United States
Department of
Agriculture

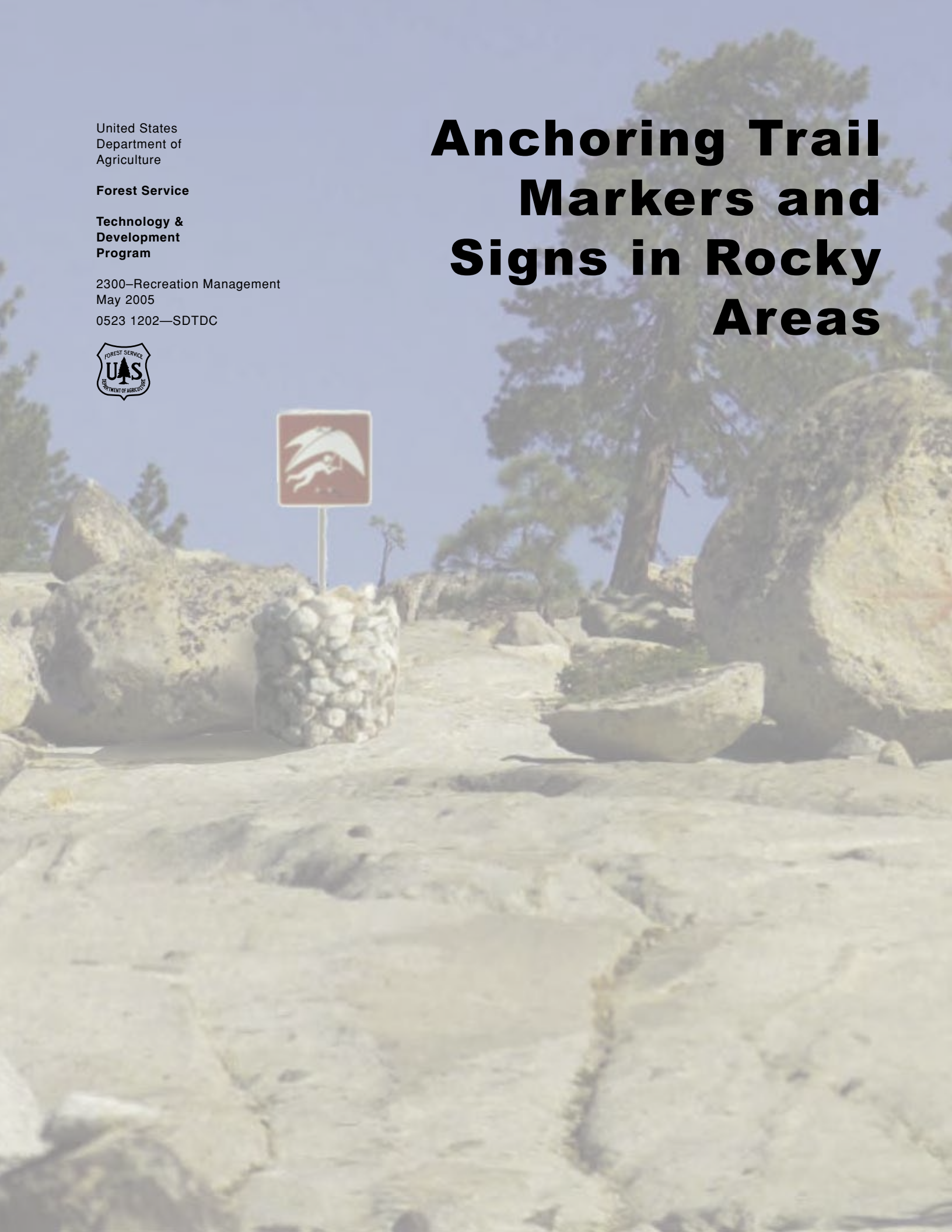
Forest Service

**Technology &
Development
Program**

2300–Recreation Management
May 2005

0523 1202—SDTDC

Anchoring Trail Markers and Signs in Rocky Areas



Anchoring Trail Markers and Signs in Rocky Areas

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May 2005

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BACKGROUND

Installing anchoring systems for trail markers and signposts in rocky backcountry terrain (figure 1) is difficult. In these settings, trails often wind through areas where only a small amount of soil covers the bedrock, making it difficult to install markers. Prior to having anchoring systems, recreation trail crews and hikers erected cairns (stacks of rocks to mark trails) (figure 2) along some trails where the path was not obvious or marked with directional arrows. Although useful during daylight hours, cairns are not easy to distinguish in twilight or darkness. They are also easily dismantled. Cairns and directional arrows, as well as other temporary solutions, require regular maintenance to maintain their usefulness.

