

## 2 Sandbagging for Flood Protection

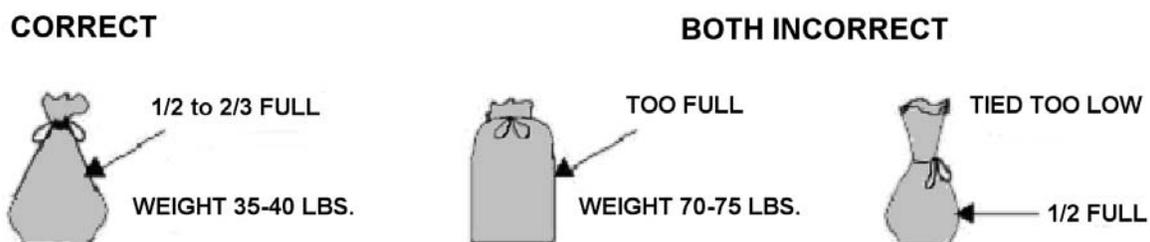
*Information in the following section is modified from several sources, in particular: 1) the North Dakota State University, Extension Service, Coping With Floods website, 2) the Dane County, Wisconsin, Department of Emergency Management website, and 3) employees of the St. Paul District U.S. Army Corps of Engineer (USACE-MVP). Links are provided in Section 6.*

A properly built sandbag dike can prevent or reduce flood damage. The sandbag size, the fill material used, and method of placement all influence the effectiveness of the sandbag dike.

### 2.1 Sandbag Size and Fill Materials

Bags must be filled and placed properly to give the best protection. Any available material can be used to fill sandbags, but sand is easiest to handle. Silt and clay will form a good dike but are more difficult to work with. Different size bags are available, but bags are easier to handle if weight is limited to between 35 and 40 pounds. This weight limit is particularly important when teenagers or older persons will be handling the bags and assisting with emergency operations and dike construction.

**Typically sandbags are filled approximately half full and do not need to be tied, although they may be tied loosely near the top.** It is desired that the sandbags lay flat when placed. Overfilled bags reduce the dike's effectiveness by leaving gaps between the bags, allowing water to seep through. *Figure 1* illustrates the correct and incorrect ways to prepare sandbags. Tying is not required for a correctly filled sandbag.



**Figure 1 – Correct and incorrect sandbag preparation.**

Ordinarily, filling sandbags is a two or three-person operation. One member of the team should place the bottom of the empty bag on the ground slightly in front of wide-spread feet with arms extended. This person may also want to kneel or sit to avoid back strain from bending. The throat of the bag is folded outward about 1-1/2 inches to form a collar and held in that position to allow a second team member to empty a shovelful of material into the open end, until the bag is 1/2 to 2/3 full. The third team member stacks and stockpiles the filled sandbags. Gloves should be used to avoid injury, and safety goggles are desirable during dry and windy days. For larger operations, bag-holding racks and funnels on the back of dump trucks, and other power loading equipment can be used to expedite the filling operation.

