were under water; South St. Paul, where strong efforts were made to raise the railroad embankment separating stockyards from the Mississippi River; La Crosse, where mechanized equipment was employed to construct an emergency levee on Caledonia Street north from the plant of the Electric Auto-Lite Co. towards Onalaska; and Chaska, where one-fourth of the town was flooded and 300 people moved from the flood area. The Navy training center on Navy Island at St. Paul and the steam-generating plant of Ford Motor Co. at the left end of lock and dam 1 were flooded and closed on April 12. The location of the several flooded areas in St. Paul is shown on figure 45.

As the crest of the Mississippi flood approached St. Paul, conditions became more and more critical, as important transportation facilities were closed or impeded by the flood and as more families were flooded from their homes. On April 13, according to the St. Paul Dispatch, 2,000 citizens of St. Paul were estimated to be homeless because of floods; by April 14, the estimate was raised to 5,000 people; and on April 16, 1,500 families were estimated to be homeless. The Chicago, Milwaukee, St. Paul and Pacific Railroad main-line tracks leading into the Union Depot at St. Paul from the west were overtopped on April 13, and it was only by emergency raising of one track about 2 feet between Chestnut and Eagle Streets that traffic was maintained. The passenger trains of the Chicago Great Western Railway coming into St. Paul were stopped and unloaded in South St. Paul from April 14 to 17 because of submerged tracks between State Street and the lift bridge across the Mississippi River. Tracks going east from the St. Paul Union Depot were partly submerged, but traffic was maintained through use of steam locomotives. Kellogg Boulevard, one of St. Paul's main traffic arteries, was closed for a length of two blocks by floodwaters at the Broadway crossing. Because so many Sunday sightseers interrupted essential traffic and because of the danger of stalling passenger-car engines in the ponds south of the bridges, both the Wabasha and Robert Street bridges were closed to passenger-car traffic for about a week during the most severe period of the flood at St. Paul. Floodwaters at lock and dam 1 (Twin City) rose high enough to flow over the tops of the lock walls for a few days. The flood crest reached St. Paul on April 16 and remained steady all that day; recession followed without secondary rises, and by April 19 the Robert Street and Wabasha Street bridges were reopened.

Just downstream from St. Paul, the industrial city of South St. Paul won a costly battle to prevent flooding of the Union Stockyards. The stockyard management wisely placed an embargo on shipments to the yards beginning on April 13, and the shutdown enabled complete concentration on fighting the flood. Many anxious moments were experienced during the dike battle, the worst coming on Sunday, April 13, when high, wind-driven waves battered against the dike. An entire hill was used to build the dike.

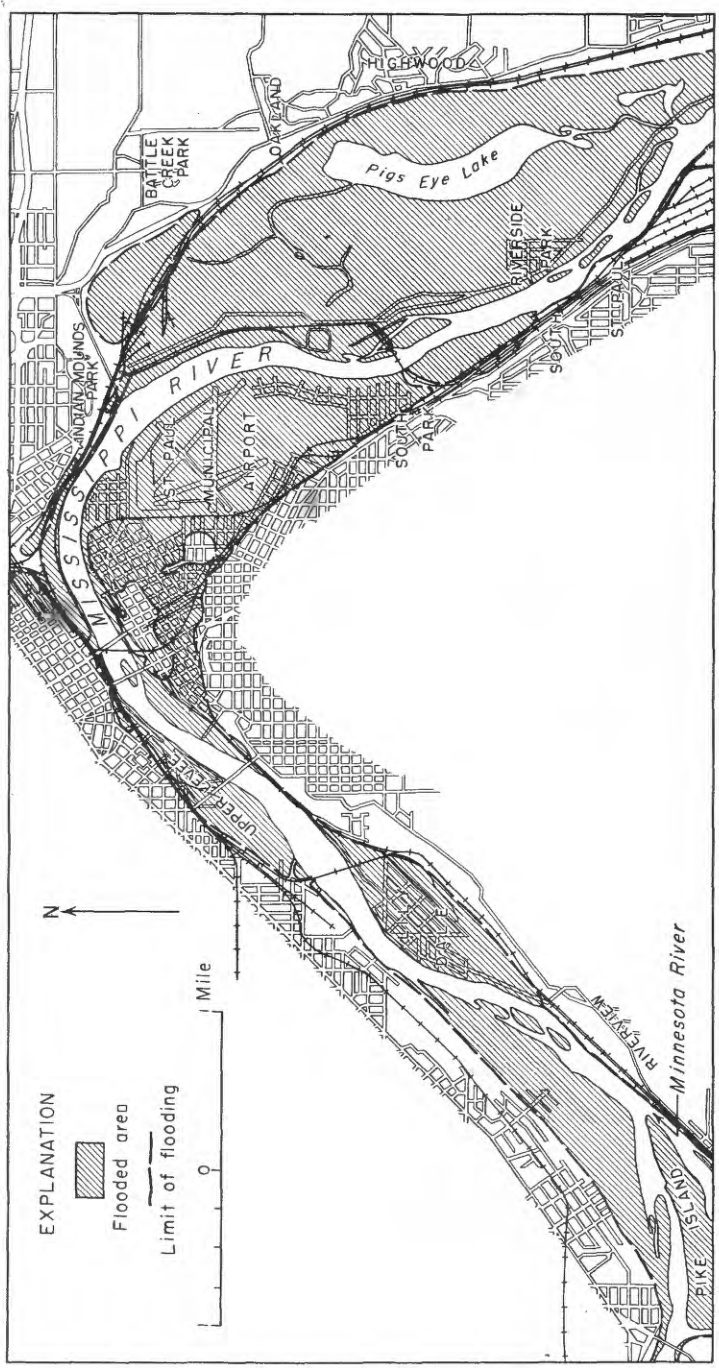

Figure 45.--Map of area flooded at St. Paul, Minn., during April 1952.

The flood protection proved so effective that the stockyards were reopened for business on April 20.

The Mississippi flood passed downstream from St. Paul to Winona without causing much distress or damage. U. S. Highway 10 was closed by floodwaters immediately west of Prescott, Wis., for a short time. No flooding of consequence occurred at Hastings or Red Wing, Minn., except on Wisconsin Island across channel from Red Wing. One residence suffered minor damage at Lake City, Minn., and U. S. Highway 61 was closed for a few days, owing to high water on Lake Pepin (fig. 46). At Wabasha, Minn., the sewage-treatment plant was forced to close, and the highway connecting Wabasha with Nelson, Wis., was closed for several days.

