

USDA United States
Department
of Agriculture

Forest Service

Rocky Mountain
Research Station

General Technical
Report RMRS-GTR-64

September 2000



Constructing Temporary Sampling Platforms for Hydrologic Studies

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Abstract

Martinez, Manuel H.; Ryan, Sandra E. 2000. Constructing temporary sampling platforms for hydrologic studies. Gen. Tech. Rep. RMRS-GTR-64. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 10 p.

This paper presents instructions for constructing platforms that span the width of stream channels to accommodate the measurement of hydrologic parameters over a wide range of discharges. The platforms provide a stable, safe, noninvasive, easily constructed, and relatively inexpensive means for permitting data collection without wading in the flow. We have used the basic techniques described herein for building platforms on channels of small to medium size, up to 70 feet in width. Lightweight joists, commonly used in housing construction, form the primary structural support for the platform. The structures can be constructed by persons having only rudimentary knowledge of building practices and using simple tools. Cost estimates for materials range from \$200 to \$1,500 depending on the required length of structure. The platforms have been used successfully in measuring flow and sediment discharge in subalpine channels in Colorado and Wyoming during runoff events with 2 to 5 year return frequencies. They are quite stable and are safer than wading in channels with fast moving flow.

Keywords: hydrologic measurements, sediment measurements, mountain streams, safety

Acknowledgments

Many useful comments concerning organization and clarification of earlier versions of this technical report were provided by John Buffington, Mark Dixon, Sue Hilton, Dan Marion, and Mike Solomon. We also acknowledge financial and logistical support provided by the Stream Systems Technology Center, Fort Collins, CO.

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Constructing Temporary Sampling Platforms for Hydrologic Studies

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Introduction

Land managers often need information on flow and sediment transport to evaluate the impacts of changing regime on channel processes, morphology, and aquatic habitat. A typical sampling scheme involves collecting sediment or measuring flow characteristics (depth, velocity, turbidity, and so forth) from many points within a cross-section, which may require wading in strong, deep currents during high flows—a particularly onerous task prone to error and safety problems. More specifically, wading may alter the dynamics of water movement in the area of collection, thereby affecting measured values and conclusions drawn from them. Sediment may be kicked up or disturbed by wading, altering the relationship between measured sediment and flow. From a safety standpoint, rivers undergoing high flow and intense transport are dangerous and often impossible to traverse safely. It is therefore advisable to collect samples without wading to eliminate the potential for sampling error and to assure the safety of the person collecting samples.

Collecting samples from vehicular bridges is one way to reduce problems introduced by wading. However, bridges are not always in desired locations, particularly in pristine mountain environments where there are few roads. Additionally, flow conditions in the vicinity of bridges are often altered by reduced channel width or through abutment placement during construction. Smaller footbridges may be used if in suitable locations, though high handrails on these structures may make it difficult to collect samples. Construction of new footbridges may disturb the riparian area, alter the shape of the channel and banks, and may be more permanent than necessary. What is needed is a temporary, stable, safe, noninvasive, easily constructed, and inexpensive means of spanning the channel in order to take measurements without wading in the flow.

We describe in this paper the design and construction of platforms that span the width of streams for the purposes of making stream measurements during high runoff. We have constructed about 20 of these structures on streams ranging from 15 to 70 feet in width. Most sites are within the subalpine environment

of Colorado and Wyoming where total annual flow is dominated by the influence of snowmelt, and so the flow rarely exceeds the banks by more than a few inches in most years. The platforms have been used successfully to aid in measuring flow and sediment during runoff events with 2 to 5 year return frequencies. The structures were fabricated using steel bar joists or TJI[®] joists¹ (as used in housing construction), plywood, and 2 x 4s. Either two or three joists are used to form the primary structural component of the platform; three joists are used to construct wider platforms that are needed when a structure is longer than about 40 feet. The plywood deck and 2 x 4 cross-members provide lateral stability and a surface to walk on. The structures are relatively inexpensive and can be assembled onsite in less than a day by those with only basic knowledge of construction practices. No heavy equipment is needed for assembly, thus minimizing disturbance to the riparian area. They may be used for a number of years on a seasonal basis and require minimal maintenance.