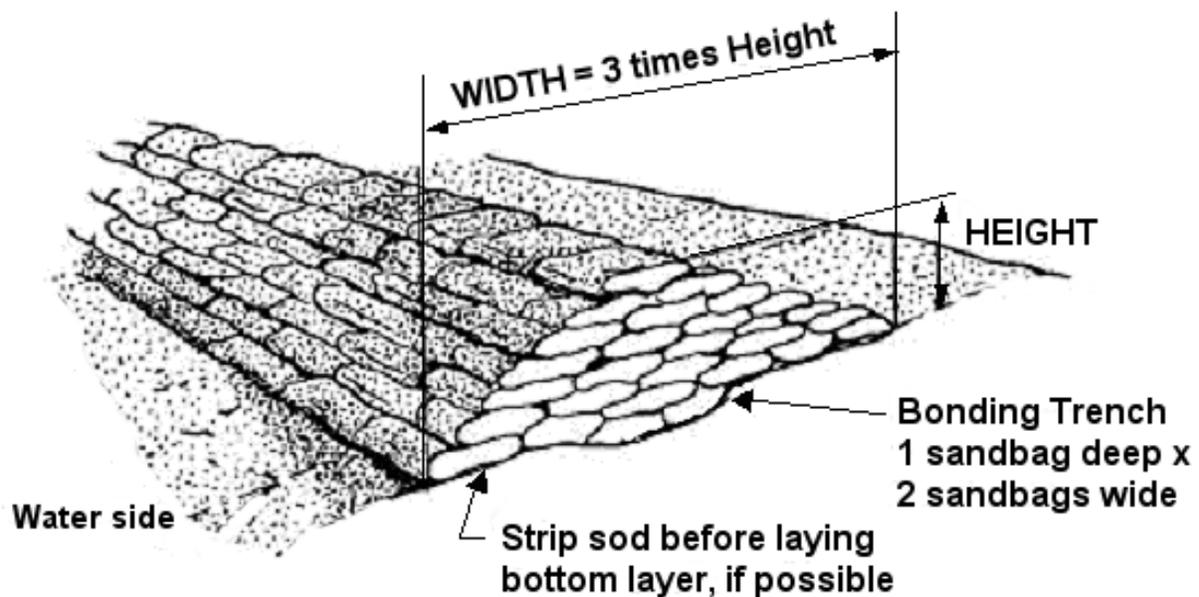
The following pages describe and illustrate a number of suggested techniques for using sandbags and other materials to build temporary flood protection dikes. Additional details are provided in Section 3.4.1 and shown on *Plates 1* through *3* at the back of this manual

Contact your county emergency office for information on where to obtain sandbags.

## 2.2 Site Selection and Preparation

When selecting the location for a dike, consider the ground elevation, ground condition, obstructions, and alignment. For stability, the dike should be kept as short and low as possible. Avoid any obstructions that would weaken the dike, and do not build the dike against a building wall unless the wall has been designed to retain floodwaters. If possible, plan to leave at least 8 feet between the landward toe / base of the dike and any building or obstructions to allow for future dike raises, dike monitoring, construction equipment and vehicles, and to prevent damage to building walls and foundations.

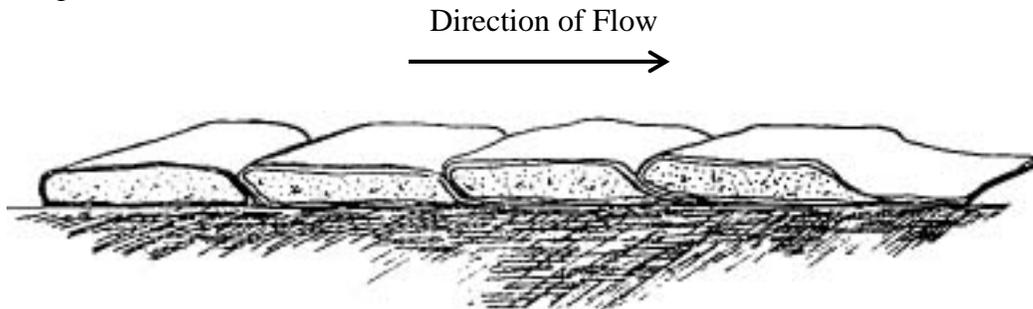
Remove all ice and snow from a strip of land at least as wide as the base of the dike. If the dike will be more than 2 - 3 feet high, remove a strip of sod to create a bonding trench along the center line of the alignment to better anchor the dike in place, as shown in *Figure 2*.