Figure 1—Rocky backcountry terrain.

Figure 2—Cairn.

To help recreation crews install permanent trail markers, the San Dimas Technology and Development Center (SDTDC) investigated and developed design criteria for effective anchoring systems. This publication provides instructions, with materials lists, for installing trail markers and signposts that meet the SDTDC-developed design criteria, under varying conditions, without the use of heavy tools and equipment.

DESIGN CRITERIA

SDTDC developed the following criteria for anchoring trail markers in rocky areas. The components to build the anchoring system must meet the following design criteria:

- Available at local hardware stores or building material suppliers.
- Easy for one or two people to assemble and install in field conditions.
- Inexpensive and easy to repair and maintain.
- Structurally sound and vandal resistant.
- Lightweight for backpacking or handcarrying to the site.

CURRENT TECHNOLOGY

SDTDC conducted a literature search to find existing anchoring systems based on the design criteria. No General Services Administration anchoring systems met the design criteria. Some commercial hardware components fit the design criteria with structural modifications.

APPROACH

SDTDC recreation personnel developed four types of anchoring systems. Each system was tested in the field, met the design criteria, and was installed with manual or power-assisted tools. Manual tools are appropriate for primitive backcountry settings and battery-powered tools are appropriate in areas where the use of mechanical tools is unrestricted.

TOOLS

Manual Tools (figures 3, 4a, 4b, and 4c)

The star drill is the most common handtool. It is available in many sizes and lengths, and requires no assembly and only occasional sharpening. Newer drills may have a drill bit holder with a locking setscrew mechanism that uses a 1/8-inch Allen hex key to change bits. Some models come with a sticky, nonslip-protected grip that absorbs shock and improves safety.

Using a manual star drill requires a star-drill bit, a blow tube, a 24-ounce hammer (minimum), and muscle. Place the tip of the drill bit in contact with a piece of rock. Strike the top of the drill bit with the hammer while maintaining contact with the rock. Rotate the drill bit after each strike of the hammer. When drilling is complete, remove any debris and dust from the hole using a blow tube or a drinking straw. Use appropriate safety gear such as gloves, eye protection, or other items identified by the job hazard analysis.

The star-drill method is slow, and depending on the rock type, the drill bit may fail before the desired depth is reached. It took an average of 30 minutes for a star drill to penetrate 1 inch of igneous rock (under test conditions).

Figure 3—Rock drill tools.

Figure 4a—Star drill.

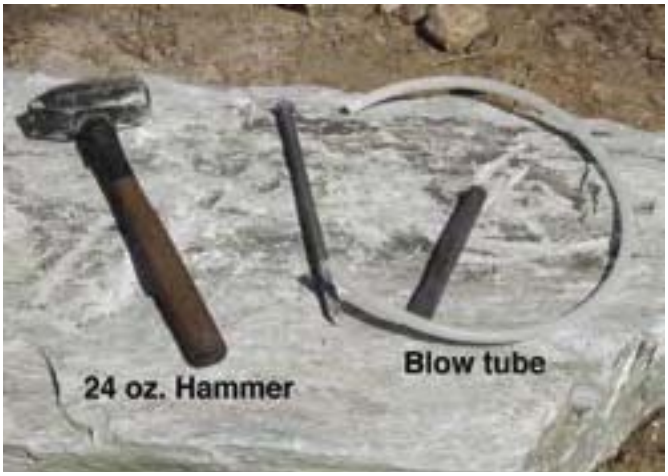

Figure 4b— Assemblage of installation tools.

Figure 4c—More tools.

Battery-Powered Tools

Several powerful cordless drills offer a portable alternative. For example, the cordless Bosch 24-volt Rotary Hammer performed well during the installation of several anchoring systems in a variety of rock types. Although cordless drills can penetrate rock quickly, the drill must have a fully charged battery. It is imperative to carry extra fully charged batteries when working in remote or backcountry areas. Typically, it takes 1 minute per inch to drill a ⅝-inch-diameter hole and 1 minute per 2-¾ inches to drill a ⅜-inch-diameter hole.

ANCHORING SYSTEMS

The rock basket shown in figure 5 is the least complex of the four anchoring systems developed in this report. The other three SDTDC-developed anchoring systems (in order of increasing complexity) are the stake anchor (figure 6), holddown anchor (figure 7), and the metal-post base anchor (figure 8).

Figure 5—Rock basket.