Platforms Constructed From Bar Joists

The earliest versions of our sampling platforms were constructed from steel bar joists obtained from construction salvage. Six platforms on St. Louis Creek on the Fraser Experimental Forest, near Fraser, CO, were constructed using these heavy supports (fig. 1). They were assembled by four persons and have been in place since 1993. The structures are still usable, having withstood particularly heavy snowloads in 1995, 1996, and 1997. The main difficulty with platforms constructed from bar joists is that the supports are heavy, requiring many persons to haul to the site; the size of the platform is, therefore, limited to that which may be packed in. Once in place, they are not readily removed and so are more permanent than what may be desired.

¹ These joists are used in construction for floors and roofs. Use of the joists for sampling platforms may not be an approved use of the supports by the manufacturer.



Figure 1—Platform constructed using steel bar joists at a site on St. Louis Creek, near Fraser, CO.

TJI® DF Joist Platforms

We began constructing platforms from TJI® joists instead of bar joists in 1996. The TJI® joists are sturdy, lighter in weight and more easily handled by workers; a 40-foot section of joist requires only three to four people to move into place. The platforms are removed at the end of the season or before winter because there is potential for breakage due to heavy snowloads on these lighter structures.

There are several manufacturers of TJI® joists. We used TJI®/35 DF Joist and TJI®/55 DF Joist manufactured by Trus Joist MacMillan (fig. 2 shows the ones we used plus other sizes available). Regardless of manufacturer, there are building guides and installation information on the manufacturer's specification sheets that can be consulted to determine the appropriate size of joist to use. Joists can be ordered by the foot in a variety of depths; we used 16 inch deep joists on our platforms. There was, however, a 40 foot limit on the length of joist that could be transported in one piece to our remote sites. While it is generally recommended that one avoid splicing the ends of the joist, we have used splices to create structures up to 75 feet in length; we describe this in more detail later. Construction of the sampling platforms over substantially wider channels has not been attempted and will likely require structural engineering support. We suggest using cableways to deploy samplers in swift flow in streams wider than 70 feet (Paradiso 2000).

Site Selection

The primary consideration in selecting a site is to establish the cross-section in a location suitable for the intended measurement. For example, the platform and cross-section should be located in a relatively straight stretch of channel for measuring bedload samples. The banks in the area should be stable, as identified by vegetative growth (grasses, herbs, and sedges) and absence of cracks or raveling faces. Banks are rarely overtopped in our snowmelt streams and so they provide a suitable base for the platform. To determine the length of joists required, measure the distance between the two edges of bank where the break in slope occurs (the height of the banks across the channel do not need to be even). This is the maximum width of the channel to be sampled (fig. 3). A minimum of 4 feet is then added to this value to obtain the length of the joists needed. In areas of where there are sloping or less-well defined banks, a minimum of 6 feet should be added to the measured width of the channel. This permits greater flexibility in the placement of the platform in channels with uneven banks. The joists may be trimmed should the length be excessive.

Supplies

The supplies needed for a typical platform constructed from two TJI® Joists and 2 x 4 lumber (shown in fig. 4) are listed below; this list is for a platform that