**Figure 2 – Proportions of sandbag dike showing bonding trench at base.**

### 2.3 Stacking Sandbags to Form a Dike

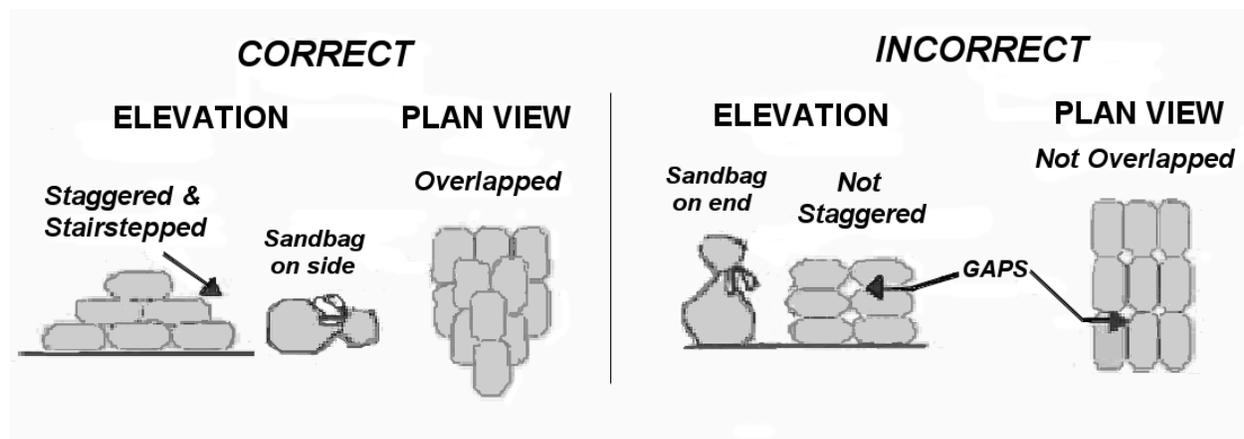
Overlap the sandbags as shown in *Figure 3*, placing the first layer of bags lengthwise along the dike and lapping the bags so the filled portion of one bag lies on the unfilled portion of the previous bag.



**Figure 3 – Overlap sandbags lengthwise and parallel to river flow.**

The bags should be placed lengthwise and overlapped parallel to the direction of the river flow. The bonding trench shown on *Figure 2* should be filled with a layer that is two sandbags wide by one sandbag high; the first full layer is then placed over this bonding trench. The base of the dike should be three times as wide as the dike is high.

The second layer of bags should be staggered perpendicular to the first layer and placed over the seams of the previous layer, with additional layers laid in alternating directions to the top of the dike, as shown in the “Correct” example in *Figure 4*. By alternating placement directions, the gaps and seams along the edges and corners in each layer below will be covered and filled in by a sandbag in the next overlying layer. *Plate 1* at the back of this manual illustrates additional details of sandbag placement.



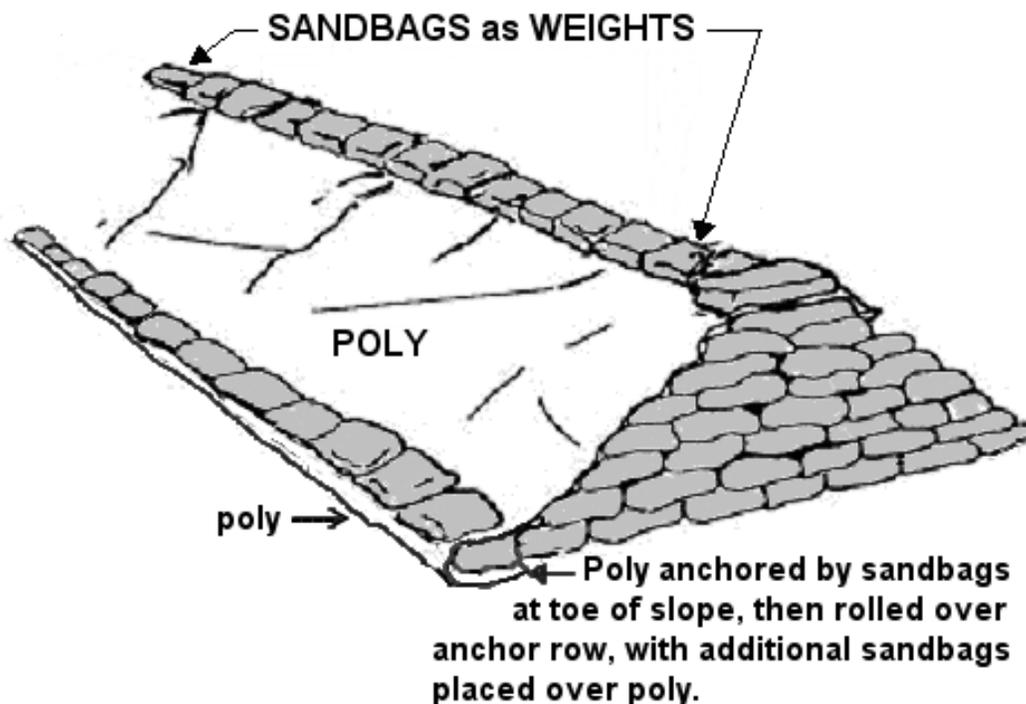
**Figure 4 – Correct and incorrect placement of staggered sandbag layers.**

