EMERGENCY ACTION PLAN

FAWN LAKE DAM

Spotsylvania County, Virginia

Inventory Number: 177009

Fawn Lake

HISTORIC FREDERICKSBURG, VIRGINIA

Revision 14.1

January 2024

Volume II

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Appendix L– Emergency Supplies

(Companies that can aid in the event of an emergency)

CONTRACTORS		
Bander-Smith (Dam Repair/Diving) 22 S Davis Ave, Richmond, VA 23220	Mr. Cameron Smith Mr. Austen Bander, P.E.	(804) 212-2898
W.C. Spratt Inc. (Earthwork) 491 Central Road Fredericksburg, VA 22401	Mr. Doug Tait	540-373-2002
Chemung Contracting Corp. (Earthwork) 7201 Rail Line Court Gainesville, VA 20155	Mr. Ed Dalrymple	540-829-7203
EQUIPMENT RENTAL (Lights and Pumps)		
Sunbelt Rentals 1200 Belman Road Fredericksburg, VA 22401		540-710-1300 800-667-9328
United Rentals 10 Le Way Drive Fredericksburg, VA 22406		540-599-0053 800-877-3687
RSC Rentals 4616 Lassen Lane Fredericksburg, VA 22408		540-710-2300 800-222-7777
Rain for Rent 23025 Airpark Drive Petersburg, VA 23803		877-667-8541
MATERIALS - SAND		
Ennstone Inc 1170 Kings Highway, Fredericksburg, VA 22405-3814		540-361-1653

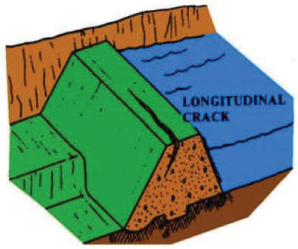
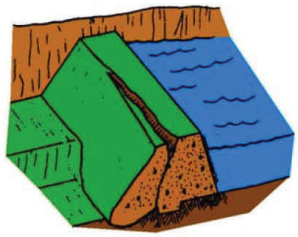
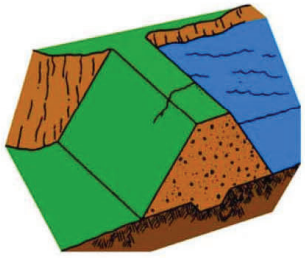
MATERIALS – CRUSHED STONE		
9100 Luck Stone Ln Fredericksburg, VA 22407-5302		540-898-6060
	MATERIALS – MISC	
Home Depot 5771 Plank Road Fredericksburg, Virginia 22407		540-785-8871

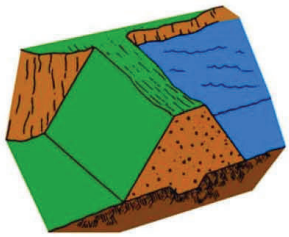
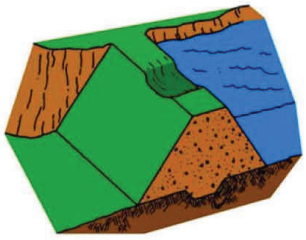
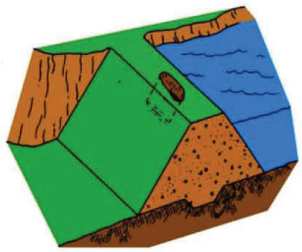
The Fawn Lake Community Association and Fawn Lake Country Club may have resources to help with an emergency situation, including manpower, trucks, and supplies (e.g. sand at the beach and sand traps).

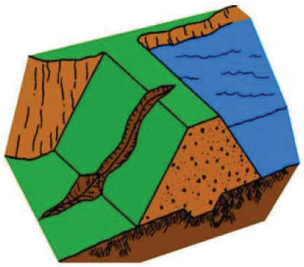
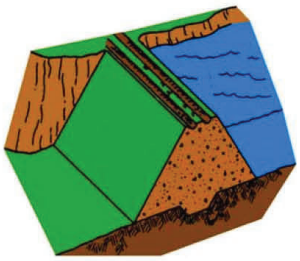
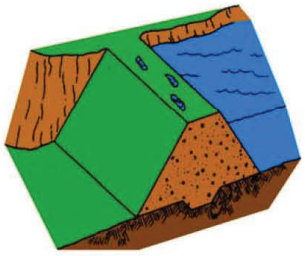
The residents of Fawn Lake are also potential sources of materials and equipment (e.g. pontoon boats), etc.

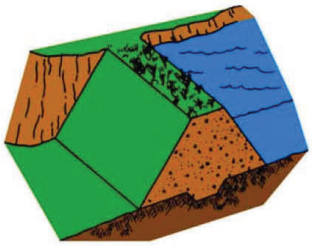
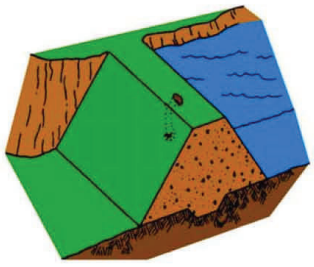
Appendix M – Potential Problems and Actions

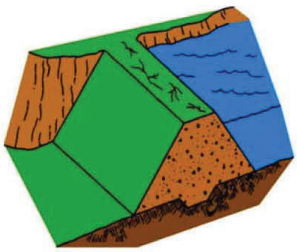
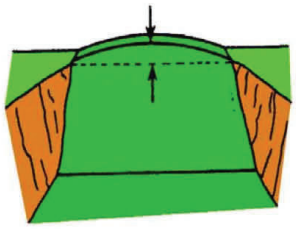
The following excepts from the Indiana Department of Natural Resources' Dam Maintenance Handbook provides numerous examples of potential problems that can occur with dams, probable causes and harm done, and recommended actions when the condition arises.

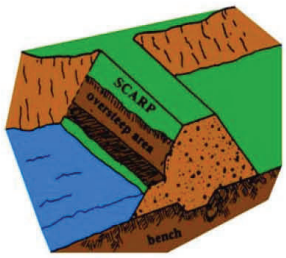
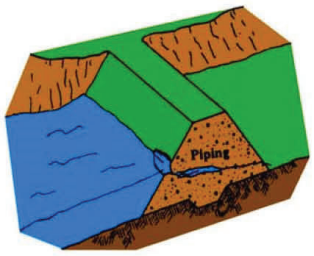
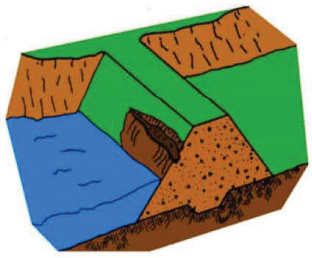
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
LONGITUDINAL CRACKING  	**Probable Cause:** 1. Uneven settlement between adjacent sections or zones within the embankment. 2. Foundation failure causing loss of support to embankment. **Harm**: 1. Creates local area of low strength within embankment. Could be the point of initiation of future structural movement, deformation, or failure. 2 Provides entrance point for surface run-off into embankment, allowing saturation of adjacent embankment area and possible lubrication which could lead to localized failure.	**Potential Action:** 1. Inspect crack and carefully record location, length, depth, width, alignment, and other pertinent physical features. Immediately stake out limits of cracking. Monitor frequently. 2. Engineer should determine cause of cracking and supervise steps necessary to reduce danger of dam and correct condition. 3. Effectively seal the cracks at the crest's surface to prevent infiltration by surface water. 4. Continue to routinely monitor crest for evidence of further cracking. *Qualified Dam Safety Professional Required*
VERTICAL DISPLACEMENT 	**Probable Cause:** 1. Vertical movement between adjacent sections of the embankment. 2. Structural deformation or failure caused by structural stress or instability, or by failure of the foundation. **Harm**: 1. Provides local area of low strength within embankment which could cause future movement. 2. Leads to structural instability or failure. 3. Provides entrance point for surface water that could further lubricate failure plane. 4. Reduces available embankment cross section.	**Potential Action:** 1. Carefully inspect displacement and record its location, vertical and horizontal displacement, length, and other physical features. Immediately stake out limits of cracking. 2. Engineer should determine cause of displacement and supervise all steps necessary to reduce danger to dam and correct condition. 3. Excavate area to the bottom of the displacement. Backfill excavation, using competent material and correct construction techniques, under supervision of engineer. 4. Continue to monitor areas routinely for evidence of future cracking or movement. *Qualified Dam Safety Professional Required*
TRANSVERSE CRACKING 	**Probable Cause:** 1. Uneven movement between adjacent segments of the embankment. 2. Deformation caused by structural stress or instability. **Harm**: 1. Can provide a path for seepage through the embankment cross section. 2. Provides local area of low strength within embankment. Future structural movement, deformation, or failure could begin at this point. 3. Provides entrance point for surface run-off to enter embankment.	**Potential Action:** 1. Inspect crack and carefully record crack location, length, depth, width, and other pertinent physical features. Stake out limits of cracking. 2. Engineer should determine cause of cracking and supervise all steps necessary to reduce danger to dam and correct condition. 3. Excavate crest along crack to a point below the bottom of the crack. Then backfill excavation using competent material and correct construction techniques. This will seal the crack against seepage and surface run-off. This should be supervised by engineer. 4. Continue to monitor crest routinely for evidence of future cracking. *Qualified Dam Safety Professional Required*