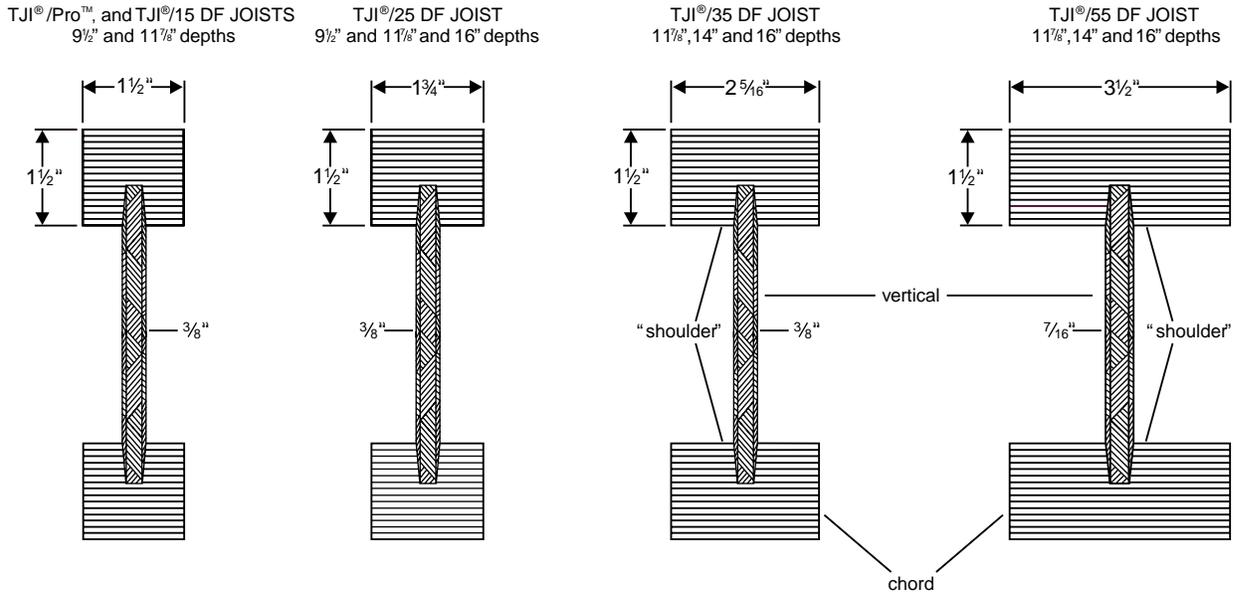


Figure 2—Some types of TJI® joists that are available; the drawing is based on specification sheets from Trus Joist MacMillan. Chord refers to the pressed wood support along the top and bottom of the joist. Shoulder refers to the interior portion of the chord where pressed particle board (the vertical) connects to the chord.

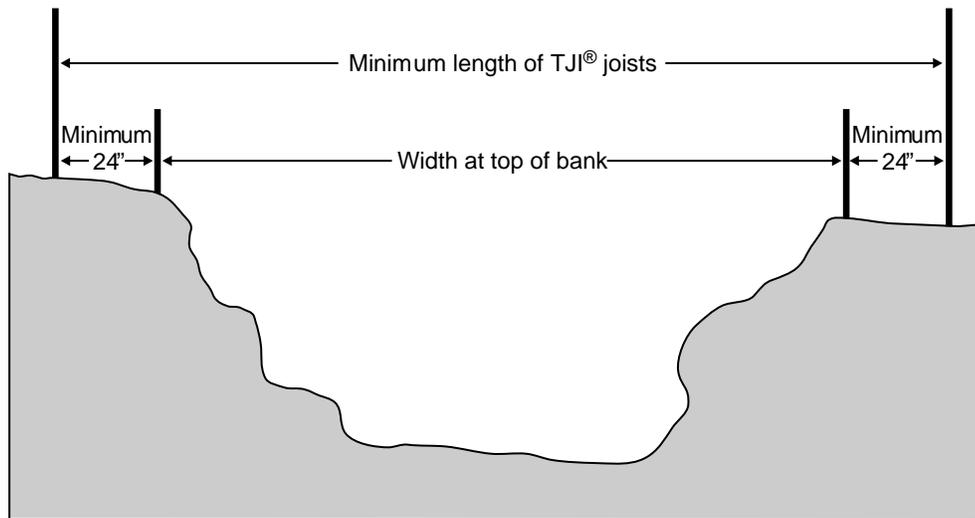


Figure 3—Field measurements needed to determine length of platform required.



Figure 4—An example of platform frames constructed using 2 x 4 lumber as spacers. Most of the construction for smaller platforms (15 and 24 feet shown here) can be done off-site because the frames are light enough to be carried to the site by two to three persons.

is 2 feet wide and less than 40 feet long. Material amounts will vary depending on the desired size of the platform. Hence, the total cost of a platform depends on the size of the structure plus available tools on hand. We determined that the costs for materials and hardware ran typically between \$500 (two joist supports) and \$1,500 (three joist supports).

Materials:

- 2 joists of same length and series, minimum of 16 inches deep
- 3/4 inch CDX grade plywood in 2 x 8 foot pieces—enough to equal total length of structure
- 2 x 4 lumber, cut to lengths so that the joists are spaced for a 2 foot wide platform (length will vary depending on joist dimensions selected)
- Several pieces of lumber of varying thickness (such as 4 x 4 and 6 x 6 inches) but at least 2.5 feet in length to construct sills
- Paint (preferably brown or green to blend with environment)

Hardware:

- Screws 2 to 3 inches long (high twist, coated deck screws work well)
- 1/2 inch bolts (6 inches long), washers, and nuts

3/4 or 1 inch rebar, 18 to 24 inches in length to stabilize sills

Tools:

- 2 or more hand-held drills with re-chargeable batteries
- Drill bits—1/2 and 3/4 inch plus other sizes as needed
- Carpenter's level
- Hammer
- Wrenches
- Sledge hammer
- Portable generator (needed if cutting plywood and spacers in field)
- Circular saw (needed if cutting plywood and spacers in field)