## 2.4 Sealing the Dike with Polyethylene Plastic Sheetting

The finished dike can be sealed with a sheet of polyethylene plastic (poly) to improve water tightness. The poly sheeting should be about 6 mils thick, and is generally available in 20-foot-wide by 100-foot-long rolls from construction supply firms, lumberyards, and farm stores. Section 3.4.1 can be consulted for additional details.

The poly must always be anchored at the bottom edge and weighted along the top and slope to be effective.

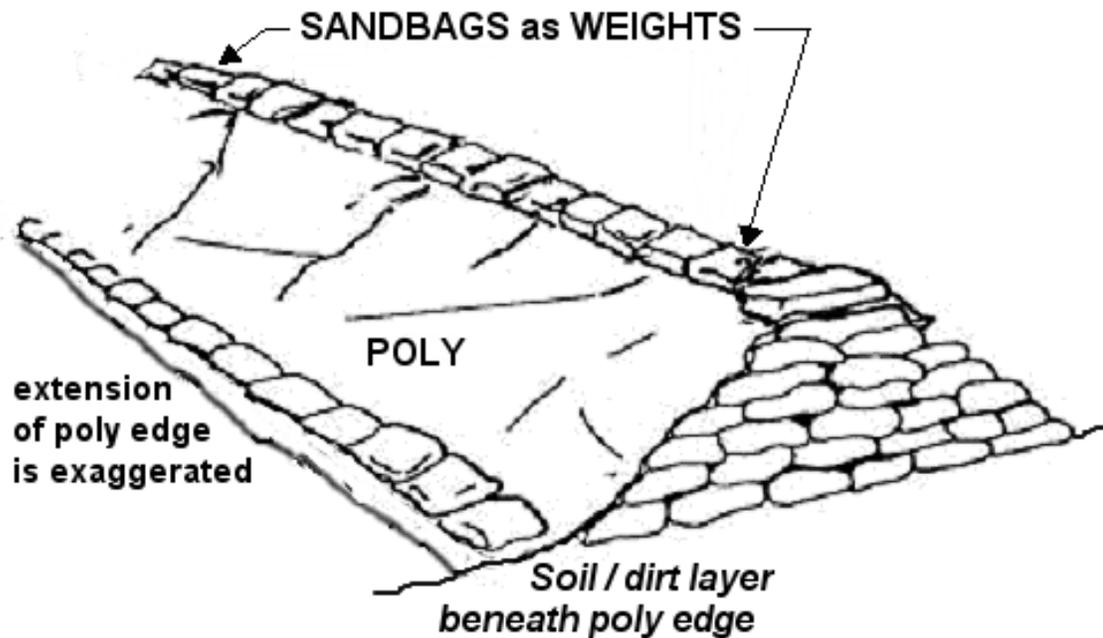
Three methods are recommended to anchor the poly on the riverward face of a sandbag dike. The most successful is shown in *Figure 5* and described as follows: (1) Poly is placed flat on the ground surface extending away from the bottom row of sandbags, and one or more rows of sandbags are placed over the flap. The poly is then unrolled over the anchoring row of sandbags, anchored again, and then up the slope and over the top of the sandbag dike, far enough to allow for anchoring with additional sandbags.



