US Army Corps
of Engineers
Kansas City District
Leaders In Customer Care

Guidebook

General Information for Sponsors of Flood Protection Projects Constructed by the Corps of Engineers

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GUIDEBOOK

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GUIDEBOOK
GENERAL INFORMATION FOR SPONSORS

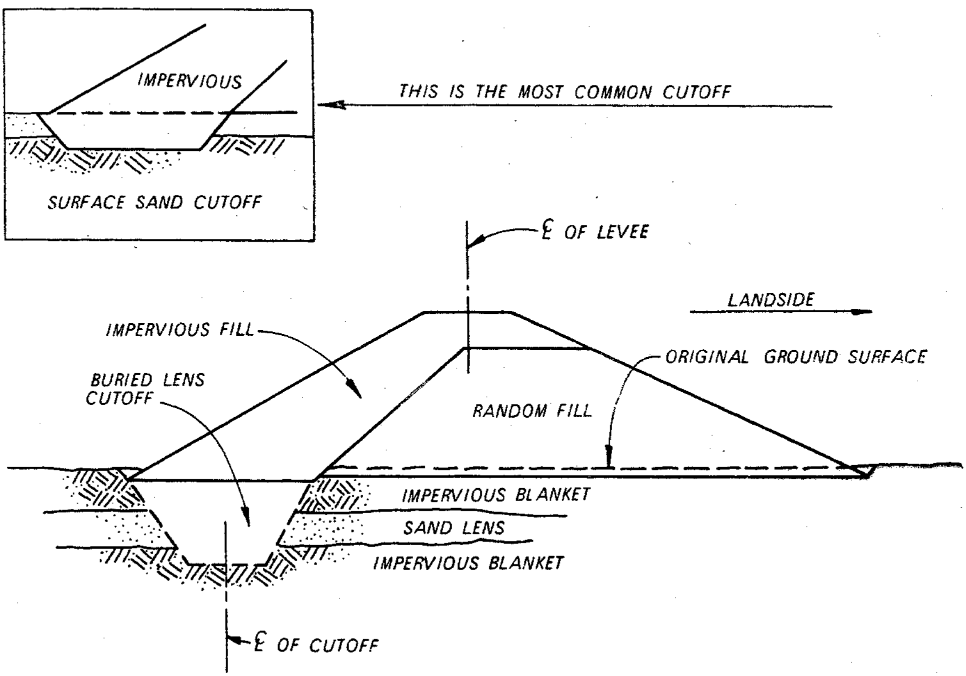
I. Purpose.

1. This booklet is intended as a brief resume of typical levee design problems only and does not govern when special problems are in conflict with the Operations & Maintenance Manual. It is furnished as a guide, or tool, to assist the sponsor or his engineering consultant in understanding what is important and why certain treatments are required. This should permit various types of construction to be considered and even partially designed. This booklet does not, however, preclude the necessity of early submission for review.

2. The sponsor should "control" all construction on his Flood Protection Unit, especially within the "critical area." This is not an attempt to restrict commercial development, since much construction would not be detrimental to the flood protection project if done properly. That construction which would be detrimental to the integrity of the flood protection can be constructed with compensating features. Almost anything can be built if properly designed. Incls 1 and 2 at the back of this Guidebook cover specifically excavation and backfill; and pipelines over levee. In addition, all pipes, lines, and any other below ground structural features within the critical area should comply with special Corps requirements.

II. Basic Levee Section.

1. As a general rule, levees are carefully constructed earthen embankments, zoned to provide the best protection possible with the available materials. Usually these are rolled, compacted levees (i.e., the materials are placed in 8-inch layers and compacted with six passes of sheepsfoot, pneumatic or vibratory rollers).



BASIC LEVEE SECTION

NOT TO SCALE

FIG 1

Sometimes, however, the materials are cast-in-place (e.g., materials are excavated from an adjacent channel being constructed by dragline, swung into place in the levee to become part of the levee). Occasionally, materials (usually the random fill zone, landside berm or pervious blanket) are dredged-in-place from the adjacent river. Dredged materials (sands) are mostly obtained from a major river with a good deep aquifer beneath its bed, such as the Mississippi, Missouri, or Kansas.

2. In a zoned levee, the riverward portion is usually an impervious zone, or water barrier. Beneath and landward is the support zone of random fill. This random material may be either pervious or impervious, but the levee must grade progressively more pervious in a landward direction.

3. In some reaches sand lens cutoffs may have been required. Figure 1 shows both a cutoff for surface sands and for a buried sand lens. Such cutoffs are necessary to establish continuity of the impervious barrier on the riverside levee face with the impervious blanket beneath the levee, thereby preventing a seepage path from occurring. Care must be exercised to maintain the integrity of such cutoffs when permitting utility lines, etc., to cross the levee. Enclosure 2 shows a typical crossing of the levee (the type of pipe and other features of the pipeline must also be approved).