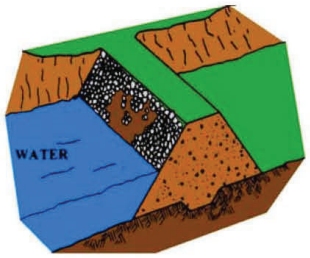
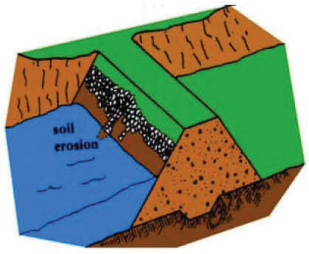
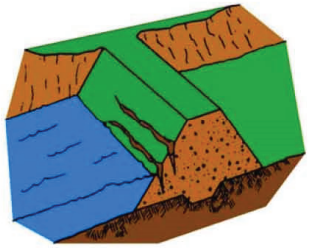
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
CREST ALIGNMENT 	**Probable Cause**: 1. Movement between adjacent portions of the structure. 2. Uneven deflection of dam under loading by reservoir. 3. Structural deformation or failure near area of misalignment. **Harm**: 1. Area of misalignment is usually accompanied by low area in crest which reduces free board. 2. Can produce local areas of low embankment strength which may lead to failure.	**Potential Action:** 1. Establish monuments across crest to determine exact amount, location, and extent of misalignment. 2. Engineer should determine cause of misalignment and supervise all steps necessary to reduce threat to dam and correct condition. 3. Monitor crest monuments on a schedule basis following remedial action to detect possible future movement. *Qualified Dam Safety Professional Required*
LOW AREA IN CREST OF DAM 	**Probable Cause**: 1. Excessive settlement in the embankment or foundation directly beneath the low area in the crest. 2. Internal erosion of embankment material. 3. Foundation spreading toward upstream and/or downstream direction. 4. Prolonged wind erosion of crest area. 5. Improper final grading following construction. **Harm**: Reduces freeboard available to pass flood flows safely through spillway.	**Potential Action:** 1. Establish monuments along length of crest to determine exact amount, location, and extent of settlement in crest. 2. Engineer should determine cause of low area and supervise all steps necessary to reduce possible threat to the dam and correct condition. 3. Re-establish uniform crest elevation over crest length by placing fil1 in low area using proper construction techniques. This should be supervised by engineer. 4. Re-establish monuments across crest of dam and monitor monuments on a routine basis to detect possible future settlement. *Qualified Dam Safety Professional Required*
SINKHOLE IN CREST 	**Probable Cause**: 1. Rodent activity. 2. Hole in outlet conduit is causing erosion of embankment material. 3. Internal erosion or piping of embankment material by seepage. 4. Breakdown of dispersive clays within embankment by seepage waters. **Harm**: 1. Void within dam could cause localized caving, sloughing, instability, or reduced embankment cross section. 2. Entrance point for surface water.	**Potential Action**: 1. Carefully inspect and record location and physical characteristics (depth, width, length) of sinkhole. 2. Engineer should determine cause of sinkhole and supervise al1 steps necessary to reduce threat to dam and correct condition. 3. Excavate sinkhole, slope sides of excavation, and backfill hole with competent material using proper construction techniques. This should be supervised by an engineer. *Qualified Dam Safety Professional Required*

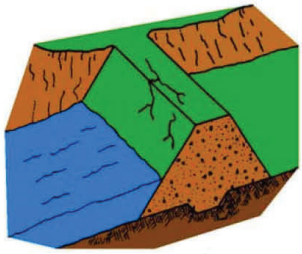
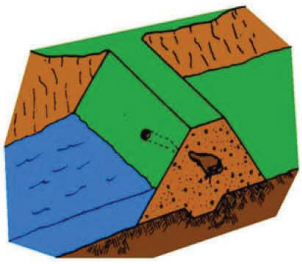
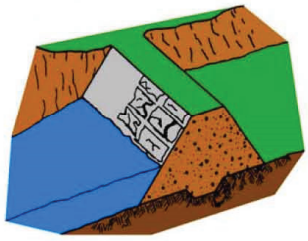
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
GULLY ON CREST 	**Probable Cause**: 1. Poor grading and improper drainage of crest. Improper drainage causes surface run-off to collect and drain off crest at low point in upstream or downstream shoulder. 2. Inadequate spillway capacity which has caused dam to overtop. **Harm**: 1. Can reduce available freeboard. 2. Reduces cross-sectional area of dam. 3. Inhibits access to all parts of the crest and dam.	**Potential Action**: 1. Restore freeboard to dam by adding fill material in low area, using proper construction techniques. 2. Re-grade crest to provide proper drainage of surface run-off. 3. If gully was caused by over-topping, provide adequate spillway which meets current design standards. This should be done by engineer. 4. Re-establish protective cover.
RUTS ALONG CREST 	**Probable Cause**: Heavy vehicular traffic without adequate or proper maintenance or proper crest surfacing. **Harm**: 1. Inhibits easy access to all parts of crest. 2. Allows continued development of rutting. 3. Allows standing water to collect and saturate crest of dam. 4. Operating and maintenance vehicles can get stuck.	**Potential Action**: 1. Drain standing water from ruts. 2. Re-grade and re-compact crest to restore integrity and provide proper drainage toward upstream slope. 3. Provide gravel or road base material to accommodate traffic. 4. Perform periodic maintenance and re-grading to prevent reformation of ruts.
PUDDLING ON CREST; POOR DRAINAGE 	**Probable Cause**: 1. Poor grading and improper drainage of crest. 2. Localized consolidation or settlement on crest allows puddles to develop. **Harm**: 1. Causes localized saturation of the crest. 2. Inhibits access to all portions of the dam and crest. 3. Becomes progressively worse if not corrected.	**Potential Action**: 1. Drain standing water from puddles. 2. Re-grade and re-compact crest to restore integrity and provide proper drainage toward upstream slope. 3. Provide gravel or road base material to accommodate traffic. 4. Perform periodic maintenance and re-grading to prevent reformation of ruts.

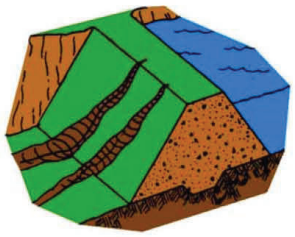
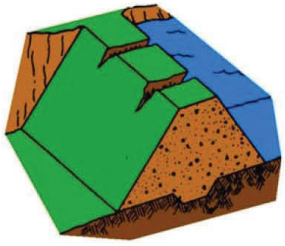
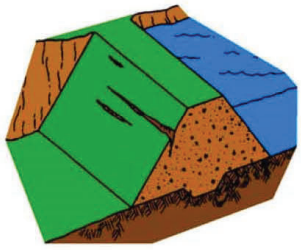
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
OBSCURING VEGETATION 	**Probable Cause**: Neglect of dam and lack of proper maintenance procedures. **Harm**: 1. Obscure large portions of the dam, preventing adequate, accurate visual inspection of all portions of the dam. Problems that threaten the integrity of the dam can develop and remain undetected until they progress to a point where the dam's safety is threatened. 2. Associated root systems develop and penetrate into the dam's cross section. When the vegetation dies, the decaying root systems can provide paths for seepage. This reduces the effective seepage path through the embankment and could lead to possible piping situations. 3. Prevents easy access to all portions of the dam for operation, maintenance, and inspection. 4. Provides habitat for rodents.	**Potential Action**: 1. Remove all detrimental growth from the dam. This would include removal of trees, bushes, brush, conifers, and growth other than grass. Grass should be encouraged on all segments of the dam to prevent erosion by surface run-off. Root systems should also be removed to the maximum practical extent. The void which results from removing the root system should be backfilled with competent, well-compacted material. 2. Future undesirable growth should be removed by cutting or spraying, as part of an annual maintenance program. 3. All cuttings or debris resulting from the vegetative removal should be immediately taken from the dam and properly disposed of outside the reservoir basin.
RODENT ACTIVITY ON CREST 	**Probable Cause**: Burrowing animals. **Harm**: 1. Entrance point for surface runoff to enter dam. Could saturate adjacent portions of the dam. 2. Especially dangerous if hole penetrates dam below phreatic line. During periods of high storage, seepage path through the dam would be greatly reduced and a piping situation could develop.	**Potential Action**: 1. Completely backfill the hold with competent, well compacted material. 2. Initiate a rodent control program to prevent the propagation of the burrowing animal population and to prevent future damage to the dam.

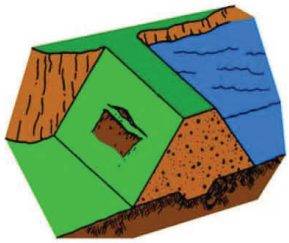
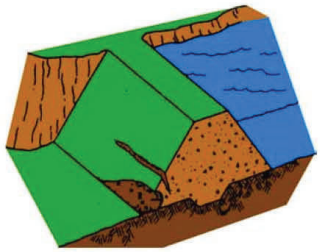
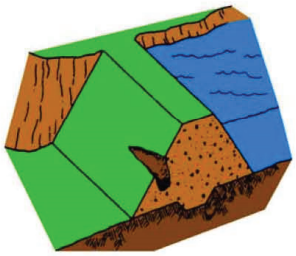
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
DRYING CRACKS 	**Probable Cause**: Material on the crest of dam expands and contracts with alternate wetting and drying of weather cycles. Drying cracks are usually short, shallow, narrow, and numerous. **Harm**: Provides point of entrance for surface run-off and surface moisture, causing saturation of adjacent embankment areas. This saturation and subsequent drying of the dam could cause further cracking.	**Potential Action:** 1. Seal surface of cracks with a tight, impervious material. **or…** 2. Routinely grade crest to provide proper drainage and till cracks. **or…** 3. Cover crest with non-plastic (not clay) material to prevent large moisture content variations with respect to time. 4. Draw the reservoir down if safety of dam is threatened.
CREST CAMBER 	**Probable Cause**: Results from construction. Proportionally more fill is placed on crest in higher segments of the embankment during construction to compensate for anticipated settlement within the dam and foundation. **Harm**: None.	**Potential Action**: None.

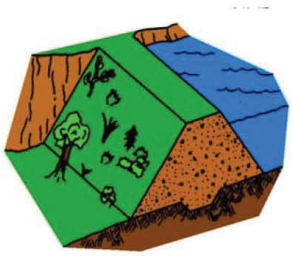
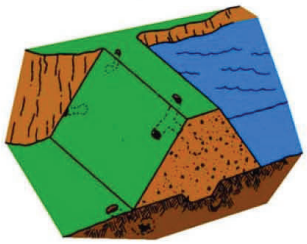
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
SCARPS, BENCHES, OVERSTEEP AREAS 	**Probable Cause**: Wave action, local settlement, or ice action cause soil and rock to erode and slide to the lower part of the slope forming a bench. **Harm**: This eroded area lessens the width and possible height of the embankment and could lead to increased seepage or overtopping of the dam.	**Potential Action**: Determine exact cause of scarps. Do necessary earthwork, restore embankment to original slope, provide adequate protection (bedding and riprap).
SINKHOLE 	**Probable Cause**: The piping of embankment material or foundation material causes a sink hole. The cave-in of an eroded cavern can result in a sink hole. A small hole in the wall of an outlet pipe can develop a sink hole. **Harm**: This condition can empty a reservoir through a small hole in the wall of an outlet pipe or can lead to failure of a dam as soil pipes through the foundation or a pervious portion of the dam.	**Potential Action**: Inspect other portions of the dam for seepage or additional sink holes. Identify exact cause of sink holes. Check seepage and leakage outflows for dirty water. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
SLIDE, SLUMP, OR SLIP 	**Probable Cause**: Earth or rocks move down the slope along a slippage surface because they were on too steep a slope, or the foundation moves. Also, look for slides in reservoir basin. **Harm**: A series of slides can lead to obstruction of the outlet or failure of the dam.	**Potential Action**: Evaluate extent of the slide. Monitor slide. Draw the reservoir level down if safety of dam is threatened. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