Other:

- Waders for assemblers
- Eye protection

For platforms longer than 40 feet we use three joists to construct a structure 3 feet wide. The spacers are cut to fit between the three joists so that the total width at the top of the platform equals 3 feet. Plywood is cut into 3 x 8 foot sections. We have also used rectangles cut from plywood as joist spacers (fig. 5)



Figure 5—Plywood rectangles are used as spacers on this 3 x 60 foot platform on South Fork Cache la Poudre, near Fort Collins, CO.

instead of 2 x 4s (fig. 4). The plywood spacers add less weight to the structure, which is important when constructing longer platforms.

General Strategy

Construction material may be cut, painted, and predrilled at an off-site work station and hauled to the site. Alternatively, some companies will deliver supplies to remote locations for moderate cost, which is worth investigating if one doesn't have access to a truck and trailer. In the latter case, construction materials must be prepared in the field and so a generator and circular saws are needed for cutting plywood and spacers onsite. Wood pieces should be primed and painted, preferably a neutral color, to help preserve and maintain the condition of the platform, as well as reduce attention to the structure from forest users. Platforms are assembled and disassembled

during low flow because the channel must be waded during construction. The structure is assembled over the channel, so all of the assembly work must be done using battery-powered or hand tools. The sequential order of construction onsite is:

- Prepare the site
- Splice the joists (if necessary)
- Move the joists into position over the channel
- Assemble the frame of the platform using spacers
- Cover the top of the structure with plywood
- Stabilize structure

Site Preparation

Site preparation involves clearing vegetation from the area near the stream cross-section and bank excavation for sills, if needed. Sills are the base upon which the structure rests and are formed from 4 x 4 inch or 6 x 6 inch pieces of treated lumber (fig. 6 and 7). The platform feels wobbly without the sills, due mainly to the instability of the bank under the joists. Different sized pieces of lumber may be needed where there are differences in bank heights; the elevation at the top of the sills on either side of the channel should be the same so that the platform is level. Excavating and placing sills into sloping banks helps stabilize their position and prevents them from slipping. Steel reinforcement bars (or rebar), $\frac{3}{4}$ or 1 inch in diameter and 18 to 24 inches in length, are driven through holes drilled into the sill and into the ground using a sledge hammer to prevent the sills from shifting.

Splices

The splice support is created from two 8 foot lengths of $\frac{3}{4}$ inch plywood cut to the depth of the joist (16 inches); one section of plywood is placed on both the inside and outside of the splice. The plywood overlaps the ends of the two joists by 4 feet and is bolted through the joist vertical using 6 inch carriage bolts and $1\frac{1}{2}$ x 10 inch steel plating (fig. 7 and 8). The ends of the bolts should face the interior of the platform to prevent catching on clothing or interference with instruments. The splices are staggered at different locations on the joists over the length of the structure so that there is no point that is less stable due to presence of two or more splices (fig. 7).

Joist Placement

A crew of three to four persons is needed to move the joists into position across the channel; the ends of the joist rest on or overlap the sills. Joists should be positioned so that they are roughly 24 inches apart and 18 inches downstream from desired sampling cross-section.



Figure 6—Platform (3 x 24 feet) resting on sill at Silver Creek, near Wolf Creek Pass, CO.