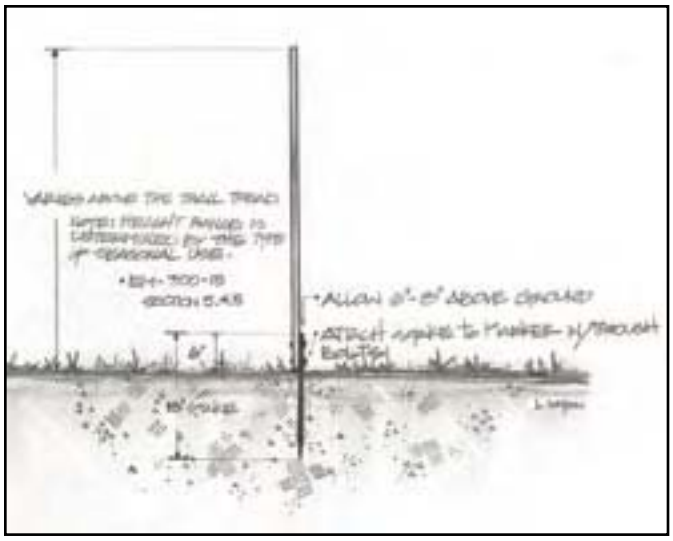

Figure 6—Stake anchor.

Figure 7—Holddown anchor.

Figure 8—Metal-post base anchor.

Rock-Basket Anchoring Systems

Figure 9—Ice Bed Trail, Green Mountain National Forest, VT.

The rock-basket anchoring system is useful in cobbled soils, lava fields, and areas with exposed rock covered by a thin soil layer as in figure 9. This system relies on the rocks' mass to resist overturning. A galvanized or sheet metal baseplate is secured to the marker or post; welded wire mesh is fit around the baseplate to make a basket; and the basket is filled with loose rock. For additional support, use sand, native soil, cement, or gravel to fill the voids between the rocks. Cut all components to size before installation.

Welded wire mesh, commonly known as hog wire, comes in many configurations, gauges, and sizes. Rock type and size dictate which wire to use; however 2- by 4-inch wire mesh works well for most installations.

Sizing Guide

The size of a rock basket can be determined using the diagram shown in figure 10. Assume the height of a marker is 4 feet and the resisting force is 200 foot-pounds if force is applied at a height of 4 feet, then F= 50 (200/4). By limiting the height of the basket to 20 inches (h = 20 inches) solve for the basket diameter, d. Use the chart in figure 11 to select the basket size. If a basket height of 20 inches is chosen, the basket diameter is 17 inches if gravel is used to fill the voids. If the height is reduced to 14 inches and the fill material remains the same, the resulting diameter is 19 inches. If your load conditions exceed 200 foot-pounds, contact the engineering staff for additonal sizing assistance.