**Figure 5 – Preferred method of tucking under and anchoring poly with two rows of sandbags.**

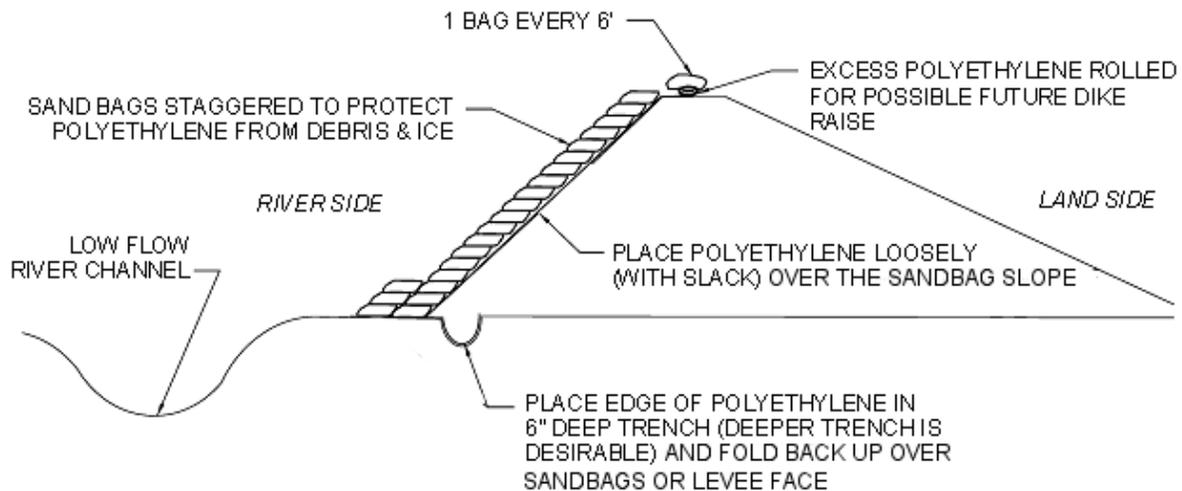
Other methods available include: (2) At the base of the dike along the water side, spread a layer of dirt or sand one inch deep and about one foot wide along the bottom of the dike, to create a uniform surface to anchor the poly. Lay the poly sheeting so the bottom edge extends one to two

feet beyond the bottom edge of the sandbags over the loose dirt. Place sandbags over the edge of the poly to anchor (*Figure 6*).