The U. S. Weather Bureau issued revised flood-crest predictions on April 14 as follows:

Stream and place	Crest stage	Date of crest
Red River of the North at Fargo	35-36	Apr. 17
Mississippi River at Hastings	21.5	Apr. 17
Mississippi River at Red Wing	18.5	Apr. 18
Mississippi River at Reads Landing	16.0	Apr. 18
Mississippi River at Winona	18.2	Apr. 20
Mississippi River at La Crosse	16.0	Apr. 21
Mississippi River at Lansing	18.8	Apr. 23
Mississippi River at Prairie du Chien	22.6	Apr. 24
Mississippi River at Clinton	22.2	Apr. 27
Mississippi River at Davenport	20.0	Apr. 28
Mississippi River at Muscatine	22.8	Apr. 29

The construction of emergency levees at Winona began on April 12. Figure 47 shows a map of the city of Winona and the location of the six separate emergency-levee structures built along the west, north, and east fringes of the city. The levee built on the Chicago and North Western Railway right-of-way proved to be a trouble spot whenever strong northerly winds whipped up waves on the broad expanse of the Mississippi River upstream (fig. 48). Erosion by waves was finally prevented by surfacing the dike with plastic building-paper, anchored by snow-fence weighted with sandbags. Emergency-levee construction kept ahead of the river's threat; by April 15 more than 15,000 feet of such structure had been completed. On April 16 the Weather Bureau lowered the crest forecast to 17.8 feet for April 19, and on April 18 the forecast date was moved to April 20. None of the emergency levees at Winona were overtopped or breached, but seepage through them created a problem. Lake Winona rose to

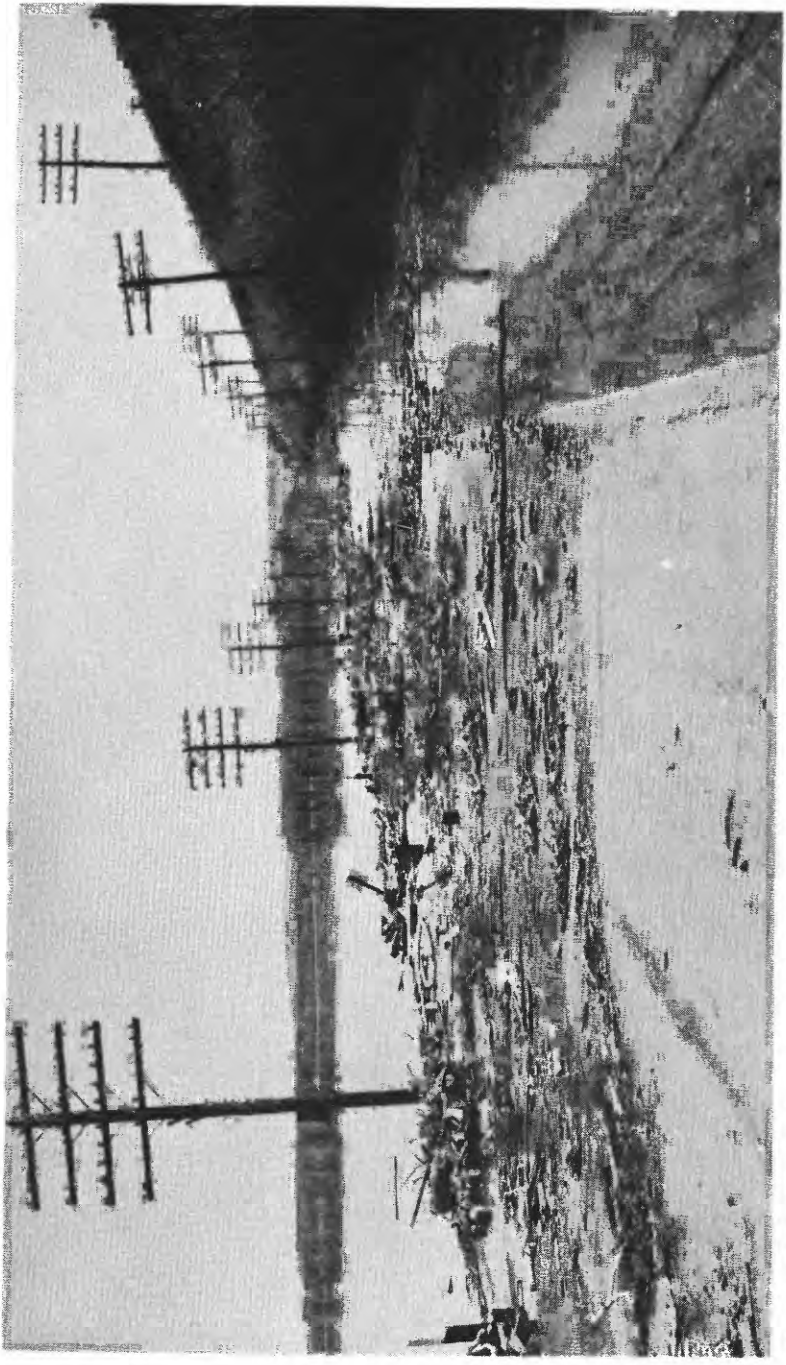

Figure 46.--View of U. S. Highway 61 where it was closed north of Lake City, Minn., owing to the high level of Lake Pepin. Photograph by the Red Wing Daily Republican Eagle.

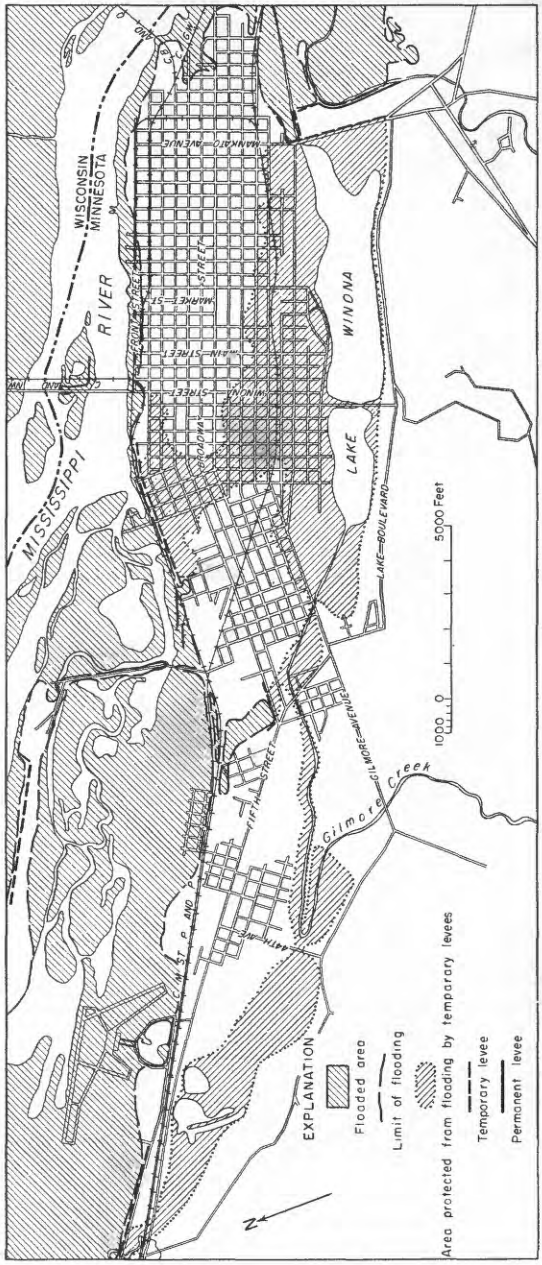

Figure 47.--Map of area flooded at Winona, Minn., during April 1952.

