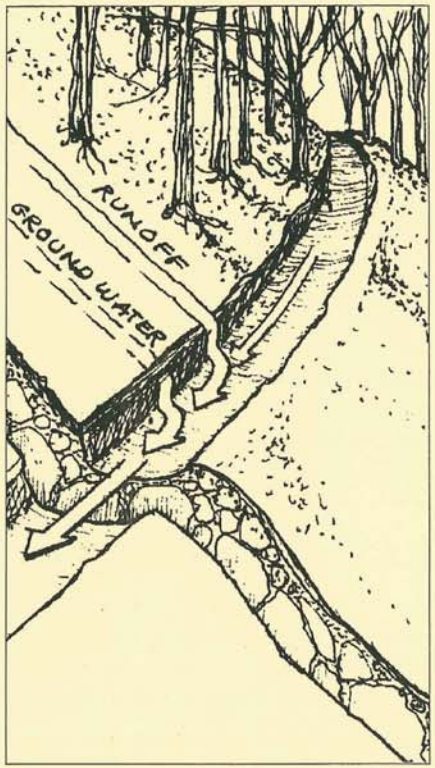
Appendix: Trail Maintenance Guidelines



Trails intercept and channel overland flow from rainstorms.

Trail Maintenance Guidelines

Text and drawings prepared by Ed Boyer, landscape architect, Philadelphia PA

This manual was prepared for training volunteer path repair crews in the Wissahickon Park, Philadelphia PA—an 1,841-acre park with trails on forested slopes that are similar to Louisville's Olmsted parks. While historical documentation of paths in the Wissahickon is scant, the wealth of documentation and plans that describe Olmsted's path proposals in Louisville's parks give a good starting basis for assessing today's path alignments. It is the intention of this Master Plan to incorporate the original Olmstedian path system, insofar as is feasible. The planning and review process for the trail system is described in Chapter 9, Implementation.

Trails in the Wissahickon Valley

The oldest paths in the Wissahickon Valley were Indian trails. Paths may have descended from the adjoining ridges to find a convenient crossing or a good fishing place, but a century of industrial activity followed by a century of park development seems to have left no traces, records or memories. Trails now in the Wissahickon were built for three purposes—as carriage roads, bridle trails, and foot paths

During the 18th and 19th centuries, roads were built to intersect the Wissahickon Creek at an old dam, or bridge or mill-site. The Wissahickon Turnpike Company was chartered in 1853 to connect these roads and factory sites with a road the length of the valley from Northwestern Avenue to Rittenhouse Town. A road (now Lincoln Drive) had already been built from there to Ridge Avenue, near the mouth of the Creek. All of these roads came under the control of the Fairmount Park Commission in 1869, when the City obtained the land to protect the city's drinking water. The Wissahickon Turnpike became Wissahickon Drive; it has been known as Forbidden Drive since motor vehicles were banned early in the 20th century. The road is about 20-feet wide. It has split rail fences bordering the slope above the Wissahickon Creek and street lights at intervals of 300 feet. The surface is crushed stone, though one can detect remains of brick and granite paving on the bridges. Stone drainage inlets may be seen here and there; erosion, sedimentation and improper grading prevent most of them from functioning.

Bridle trails were built along both sides of the valley at elevations where slopes were easier and widths of 6 to 10 feet could be maintained. Most of them were built by the Fairmount Park Commission during the late 1800s and early 1900s, or by the federal WPA (Works Progress Administration) in the 1930s.

Foot paths were built where slopes confine the treadway to a 3- to 5-foot width. In many places slopes are so steep that the narrow treadway is supported on stone retaining walls. Some of the foot trails follow sewer lines. The WPA rebuilt and extended the foot paths during the 1930s. Stone culverts were added to convey water under the trails, and the paths were regraded and surfaced with gravel.

Standards for Woodland Trails

What is a well built and well maintained trail? It is a cleared path without obstructing tree limbs or brush. The line of sight is open, both ahead and to the rear, so the trail may be followed without confusion or straying. Signs or trail markings identify the trail and its intersections with other trails. The treadway provides a clear, firm footing. Water drains from the treadway without causing erosion.

The trail's cleared width may vary from 3 to 6 feet depending on terrain and vegetation, and the treadway should be no less than 2 feet wide where conditions are most limiting. Overhead, the trail should be clear of vegetation 8 feet above the treadway. It should be possible for a tall man to stand in the middle of a trail and spread both arms, then bring them together over his head, without touching any obstruction.

A popular trail in the valley with hikers, mountain bicyclists and occasionally equestrians is the Orange Trail, on the opposite side of the Wissahickon Creek from Forbidden Drive. Because it is narrow and is typically supported by stone walls, it cannot accommodate the traffic that throngs it on sunny weekends.

The Orange Trail exemplifies all the problems with trails in the Wissahickon. Because it is both scenic and rugged, it attracts many hikers and mountain bicyclists. Bicyclists are loath to dismount, so they make parallel trails on steep, unstable slopes where they try to pass. Where there is no room for a two-lane trail, hikers are obliged to stand out of the way, trampling trailside vegetation. Both bicycles and horses churn the saturated soil of early spring into mud. Hikers enlarge the puddles trying to get around them. Collapsed walls or fallen trees cause travellers to make detours onto soft, easily eroded terrain, doubling the area of trampling and plant destruction. Equestrians make destructive short cuts to leave the Orange Trail where they meet obstructions. Anglers leave and enter the Orange Trail at many places, since most of them do not wade in the stream, but scramble along the banks of the Wissahickon.

A lot of maintenance, a little courtesy and a heightened awareness of how fragile is the hold of plant life on the steep slopes of the Wissahickon Gorge will save the beauty and pleasure of this rare place for all visitors.

The Purpose of Trail Maintenance is to Control Erosion

A well maintained trail conducts human and horse traffic through the more erodible and fragile terrain to either side. Where a trail is gullied, or muddy or hard to follow, traffic will find its own way; this increases erosion, enlarges mud holes and spreads the effects of trampling.

Feet, hooves, paws and wheels cause trampling and erosion. Running water causes heavy erosion where it gathers volume and velocity. Trails, unless they are located on ridges or in bottomlands, intercept surface flow and tend to channel the water they collect. The results are erosion where the runoff is swift, or puddles where the runoff is impeded. Neither condition is good for the trail or for the surrounding land.

Water channeled by the trail will erode the trail and create gullied areas where it leaves the trail. Water trapped on the trail will create mud holes that grow wider as traffic tries to get around them.

