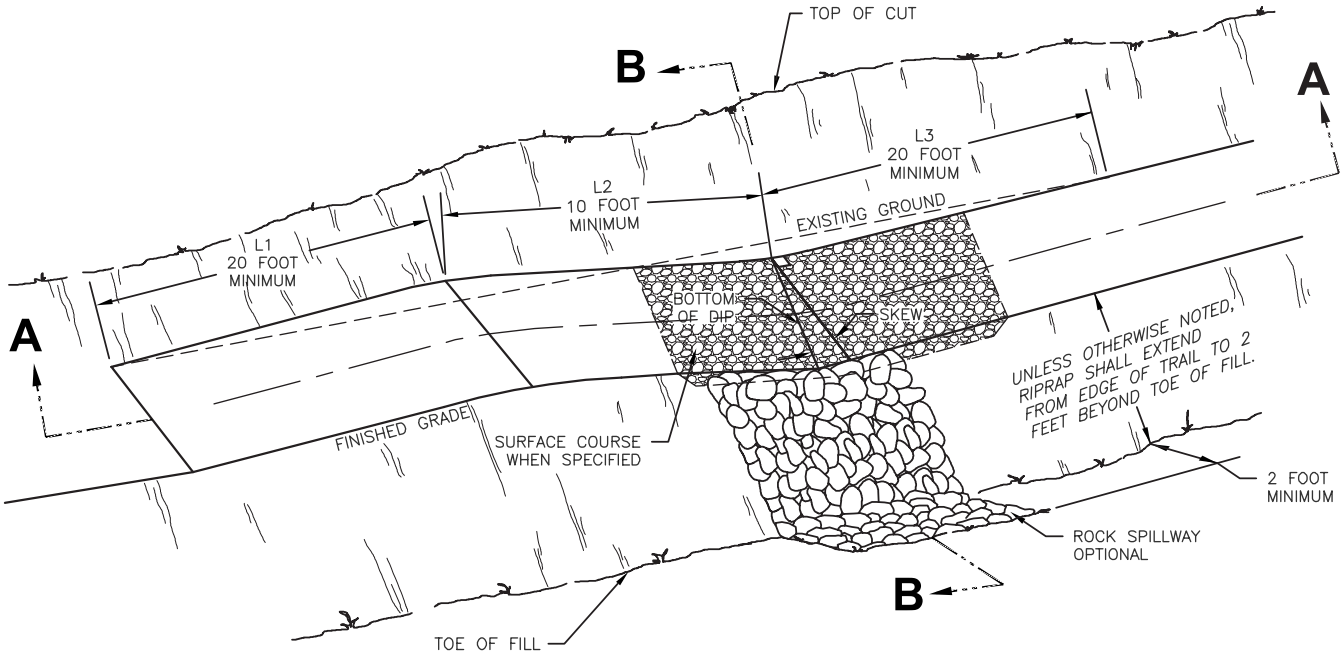
SURFACE COURSE MATERIAL TYPE

TYPE	MATERIAL	GRADATION	COMMENTS
S1	PITRUN	X	X
S2	AGGREGATE	X	
S3	X	X	

DRAIN DIP CONSTRUCTION DIMENSIONS

DRAIN DIP TYPE	% PROFILE GRADE	L1	L2	L3	(H)	(E)
DD1	0 TO 4	X	X	X	X	X
DD2	5 TO 6					
DD3	7 TO 8					
DD4	9 TO 10					
DD5	X					

OVER 10% NOT RECOMMENDED
H = ℄ OF TREAD



NOTES:

1. DRAIN DIPS WILL BE STAKED IN THE FIELD.
2. ROCK SPILLWAY SLOPE SHALL BE THE SAME AS THE CONSTRUCTED FILL SLOPE.

We are grateful to our partners and funders for their support and contribution:
The Leona M. and Harry B. Helmsley Charitable Trust
New York City Department of Parks & Recreation

Natural Areas Conservancy