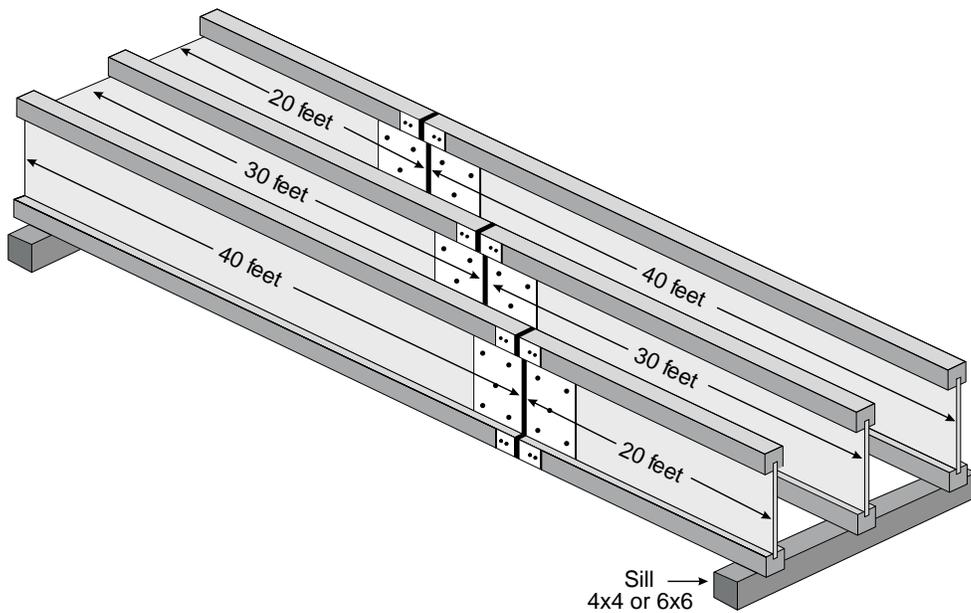


Figure 7—An example of lengths of joists and splices used in constructing a platform 60 feet in length. Note that the positions of the splices are offset across the frame of the platform.



Figure 8—One of the 8 foot splices on a platform (2 x 48 feet) at Little Granite Creek near Jackson, WY. Note the metal plate (above the bent knee of the worker) used to add strength to the chord at the point where the two joists are joined.

Assembly Instructions

The shell of the platform is formed using spacers between the top and bottom chord of the joists (fig. 9). Plywood rectangles, cut to fit the inner dimensions of the platform, or 2 x 4 pieces of lumber are used as spacers. The spacers rest on the inner side of the shoulders or are fitted into the space between the top and bottom chord. They are attached using two to three wood screws drilled into the edge of the spacer through the vertical portion of the joist. Spacers are placed 18 inches apart (on center). When using 2 x 4s (fig. 4), the second piece of lumber is placed under the shoulder of the top chord and attached; alternating between the top and bottom chords adds lateral stability and prevents the joists from twisting. The frame of the structure is complete and stable once the spacers are in place.

Plywood Top

The entire surface of the structure is covered by plywood laid end to end so that the plywood edges are flush with the edges of the joists and there are no gaps (fig. 10). Plywood is attached using wood screws drilled from the top of the structure into the top of the joist; the screw head is countersunk slightly to avoid catching clothing or tripping while sampling.

Stabilizing Structure

While the weight of the structure is sufficient to prevent the completed platform from moving during typical use, there is potential for the structure to slip off the sill. To prevent separation at the sill-to-platform contact, the platform is directly attached to the sill using several 6 inch carriage bolts (and washers) drilled through the bottom shoulder of the joist into the top of the sill. The entire structure may be cabled to a nearby tree to ensure its retention if flows are unexpectedly high.

Safety Precautions and Limitations

Our experience with these platforms has generally been limited to smaller channels in the subalpine environment of Colorado and Wyoming where flow rarely exceeds channel banks by more than a few inches during peak discharge. These channels are easily waded during low flows, facilitating straightforward construction of the platforms. Furthermore, channel banks are generally stable and distinct and the area of inundation is well defined. While platforms such as those described herein are useful under these environmental conditions, they may be unsafe in channels with less predictable flow or unstable ground.