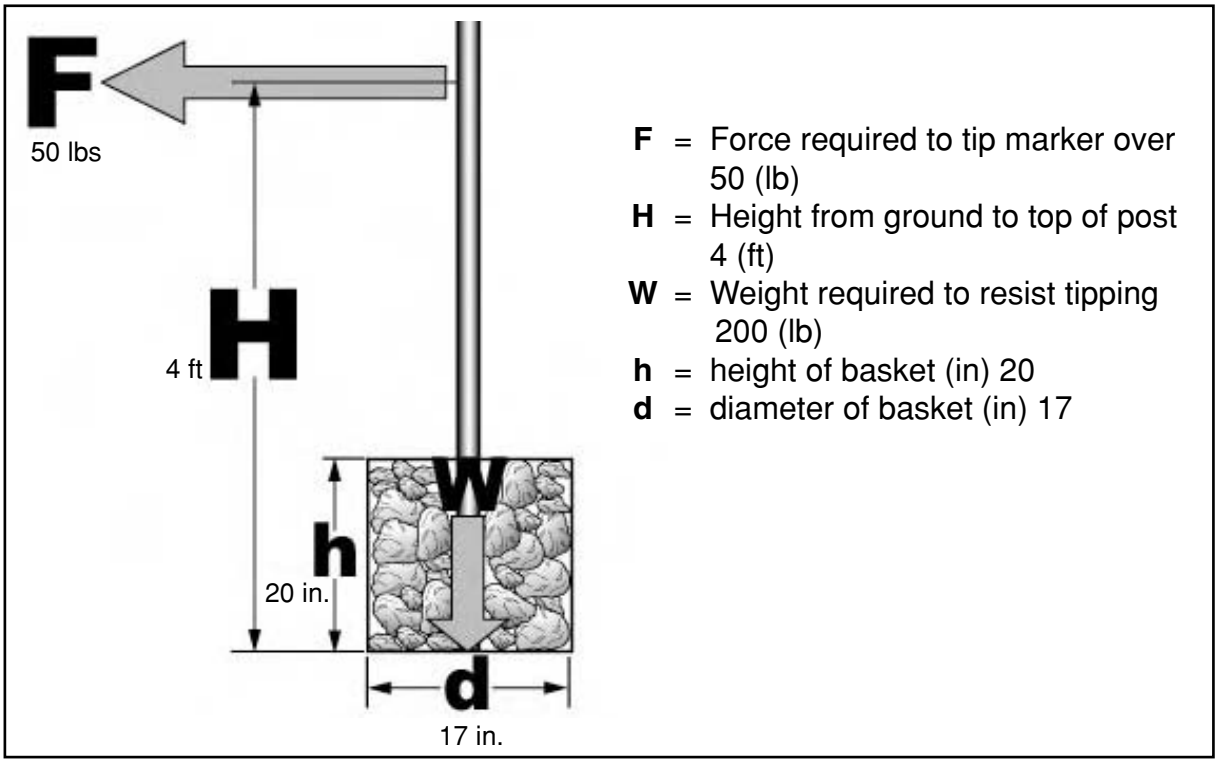

Figure 10—Diagram for sizing rock baskets with an overturning moment of 200 foot pounds.

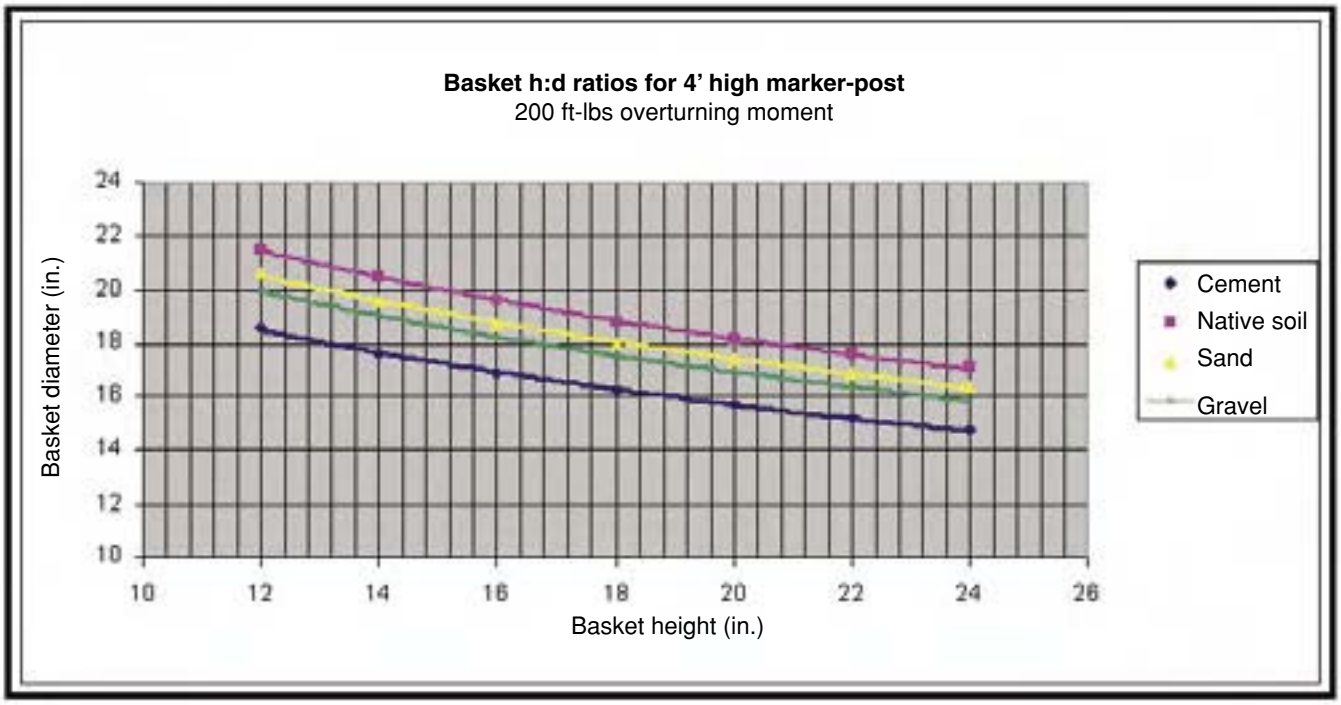

Figure 11—Chart to determine basket height.

Rock-Basket Signposts or Trail Markers

The rock-basket baseplates for signposts are made of ⅛-inch (10-gauge) or heavier steel. Baseplates for trail markers use 18-gauge or heavier galvanized sheetmetal. Predrill the plate to fit the flange hardware. A square baseplate is easiest to cut, although a round plate is equally effective. Fabricate the baseplate in two sections and hinge together. Hinges make the plate easier to transport in a backpack (figures 12 and 13).