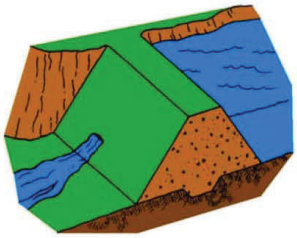
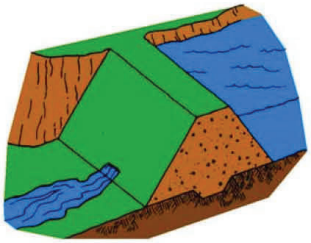
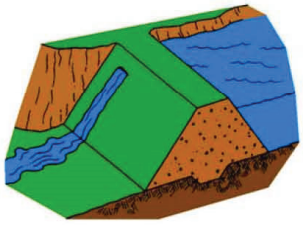
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
BROKEN DOWN, MISSING RIPRAP 	**Probable Cause**: Poor quality riprap has deteriorated. Wave action or ice action has displaced riprap. Round and similar sized rocks have rolled downhill. **Harm**: Wave action against these unprotected areas decreases embankment width.	**Potential Action**: Re-establish normal slope. Place bedding and competent riprap.
EROSION BEHIND POORLY GRADED RIPRAP 	**Probable Cause**: Similar-sized rocks allow waves to pass between them and erode small gravel particles and soil. **Harm**: Soil is eroded away from behind the riprap. This allows riprap to settle, providing less protection and decreased embankment width.	**Potential Action**: Re-establish effective slope protection. Place bedding material ENGINEER REQUIRED for design of gradation and size of rock for bedding and riprap. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
LARGE CRACKS ON SLOPE 	**Probable Cause**: A portion of the embankment has moved due to loss of strength, or the foundation may have moved, causing embankment movement. **Harm**: Can lead to failure of the dam.	**Potential Action**: Depending on the amount of embankment involved, draw reservoir level down. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
CRACKS DUE TO DRYING 	**Probable Cause**: The soil loses its moisture and shrinks, causing cracks. Note: Usually seen on crest and downstream slope mostly. **Harm**: Heavy rains can fill up cracks and cause small portions of embankment to move along internal slip surface.	**Potential Action**: 1. Monitor cracks for increases in width, depth, or length. 2. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
BEAVER OR MUSKRAT ACTIVITY 	**Probable Cause**: Holes, tunnels, and caverns are caused by animal burrows. Certain habitats like cattail-type plants and trees close to the reservoir encourage these animals. **Harm**: If a tunnel exists through most of the dam, it can lead to failure of the dam.	**Potential Action**: Remove rodents. Determine exact location of digging and extent of tunneling. Remove habitat. Repair damages.
CRACKED DETERIORATED CONCRETE FACE 	**Probable Cause**: Concrete deteriorated due to weathering. Joint filler deteriorated or displaced. **Harm**: Soil is eroded behind the face and caverns can be formed. Unsupported sections of concrete crack. Ice action may displace concrete.	**Potential Action**: 1. Determine cause. Either patch with grout or contact engineer for permanent repair method. 2. If damage is extensive, a qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

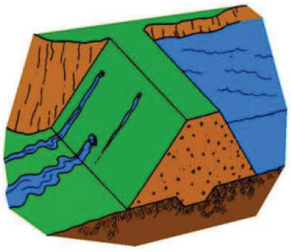
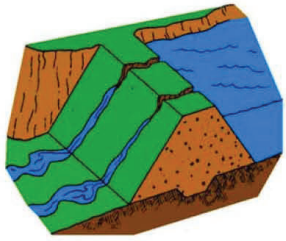
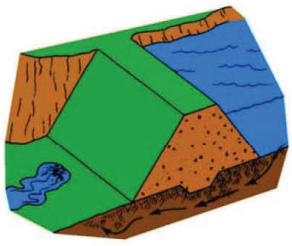
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
EROSION 	**Probable Cause**: Water from intense rainstorms or snow-melt carries surface material down the slope, resulting in continuous troughs. **Harm**: If allowed to continue, erosion can lead to eventual deterioration of the downstream slope which can shorten the seepage path.	**Potential Action**: 1. The preferred method to protect eroded areas is rock or riprap. 2. Re-establishing protective grasses can be adequate if the problem is detected early.
TRANSVERSE CRACKING AFFECTING SLOPE 	**Probable Cause**: 1. Drying and shrinkage of surface material is most common. 2. Differential settlement of the embankment also leads to transverse cracking (e.g., center settles more than abutments). **Harm**: 1. Shrinkage cracks allow water to enter the embankment. This promotes saturation and increases freeze thaw action. 2. Settlement cracks can lead to seepage of reservoir water through the dam. 3. Can lead to uncontrolled breach.	**Potential Action**: 1. If necessary plug upstream end of crack to prevent flows from the reservoir. 2. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
LONGITUDINAL CRACKING ON SLOPE 	**Probable Cause**: 1. Drying and shrinkage of surface material. 2. Downstream movement or settlement of embankment. **Harm**: 1. Can be an early warning of a potential slide. 2. Shrinkage cracks allow water to enter the embankment and freezing will further crack the embankment. 3. Settlement or slide indicating loss of strength in embankment can lead to failure.	**Potential Action**: 1. If cracks are from drying, dress area with well-compacted material to keep surface water out and natural moisture in. 2. If cracks are extensive, a qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
SLIDE/SLOUGH 	**Probable Cause**: 1. Lack of or loss of strength of embankment material. 2. Loss of strength can be attributed to infiltration of water into the embankment or loss of support by the foundation. **Harm**: Can lead to failure of the dam.	**Potential Action**: HAZARDOUS! 1. Measure extent and displacement of slide. 2. If continued movement is seen, begin lowering water level until movement stops. 3. Have a qualified engineer inspect the condition and recommend further action. *Qualified Dam Safety Professional Required*
SLUMP (LOCALIZED CONDITION0 	**Probable Cause**: Preceded by erosion undercutting a portion of the slope. Can also be found on relatively steep slopes. **Harm**: Can expose impervious zone to erosion.	**Potential Action**: 1. Inspect area for seepage. 2. Monitor for progressive failure. 3. Have a qualified engineer inspect the condition and recommend further action. *Qualified Dam Safety Professional Required*
SINK HOLE/COLLAPSE 	**Probable Cause**: Lack of adequate compaction; rodent hole below; piping through embankment or foundation. **Harm**: Shortens seepage path, can lead to washout of embankment and uncontrolled breach.	**Potential Action**: 1. Inspect for and immediately repair rodent holes. Control rodents to prevent future damage. 2. Have a qualified engineer inspect the condition and recommend further action. *Qualified Dam Safety Professional Required*

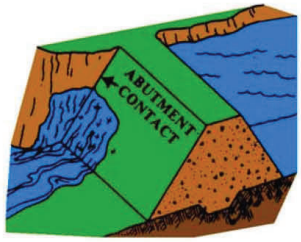
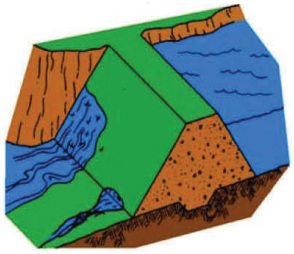
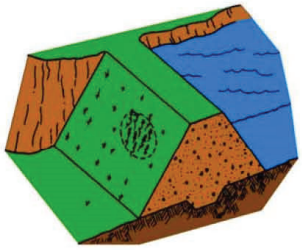
PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
TREES/OBSCURING BRUSH 	**Probable Cause**: Natural vegetation in area. **Harm**: Large tree roots can create seepage paths. Brushes can obscure visual inspection and harbor rodents.	**Potential Action**: 1. Remove all large, deep-rooted trees and shrubs on or near the embankment. Properly backfill void. 2. Control all other vegetation on the embankment that obscures visual inspection.
RODENT ACTIVITY ON SLOPE 	**Probable Cause**: Overabundance of rodents. **Harm**: Reduces length of seepage path. Can lead to piping failure.	**Potential Action**: 1. Control rodents to prevent additional damage. 2. Backfill existing rodent holes.
LIVESTOCK/CATTLE TRAFFIC 	**Probable Cause**: Excessive travel by livestock especially harmful to slope when wet. **Harm**: Creates areas bare of erosion protection and causes erosion channels. Allows water to stand. Area susceptible to drying cracks.	**Potential Action**: 1. Fence livestock outside embankment area. 2. Repair erosion protection, i.e., riprap, grass.

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
MUDDY WATER EXITING FROM A POINT SOURCE 	**Probable Cause**: 1. Water has created an open pathway, channel, or pipe through the dam. The water is eroding and carrying embankment material. 2. Large amounts of water have accumulated in the downstream slope. Water and embankment materials are exiting at one point. Surface agitation may be causing the muddy water. **Harm**: Continued flows can further erode embankment materials. This can lead to failure of the dam.	**Potential Action**: 1. Begin measuring outflow quantity and establishing whether water is getting muddier, staying the same, or clearing up. 2. If quantity of flow is increasing, the water level in the reservoir should be lowered until the flow stabilizes or stops. 3. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
WATER EXITING FROM A POINT SOURCE 	**Probable Cause**: Water has created an open pathway or pipe through the dam. **Harm**: Continued flows can further erode embankment materials. This can lead to failure of the dam.	**Potential Action**: 1. Begin measuring outflow quantity. 2. If quantity of flow is increasing, the water level in the reservoir should be lowered until the flow stabilizes or stops. 3. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
WATER EXITING FROM A POINT SOURCE HIGH ON THE EMBANKMENT 	**Probable Cause**: 1. Rodents, frost action, or poor construction have allowed water to create an open pathway or pipe through the embankment. **Harm**: 1. Continued flows can saturate portions of the embankment and lead to slides in the area. 2. Continued flows can further erode embankment materials and lead to failure of the dam.	**Potential Action**: 1. Begin measuring outflow quantity. 2. If quantity of flow is increasing, the water level in the reservoir needs to be lowered until the leak stops. 3. Search for opening on upstream side and plug it if possible. 4. A qualified engineer should immediately inspect the condition and recommend further action to be taken. *Qualified Dam Safety Professional Required*

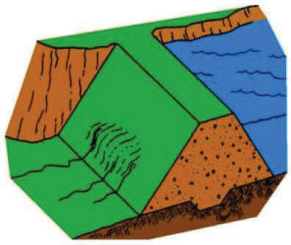
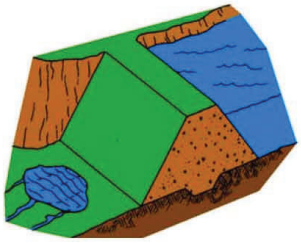
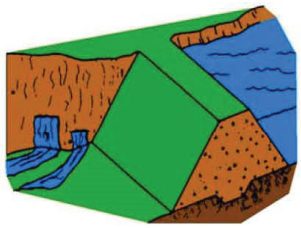
All problems are potentially hazardous.