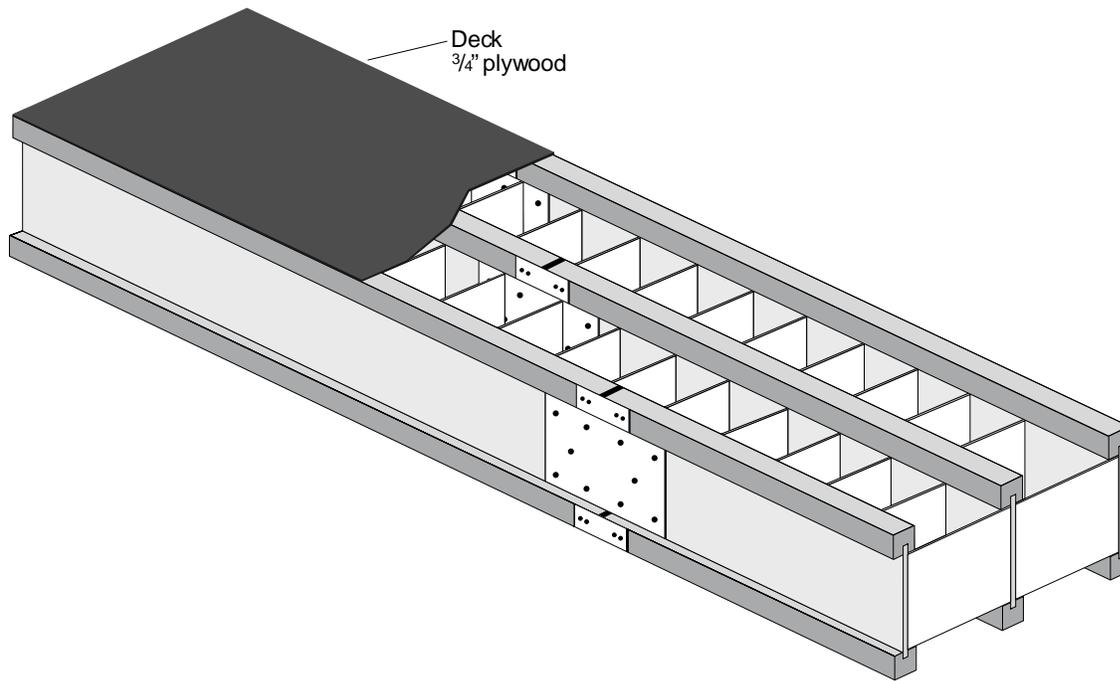


Figure 9—Joists, spacers (either 2 x 4s or plywood rectangles), and plywood deck (cut away) used in constructing platform.



Figure 10—Plywood placed on a platform (3 x 40 feet) at Halfmoon Creek, near Leadville, CO. Note that the edges of the plywood are flush against the edges of the platform frame.

We recommend that the platform be built using estimates of the highest measurable flows for the environment in which they are constructed. This is because the platforms are unsuitable for use when flow is higher than the bottoms of the joists. If it appears that flows may exceed this level, platforms must be raised using additional lumber placed under the joists at the sill contact before it is used at higher flows.

As a cautionary note, floating pieces of woody debris may catch under platform during periods of sustained high flow (though this has not been encountered at any of the sites where these platforms have been constructed to date). Woody pieces must be removed before platform is used because of interference with instruments and samplers and potential safety issues.

Unfortunately, the platforms often draw the attention of forest users and recreationists; they may therefore be subject to vandalism and should be inspected prior to each use. Study sites and platforms should be located at inconspicuous locations, if possible. Educational signs may be attached to the structures explaining the nature of the hydrologic project, emphasizing the structure's impermanence. Posting warning signs in the area provides cautionary notice to forest users that helps cover the land manager's liability. As an additional safety precaution, fencing may be placed

around the ends of the platforms, particularly in areas frequented by families whose children are unable to read warning signs. We have constructed fences using wire and metal t-posts (fig. 11); locks and chains may be used around an opening in the fence to permit operator access. If the stream is large enough for recreational boating, signs should be placed upstream warning of the presence of an obstacle. The platform should also be flagged and marked on the upstream side, increasing its visibility to boaters.

Handrails were not used on our platforms mainly because they interfered with movement and placement of samplers with long handles. Our employees were comfortable without them. If handrails are preferred, we suggest consulting with an engineer in their design because improperly designed handrails are subject to failure and may give a false sense of security. We recommend placing handrails only on the downstream side of platform; the upstream side should be kept clear to prevent interference with instruments and samplers.

The platforms are quite stable and much safer than the alternative of wading in channels with fast moving flow. The platform will support several persons at one time, though we generally limit its use to two persons; this is mainly because the structure is narrow and caution is needed when passing by other users. In



Figure 11—Wire fencing used to discourage use of sampling platform (3 x 75 feet) at East Fork San Juan River, near Pagosa Springs, CO.

6 years of use, no person has fallen from any of the platforms we have used in research projects. Still, crews should be outfitted with ropes and throw bags to use in the event that a person accidentally falls from one of the structures. Adhesion tape, such as that used around swimming pools, may be attached to the surface of the platform to help prevent slippage when surfaces are wet.

Summary

The primary benefit of sampling platforms is that they ensure safety in hydrologic research by elevating persons and equipment above the water surface, thereby limiting bodily contact with swift currents

while also eliminating disturbance to the flow and streambed from wading. In addition, they are relatively inexpensive and easily constructed and disassembled within a few hours using simple hand tools. The primary difficulty in platform construction is in hauling long sections of joists to remote sites on unpaved roads. There are, however, some companies that will deliver to remote locations for moderate cost, which is worth looking into.

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