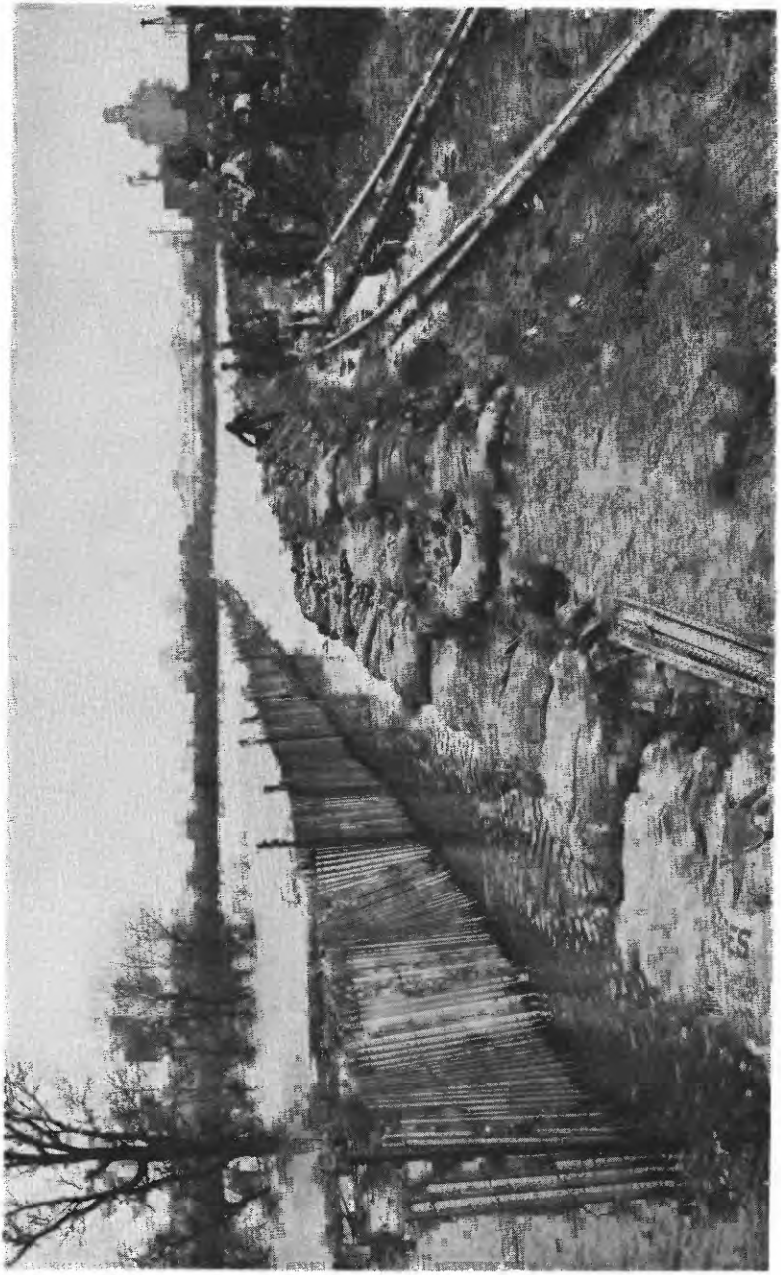

Figure 48.--Emergency levee, built on the embankment of the Chicago and North Western Railway, that kept the floodwater of the Mississippi from part of Winona, Minn. Photograph by the Winona Republican Herald.

an 8.38-foot stage on April 18 as a result of seepage and local inflow. The actual crest of the flood came at Winona on April 20 at a stage of 17.9 feet, and recession followed without a single failure in the city levee system. The major flooding in the Winona area occurred April 13 when the Prairie Island road dike was breached and the municipal airport was flooded. Figure 47 also shows the size of area in Winona that would have been flooded at time of crest if the emergency levees had not been built.

The next major urban area downstream, La Crosse, Wis., began emergency levee construction prior to April 12. The largest emergency levee unit was the one stretching from the plant of the Electric Auto-Lite Co. to Onalaska built on top of an abandoned railroad embankment. Figure 49 shows the map of La Crosse with locations of emergency dikes, flooded areas, and seeped areas. Pettibone Island, across the main channel of the Mississippi River from La Crosse, was completely flooded, and only by building emergency sandbag levees on each side of U. S. Highway 16 could interstate highway traffic be maintained. Seepage through the levees became the most serious problem in the flood battle at La Crosse; it was solved by installing big pumps to pump water from sewer manholes and discharge it over the levees back into the river. The crest forecast for La Crosse was lowered by the Weather Bureau on April 16 to 15.6-15.8 feet for April 21, and again on April 17 to 15.2-15.3 feet for April 20, and raised on April 18 to 15.3-15.4 feet for April 20 or 21. The final forecast issued on April 19 predicted a crest of 15.4 feet on April 20. The actual crest of 15.33 feet came late April 19 and held for several hours on April 20. The effort to save parts of La Crosse from flooding was considered successful (figs. 49 and 50), although seepage flooded some areas that were supposedly safe behind dikes (the wide area through which La Crosse River flows is a slough and normally floods at high stages of either the Mississippi or La Crosse Rivers).

Prairie du Chien, Wis., a city with a long history, was the next downstream urban area below La Crosse to be flooded. As of April 14, 30 families in the fourth ward were flooded from their homes. On April 15, Mayor Harvey of Prairie du Chien proclaimed that an emergency existed. By April 17 the Chicago, Milwaukee, St. Paul & Pacific Railroad pontoon bridge from Prairie du Chien, Wis., to Marquette, Iowa, was inoperative because of the swift current. By April 20 almost 1,000 people of Prairie du Chien's fourth ward were homeless. The interstate bridge from Prairie du Chien to the Iowa side was closed a day before flood crest when the approach on the Wisconsin end became submerged too deeply for the transit of passenger cars. The crest of the flood came on April 22 at a stage of 21.0 feet, which was the highest river stage since 1826 and 4 inches higher than the 1951 level. Figure 51 shows the extent of flooding at Prairie du Chien (note the main business and residential sections