Close observation of how water drains onto, along and from the trail will show where attention is needed to correct or prevent erosion by water.

Erosion Control Structures

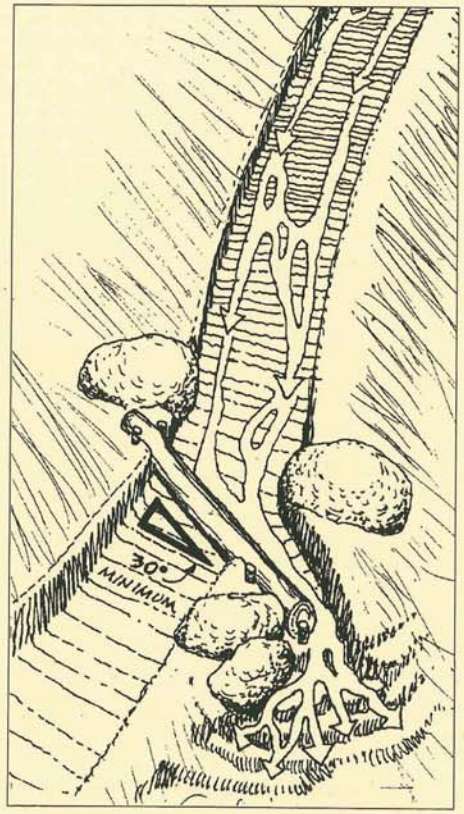
Water flowing along a trail can be slowed by steps and can be diverted from the trail by water bars. Both trail structures are useful. Steps are needed on the sections of a trail where erosion is evident or the gradient is steep. Steps are set across the trail at a right angle to the trail. Water bars are set at an oblique angle to the trail and are shaped to direct drainage off the trail.

Location of these structures is important, as is the firmness and neatness of their execution. You do not want to waste your time on weak and inadequate construction; study what the situation needs and what materials the place affords to make a lasting improvement.

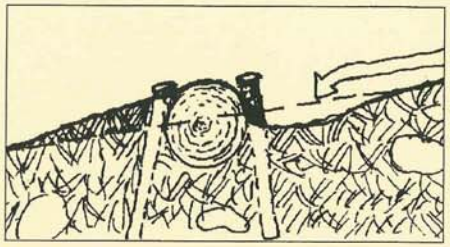
The erosive force of running water is proportional to its volume and its speed. The volume of water flowing along a trail is controlled by diversions above the trail and by water bars on the trail. The velocity, or speed, of water flowing along a trail is controlled by the trail's slope and by steps that modify the slope. Velocity is also affected by the volume of water that flows along the trail.

Water Bars to Drain the Trail

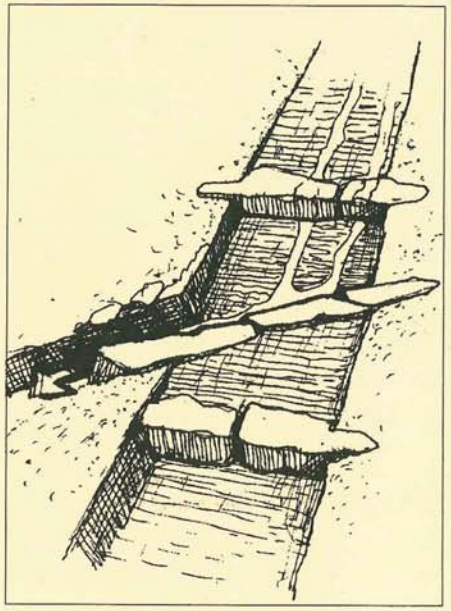
A water bar is a low barrier angled to direct the flow of drainage off the trail. Stones or logs can be used for water bars; they should be straight and fairly smooth or they will quickly trap sediment and cease to function. The water bar acts as a small dam to divert flow that would gain in volume and speed if allowed to continue along the trail. Its cross section resembles a hump in the treadway.



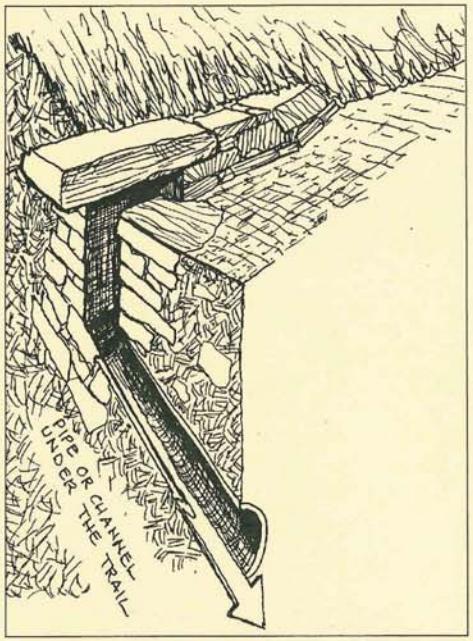
A water bar built with a log. The log is held in place by wood stakes. Large stones have been placed to keep traffic from going around the log.



Cross section of a log water bar.



Stone water bar is guarded by a stone step above to slow the water, and by a stone step below to support the fill.



Stone catch basin with pipe or stone culvert is typical construction of the WPA in the 1930s.

Plan the water bar's location carefully. Sometimes a shallow ditch on the outside of a curve is enough to throw water off the trail. The stone or log barrier must cross the trail and extend beyond to prevent water and people from going around it. This is especially important on trails used by bicyclists who are tempted to ride off the edge of the trail to avoid a bump. Place rocks below the outlet to disperse the water and prevent a gully from forming.

Begin by digging a shallow ditch across the trail. It should not go straight across, but at an angle of 30 to 45 degrees. Dig through the berm on the downhill side of the trail at a gentle slope that water will follow. The ditch should be no deeper than one-third the thickness of the log used, and twice as wide. Place the log against the downhill side of the ditch. Use stakes to secure the log. Smooth the trail surfaces above and below the barrier, and pack the earth firmly.

The peeled log used for a water bar should have a minimum diameter at its small end of 6 to 8 inches. It will be at least 6-feet long for a trail 3-feet wide, and 10-feet long for a trail 6-feet wide. At 20 to 30 pounds per foot, the log will be heavy to move. Look for fallen timber that has not begun to rot. Hemlock is the most durable wood for this purpose found in the Wissahickon, but whatever is closest to hand and meets the criteria must serve.