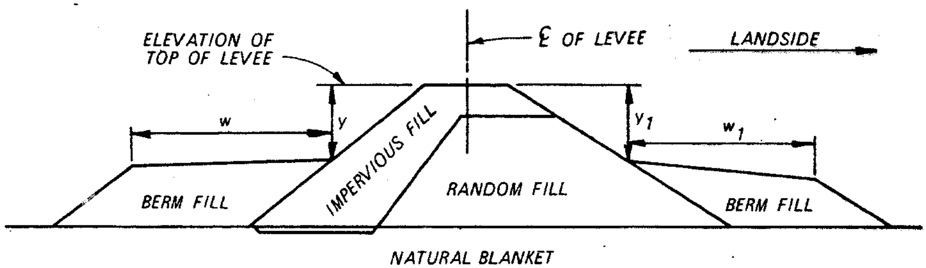
4. Pervious landside drains are sometimes used within the levee embankment to draw the phreatic (saturation) line down for added safety. These must be maintained in a free-draining (unchoked) condition. They may not be covered over or removed without compensating treatment.

III. Section with Stability Berms.

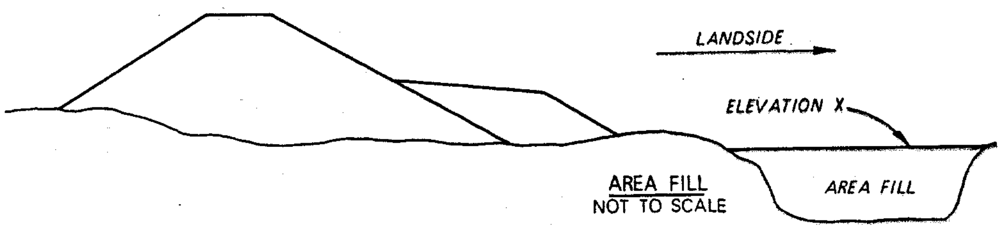
1. Stability berms are required to be added to the basic levee (either landside, riverside, or both) for a number of reasons. Primarily they are used to add weight to the passive (resisting) portion of a critical section, or one which under certain conditions, would have a tendency to slide or fail.

2. Typical sections of reaches are analyzed for various cases (sets of conditions which can develop), and berms are proposed of the size, shape and materials required to obtain our minimum safe or allowable requirements, based on the original design data and assumptions for typical reaches.

3. Berm proportion is usually controlled during construction by designating the dimension between the top of levee and the spring point - "y" - (junction of the berm with the main levee embankment, see figure 2) and the berm width, shown as "w." The sections in the Operations and Maintenance Manual may, or may not, be shown this way.



SECTION WITH STABILITY BERMS
NOT TO SCALE
FIG 2



AREA FILL
NOT TO SCALE
FIG 3

4. Berm materials are usually soil, sand, or rock. For various reasons, the material may be specified; i.e., pervious, impervious, random, rock, etc. If it becomes necessary to excavate and backfill through a berm zone, material matching the adjacent undisturbed soil should be used.

5. Ordinarily, material used in stability berms is specified only as berm fill. This gives the Contractor a much wider choice of material usable for this construction feature. In such cases, traffic compaction is usually adequate and neither moisture nor density controls are normally required.

6. This type of material is sometimes used to fill local depressions of irregular shape where specifications require filling to a predetermined elevation. These fills, see figure 3, are sometimes referred to as "area fills."

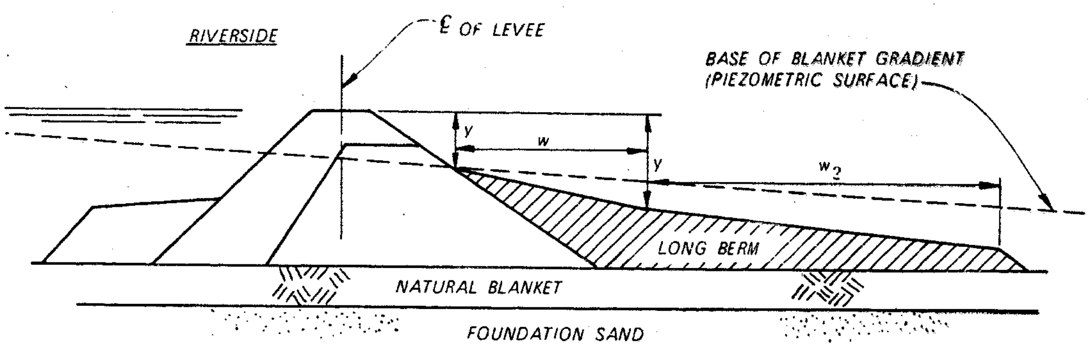
IV. Underseepage Berms.

1. Underseepage berms are often required in thin blanket areas. Where the impervious natural blanket is thin, there is danger of rupture landward of the levee because there is more water pressure (hydrostatic head) at the base of the natural impervious blanket at the landward levee toe than there is weight in the blanket. Some sort of control is necessary.