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
WATER EXITING FROM RODENT HOLES 	**Probable Cause**: Diggings by the rodent have shortened the flow path. **Harm**: Continued flows can further erode embankment material and lead to failure of the dam.	**Potential Action**: 1. Locate any entrance points on the upstream slope and plug them. 2. If the quantity of flow is increasing, the water level in the reservoir needs to be lowered until the leak stops. 3. Bring a halt to the rodent activity. 4. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
STREAM OF WATER EXITING THROUGH CRACKS NEAR THE CREST 	**Probable Cause**: 1. Severe drying has caused shrinkage of embankment material. 2. Settlement in the embankment or foundation is causing the transverse cracks. **Harm**: Flow through the crack can cause failure of the dam.	**Potential Action**: 1. Plug the upstream side of the crack to stop the flow. 2. The water level in the reservoir should be lowered until it is below the level of the cracks. 3. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
SEEPAGE WATER EXITING AS A BOIL IN THE FOUNDATION 	**Probable Cause**: Some portion of the foundation material is providing a flow path. This could be caused by a sand or gravel layer in the foundation. **Harm**: Increased flows can lead to erosion of the foundation and failure of the dam.	**Potential Action**: 1. Examine the boil for transportation of foundation materials. 2. If soil particles are moving downstream, sandbags or earth should be used to create a dike around the boil. The pressure created by the water level within the dike may control flow velocities and temporarily prevent further erosion. 3. If erosion is becoming greater, the reservoir level should be lowered. 4. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

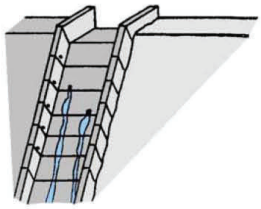
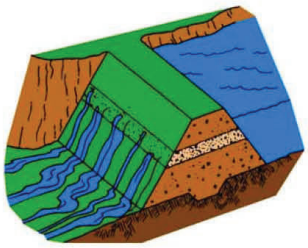
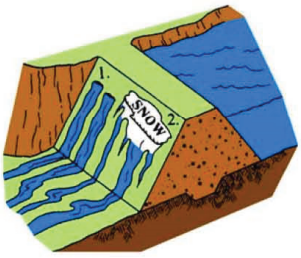
All problems are potentially hazardous.

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
SEEPAGE EXITING AT ABUTMENT CONTACT 	**Probable Cause**: 1. Water flowing through pathways in the abutment. 2. Water flowing through the embankment. **Harm**: Can lead to erosion of embankment materials and failure of the dam.	**Potential Action**: 1. Investigate leakage area to determine quantity of flow and extent of saturation. 2. Inspect daily for developing slides. 3. Water level in reservoir may need to be lowered to assure the safety of the embankment. 4. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
LARGE AREA WET OR PRODUCING FLOW 	**Probable Cause**: A seepage path has developed through the abutment or embankment. **Harm**: 1. Increased flows could lead to erosion of embankment material and failure of the dam. 2. Saturation of the embankment can lead to local slides which could cause failure of the dam.	**Potential Action**: 1. Stake out the saturated area and monitor for growth or shrinking. 2. Measure any outflows as accurately as possible. 3. Reservoir level may need to be lowered if saturated areas increase in size at a fixed storage level or if flow increases. 4. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
MARKED CHANGED IN VEGETATION 	**Probable Cause**: 1. Embankment materials are providing flow paths. 2. Natural seeding by wind. 3. Change in seed type during initial post construction seeding. **Harm**: Can indicate a saturated area.	**Potential Action**: 1. Use probe and shovel to establish if the materials in this area are wetter than in surrounding areas. 2. If area shows wetness when surrounding areas do not, a qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

All problems are potentially hazardous.

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
BULGE IN LARGE WET AREA 	**Probable Cause**: Downstream embankment materials have begun to move. **Harm**: Failure of the embankment due to massive sliding can follow these initial movements.	**Potential Action**: 1. Compare embankment cross-section to the end of construction condition to see if observed condition may reflect end of construction. 2. Stake out affected area and accurately measure outflow. 3. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
TRAMPOLINE EFFECT IN LARGE SOGGY AREA 	**Probable Cause**: Water moving rapidly through the embankment or foundation is being controlled or contained by a well-established turf root system. **Harm**: Condition indicates excessive seepage in the area. If control layer of turf is destroyed, rapid erosion of foundation materials could result in failure of the dam.	**Potential Action**: 1. Carefully inspect the area for outflow quantity and any transported materials. 2. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
LEAKAGE FROM ABUTMENTS BEYOND THE DAM 	**Probable Cause**: Water moving through cracks and fissures in the abutment materials. **Harm**: 1. Can lead to rapid erosion of abutment and evacuation of the reservoir. 2. Can lead to massive slides near or downstream from the dam.	**Potential Action**: 1. Carefully inspect the area to determine quantity of flow and amount of transported material. 2. A qualified engineer or geologist should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

All problems are potentially hazardous.

PROBLEMS	CAUSES & HARM DONE	ACTION REQUIRED
TOO MUCH LEAKAGE FROM SPILLWAY UNDER DRAINS 	**Probable Cause**: Drain or cutoff may have failed. **Harm**: 1. Excessive flows under the spillway could lead to erosion of foundation material and collapse of portions of the spillway. 2. Uncontrolled flows could lead to loss of stored water.	**Potential Action**: 1. Immediately measure flow quantity and check flows for transported drain material. 2. If flows are accelerating at a fixed storage level, the reservoir level should be lowered until the flow stabilizes or stops. 3. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
WET AREA IN HORIZONTAL BAND 	**Probable Cause**: Frost layer or layer of sandy material in original construction. **Harm**: 1. Wetting of areas below the area of excessive seepage can lead to localized instability of the embankment. (SLIDES) 2. Excessive flows can lead to accelerated erosion of embankment materials and failure of the dam.	**Potential Action**: 1. Determine as closely as possible the amount of flow being produced. 2. If flow increases, reservoir level should be reduced until flow stabilizes or stops. 3. Stake out the exact area involved. 4. Using hand tools, try to identify the material allowing the flow. 5. A qualified engineer should inspect the condition and recommend further actions to be taken. *Qualified Dam Safety Professional Required*
LARGE AREA SATURATED FROM ABOVE 	**Probable Cause**: 1. Water flowing through the embankment. 2. Snowdrifts melting slowly during mild spring temperatures. **Harm**: Can lead to saturation of embankment materials and local or massive slides which could cause failure of the dam.	**Potential Action**: 1. Investigate saturated area to determine depth and extent of saturation. 2. Inspect daily for developing slides. 3. Water level in reservoir may need to be lowered to assure the safety of the embankment. 4. A qualified engineer should inspect the conditions and recommend further actions to be taken. *Qualified Dam Safety Professional Required*

All problems are potentially hazardous.

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Appendix N – US Corps of Engineers – Sandbagging Techniques

The following article by the US Army Corps of Engineers provides a lot of useful information about sandbagging techniques.

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Portland, OR 97208-2946
(503) 808-4400

Seattle District
P.O. Box 3755
Seattle, WA 98124-3755
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Kansas City District
635 Federal Building, 601 E. 12th Street
Kansas City, MO 64106-2824
(816) 426-6320

Omaha District
1616 Capitol Ave.
Omaha, NE 68102-4901
(402) 995-2448

Walla Walla District
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US Army Corps
of Engineers ®
Northwestern Division

Sandbagging Techniques

Printed on recycled paper 2004.

The use of sandbags is a centuries old, tried and true method for flood fighting. See procedures and safety tips inside on efficient bagging operations.

Sandbags:

a steadfast tool for flood fighting

Sandbagging is one of the most versatile of flood fighting tools and is a simple, effective way to prevent or reduce flood water damage.

Although sandbags do not guarantee a watertight seal, they are a proven deterrent to costly water damage.

Sandbags have been used to:

- prevent overtopping of levees.
- direct a river's current flow to specific areas.
- construct ring dikes around boils on levee back slopes, levee toes or behind levees.
- use as weight on back slopes of saturated levees.
- weigh down visquine and straw bales.
- build buttresses on back slopes and the toes of saturated levees.
- reduce seepage at closure structures.

Read this brochure to learn proper filling and placement methods aimed at increasing productivity of sandbagging operations. Included are hints, safety tips and correct procedures which will minimize work-related injuries and strain and will maximize essential time.

THE FIRST LINE OF DEFENSE

Sandbag construction is a centuries old technique that has changed little. Bags are made from different materials including treated burlap and plastic. They measure approximately 14 inches wide and 24 inches long.

Sandbags filled one-half to two-thirds full should generally be left untied. Tied bags, filled slightly fuller, have specific purposes: filling holes, holding visquine or straw bales in place, or forming barriers backed by supportive planks or aluminum sheet piles.

If access to the flood site is limited to boat, tractor or helicopter, then pallets and forklifts may be needed to load and off-load sandbags.

Unused empty bags can be stockpiled for emergency and will be serviceable for years if kept dry and properly stored.

FILL MATERIALS

Sand is by far the easiest material for filling and shaping sandbags and becomes heavier when saturated from rain or moisture.

In emergencies, other materials such as silt, clay, gravel or a mixture of these may be used, but none work as well as sand.

When vehicle access is cut off to the flood site, and you have no other choice, use the back side of the levee or an adjacent field to find whatever material is available to fill sandbags.

Here are pros and cons on use of other materials:

- Silty soils get soft when wet and are more difficult to shape, and finer particles leak through the weave in the material.
- Clay materials are difficult to shape and to bag.
- Coarse-grained gravels are pervious and are also difficult to shape but can be used for redirecting the main stream flow while allowing seepage through bags.

ALTERNATIVES

Other methods and remedies for flood fighting are as follows:

- Readily available, straw bales are an economical alternative. They range in size from 18 inches high by 30 inches long to 4 by 4 by 8 foot long blocks. Secure the bales by driving 4 to 10 foot stakes (or rebar) through the straw into the levee top, and weight down with filled sandbags. Water swells the straw, making the bales heavier and watertight.
- Concrete Jersey Barriers or Ecology Blocks can be used to divert water and can be cost effective solutions.
- Plastic sheeting can be used effectively by placing sand along a fold.