Figure 12—Split and hinged baseplate.

Figure 13—Split and hinged baseplate with pipe-flange connection.

Figures 12 and 13—These photos show a split-and-hinged baseplate with a pipe-flange connection for a signpost. The plates were predrilled to fit the 1½-inch pipe flange that secures the pipe to the base. The split-and-hinged baseplate design conserves space while in transit.

Use the basket diameter values obtained from figure 11 to determine the component sizes for the baseplate.

Signpost Parts List

Use galvanized steel material and hot-dipped galvanized hardware to avoid rust (if possible). Galvanized steel material includes:

- 2- by 4-inch wire mesh (see figure 11 to determine size).
- ⅛-inch steel plate (see figure 14 to determine size).
- 2- by 2½ by 5⁄16-inch U-bolts (2).
- 1½-inch galvanized steel pipe flange (1).
- 1½- by 60-inch steel pipe; threaded on one end. (1) (Shorter sections threaded on both ends with couplings can replace a single 60-inch section. Secure short sections with plumber's epoxy.)
- ⅜- by 1-inch cap screws with nuts and flat washers (4 each).
- 2- by 6-inch square U-bolts (2) [optional].
- Blank steel hinges (2) [optional].
- ½- by 18-inch threaded pipe (4) [optional].
- ½-inch pipe caps [optional].

Nongalvanized material includes:

- 2- by 2- by 12-inch square wood stock (2) [optional].

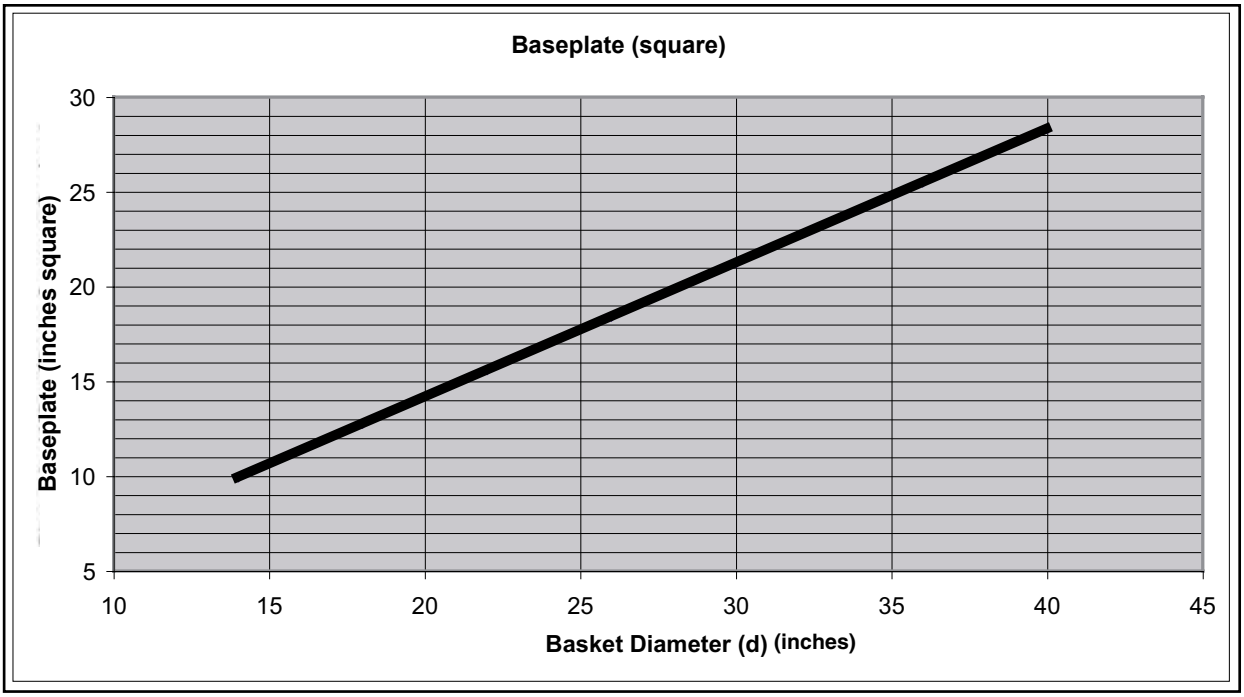

Figure 14—Determining the proper baseplate size.

Signpost Installation

1. Predrill the baseplates to fit a 1½-inch pipe flange.

2. Level the underlying area with sand, native soil, or crushed rock (figure 15).

3. Attach the pipe flange to the baseplate with ⅜-inch cap screws (figure 16).

4. For additional security: (optional)

   a. Stake baseplate (figure 17).

   b. Clamp two pieces of 2- by 2-inch wood to the pipe with square U-bolts, or apply plumber's epoxy to the threads (figure 18).