The Friends of the Wissahickon have built some water bars using treated timber. The lumber is guaranteed to last for 15 years and may last far longer. It has the advantage over stone of being much less heavy to move, it is regular in section, and can be cut to any length wanted. Timbers 6 by 6 inches in cross section have been used; heavier sections of at least 6 by 8 inches would be more stable. Time will tell how well the material lasts under horses' hooves, and how it weathers to fit into the landscape.

Water bars made of recycled rubber belting have been used successfully on bicycle trails. Because they give way under the wheels of a bicycle, they present no physical barrier to bicyclists, only to flowing water. Because they do not require the curbing of logs or stones at the side of the trail so often necessary to prevent bicyclists from going around them, they are quickly installed. Riders who are alarmed at first, since the rubber belting looks like a strip of metal, are quickly accustomed to the devices where they have been installed. Neither horses nor hikers have any problem stepping over the barriers. They are being installed experimentally in the Wissahickon so we may see how they function.

A well made stone water bar will last much longer than wood, treated or untreated. The stones must be as long as can be found and set on edge in a trench with at least two-thirds of their bulk anchored in the earth. The barrier must be smooth and straight, and the stones should fit tightly against one another. Extend the stone barrier far enough beyond the trail to prevent water and hikers from running around the end.

The cross-section of a water bar must be maintained by Trail Maintenance Patrols. Clear accumulated sediment and leaves from the bar and from the ditch which leads water down the hillside. Mound the soil against the downhill side of the barrier. If necessary, reset the barrier and drive new stakes.

Catch Basins and Culverts

Stone catch basins were built along Forbidden Drive and on Wissahickon trails. Few of them drain water any longer, as they are several inches higher than the present trail surface, resulting in unchecked erosion. Most of the work was probably done by the WPA during the 1930s. The work crews of that time evidently employed enough highly skilled masons to produce walls that are uniformly solid and beautiful 50 years later.

The catch basins and culverts provided a more complicated method of routing drainage than is commonly used on mountain trails. The trail was originally given a cross slope into the hillside, creating a shallow ditch to intercept runoff from the slope above. Stone catch basins at regular intervals intercepted the flow, conducting it into stone channels or culverts under the trail. The catch basins work very well when kept clear of debris and when the treadway elevation is maintained by routine regrading. There is much to be said in favor of keeping all water off the treadway; heavy springtime traffic on the erodible clay soils of the Wissahickon creates muddy conditions and high erosion potential.

These beautifully made structures must be protected from damage and robbing for trail materials, and they should be incorporated into the drainage system as often as possible. Not until we have a small, self-propelled grading machine for trail maintenance can we reconstruct the sensitively designed drainage system of those primitive times when it was all built by hand and with mule-drawn graders.

Other stone culverts convey streams under the trails of the Wissahickon; many need clearing and rebuilding. The channel or pipe must be covered by at least one foot of soil or rock, and its pitch must be adequate to flush leaves and sediment out with each rainstorm. The inlet should be framed by a stone head wall or catch basin; the outlet should be similarly framed to protect and hide the pipe.

Cover the channel with rock slabs of as flat and regular shape as can be found. Moving such massive pieces will test the construction crew's strength and ingenuity. Use rollers, levers, winches and great care. Above all, take the time to be safe and to guard the safety of trail users. Just to move a stone slab might occupy a crew for the entire 3 hour work outing.

Controlling Water Velocity with Steps Built of Stones or Logs

There are steps in the Wissahickon of dressed and regular stone; they were built more to ease foot travel than to control erosion. Many steep parts of Wissahickon trails need steps to control erosion by running water. The placement of steps on the trail must be planned carefully. Avoid locations where the hiker will come upon the step without warning. Steps in series are better than steps placed individually or at random. The spacing and rise of steps should be as regular and as well suited to the human stride as the situation will allow.

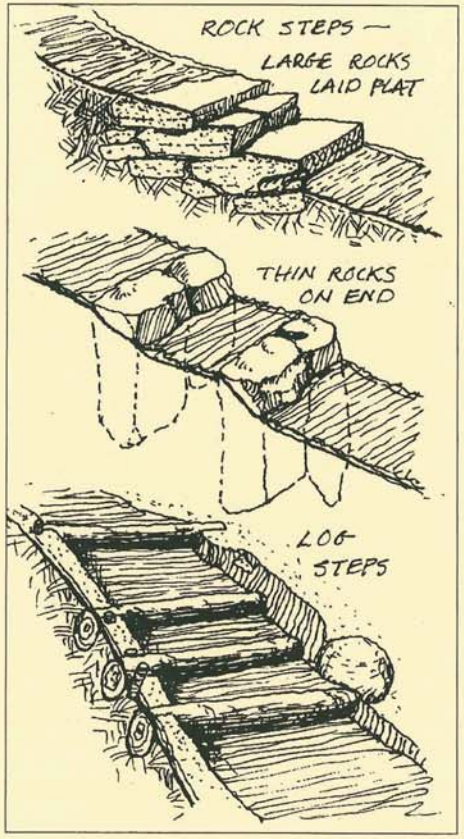
Stone makes the most durable step, but stone large enough and of a sufficiently rectangular shape may not be available. The stone that lies at hand will seldom be very regular in shape, but if it has one nearly flat surface and is too heavy to lift, it should serve the purpose. When the stone is in place, check its stability by trying to shift it. Use smaller stones to wedge and support its edges. Pack soil behind the stone and into any gaps between stones. Don't leave an unstable stone on the trail when you quit.

Logs or rough-hewn timbers are good substitutes for stone; they are easier to handle and they can be cut to size . Of course, they don't last more than 5 to 10 years. Steps should not be lower than 6 inches nor higher than 12 inches; choose the log diameter accordingly. The log should be cut from fallen timber and it should have its bark peeled; unpeeled logs can be treacherous when rotten bark falls away to uncover a slippery surface. Anchor the timber by digging it into the sides of the trail or by driving stakes into the ground where its ends are clear of the treadway. Always test your work for firmness; make sure it won't roll out of place under the tread of a hiker or a horse.