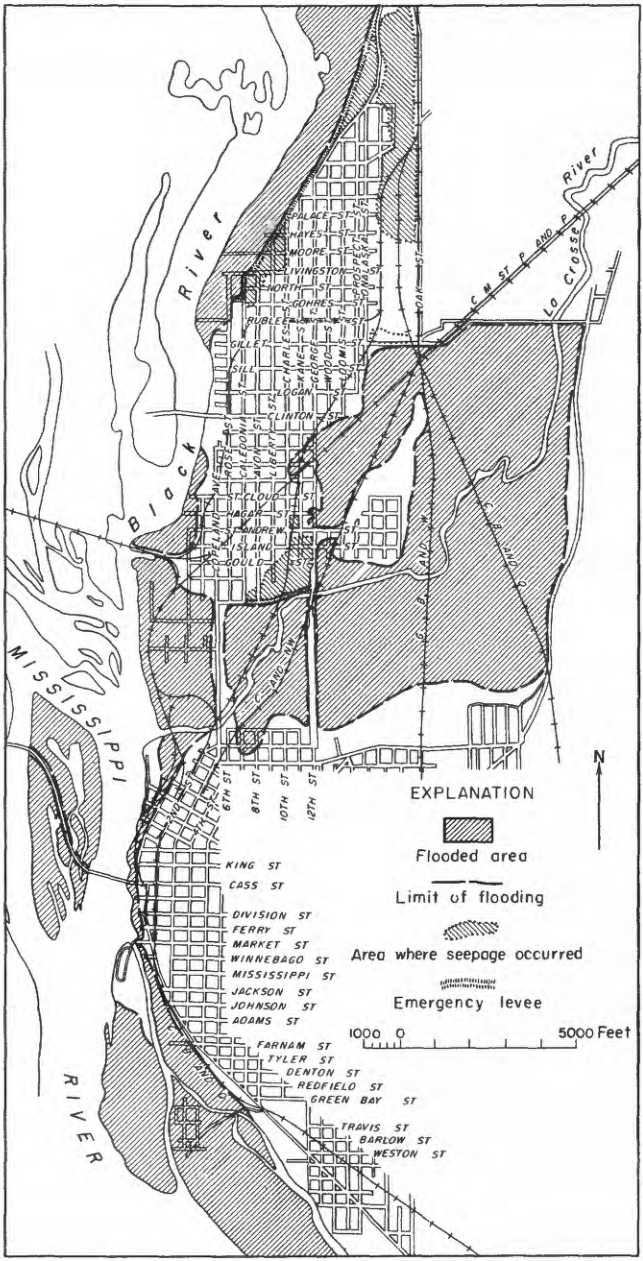

Figure 49.--Map of area flooded at La Crosse, Wis., during April 1952.

Figure 50.--Emergency levee that protected residential area at La Crosse, Wis. Photograph by the La Crosse Tribune.

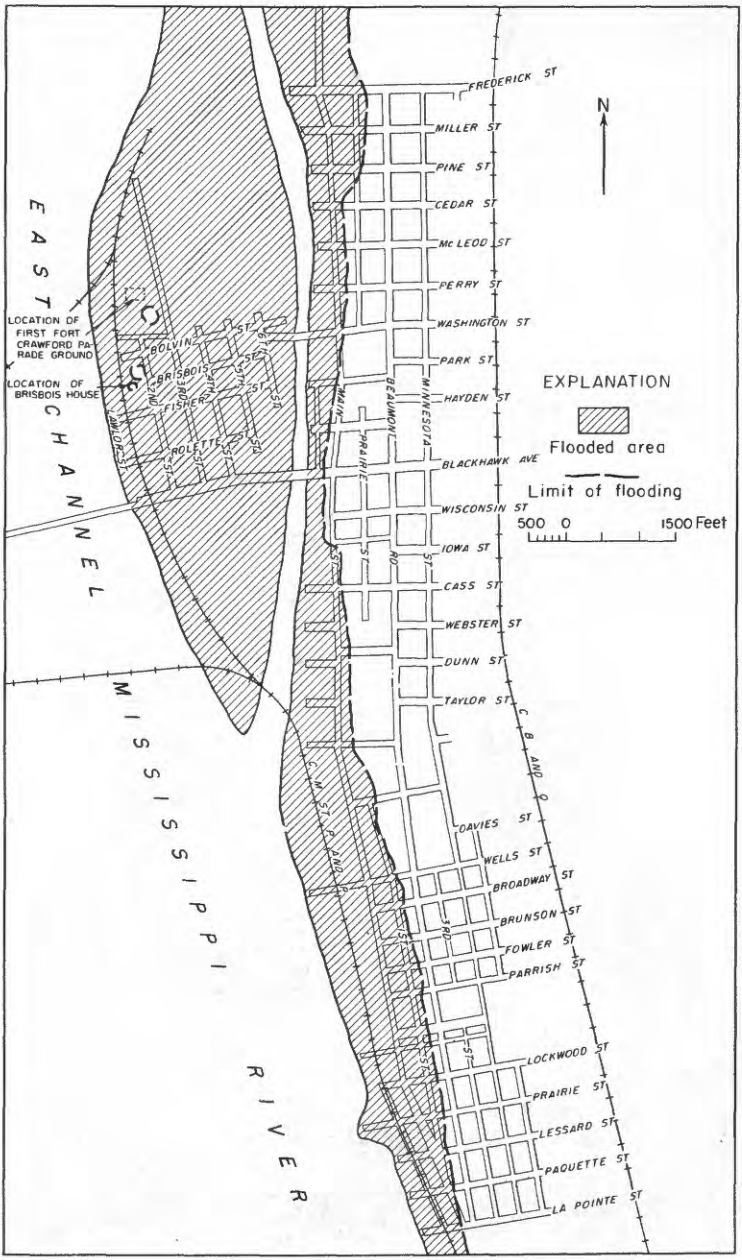

Figure 51.--Map of area flooded at Prairie du Chien, Wis., during April 1952.

Figure 54.--Sandbag ring dike that prevented reverse flow at sewer manhole in the Garden addition of Davenport, Iowa. Photograph by Corps of Engineers.