5. Thread the signpost into the flange.

6. Assemble wire mesh around the baseplate assembly (figure 19).

7. Fill the basket with large rocks to hold the signpost in place (figure 20).

8. Fill the voids between the rocks with cement, sand, native soil, or gravel (figure 21).

Figure 15—Rock basket fabrication materials.

Figure 16—Attaching the pipe flange to the baseplate.

Figure 17—Staking the baseplate.

Figure 18—Using wood blocks to secure the pipe.

Figure 19—Fabricating the wire basket.

Figure 20—Basket filled with rocks.

Figure 21—Completed rock basket for signpost.

Trail-Marker Parts List

- 2- by 4-inch wire mesh.
- ⅛-inch steel plate.
- Angle bracket.
- Bolts, nuts, and washers or rivets.

Trail-Marker Installation

1. Attach the trail marker to the base using an angle bracket (figure 22).
2. Assemble the wire mesh basket around the marker and baseplate (figure 23).
3. Place the entire system in the desired location along the trail.
4. Fill the basket with rocks large enough to hold the marker securely in place (figure 24).

Over time, nongalvanized wire weathers and visually recedes, creating a natural look in most settings.

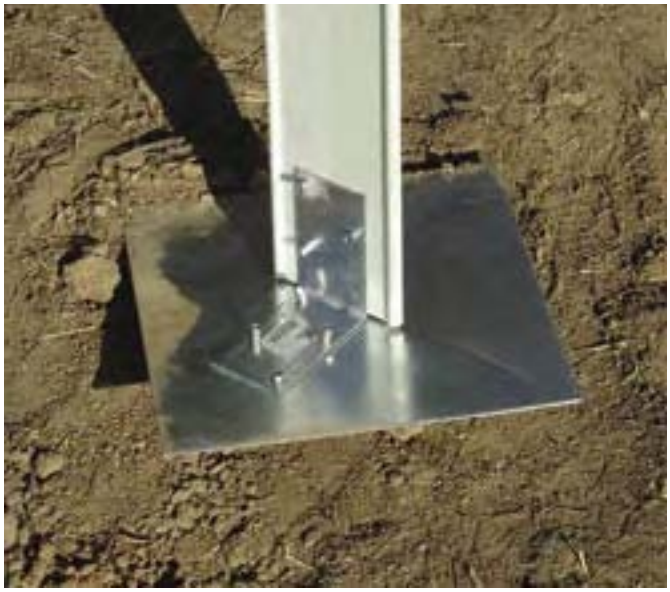

Figure 22—Attaching the trail marker to the base with angle brackets.

Figure 23—Rock basket prior to adding rocks.

Figure 24—Completed rock basket for trail marker.

Stake Anchor

In some cobbled soils, heavy steel stakes offer a durable alternative. Steel stakes made of 1¼- by ⅜-inch steel are available in assorted lengths at major commercial supply outlets. Predrill the stakes to fit the marker and remove the tip of the marker before installation. See the *Sign Installation Guide*, 0371-2812-MTDC, for suggested trail-marker heights.

Figure 25—Steel stakes.

Trail-Marker Parts List

- 18-inch steel stake (figure 25).
- ¼- by 1½-inch bolts, nuts, and washers.

Trail-Marker Installation (figure 26)

1. Drive the stake into the rocky soil leaving 6 inches of the stake exposed above ground before attaching the stake to the marker. Ensure that the stake is straight before attaching the marker. For additional stability, remove the stake and apply a quick-setting, expanding grout in the hole. Before the grout sets, reinsert the stake into the hole, allowing the grout to completely set around the stake.