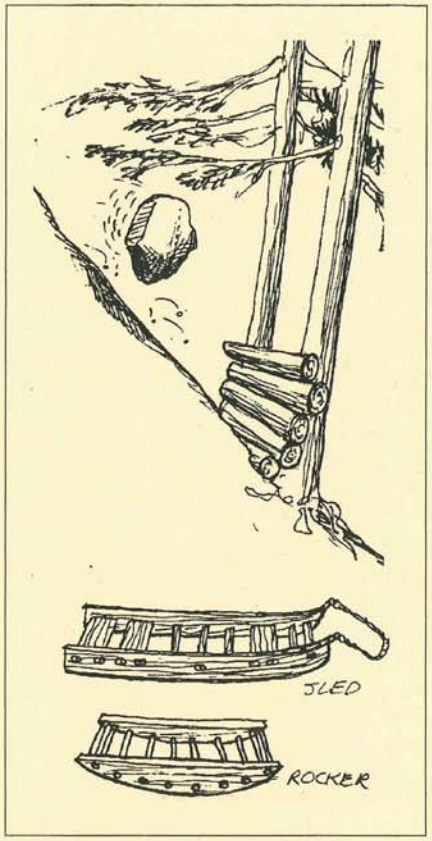
Moving Rocks and Heavy Objects

The challenge of trail work is to use the materials closest to hand to build durable structures that look part of the landscape because they are made from the very elements of the surrounding scene. The stones and logs that are heaviest usually make the strongest work; they don't shift under the tires of a bicycle or the hooves of a horse. Massive construction also resists the forces of gravity and erosion. Such large materials are seldom in the spot where they are wanted and Neolithic skills are needed to accomplish their transport.

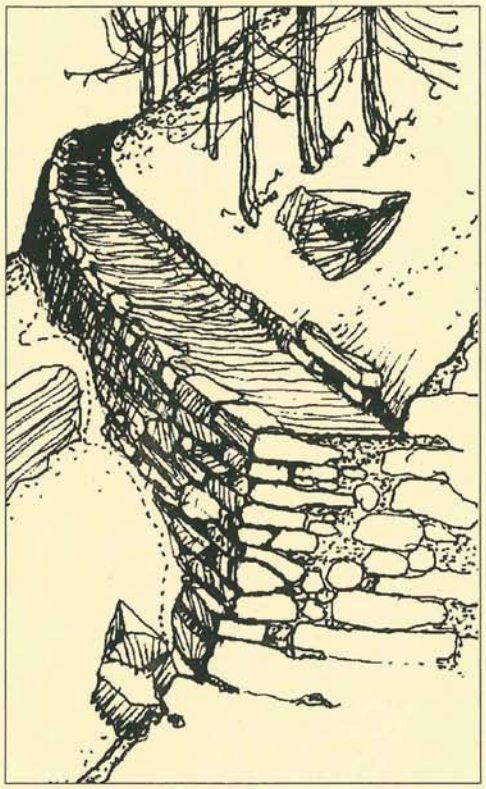
Safety is paramount. Never forget that gravity will take over if a load slips, a rope breaks or a tool loses its grip. Shout a warning if a rock gets out of control. Wear gloves; they will prevent blisters and abrasions; they might also enable you to slip your fingers from under a crushing load. Watch out for hikers who may be below you or who may be watching while standing in harm's way. It might be necessary to close the trail while large stones are being moved. Limit the size and number of crews; there can be too many hands and too much activity.



Steps built of stones or logs.



Use gravity, sled or rocker for moving heavy loads.



Section through a stone retaining wall.

Use a crow bar or digging bar to lift the stone; this will give you a feel for its heft and balance while you decide how to move it. Put a logging chain around the stone and try dragging or flipping it. Use rollers on the trail. Use a stone sled or rocker, or improvise skids from fallen tree limbs to cross rough ground. Nylon cargo slings can be used by several workers, and they keep your fingers and toes out of danger. Work in unison; don't start heaving until everybody knows what's going to happen.

Rebuilding Retaining Walls

The Wissahickon, where it flows through Philadelphia, has cut a narrow gorge that is exceptionally steep and dramatic. Wissahickon trails are fitted into this rugged topography with stone retaining walls in many places. Where retaining walls collapse or deteriorate, severe erosion and damage to the treadway result.

Retaining walls built 50 and 150 years ago still stand in the Wissahickon Valley. Most of the work was laid without mortar, using the friction of stone upon stone to resist the outward push of earth and frost. It is instructive to study these old walls. Most of them are as well knit and sound as when they were built; some of them have actually slid downhill as a unit when the soil beneath them failed, even though there is no mortar bonding the stones together. Dry-laid walls require the most skill, care and artistry in their construction. It may seem inadvisable for unskilled volunteers to attempt difficult work of this sort, but we have no good alternatives and the technique has several advantages:

- Volunteer work is episodic by nature. Crews can stop building at any point and the wall's structural integrity is not impaired.
- Dry-laid walls settle into place without suffering damage and they allow ground water to drain freely; their construction creates the least mess.
- Stone is available throughout the valley and the walls look right because they are a part of the place.
- If a wall is poorly built, it will soon collapse and its builders will learn to lay the stones more carefully.

One should start by collecting many stones of different sizes near the construction site, but off the trail. A good selection of stone is essential and the largest and most regular stones available should be gathered. The wall should be built on a level, solid base; either clear loose stones and debris from the remains of an existing wall, or start from a stone foundation 1 or 2 feet below the soil level. The foundation must be solid; compact the soil with shovels and tampers; lay large, flat stones on the soil with a 5 degree tilt into the hillside. The wall should lean into the hill with a batter of 1:10 (5 to 6 degrees from the vertical).

Choose each stone carefully; try it in different positions; try to rock or shift it; try another stone if you can't make it comfortable on the bed you have prepared for it. Use small stones to wedge and fill gaps. Use long stones as stretchers to tie the work together laterally; use them as headers to tie the work into the earth behind the wall. Backfill with soil and rock in firmly compacted layers as the wall rises. Cap the wall with large, heavy and regular stones; these will be subject to the shifting forces of foot and hoof.

Pause frequently to admire the work and look for aspects to disparage—features that may betray some weakness or inadequacy that wants to be made better.

Materials for Trail Surfaces

The surface of trails in the Wissahickon is the soil and rock that exists in the valley. There have been a few attempts to improve trails with imported material. A topping of crushed limestone has been added to some roads and trails in order to make the way easier for equipment used on sewer repair projects. On steep hills, the fines wash away, leaving angular stones of one size that are difficult to walk on and do nothing to reduce erosion.

Additional material may be needed to raise the treadway out of wet and muddy ground. Stone, unless a great deal of it is used, will only sink into the mud. Wood chips will improve the seasonally wet areas, assuming drainage is improved as well. Yearly additions may be needed, but they are free, abundant, and easy to haul. Stepping stones, log stringers or fill can be used to raise the treadway out of the mud and wet. As in all trail work, the construction should look part of the landscape. The Wissahickon is no place for causeways or similar intrusive structures.