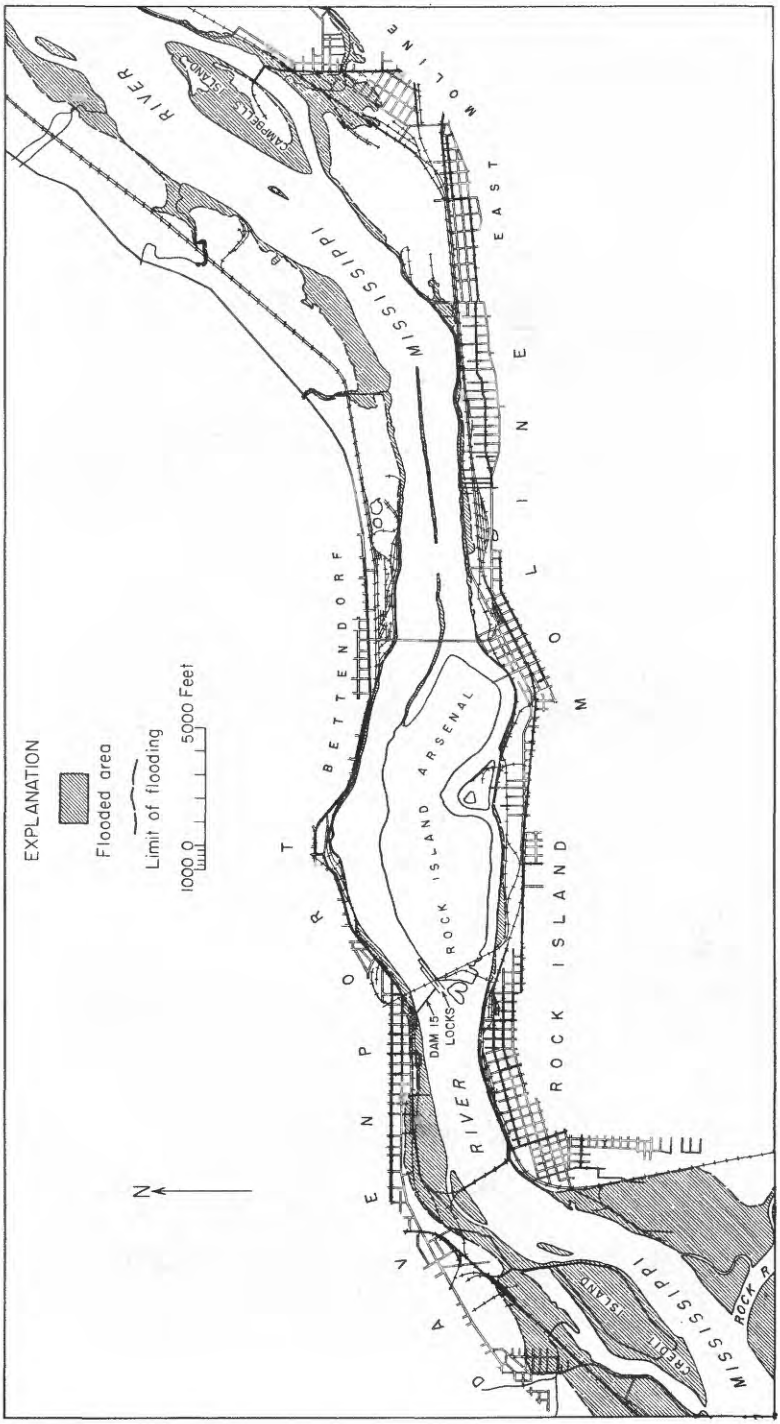

Figure 55.--Map of area flooded at Rock Island and Moline, Ill., and Davenport and Bettendorf, Iowa, during April 1952.

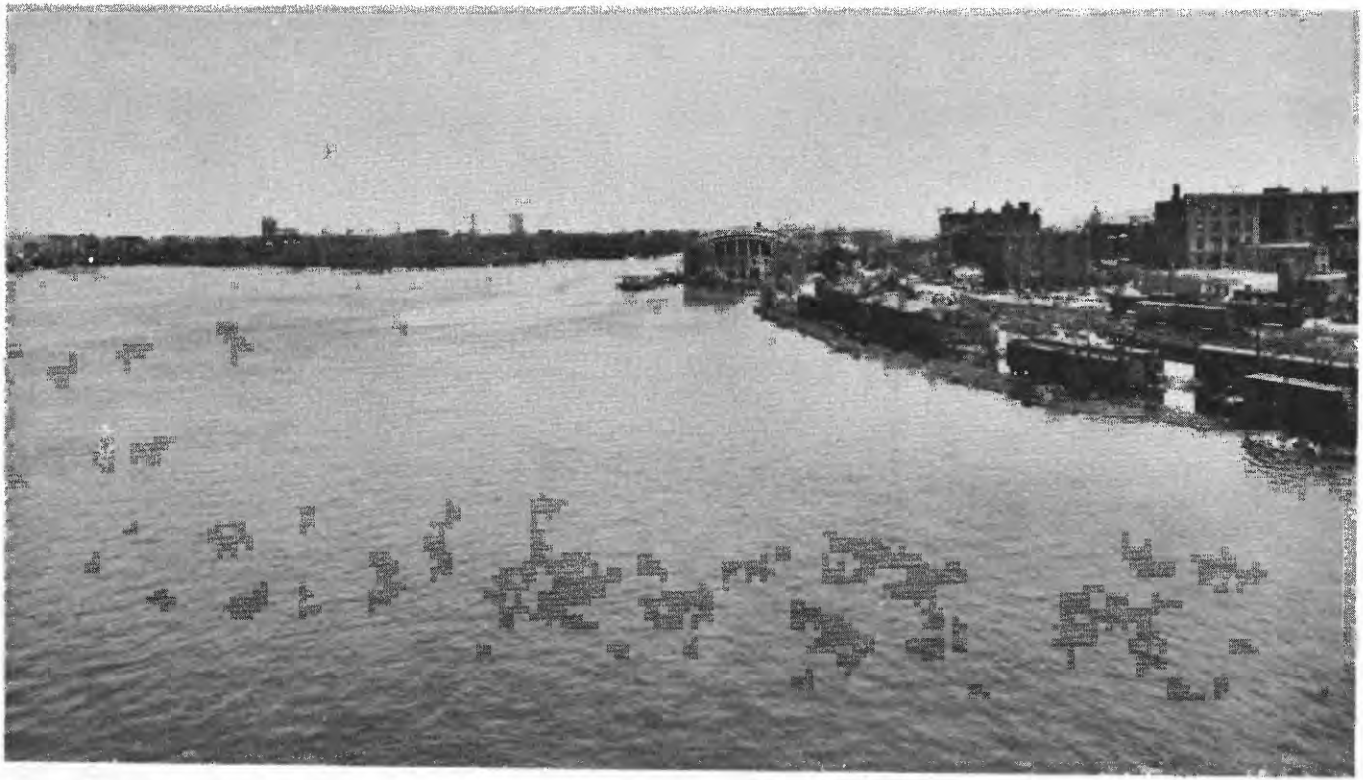

Figure 56.--The Rock Island armory is surrounded by floodwater of the Mississippi River. Photograph b
Corps of Engineers.

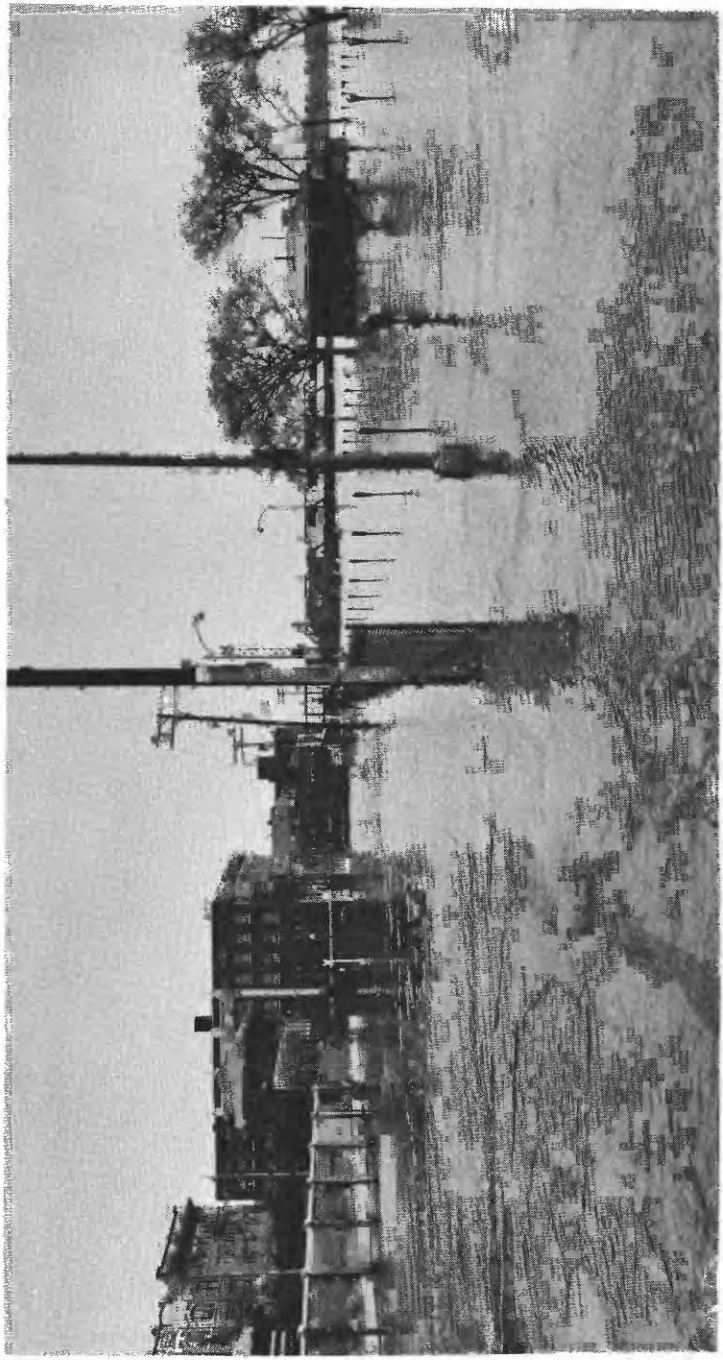

Figure 57.--Riverfront property at Davenport, Iowa, covered by Mississippi River flood on April 28, 1952. Photograph by Corps of Engineers.