2. It is obvious that either the uplift pressure must be decreased, or the weight of the resisting material (natural blanket) must be increased. Whichever treatment is used, the weight of this impervious material must resist the upward pressure of the water during floods.

3. These underseepage berms (commonly called long berms) are an application of the second method. The construction of long berms is a means of increasing the blanket thickness artificially, for a limited distance landward.

4. Fortunately, the condition improves with distance landward due to loss of head or water force as a result of increased distance, or resistance to flow from the source (river). This can be noted by the shape of the long berm. The thickest portion is adjacent to the levee and thickness becomes less, with distance away from the "line of protection" (levee). The top of the berm generally approximates the slope of the base of blanket gradient. It should be noted that, to avoid a diaphragm effect, the berm material was selected to be as pervious or more pervious than the underlying natural blanket. Where excavation through underseepage berm areas is required, these materials must be replaced to match the adjacent undisturbed materials.



SECTION WITH UNDERSEEPAGE BERM

NOT TO SCALE

FIG 4

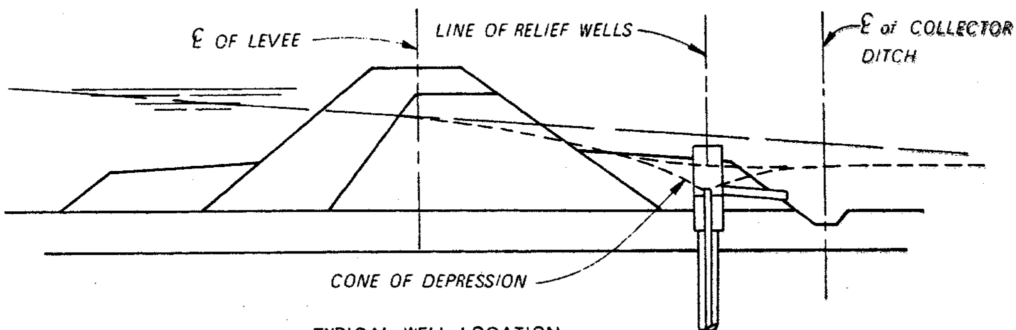
V. Pressure Relief Wells.

1. Often, especially in cities or congested areas, it is not practical to use an artificial blanket (long berm) and some method of drawing the piezometric surface down must be selected. This can be accomplished by construction of relief wells, underseepage interceptors, french drains or other means. The use of relief wells is probably the most common method and certainly the most reliable.

2. These wells are usually artesian flow, although pumped wells can be used. The artesian wells only flow when the river surface reaches a critical predetermined elevation. On some projects these relief wells discharge into ditches or low areas, or on the ground along the landside toe. In cities, more often each well discharges into a manhole and the manholes are connected by a gravity header pipe. The discharge flows toward a pumping plant (usually located near the center of the relief well reach), where it is collected and pumped back over the levee into the river.

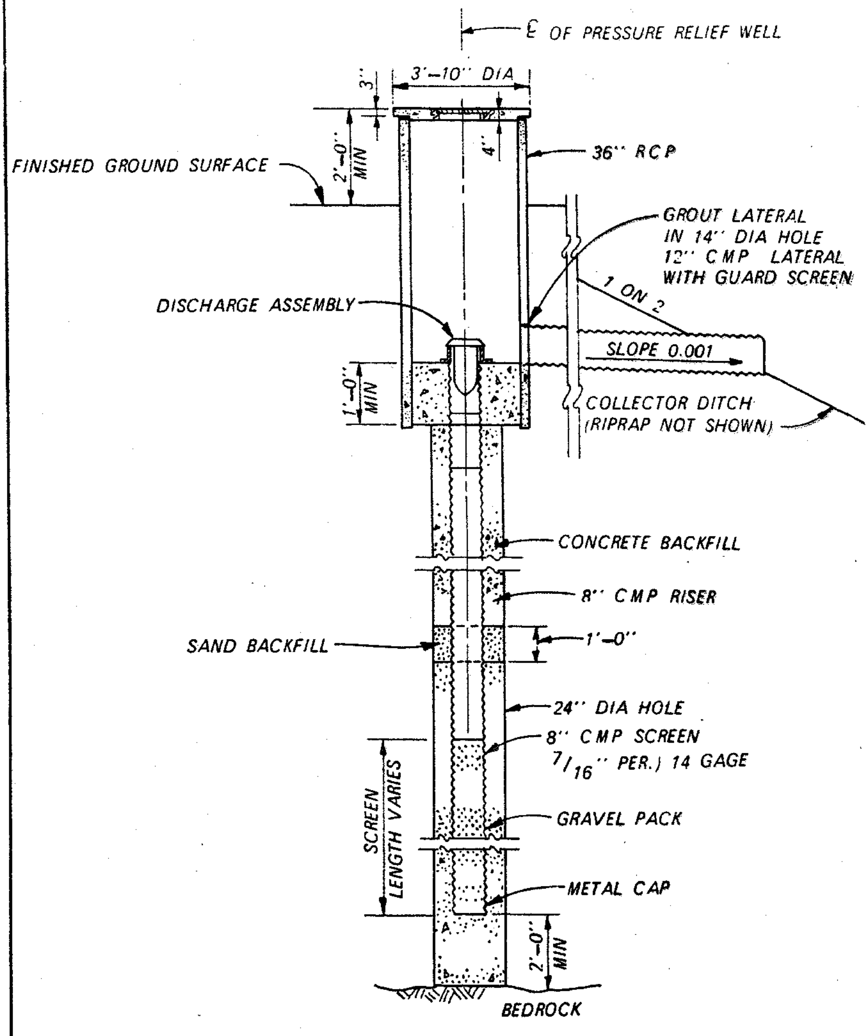
3. Each well, during flood stages, causes a cone of depression in the piezometric surface (i.e., the above-ground pressure) and these "cones" can be adjusted for size and depth. They are overlapped to pull all the excess head down to within allowable limits between wells or at check points. The well systems are designed for "existing conditions" at the time of design, and it is readily apparent that excavating for basements, buried tanks, loading ramps, etc., near the levee could greatly endanger the protection. All these things can be done, if done properly.