2. Attach the marker to the stake with ¼- by 1½-inch bolts after the stake is in place.

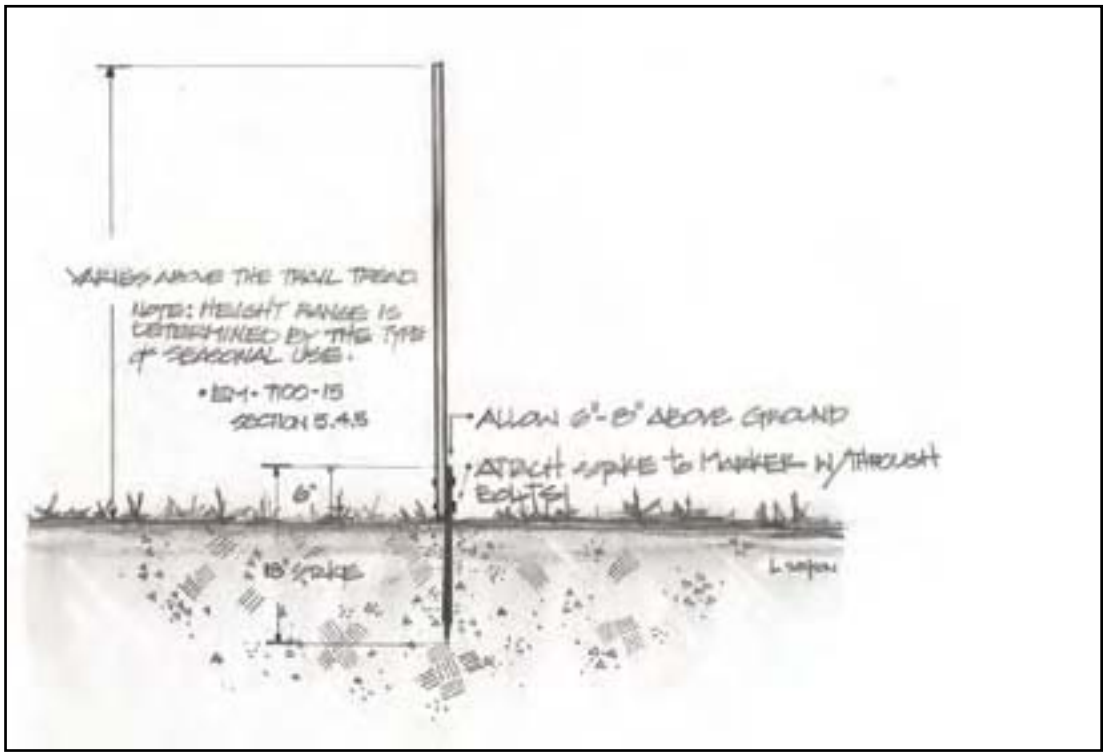

Figure 26—Schematic of trail marker installation.

Holddown Anchor

In situations where trail markers and signs are installed in rock, a holddown anchoring system offers a durable and inexpensive alternative. If the trail marker is predrilled, then attach to the holddown with two machine bolts.

Holddown Anchor for Trail Marker

Trail-marker parts list (figure 27).

- Holddown.
- Anchoring cement.
- Cement trowel.
- Water.
- Cement mixing bucket.
- Drill (cordless drill or star drill and hammer).
- Wedge anchor.
- Mallet.
- 1½-inch machine bolts (2).

Figure 27—Supplies for holddown anchor installation.

Trail-Marker Installation (figures 28 and 29)

After drilling a hole to the desired depth, insert a wedge anchor. If needed, drive the wedge anchor into the drilled rock with a mallet. Ensure that the threaded end of the anchor shaft is covered with a nut or piece of wood before striking with a mallet. To set the anchor after it is embedded in the hole, place a washer beneath the nut, torque to the manufacturer's recommended value, and then remove the nut and washer. The anchor is now ready for use.

In most locations, the rock surface is not smooth or level enough to form a steady base for the connecting bracket. Use anchoring cement to form a level base. Quick-drying anchoring cement is available at most hardware stores; it requires very little water and hardens in 10 minutes. Only a small amount is required at each marker location. Refer to the manufacturer's mixing instructions to determine how much water is needed.

Figure 28—Anchor installation.

Figure 29—Completed anchor installation.

Holddown Anchor for Signposts (figure 30)

Holddown anchors also work well to secure signposts to large boulders or rock outcrops.

Signpost parts list

- Holddowns (2).
- Anchoring cement.
- Cement trowel.
- Water.
- Cement-mixing bucket.
- Drill (cordless drill or star drill and hammer).
- Wedge anchors (2).
- Mallet.
- ¼- by 4½-inch carriage bolts (2)

Figure 30—Holddown anchor installation.

Signpost Installation

Prepare the rock surface before installing the signpost by ensuring that the surface is clean and level. Use anchoring cement to form a level surface.

Follow the steps for installing trail markers using holddowns for general installation information. Remember to include the measurements for a 4- by 4-inch post between the two holddowns.

Metal-Post Base Anchor

Another commercial product suitable for field use is the metal-post base system. This system is commonly used in a variety of adaptations to allow a vertical member to resist force when applied in wood and concrete construction.

Over-the-counter metal-post base components tend to fail when lateral forces exceed the design capacity. Some of these systems are viable alternatives if vandals and high winds are not a threat. Read the manufacturer's design data and installation information before using a commercial system.

SDTDC developed and tested a metal-post base system for high-wind conditions.

Figure 31—Commercial display of post caps and bases.

Figure 32—Metal-post base installation materials.