All of the larger bridges in the valley, including those across the Wissahickon, are maintained by Fairmount Park. Bridges and culverts on minor streams have been built or repaired through the efforts of the Friends of the Wissahickon. Trail construction crews will encounter small structures in need of repair, especially culverts and bridge railings. The more ambitious jobs require planning and skills that are beyond the scope of this manual.

Trail Blazing Patrols

Trail Blazing Patrols to maintain trail markers and paint blazes should be conducted annually. Blazes of paint or signs identify the trail and mark its intersections with other trails and roads.

Trail Maintenance Patrols

Trail Maintenance Patrols should be conducted early in the spring to remove trees and limbs felled by winter's storms, to clear and restore water bars and to take note of places where reconstruction is needed. To transport materials:

- 2 two-wheeled carts of 300-pound capacity.
- 1 heavy tree dolly with pneumatic tires.

Patrolling is best done in pairs. The team should clear the trail to the dimensions noted in the standards, clear and restore water bars, repair the treadway where damage is minor and report the need for larger operations requiring construction crews, chain saw crews or trash removal crews.

Maintenance patrols should carry a light equipment load:

- 1 mattock-pick.
- 1 shovel.
- 1 bow saw (ax for the qualified only)
- 1 pair of long-handled pruners.
- 1 trail map and notebook to record trail conditions.

Trail Construction Crews

Trail construction crews repair the treadway and rebuild drainage and erosion control structures. Most reconstruction involves correcting and preventing erosion.

Trail construction crews have at least 6, and at most 12, members. The nature of the task and the tools and materials required determine the best size for the crew. Groups larger than the optimum can be divided into crews working nearby, but on different tasks.

A six-member construction crew should carry as basic equipment:

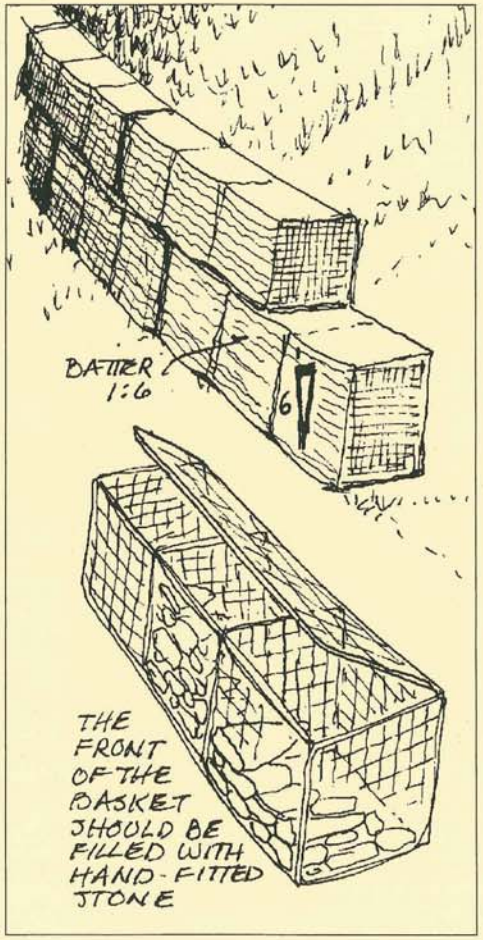
- 2 shovels.
- 2 mattocks.
- 2 16-pound digging bars.
- 2 nylon cargo slings.
- 1 logging chain with hook.
- 1 bow saw.
- 1 trail map and notebook to record work.

Special equipment should be suited to the task, for example:
100 feet of manila hemp rope.

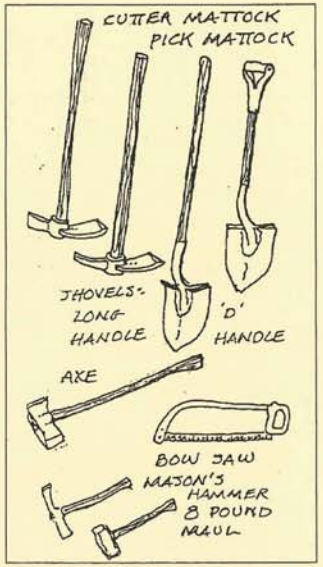
- 2 two-sheave pulleys with short lengths of rope to fix them to trees or beams.
- 1 cross-cut saw or chain saw.
- 1 8-pound maul.
- 1 rake.
- 1 brush hook.
- 2 plastic buckets.
- 6 wooden rollers, about 2 feet long, cut from fallen saplings.

For moving heavy rocks and trees:

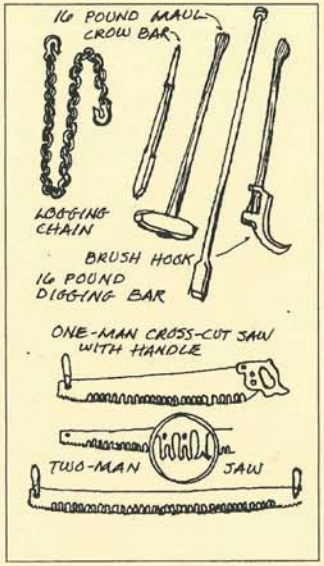
- 1 stone sled or rocker.
- 1 portable crane consisting of: 12-foot mast and 12-foot boom, with rope, steel stakes and pulleys to fit it out (this whole kit weighs about 350 pounds and needs a cart to transport it).



Details of gabion construction.



Tools used for trail maintenance.