4. Relief wells are usually spaced along the levee or floodwall toe, but occasionally are used around buildings or along approach ditches. A typical surface discharging well installation is shown in figure 5.



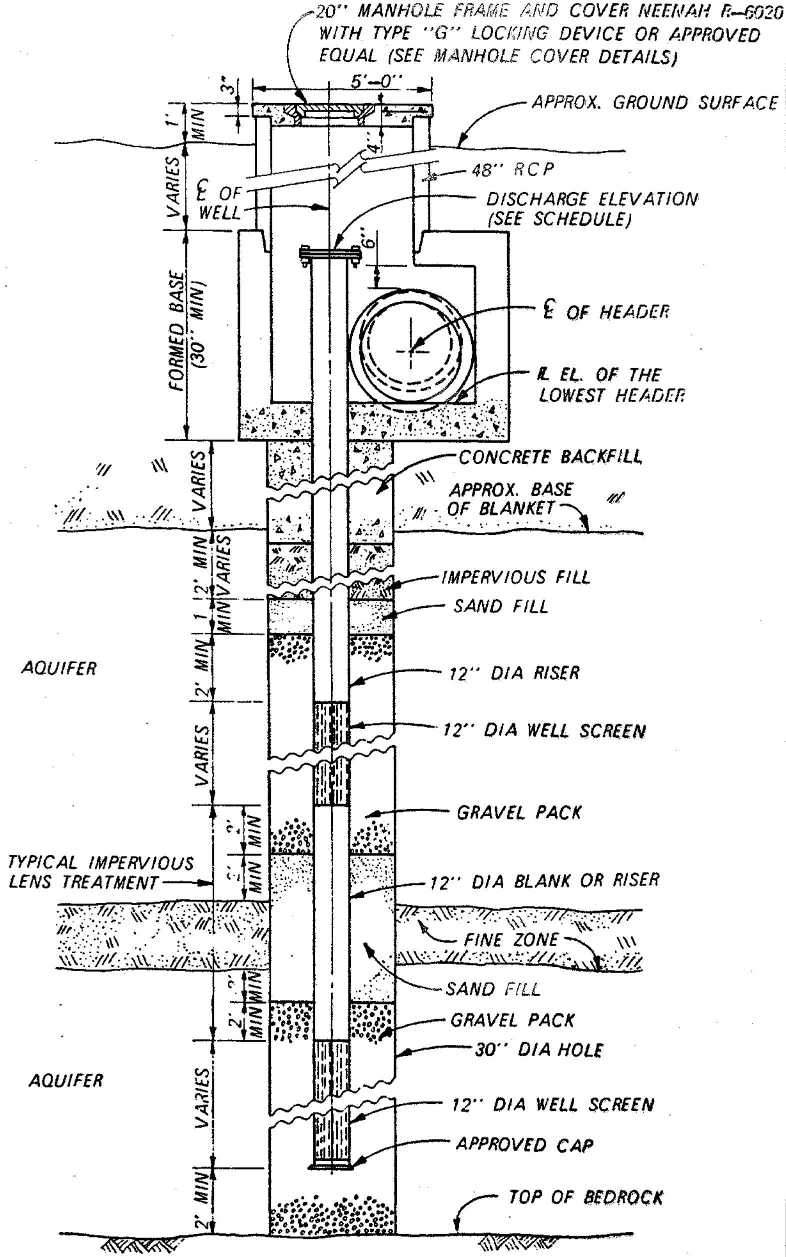
TYPICAL WELL LOCATION
NOT TO SCALE
FIG 5

5. Relief wells should be inspected semiannually for contamination or damage and at least once in 5 years should be checked by performing pumping tests. These tests (i.e., drawdown, yield, etc.) should be compared to previous tests to determine if there has been any loss of well efficiency.