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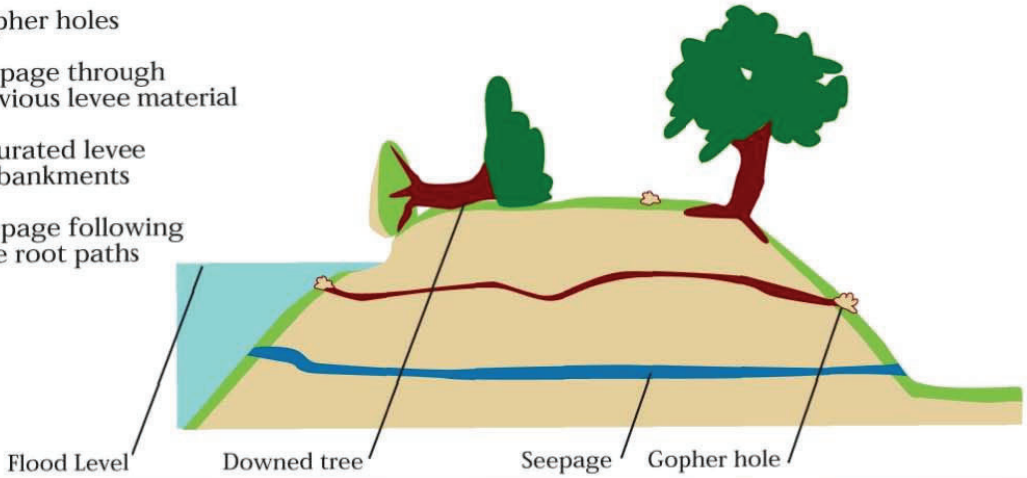
CAUSES OF LEVEE FAILURE

- Overtopping
- Downed trees on levee slope
- Gopher holes
- Seepage through pervious levee material
- Saturated levee embankments
- Seepage following tree root paths



CORRECT FILLING PROCEDURES

Filling sandbags is normally a two or three person operation. One member of the team, while crouching with feet apart and arms extended, should place the bottom of the empty bag on the ground.

The opening of the bag is folded outward about 1-1/2 inches to form a collar and held open to allow the second team member to empty a fully rounded No. 2 shovel of material into the open end of the bag.

Don't hurry. Haste can result in undue spillage and added work. The third team member stockpiles or stacks the open sacks. The three team members should rotate duties often to reduce job-specific muscle fatigue.

This two-member team uses correct positions for sandbag filling.

Untied bags should be filled approximately one-half to two-thirds full. Tied bags can be filled slightly more, but with enough room left at the top to tie the bag off properly.

Always use gloves to protect your hands during the filling operation. After handling treated bags, avoid contact with your eyes and mouth.

Dress appropriately and layer clothing. Safety goggles should be used on dry and windy days. Sandbag filling operations are done either near the actual placement site or at centrally located filling sites such as fire

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stations, diking districts or sand pits.

If the bags are filled at a distant location, vehicle transportation and access to the flood site are primary planning considerations.

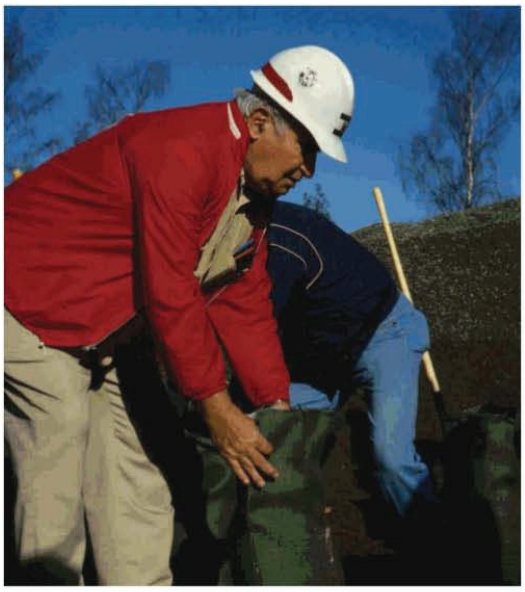
For large scale operations, a variety of specialized filling equipment - such as funnels on the back of dump trucks - is commercially available.

Such equipment is not always available during an emergency and may be best suited for a staging area where bags can be filled and then delivered to the site.

PROPER PLACEMENT

Remove any debris from the areas where bags are to be placed. Place the bags lengthwise and parallel to the direction of flow. Fill the low spots first before placing bags the full length of the area to be raised.

Start at approximately 1 foot landward from the river or levee's edge. Fold the open end of the bag under the filled portion. Folded end of bag should face upstream. Place succeeding bags with the bottom of the bag tightly and partially overlapping the previous bag.



Veteran flood engineer Ernie Sabo demonstrates that the sandbag should be two-thirds full, folded at the top.

Offset adjacent rows or layers by one-half bag length to avoid continuous joints.

To eliminate voids and form a tight seal, compact and shape each bag by walking on it and continue the process as each layer is placed.

Place each succeeding bag tightly against and parially overlapping the previous one. Compact and shape each bag by walking on it.

This flattens the top of the bag and prevents slippage between succeeding layers.

SINGLE STACK PLACEMENT

Sandbags stacked in a single row work well in flood areas where there is no streamflow velocity or danger from floating debris, such as logs and tree stumps, or from wave action which could topple the bags.

Single stack placement

Although generally not recommended to be above three courses or layers in height (approximately 1 foot), higher single stack placement can be effectively used as a barricade to protect structures from impending water damage as shown in the photo.

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PYRAMID PLACEMENT METHOD

Use pyramid placement to increase the height of sandbag protection; however, use caution when rasing the levee height. Determine the height of the sandbag raise by using the best available forecasts of flood conditions.

An example: When the water level is currently 1 foot below the top of the levee and is predicted to rise 3 more feet, construct a 2-1/2 foot sandbag operation which includes one-half foot of height as a safety factor.

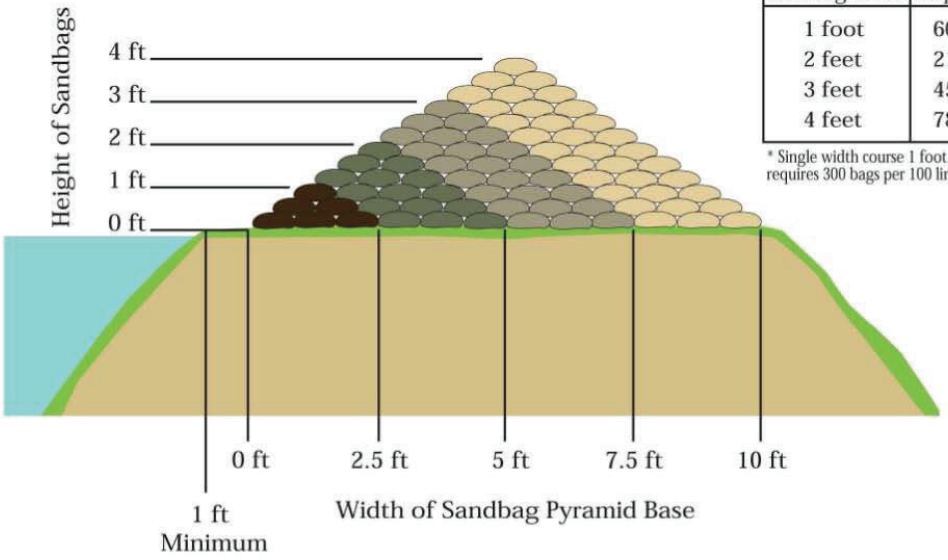
It's important to compact each bag in place by walking on it, butting the ends of the sacks toether, maintaining a staggered joint placement and folding under all loose ends.

Watch for flooding elsewhere, and watch for boils on the landward side of the levee due to the increased water elevation.

TYPICAL PYRAMID SANDBAG PLACEMENT

Bags Required Per 100 Linear Feet of Levee	
Height of Sandbag Levee	Bags Required
1 foot	600*
2 feet	2100
3 feet	4500
4 feet	7800

* Single width course 1 foot high requires 300 bags per 100 linear feet.



The pyramid placement method issued to increase the height of sandbag protection.

Use this rule of thumb in determining dimensions of the pyramid:

- 1 bag in length equals about 1 foot
- 3 bags in width equals about 2-1/2 feet.
- 3 bags in height equals about 1 foot.

Place the sandbags by laying an equal number of horizontal rows on the bottom as there are vertical layers.

It's important to compact each bag in place by walking on it, butting the ends of the sacks together, maintaining a staggered joint placement and folding under loose ends.

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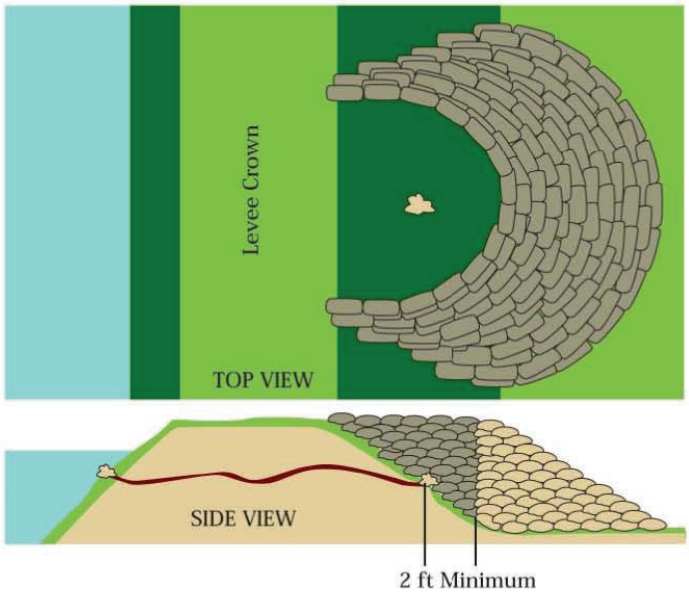
RINGING SAND BOILS

- Minimum 2 ft. radius from center of boil to edge of ring dike.
- Tie into levee if boil is near toe of levee
- Build half-moon shaped ring dike if boil is on levee slope.



RINGING SAND BOIL METHOD

A sand boil is created by water seepage through the levee foundation or embankment. When that seepage transports dirty water, the levee's integrity is threatened.

Corps employees demonstrate building a ring dike.

6

It's generally not necessary to build a ring dike around a boil that is not transporting soils but monitor the boil for any change in condition.

Don't attempt to place sandbags directly on the boil. Pressure applied to plug the boil will cause water seeping through the levee to seek other avenues to follow and could cause levee failure.

As a minimum, there should be a 2 to 3 foot radius from the center of the boil to the inside edge of the ring dike. Take care to contain the entire area experiencing boils within the ring dike.

Build a spillway section in the dike so water runs out in a controlled manner. This diverts the overflow water away from the dike and reduces erosion on the levee slope. Once the spillway water runs clear, and is not transporting soils, then the ring dike is completed.

U.S. ARMY CORPS OF ENGINEERS

The U.S. Army Corps of Engineers is the nation's oldest engineering organization and one of its oldest military branches. It dates back to the Revolutionary War when, in 1775, George Washington appointed Col. Richard Gridley as Chief Engineer of the Continental Army.