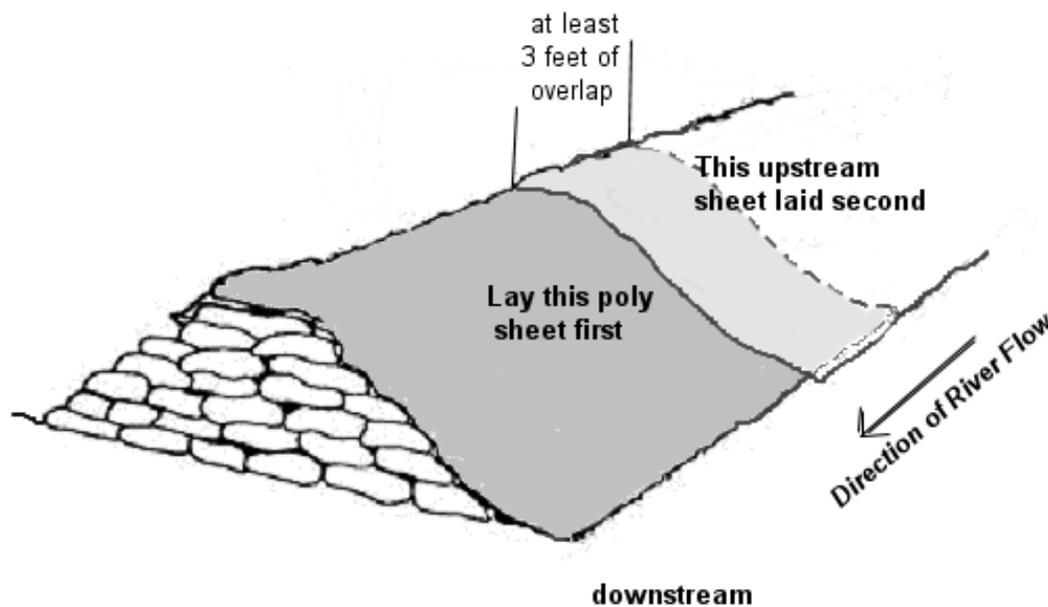
**Figure 6 – Poly edge placed over dirt and anchored with a row of sandbags.**

A third method to anchor the poly is: (3) Excavate a 6-inch or deeper trench along the toe of the levee, place poly in the trench, and backfill the trench, compacting the backfill material or placing a row of sandbags over the trench to prevent loss of the backfill material (*Figure 7*). This method will be unsuitable if water levels have reached the sandbags at the toe of the dike. In all cases the poly is unrolled up the slope and over the top, and anchored along the top with additional sandbags.



**Figure 7 – Poly anchored within a trench – placed under dry conditions.**

Poly should be placed from downstream to upstream along the slopes and the next sheet upstream overlapped by at least 3 feet, as shown on *Figure 8*. Overlapping in this direction prevents the current from flowing under the overlap and tearing the poly loose. Lay the poly sheeting down very loosely, as the pressure of the water will make the poly conform easily to the sandbag surface if the poly is loose. If the poly is stretched too tightly the force of the water against the poly and sandbags could puncture the poly. Once the poly is placed, additional sandbags, boards, and/or loose dirt placed over the poly are needed to anchor the poly in place and prevent the wind or river current from disturbing it. These anchors are not shown on the illustration. Avoid puncturing the poly with sharp objects or by walking on it.



**Figure 8 – Poly placement from downstream to upstream with overlap shown.**

**Plate 2** and **Plate 3** summarize the methods of anchoring poly sheeting along the riverward face of the dike. **Plate 2** shows placement when dry conditions are present, and **Plate 3** shows placement in the wet, after water has risen to a level along the side of the sandbag dike or levee.

## 2.5 Number of Sandbags Needed

The following information in **Table 2.1** indicates the approximate number of sandbags that are needed for dikes of various heights and lengths. Note that 5 feet high is the practical limit of a sandbag dike. If a higher sandbag dike is needed, alternative means of construction should be considered. The preferred height limit is 3 feet.

**Table 2.1 - Estimated number of sandbags needed per foot of length and height of dike.**

ESTIMATED NUMBER OF SANDBAGS PER LINEAR FOOT OF DIKE	
Height in Feet	Bags Required
1	5
2	10
3	21
4	36
5	55

DIKE HEIGHT	NUMBER OF SANDBAGS REQUIRED FOR LENGTH OF DIKE									
	50 FT	100 FT	175 FT	200 FT	250 FT	300 FT	350 FT	400 FT	450 FT	500 FT
1 Foot	250	500	750	1,000	1,250	1,500	1,750	2,000	2,250	2,500
2 Feet	850	1700	2,550	3,400	4,250	5,100	5,950	6,800	7,650	8,500
3 Feet	1,800	3,600	5,400	7,200	9,000	10,800	12,600	14,400	16,200	18,000
4 Feet	3,100	6,200	9,300	12,400	15,500	18,600	21,700	24,800	27,900	31,000