TYPICAL SURFACE DISCHARGING
RELIEF WELL SECTION
NOT TO SCALE

FIG 6



TYPICAL WELL AND MANHOLE

NOT TO SCALE

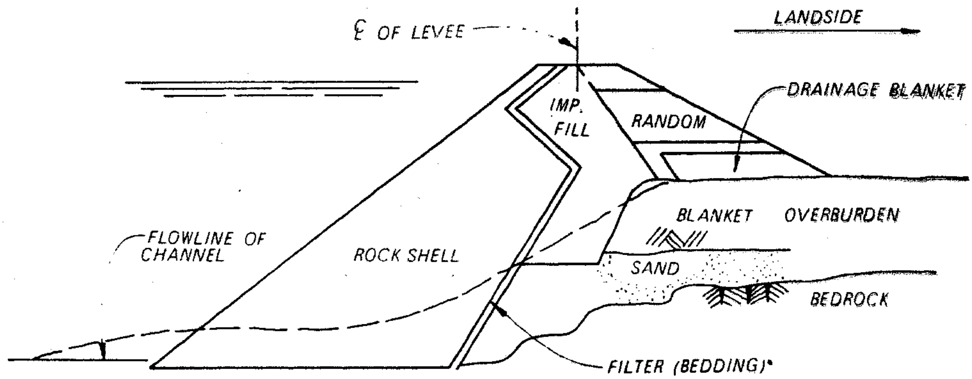
NOTE:

RELIEF WELL DISCHARGE INTO A HEADER SYSTEM

FIG 7

VI. Rock Shell Sections.

1. Rock shell sections are sometimes used where right-of-way is very limited and the section is essentially the high over-build type.
2. Advantage is taken of the relatively high shear strength of the rock zone, to proportion the section so that adequate stability can be maintained with a steep and narrow embankment.
3. Often a landside drain is used in conjunction with the riverside rock shell to allow steepening of the landward slope.
4. If it is necessary to cut through a rock shell section to install a utility line or for other reasons, great care must be taken to replace the materials exactly. Rockfill, filter, spalls or pervious drain materials which have become mixed with soil are no longer free draining or high shear strength. If excavated materials cannot be selectively stockpiled successfully, new materials should be obtained and the mixed materials used in random or berm zones or wasted.



ROCK SHELL SECTION
NOT TO SCALE
FIG 8

VII. Exit and Approach Channel and Ditch Treatments.

1. Because of underseepage conditions at many ditches and creeks where structures are located, special treatments are required.
2. **Riverside Blanket.** Where channels or ditch excavations are required or sometimes where a structure is located in a natural channel, it is often necessary to blanket the excavation on the riverside to inhibit underseepage. This maintains continuity of the blanket through the ditch and ties to the main embankment or berm.
   a. This process requires overexcavating and backfilling with rolled impervious material along the bottom and sides to the minimum thickness specified.
   b. These blankets are constructed of good clay material to avoid scour or erosion. Any erosion or excavation in this blanket should be carefully repaired with similar material.
   c. The artificial blanket should overlap the natural blanket at the sides a sufficient amount to eliminate flow paths through weakened boundaries and should tie to the impervious zone of the levee.
   d. It is usually unnecessary to construct the blanket more than 500 feet riverward.