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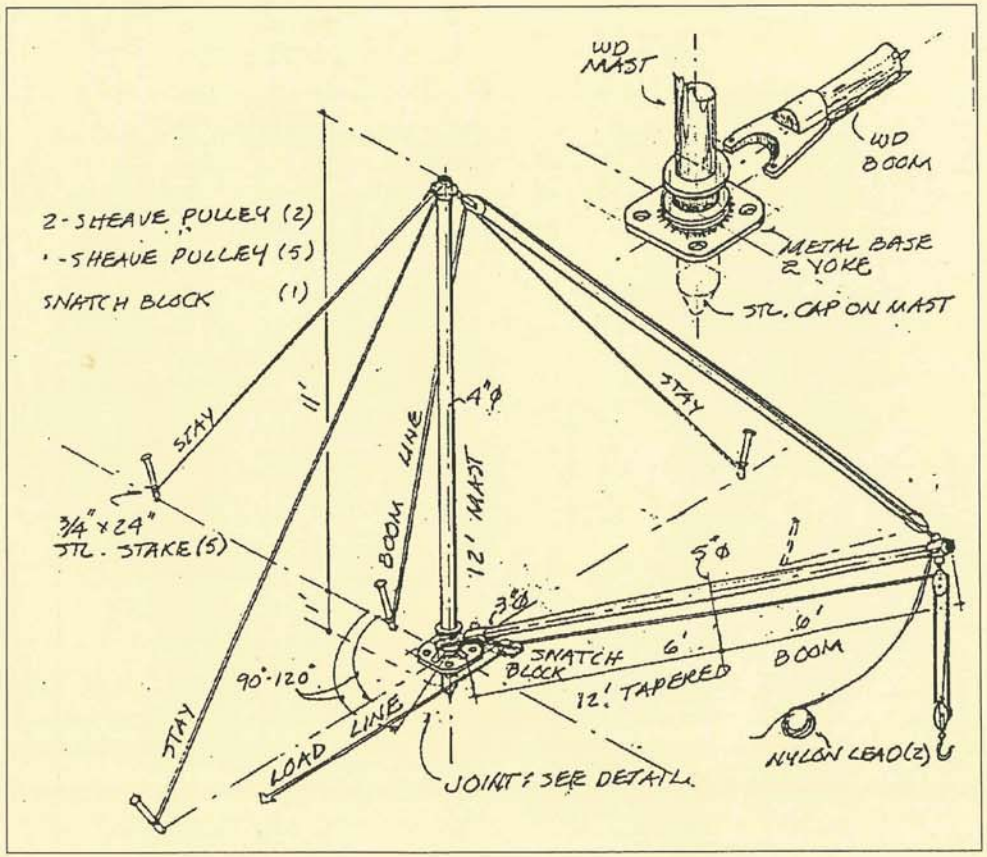


Portable crane for trail construction.

Keeping Records is Essential for Planning Construction Projects

The Friends of the Wissahickon are engaged in work all over the 1,841 acres of the Wissahickon Valley. This work will require decades to accomplish. Plans for construction work will be based on reports from Trail Maintenance Patrols.

Just as records of what needs to be done are useful, so are records of what has been done. Construction reports should note the location, nature and extent of the work, how long it took, and the crew size. Such records will allow one to assess the longevity of various kinds of construction. Long-range plans and budgets for time and resources will be based on this information as well.
Maps at a scale of 200 feet to the inch should be used to note trail conditions, and to record the location of reconstruction. Larger maps are used for planning purposes.

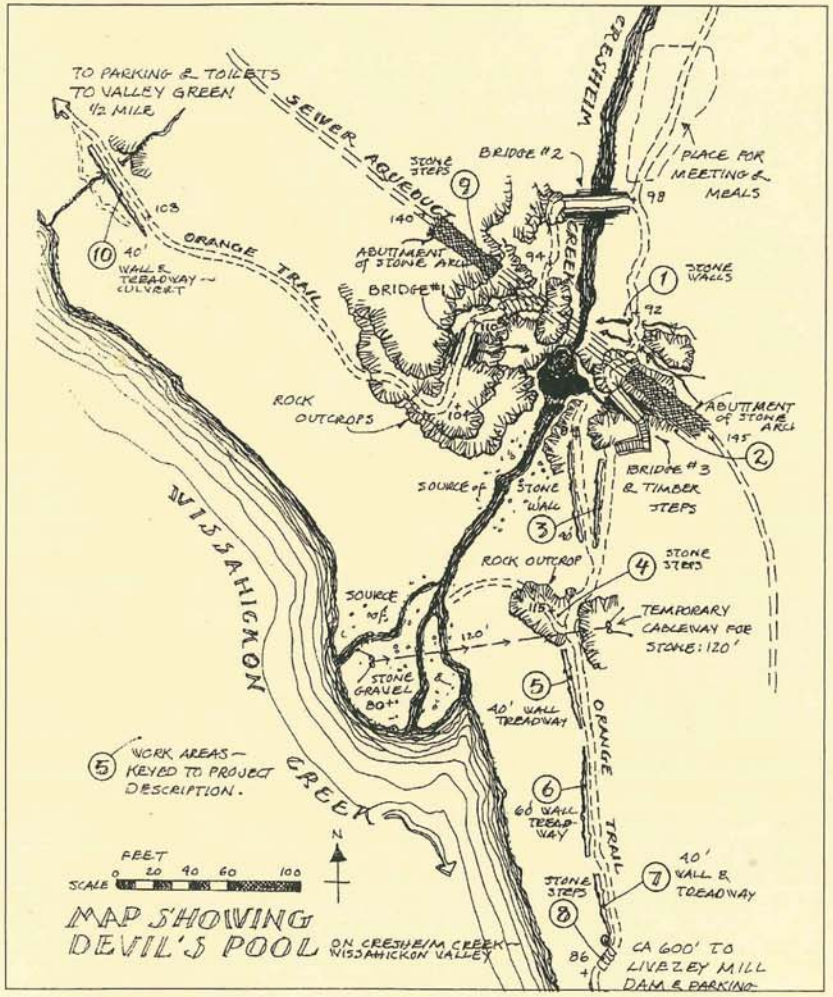
Maps published by the Friends of the Wissahickon are essential for finding your way in the valley and identifying trails. The scale of 1,000 feet to the inch is too small for recording maintenance accurately.

Permits for Trail Maintenance

Volunteer work in the Wissahickon is governed by the rules of the Fairmount Park Commission. Trail Maintenance Patrols, Trail Blazing Patrols and Clean-up Patrols are covered by a blanket permit issued to the Friends of the Wissahickon. All activities must be coordinated with District #3, Park Manager, who is responsible for the Wissahickon Valley. Construction projects require separate permits describing the location, nature and duration of the work.

Safety First—Ten Rules for Painless Trail Work

- Watch your footing.
- Don't work when the ground is slippery.
- Don't try to carry a stone that is too heavy.
- Rest when you feel tired.
- Use the proper tools.
- Use the simple tools, lever, wedge, ramp, roller to move stones and logs.
- Wear gloves.
- Keep fingers and toes out from under.
- Always think of where the stone would fall if it should slip.
- Always be aware of what your partners are doing, and never let go or shift something without giving warning.



Conceptual plan describing volunteer trail repair projects. (Ed Boyer, 1992)

LANDSCAPE WORK

THE FRIENDS OF THE WISSAHICKON, INC.