Parts list **(figures 31 and 32)**

- 4- by 4-inch steel tubing.
- Steel plate.
- ½-inch bolts.

Installation **(figure 33)**

Drill holes on each side of the steel tubing to allow two threaded bolt screws to pass through the signpost and the metal base. Weep holes are located at the base to allow drainage and air circulation. SDTDC designed this system with adjustable setscrews to compensate for varying slopes and angles on some rock surfaces.

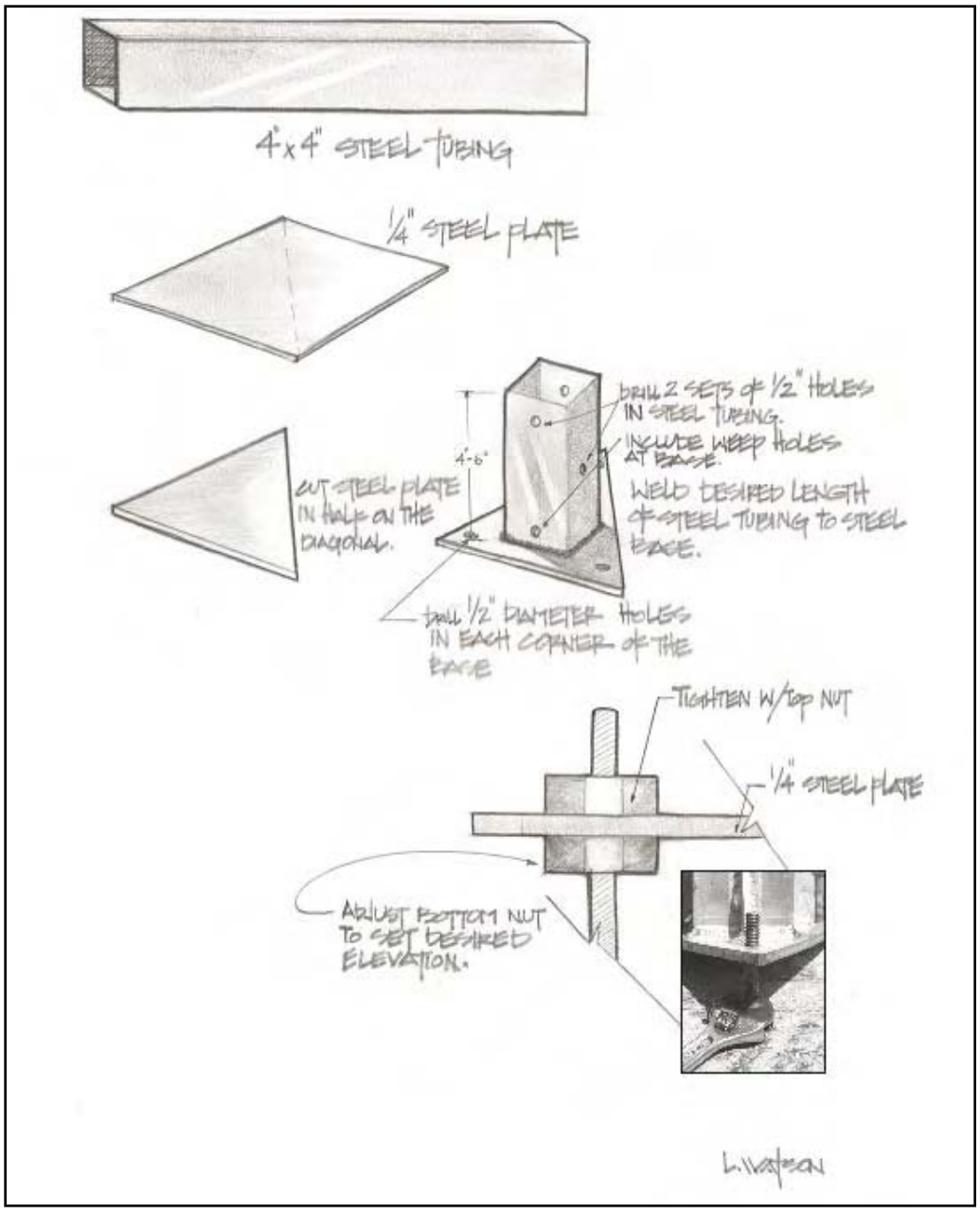

Figure 33—Fabrication drawing of metal-post base installation.

SUMMARY

SDTDC's investigations found that many variables best dictate the anchoring system for a project's needs. Recreation personnel using the materials and installation instructions discussed in this publication will find that they are able to install trail markers in rocky areas without the use of heavy tools and equipment and have them remain in place under varying conditions.