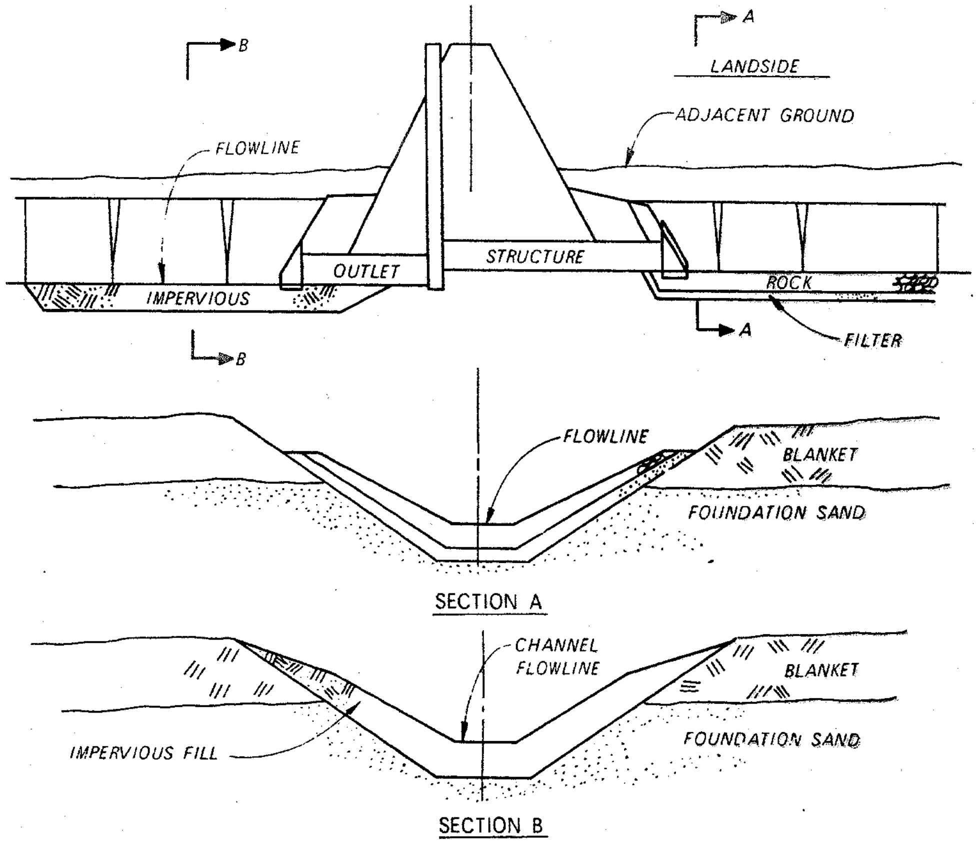


FIG 9

BLANKET SECTIONS

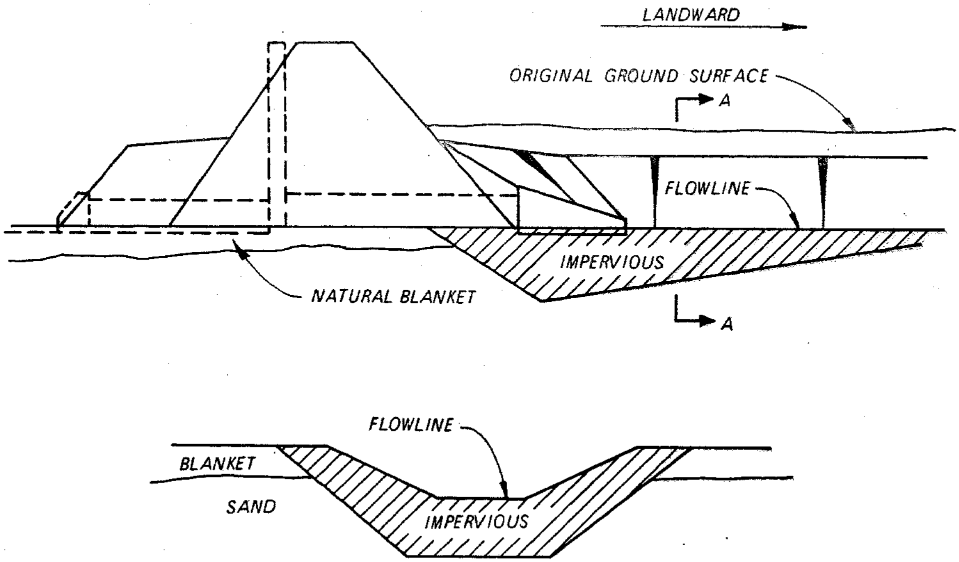
3. **Landside Filter Blanket.** Sometimes, especially where ponding is assured, the landside ditch blanket consists of a filter installation. This is constructed by overexcavation, placement of bedding material, and placement of riprap or rock on top of this to flowline grade. See figure 9.

a. This treatment allows controlled seepage into the pond during flood stages. It is designed to stop seeping when the channel is nearly full.

b. The filter should, as in the case of riverside blanket, overlap the natural blanket and levee, or berm toe.

c. Relief wells are used in conjunction with this treatment on many projects (i.e., relief wells are placed on either side of the filtered ditch and discharge into it).

d. Extension of this filter beyond range 5+00 landward is rarely required. Most often, the first 100 or 200 feet of landward channel is all that requires treatment.



SECTION A
NOT TO SCALE
FIG 10

BLANKET SECTIONS

4. **Landside Impervious Blanket.** Landside impervious blanket is commonly used as an underseepage control measure in interior drainage ditches, relief well header ditches, or in existing creek channels. Where these features cut through, or nearly through the natural blanket, some treatment must be used which will: (a) maintain the required flowline, (b) provide an adequate blanket through (around and under) the ditch or creek, and (c) provide a relatively watertight lining for the ditch during normal periods. The landside impervious blanket or ditch lining will accomplish these purposes, provided it has been properly designed and installed. Sometimes it is necessary to dewater with well points to properly install the blanket.

5. **Channel fill** is often used for a combination stability and underseepage treatment. This is very effective in old oxbows, channels and depressions where no drainage structure is involved. Such material should not be removed and all excavation should be controlled.

VIII. Structural Excavation and Backfill.

1. Excavation around existing structures (such as bridge abutments) or in preparation for new structures must be carefully executed to maintain the required minimum stability under temporary conditions. If the excavated materials are to be reused for backfill, selective stockpiling will be required. Care should be exercised not to place the stockpile or excavated material so close to the excavation as to surcharge (add load to) the slope. At least the danger of such surcharge should be pointed out to the contractor so that in the event of failure, repair will be at his expense. Stockpiles should be placed at least a distance back from the edge of the excavation equal to the depth.