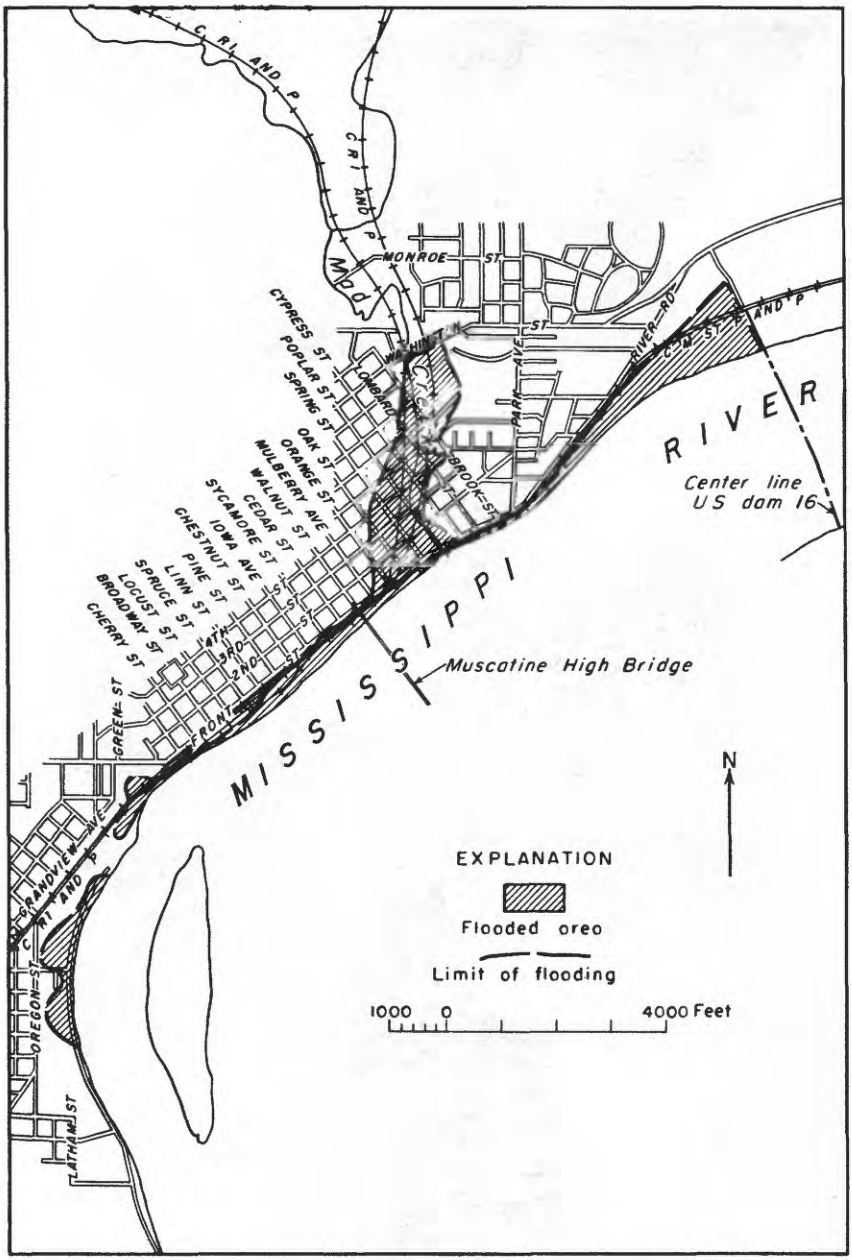

Figure 58.--Map of area flooded at Muscatine, Iowa, during April 1952.