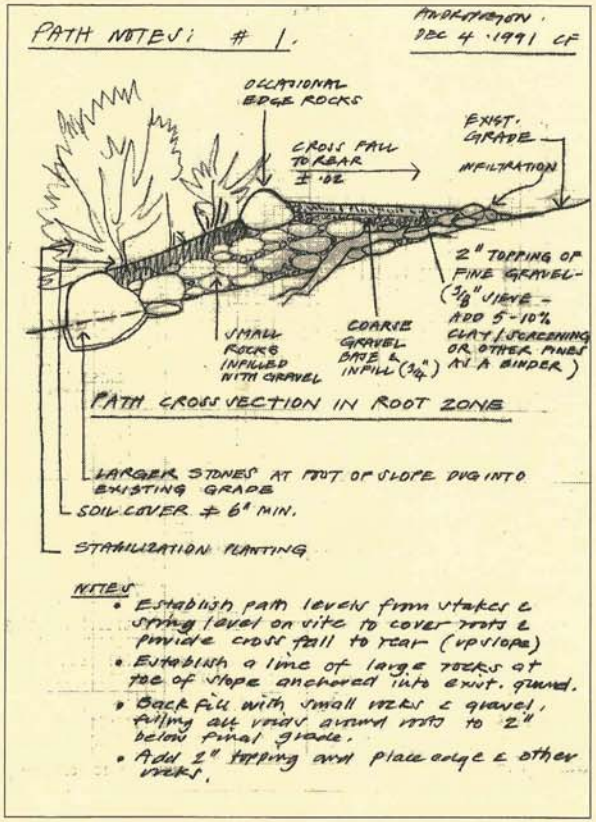
To preserve the natural beauty and wildness of the Wissahickon Valley and to stimulate public interest therein

SCHEDULE OF ACTIVITIES showing the number of participants at each work site

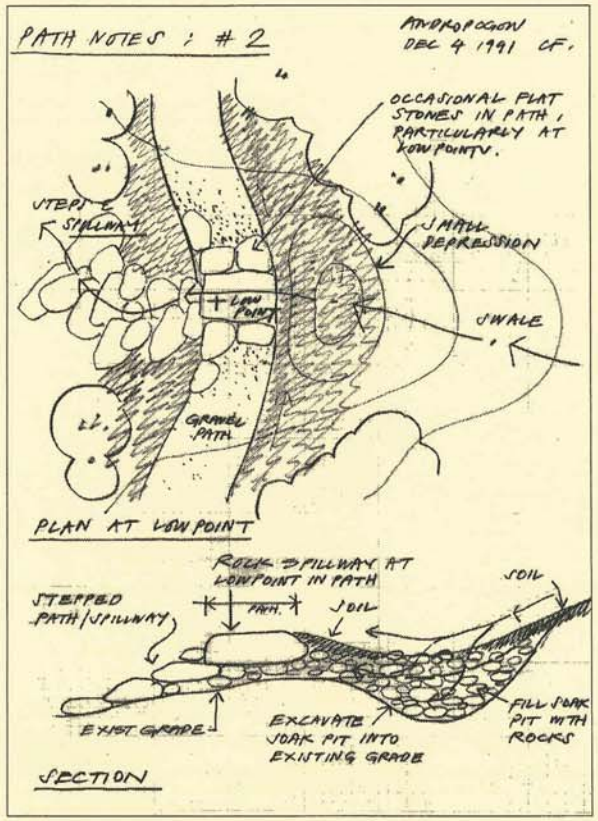
	9 - 10	10 - 11	11 -12	12 -1	1 -2	2 - 3	3 - 4
Stone Supply	8	8	8	8	8		
Fence Crew		12	12	12	12	12	12
Planting Crew	30	30	30	30	30	30	30
Log * Moving			16/2	16/2	24/2	16/2	
Site 1	4						
Site 2	4						
Site 3	8	8	8				
Site 4	6	6					
Site 5		8	8	8			
Site 6			12	12	12		
Site 7				8	8	8	
Site 8	6	6					
Site 9					6	6	6
Site 10	6	6	6	6	6	6	
Clean-up	6						6
Lunch etc.				4	4		
TOTALS	78	84	84	88	86	62	54
hours	9 - 10	10 - 11	11- 12	12 -1	1 -2	2 - 3	3 - 4

* not included in totals

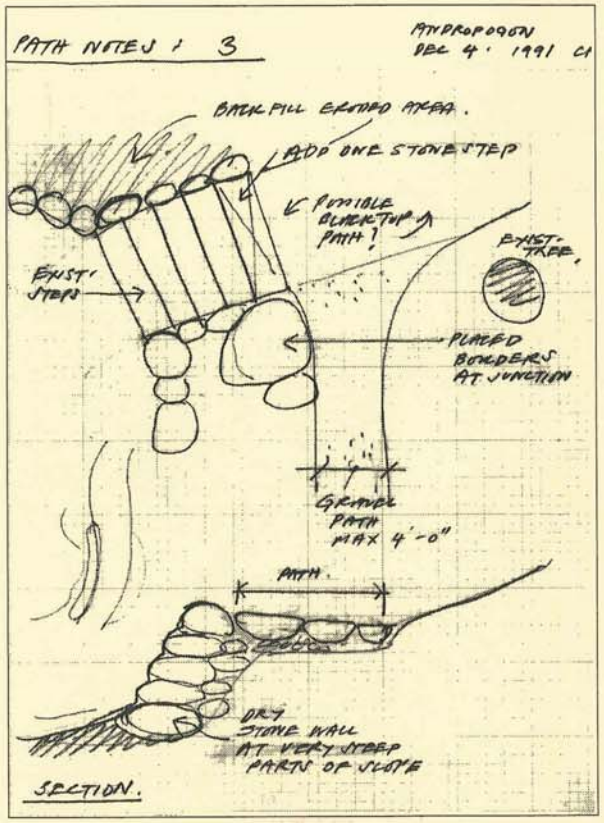
Schedule for volunteer trail repair crews by site and hours. (Ed Boyer, 1992)



On a cross-slope within the root zone of large trees, the path should be built up on the existing grade with small rocks and coarse gravel, taking care not to disturb existing grade or damage any roots. The path surface is formed of fine gravel sloped to rear. Drainage is maintained by infiltration through the stone and gravel base. Larger rocks are used to anchor the toe of the slope and provide occasional emphasis along the path. Path edge is completed with topsoil and planting.