The Corps' water resource program began in 1824 when Congress appropriated money for improving river navigation. In the following decade, the involvement in civil works mushroomed, including new roads, railroads and bridges, and assistance to local communities during flood disasters.

Annually Congress sets aside funds for disaster response flood work. This gives the Corps the ability

SAFETY FIRST

Tip#1: Use proper lifting techniques to avoid injury and fatigue. Lift with your legs and bend at the knees to save your back.

Tip #2: Sandbags are treated to prevent deterioration when stored. Use work gloves and avoid contact with your eyes and mouth.

Tip #3: Stay in eye contact with heavy equipment operators and keep alert for truck backup alarms.

Tip#4: Flood waters can be polluted. Use rubber gloves and appropriate clothing if contact with water is unavoidable.

Tip#5: Wear adequate clothing in layers and watertight boots. Reflective material on outer clothing is essential for night work.

Tip#6: Rotate team members frequently to avoid fatigue.

Starting at the top, going clockwise: Watch for trucks and other heavy equipment frequently at flood sites; boots, clothing and other items are necessary for flood fighting; and heavy gloves are protection from treated burlap bags.

7

This classic shot shows conditions frequently are not even close to perfect. In the early '50s, flood fighters moved fast and furious to contain the swollen Snohomish River at Ebey island - a major flood event.

THE CORPS (continued from page 7)

to provide preparation, response and recovery measures concerned with flood fighting.

Public Law 84-99 today authorizes the Corps to engage in flood fighting and rescue operations if the emergency is beyond local and state capabilities. The Corps is there to perform a basic mandate as set down by the Corps' forefathers.

During a flood the corps has the authority to:

- inspect and, if necessary, strengthen flood control structures,
- make temporary levee raises,
- provide supplies and 24-hour technical assistance, and
- assist in the evacuation of people and livestock.

8

The Army Corps of Engineers conducts flood fight training every year which includes sandbagging techniques. The Corps' districts maintain a limited supply of sandbags and other flood fighting materials intended to augment the stocks of state and local jurisdictions during actual flood emergency situations.

Local jurisdictions should first use their supplies and then request additional sandbags from the state.

If the state supplies become depleted, then the Corps supplies are available for use when requested by state or local officials.

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Appendix O – Omitted

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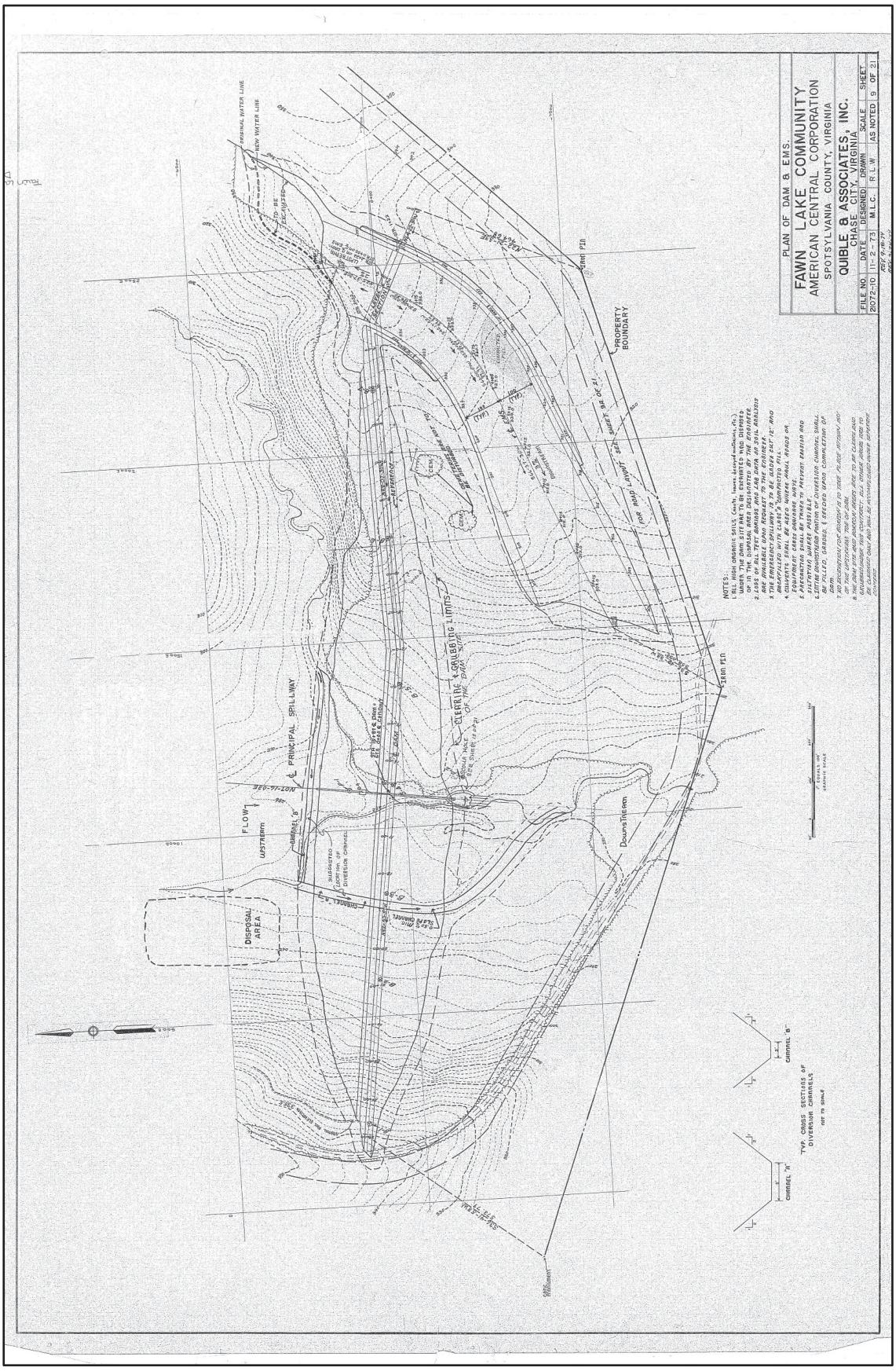
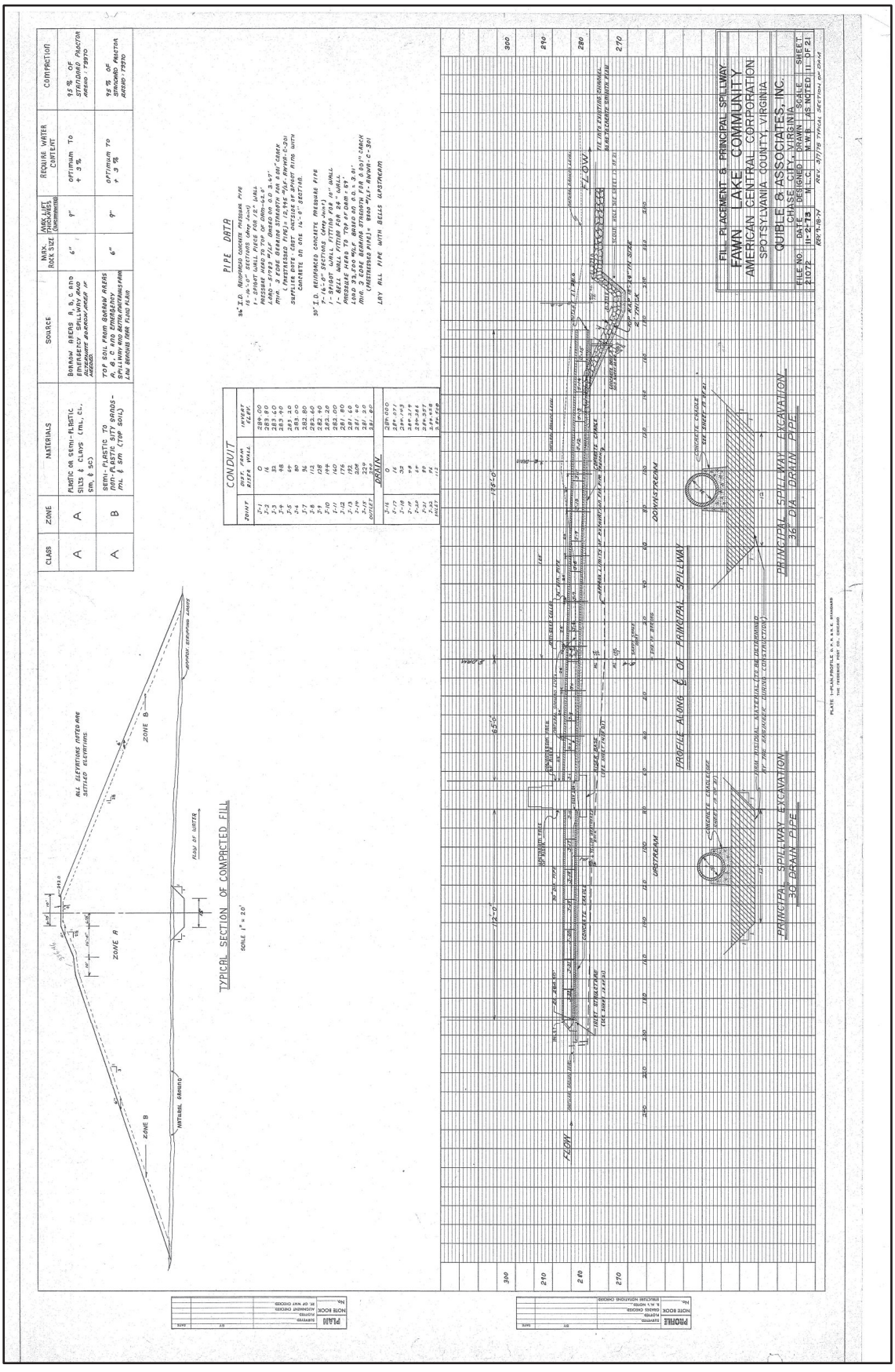
Appendix P – Original Dam Design Plans (Partial Set)