2. Water problems often arise during excavation operations due to (a) a rise in the nearby river, (b) proximity of the floor of the excavation to the ground water level, or (c) from surface runoff into the excavation.

a. Problems (a) and (b) above can be quite serious and can threaten existing facilities as well as those under construction. In this case, water usually enters the excavation under hydrostatic head from the bottom and/or sides. If the head differential is large, the water tends to float out soil particles causing a "quick" condition or "boil." This problem can worsen rapidly and pumping out the pit will only further worsen the condition. Dewatering with a well point system is effective in lowering the gradient (excess pressure), but its operation must be continuous until the critical period of construction and/or backfill is completed. There are several other methods to satisfactorily dewater an excavation without creating a "quick" condition, such as installing one, or a few deep wells at strategic locations.

b. Water in the hole from runoff is quite different and, where an "upward gradient" is not involved, this water may be drained off, or drained into a sump and pumped out with portable pumps. This ponded water will cause a loss of stability to slopes, particularly steep, temporary slopes. Water should not be allowed to stand in an excavation.

3. Backfill around structures is often zoned and generally requires careful selection of backfill material.

4. Zoning may have been used for various reasons:

a. To maintain the integrity of adjacent protection.

b. To alleviate dewatering problems during the original construction.

c. To maintain adequate stability of the structure and/or embankment.

5. Due to limited operating space, compaction of such backfill often requires a hand operation (mechanical tampers, etc.) in lieu of conventional rolling or compacting equipment.

6. A careful, systematic check of zoning, materials, and resulting densities must be made throughout these backfill operations. Proper preparation of adjacent slopes to receive fill is necessary for good bonding.

IX. Inspection Trenches.

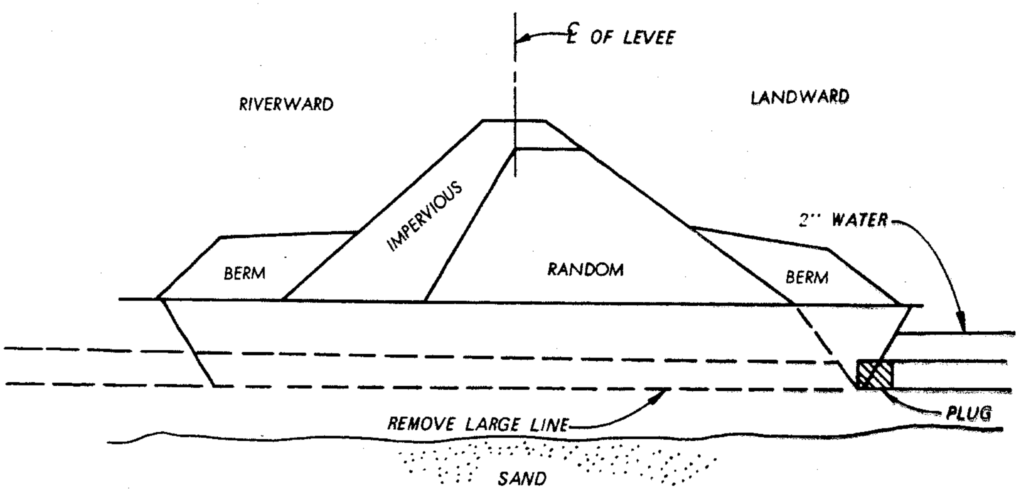
1. Where levee alignment traverses old residential or industrial areas, removal of abandoned utilities is often required. Generally, local interests furnish plots and detailed plans of all known service lines and sewerlines involved but experience has shown that abandoned lines (often fairly large) may be present.

2. Where lines are shown on the construction plans or are discovered later during construction operations for other work, the following will serve as a guide, provided there is no conflict with plans and specifications for the specific job.

a. Lines less than 2 inches in diameter (house service waterlines, etc.), may be capped and left in place.

b. Larger lines within the blanket and beneath the levee proper and 8 feet or less in depth should be removed.

c. Should such lines be located below the natural blanket (in the foundation sands), they may be plugged at the exposed (trench) end, cleaned, and grouted full in an "up slope" direction.

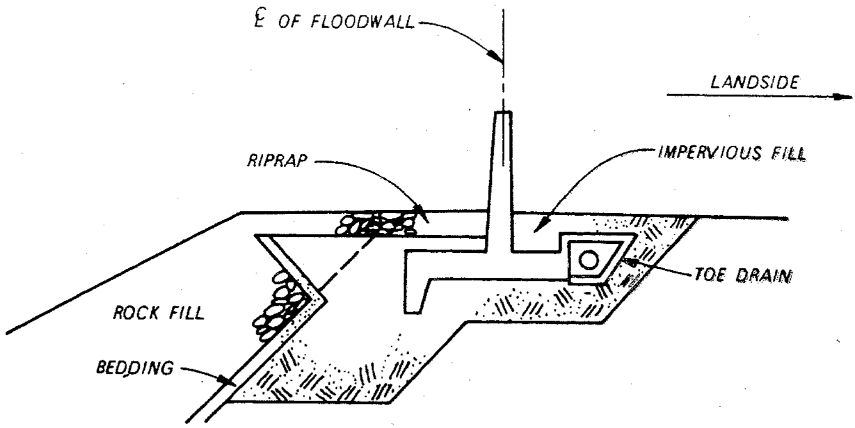


PLUGGING LINES
NOT TO SCALE

FIG 11

d. Should the pipe be vitrified clay, it is usually good practice to remove it in any case.