In small valleys, where runoff is concentrated into a swale, form a spillway on the path with large flat rocks and line swale with rocks on the steeper banks until the slope lessens. If the topography allows, reduce flow above the path by providing small depressions with soak pits beneath for the detention and infiltration of water.



On steeper cross slopes, build up dry stone walls to support the path edge and reinforce the edges of steps. Drain path to rear and always backfill with small rocks and coarse gravel to provide drainage and prevent damage to dry wall by frost-heave. Use large stones for bottom of walls set into the existing grade. Do not cut existing roots for foundations but place rocks carefully around them.

Field sketches for path construction in three sensitive areas, drawn by Colin Franklin, Andropogon Associates, for the Central Park Conservancy's trail project in the North Woods, 1991.

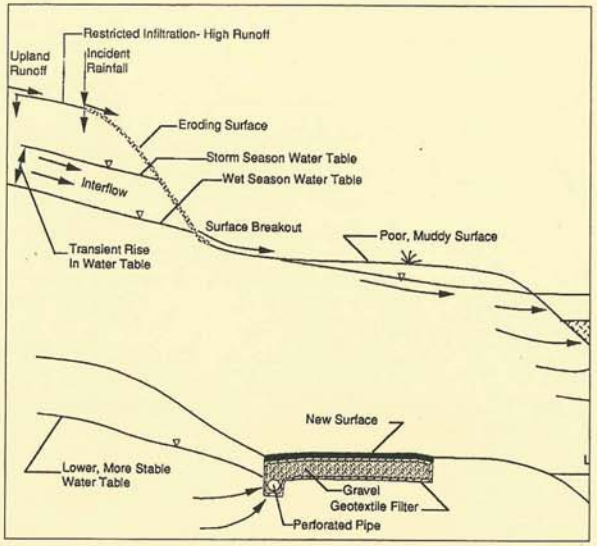
Examples of Trail Repair Projects

These are site-specific sketches of trail construction and repair projects with the intention of providing drainage facilities with the usual goal of keeping paths clear in storms and protecting their longevity, but doing so with as little impact as possible on the environment in which park vegetation grows, which includes minimizing erosion and stabilizing subsurface moisture in the root zone.

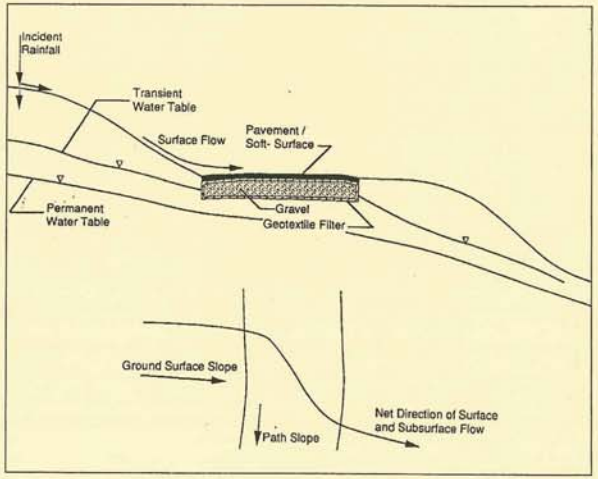
Sketches below were drawn by Colin Franklin, Andropogon Associates, to illustrate the aesthetics of vegetation management to heighten the experience of natural features along a woodland path.

A patch of ferns in a small clearing, as discovered. Removing brush and small trees will help to perpetuate the fern patch because the light, which was the reason for the ferns growing there initially, will remain. Removal of competing plants also encourages them.

The fern patch is revealed and becomes an important event along the path. The path curves around the fern patch to emphasize its form. The foreground is simplified to direct attention to the ferns. Small branches, fallen and dead stems have been removed to reveal many vertical stems, contrasting with the brilliantly lit horizontal patch of ferns.

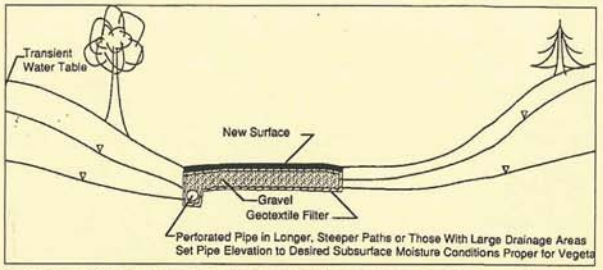


Waterlogged section of path near pond—(top) existing, (bottom) proposed.

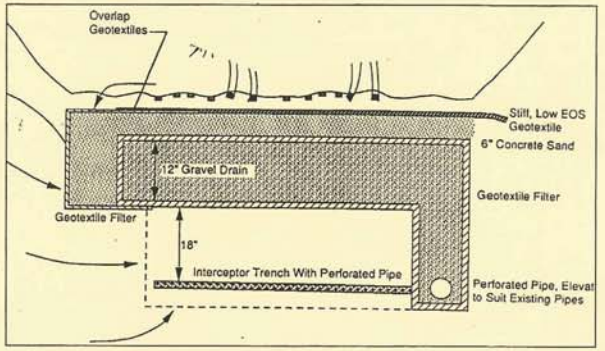


Use of geotextile filter to protect and use gravel base as cross drain in sideslope paths.

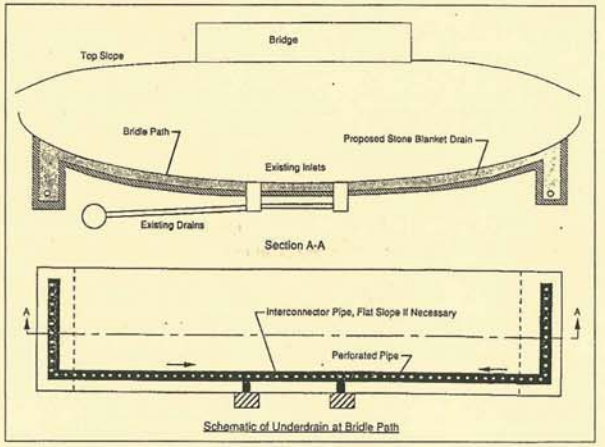
Diagrams prepared by Joseph P. Martin, P.E. and drawn by H. L. Rohde, for the Central Park Conservancy's path and bridle trail drainage studies, 1991.



Use of geotextile fabric to protect and use gravel base as cross drain in downslope paths.



Cross section of underdrain at low point on bridle trail.



Schematic of underdrain at bridle trail.