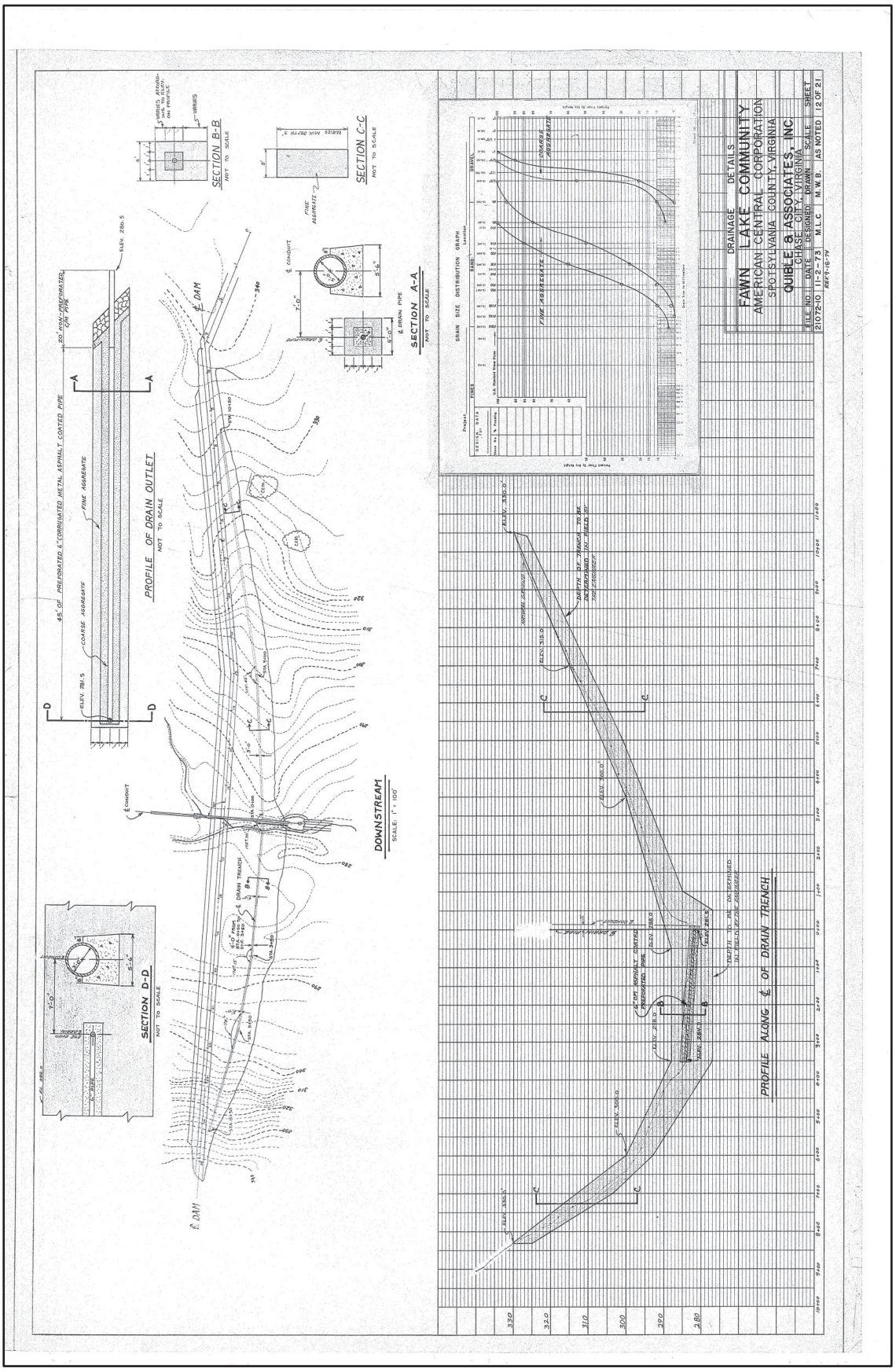
A partial set of the original design plans for the dam are provided in the following link. This link if for the full size PDF file which can be printed on large size paper, or displayed on a computer screen so you can zoom in on particular areas of the map.

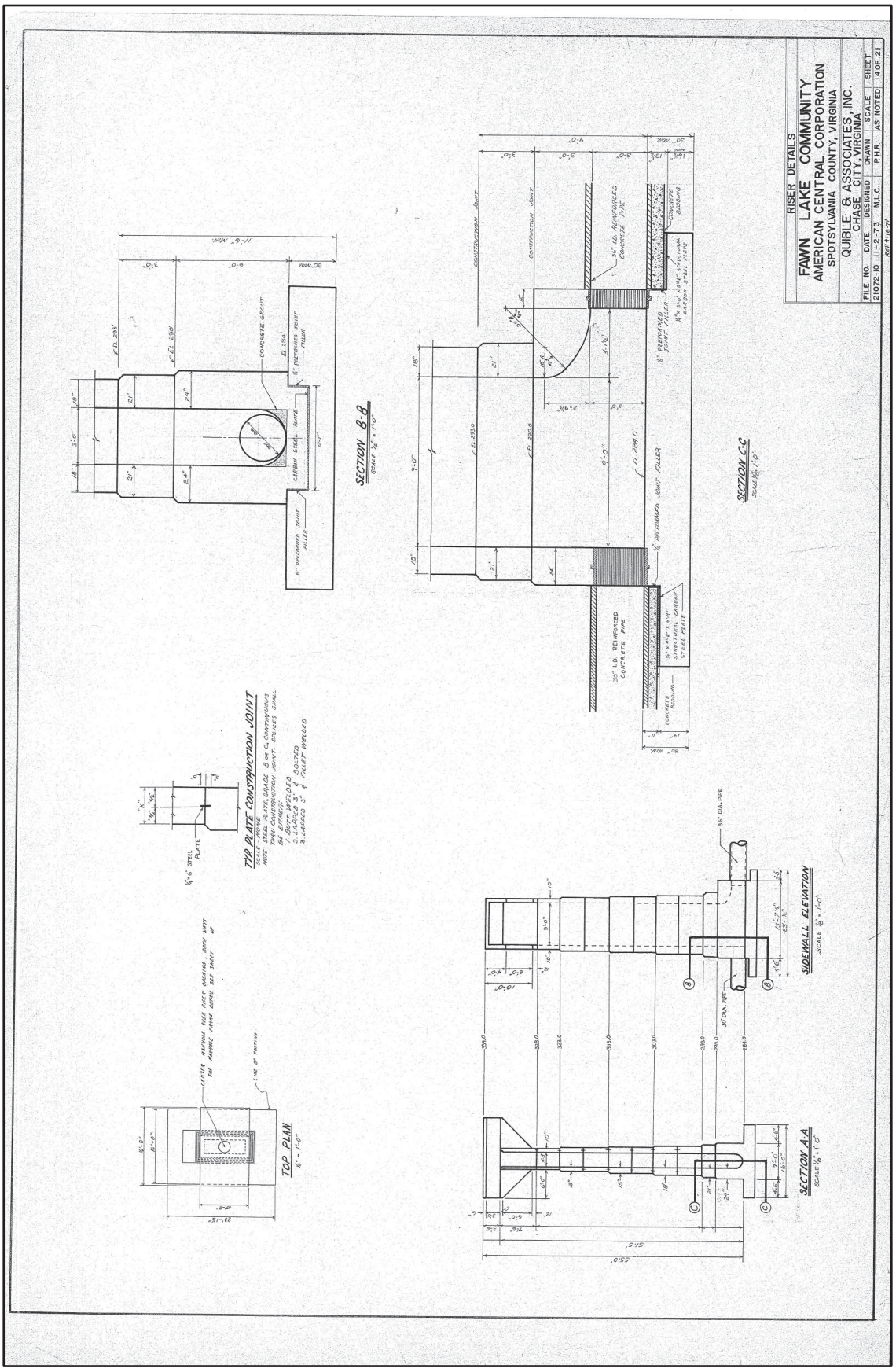
Fawn Lake Dam EAP - Original Dam Design Plans (Partial Set)

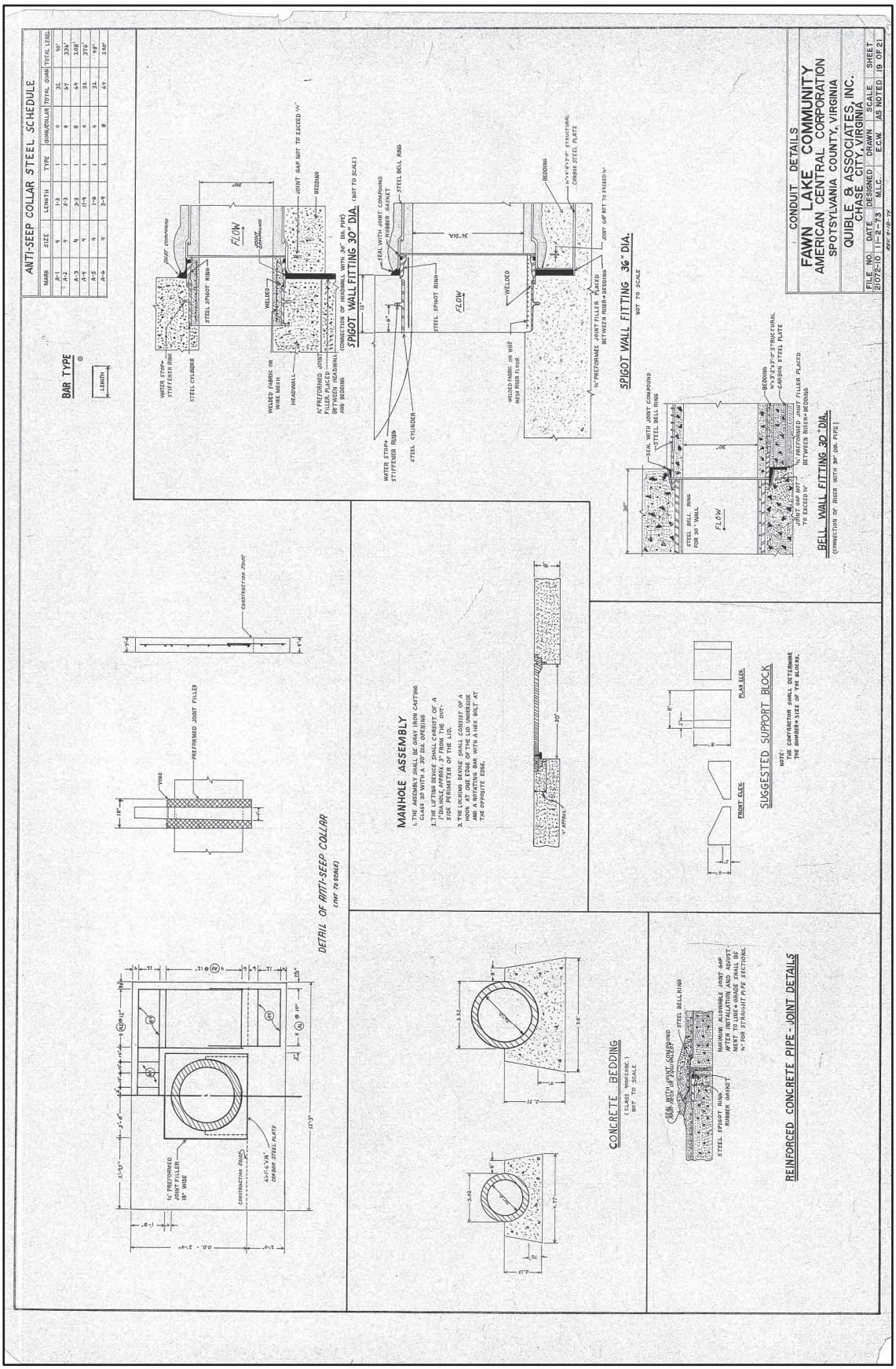
The following pages show reduced size drawings for convenience.