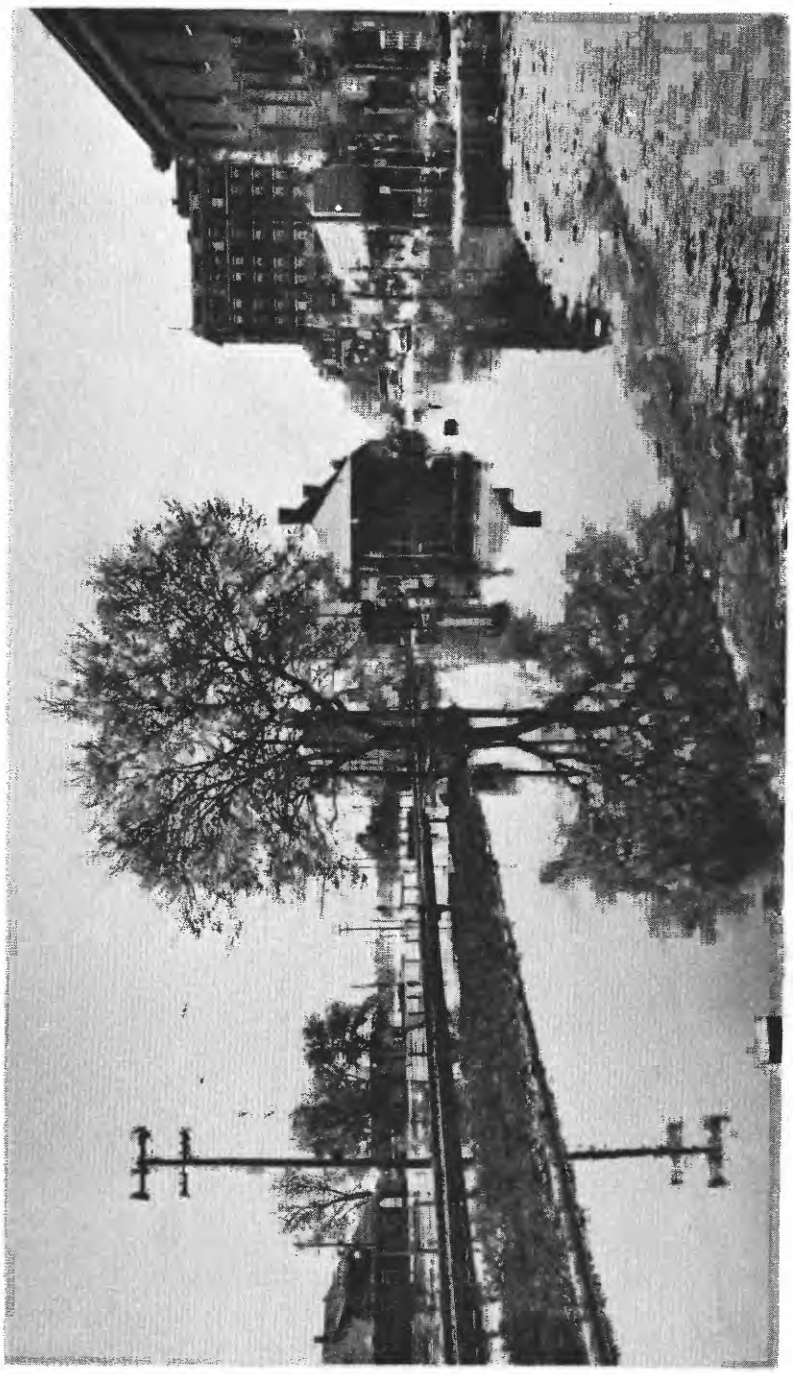

Figure 59.--Edge of the Mississippi River flood near the railroad depot at Muscatine, Iowa, on April 29, 1952. Photograph by Corps of Engineers.

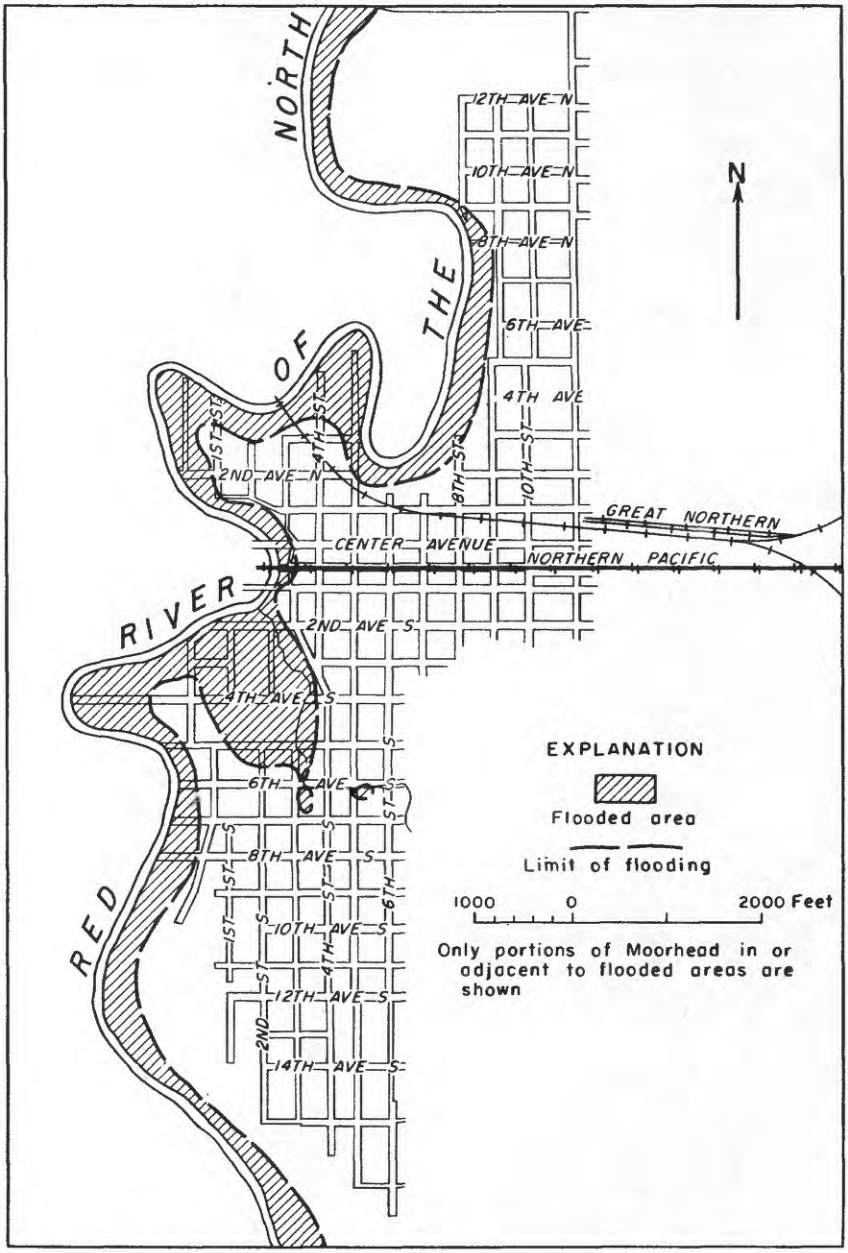

Figure 61.--Map of area flooded at Moorhead, Minn., during April 1952.

Figure 62.--Timber flashboards being added to Bay Island levee near Muscatine, Iowa, April 19, 1952. Photograph by Corps of Engineers.

In the protection of private property, many novel ideas were tried and proved to be satisfactory. Several homeowners, warned in advance of flooding, after first disconnecting all utility lines, raised their houses above the flood level by jacking and supported them on concrete-block piers. This method was successful in slack water. In other homes the owners saved furniture from flooding by suspending them from hooks placed in the ceilings. The windows and doors of concrete or masonry buildings may be sealed with temporary masonry barricades to prevent flooding--this method proved successful at several factory buildings in flooded Iowa communities (fig. 63). The owners of buildings that are to be barricaded and kept dry by pumping should provide for relief of pressure under the basement floor slab and possibly behind the basement walls. Usually a number of seep holes punched through the floor will prevent the buildup of pressure strong enough to burst the floor.

Sanitation became a major problem throughout most of the flooded area because of failure of the normal sewage disposal systems, submergence of wells, flooding of dumps, and breakdown of garbage collection. At Clinton, Iowa, farsighted city employees put Warfarin, a new ratpoison, around the periphery of the city dump as soon as it was certain the dump would be flooded. As a result of this precaution, Clinton had no influx of rats during the flood. Because many very large cities were dumping untreated sewage into the Mississippi (for example, Minneapolis and St. Paul during shutdown of treatment plant), the pollution count became dangerously high. The natural factors tending to purify the stream had little effect because of the low temperature of the water. Additional chlorine dosage became the general rule at all water-treatment plants. This was especially true at the cities where well fields were flooded. Garbage collection became a problem in the parts of cities ringed by protective levees when floodwaters completely surrounded the area. Perhaps storage of garbage temporarily in a container of sufficient capacity, installed at each home before the area is cut off from the rest of the city, is the solution to this problem.