e. Where a line is of a size as in "b" above, and is within the blanket but greater than 8 foot depth, each such case should be discussed with the Corps of Engineers and treated on a case-by-case basis.



FLOOD WALL SECTION
NOT TO SCALE
FIG 12

X. Floodwall Treatments.

1. It is often necessary to go through or under existing floodwalls with sewer outfall lines, waterlines, or utilities. In such cases, the excavation and backfill requirements are at least as critical as those for levees. If possible, all lines should go over the floodwall. Where gravity storm sewers, etc., are involved, each case should be studied separately. With pile bearing walls, it is sometimes possible to tunnel with less disturbance than open excavation.

2. Zoning during backfill operations is very important here since underseepage is often a problem. In such cases, careful inspection of the operation is required. Unusually high densities may be specified for wall foundations backfill. These are necessary to prevent subsequent settling and misalignment of the reconstructed wall. In this case, the specified densities should be strictly adhered to. These densities are critical whether the wall was removed and rebuilt, or merely undercut.

3. Toe drains are ordinarily used to intercept seepage. These are usually surrounded by a single or multistage filter course and are necessary to the stability of the wall under flood conditions. These must be replaced if they are removed during excavation.

4. If replacement is necessary because of damage, they must be constructed as specified. Check to see that: pipes are properly coated, aligned and open, perforations are open, and there is proper gradation, and placement of filter materials.

5. Should the wall be rock bearing (placed on bedrock), it will probably be necessary to place any lines through the wall stem.

XI. Slope Protection.

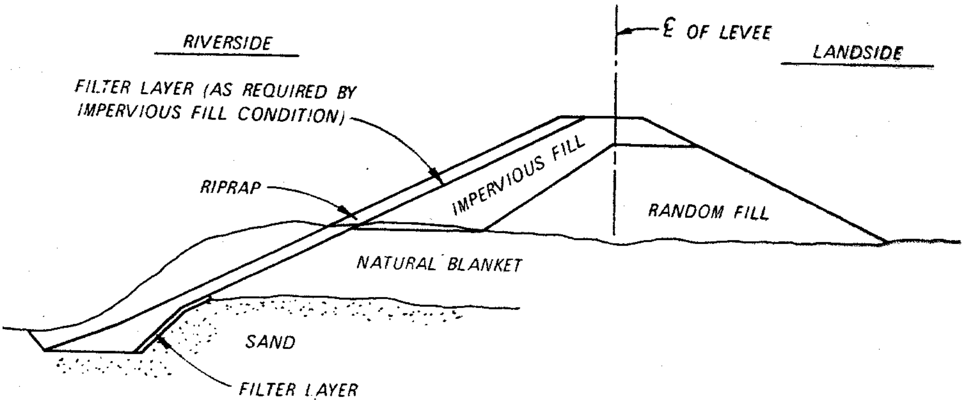
1. The riverward levee slope is surfaced with riprap at certain locations to prevent the levee from being eroded due to high water velocities and/or direct attack on the levee face.

2. At locations where riprap is required, it is usually necessary to provide an underlying filter layer (bedding) to prevent the levee material from being drawn through the riprap.

3. Generally the bedding layer is used over the impervious zone when the liquid limit of the impervious material indicates silt or clayey silt.

4. On many projects, the ground riverward of the levee has been excavated and the levee slope is extended to a rock toe below mean low water. This riverward excavation sometimes exposes sand lenses or strata in or below natural blanket. Where these conditions are encountered and have not been provided for in the plans and specifications, the office should be notified, since it is necessary to provide a filter layer under the riprap to prevent undermining of the levee slope.

5. Riprap and filter gradations are designed so that the underlying soil particles cannot be drawn through the voids in these materials. Gradations in the specifications must be strictly adhered to in order for the slope protection to properly perform its function. In general, for riprap, the 50 percent size is the most important gradation control. Such gradations will be furnished, along with suitable sources, by the Corps of Engineers. See figure 13.



TYPICAL RIPRAP AND FILTER LAYER
NOT TO SCALE
FIG 13

XII. Guidelines for Excavation and Backfill (inclosure 1). This is a set of guide specifications which are general in nature and may be copied and furnished to property owners, utility companies, railroads, highway departments, and others planning levee crossings or excavation and backfill within the "critical area."

XIII. Pipelines over Levees (inclosure 2). This drawing shows the method to use for a typical pipeline crossing of a levee.