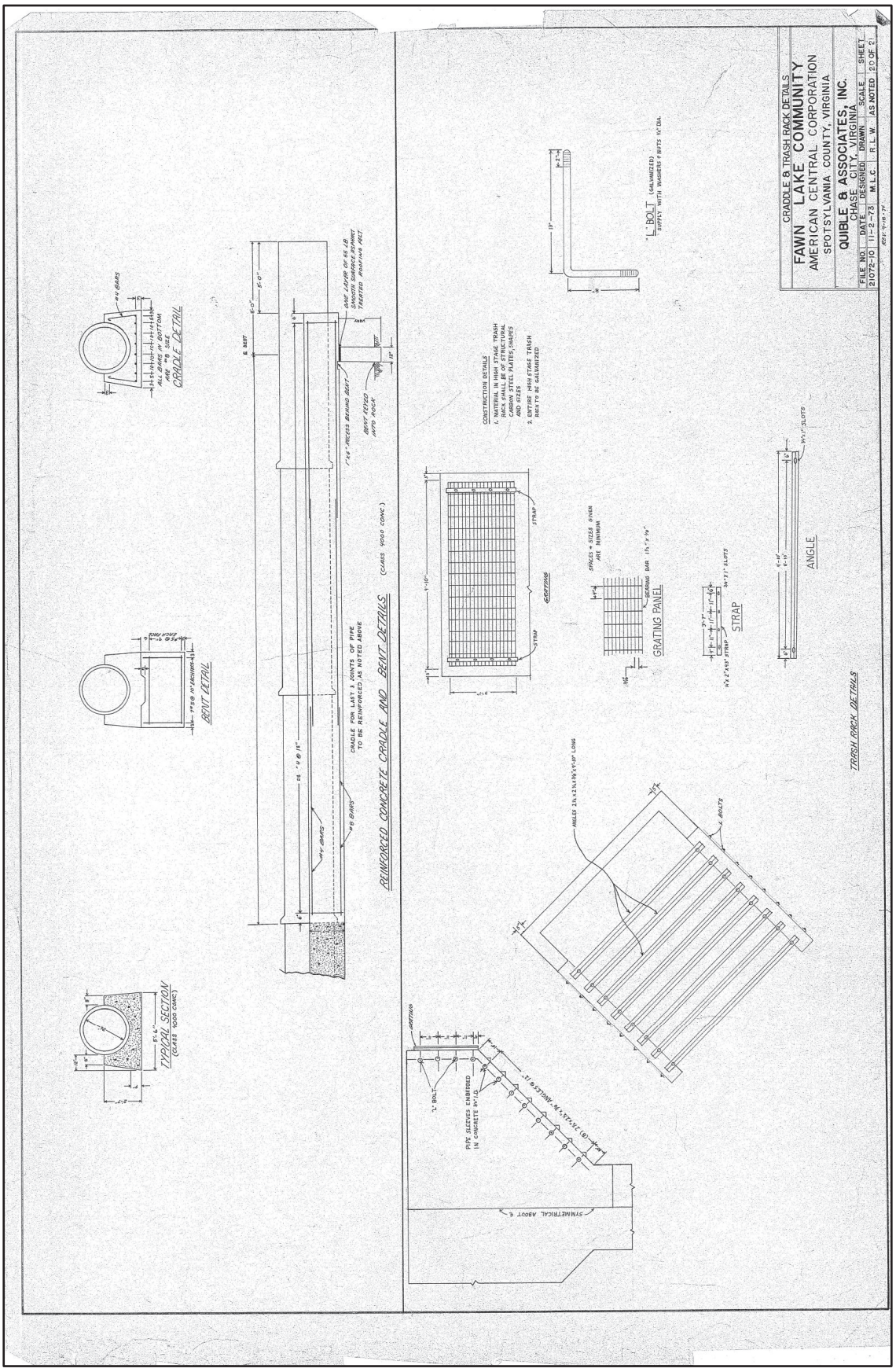

PLAN OF DAM & EMS.
FAWN LAKE COMMUNITY
AMERICAN CENTRAL CORPORATION
SPOTSYLVANIA COUNTY, VIRGINIA
QUIBLE & ASSOCIATES, INC.
CHASE CITY, VIRGINIA
FILE NO. 2072-10
DATE 1-23
DESIGNED M.L.C.
DRAWN R.L.W.
SCALE AS NOTED
SHEET 9 OF 21
PROPERTY BOUNDARY
PRINCIPAL SPILLWAY
DISPOSAL AREA
FLOW
CLEARING LIMITS
NOTES:
TYP. CROSS SECTIONS OF DIVERSION CHANNELS
CHANNEL 'A'
CHANNEL 'B'


FILL PLACEMENT & PRINCIPAL SPILLWAY
FAWN LAKE COMMUNITY
AMERICAN CENTRAL CORPORATION
SPOTSYLVANIA COUNTY, VIRGINIA
QUIBLE & ASSOCIATES, INC.
CHASE CITY, VIRGINIA
PRINCIPAL SPILLWAY EXCAVATION
36" DIA. DRAIN PIPE
PROFILE ALONG ℄ OF PRINCIPAL SPILLWAY
TYPICAL SECTION OF COMPACTED FILL
PIPE DATA
CONDUIT
DRAIN
FLOW
DOWNSTREAM
UPSTREAM


DRAINAGE DETAILS
FAWN LAKE COMMUNITY
AMERICAN CENTRAL CORPORATION
SPOTSYLVANIA COUNTY, VIRGINIA
QUIBLE & ASSOCIATES, INC.
CHASE CITY, VIRGINIA
FILE NO. 2107-10 DATE 11-2-73 DESIGNED M.L.C. DRAWN M.W.B. SCALE AS NOTED SHEET 12 OF 21
REVISED 6-19-74
PROFILE OF DRAIN OUTLET
NOT TO SCALE
SECTION A-A
NOT TO SCALE
SECTION B-B
NOT TO SCALE
SECTION C-C
NOT TO SCALE
SECTION D-D
NOT TO SCALE
DOWNSTREAM
SCALE: 1" = 100'
PROFILE ALONG ℄ OF DRAIN TRENCH
GRAIN SIZE DISTRIBUTION GRAPH
COARSE AGGREGATE
FINE AGGREGATE
45' OF PREFORMED CORRUGATED METAL ASPHALT COATED PIPE
20' NON-PERFORATED C.M.P.
FINE AGGREGATE
COARSE AGGREGATE
ELEV. 281.5
ELEV. 280.5
℄ DAM
℄ CONDUIT
℄ DRAIN PIPE
DRAIN TRENCH
ELEV. 330.0
ELEV. 320.0
ELEV. 310.0
ELEV. 300.0
ELEV. 290.0
ELEV. 280.0


RISER DETAILS
FAWN LAKE COMMUNITY
AMERICAN CENTRAL CORPORATION
SPOTSYLVANIA COUNTY, VIRGINIA
QUIBLE & ASSOCIATES, INC.
CHASE CITY, VIRGINIA
FILE NO. 21072-10
DATE 11-2-73
DESIGNED M.L.C.
DRAWN P.H.R.
SCALE AS NOTED
SHEET 14 OF 21
SECTION B-B
SCALE 1/8" = 1'-0"
SECTION C-C
SCALE 1/8" = 1'-0"
TOP PLATE CONSTRUCTION JOINT
TOP PLAN
SIDEWALL ELEVATION
SECTION A-A


ANTI-SEEP COLLAR STEEL SCHEDULE
MARK | SIZE | LENGTH | TYPE | QUAN/CYLIN | TOTAL QUAN | TOTAL LENG
A-1 | ¼ | 1'-3 | I | ½ | 32 | 40'
A-2 | ¼ | 4'-3 | I | 8 | 64' | 336'
A-3 | ½ | 3'-3 | I | 8 | 64 | 208'
A-4 | ¼ | 11'-9 | I | ½ | 32 | 376'
A-5 | ¼ | 1'-6 | I | ½ | 32 | 48'
A-6 | ¼ | 5'-6 | L | 8 | 64' | 240'
BAR TYPE
LENGTH
DETAIL OF ANTI-SEEP COLLAR
(NOT TO SCALE)
PREFORMED JOINT FILLER
CONSTRUCTION JOINT
MANHOLE ASSEMBLY
SPIGOT WALL FITTING 30" DIA.
(NOT TO SCALE)
SPIGOT WALL FITTING 36" DIA.
NOT TO SCALE
BELL WALL FITTING 30" DIA.
(CONNECTION OF RISER WITH 30" DIA. PIPE)
CONCRETE BEDDING
(CLASS 'A' CONC.)
NOT TO SCALE
SUGGESTED SUPPORT BLOCK
REINFORCED CONCRETE PIPE - JOINT DETAILS
CONDUIT DETAILS
FAWN LAKE COMMUNITY
AMERICAN CENTRAL CORPORATION
SPOTSYLVANIA COUNTY, VIRGINIA
QUIBLE & ASSOCIATES, INC.
CHASE CITY, VIRGINIA
FILE NO. 21072-10 | DATE 11-2-73 | DESIGNED M.L.C. | DRAWN E.C.W. | SCALE AS NOTED | SHEET 19 OF 21


CRADLE & TRASH RACK DETAILS
FAWN LAKE COMMUNITY
AMERICAN CENTRAL CORPORATION
SPOTSYLVANIA COUNTY, VIRGINIA
QUIBLE & ASSOCIATES, INC.
CHASE CITY, VIRGINIA
FILE NO. 21072-10 | DATE 11-2-73 | DESIGN M.L.C. | DRAWN R.L.W. | SCALE AS NOTED | SHEET 20 OF 21
CRADLE DETAIL
BENT DETAIL
TYPICAL SECTION (CLASS 1000 CONC.)
REINFORCED CONCRETE CRADLE AND BENT DETAILS (CLASS 1000 CONC.)
CONSTRUCTION DETAILS
GRATING PANEL
STRAP
ANGLE
TRASH RACK DETAILS
"L" BOLT (GALVANIZED)
SUPPLY WITH WASHERS & NUTS ½" DIA.

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