Transportation in all the flooded areas was completely stopped or severely curtailed by the floodwaters. Rail traffic along the Minnesota River was completely stopped for several days by submergence of right-of-way or by washouts. The main lines of the Chicago, Milwaukee, St. Paul & Pacific Railroad and the Chicago, Burlington & Quincy Railroad parallel the Mississippi River for more than 100 miles between St. Paul and Chicago. Surprisingly, the river stage did not rise high enough at any place to interrupt rail travel on this stretch of main line, although diesel locomotives had to be replaced by steam locomotives. The latter can travel on submerged rails until the water quenches their fires, whereas diesel engines stall in a relatively shallow cover of water

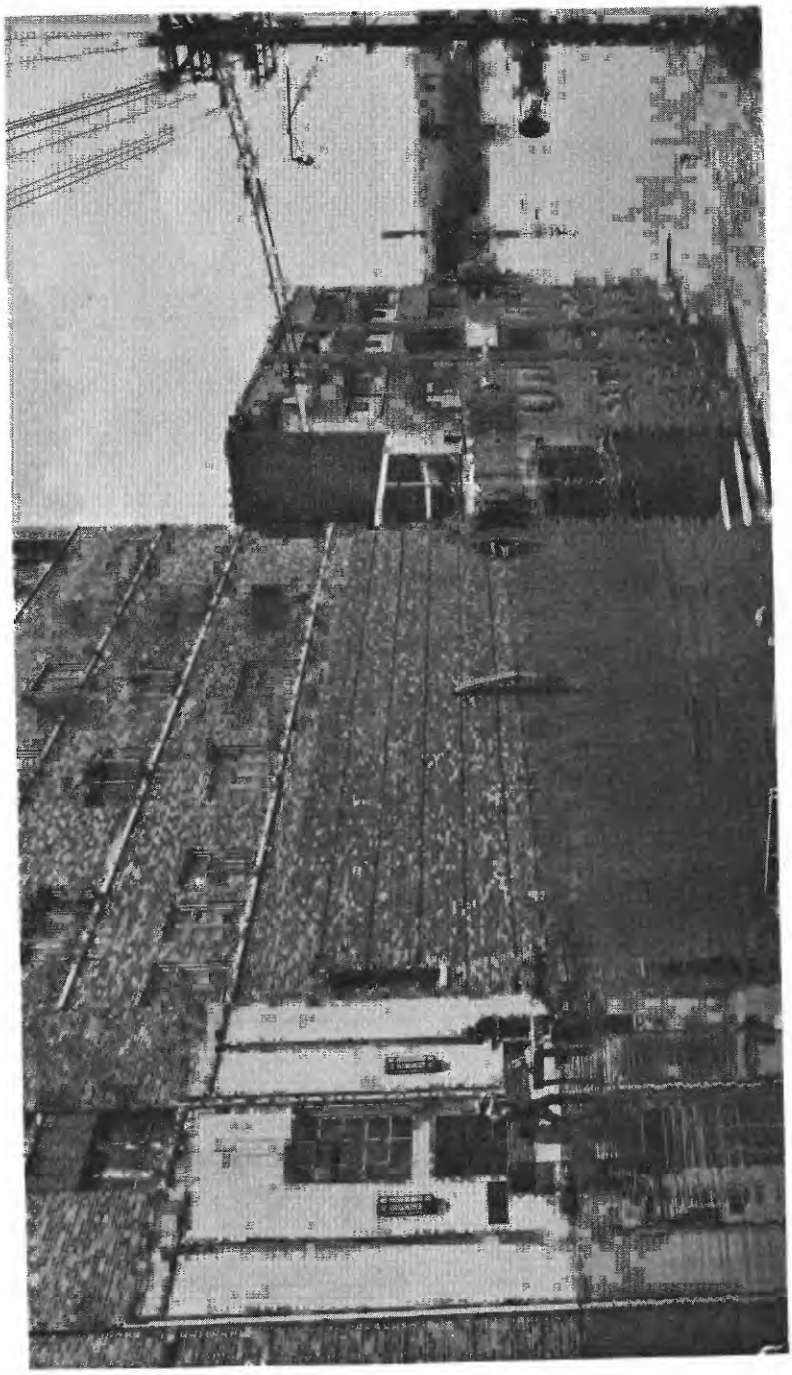

Figure 63.--Masonry barricade against flood constructed at entrance to Dubuque Packing Co. Photograph by Corps of Engineers.

Figure 66.--View of U. S. Highway 212 near Madison, Minn., showing scour of downstream shoulder of highway, after highway was overtopped during April 1952. Photograph by the Madison Western Guard.

eroded by wave action although the ponded water never reached the road surface. Statistics on road damages in North Dakota and Minnesota in the area covered by this report, as furnished by the St. Paul office of the U. S. Bureau of Public Roads, are shown in table 4.

The cost figures listed in this section on damages have been compiled from actual expenditures for rehabilitation and relief, from estimates of restoration or replacement costs, and from estimates of the loss of revenue or trade due to the flood. The latter item, being intangible, is difficult to evaluate accurately. The effects of a severe flood may last many more months than has usually been assumed to be true. According to experience in the flooded Kansas City industrial area in 1951, the full loss in industry and trade in a flooded area can't be evaluated for many months after the flood because many industries are slow to reopen or make definite plans to move elsewhere. Because flood damage to industry was either prevented by emergency diking or reduced to a minimum in the basins of the upper Mississippi River and Red River of the North, only a very small number of industries will probably relocate elsewhere.

Table 4.--Highway damages during April 1952 in Minnesota and North Dakota in the basins of the Red River of the North and upper Mississippi River

State and county	Federal aid system		County and township system	Total
	Primary	Secondary		
Minnesota:				
Aitkin	----------	$5,000.00	----------	$5,000.00
Anoka	----------	3,306.74	----------	3,306.74
Benton	----------	----------	$5,850.00	5,850.00
Blue Earth and Nicollet	$6,042.00	300,000.00	----------	306,042.00
Carver	11,945.96	----------	301.19	12,247.15
Chippewa	112.20	9,339.00	----------	9,451.20
Dakota	55,999.62	----------	----------	55,999.62
Fillmore	2,464.13	----------	----------	2,464.13
Goodhue	7,683.91	----------	----------	7,683.91
Hennepin	14,814.09	----------	----------	14,814.09
Houston	8,030.43	----------	----------	8,030.43
Lac qui Parle	11,494.70	1,688.95	----------	13,183.65
Le Sueur	3,866.05	16,909.14	7,000.00	27,775.19
Lincoln	157.85	382.08	----------	539.93
Lyon	3,783.04	232.87	----------	4,015.91
Meeker	239.42	4,100.00	79,000.00	83,339.42
Murray	----------	333.21	----------	333.21
Pine	----------	----------	4,000.00	4,000.00
Redwood	1,062.82	21.12	----------	1,083.94
Renville	583.44	4,000.00	5,800.00	10,383.44
Rock	----------	----------	8,000.00	8,000.00
Scott	21,164.84	----------	7,298.93	28,463.77
Sherburne	73.24	----------	----------	73.24
Sibley	2,082.99	----------	----------	2,082.99
Stearns	----------	1,000.00	21,200.00	23,200.00
Stevens	----------	2,500.00	----------	2,500.00
Swift	4,000.00	13,920.00	----------	17,920.00
Wabasha	118.03	352.44	----------	470.47
Washington	7,543.23	----------	----------	7,543.23
Wilkin	----------	----------	30,000.00	30,000.00
Winona	4,135.64	2,993.03	----------	7,128.67
Wright	2,811.35	2,764.64	----------	5,575.99
Yellow Medicine	5,160.67	35,983.74	21,410.00	62,554.41
North Dakota:				
Cass	----------	----------	11,700.00	11,700.00
Ransom	----------	----------	2,000.00	2,000.00
Total	$175,369.65	$405,826.96	$203,560.12	$784,756.73