INSPECTION OF EMBANKMENT DAMS
INSTRUCTIONS

Through regular inspections, you will become more familiar with your dam and better able to recognize changes which could be of concern. Following are general guidelines for completing the Embankment (Earth) Dam Inspection Form. As all dams are different, every situation cannot be included in these instructions. If you have any questions, please contact the Safe Dams Program or the Engineer of Record (EOR) of your choice.

Each item listed below corresponds with an item on the Embankment (Earth) Dam Inspection Form. Within each item listed below, there is a short description which discusses the importance of the item for the inspection and things to observe. There is also a CORRECTIVE ACTION section. When completing the inspection form, make notes of anything that you see concerning that inspection item, and make the appropriate notes on your inspection form based off the CORRECTIVE ACTION section.

If an inspection item requires further action on your part (hiring an EOR, monitoring changes in cracks, etc.), place a check mark to the left of the number of the item on the inspection form. This will provide an easy way for you and the Safe Dams Program to determine items which need to be observed or corrected.

Thank you for taking the time to complete this inspection, as it will proactively help you to maintain your dam while at the same time providing for the protection of fellow Georgians downstream.

A. Crest

The crest of a dam is the top surface of the dam, and is usually relatively flat. The following items should be noted when inspecting the crest:

1. Unless there is a road on the dam (see Item 3 in this section), the crest of the dam should have a good cover of a low-growing grass. The vegetation should be regularly mowed to allow for easy identification of problems with the dam. CORRECTIVE ACTION: Note any areas that need to be reseeded or need to have maintenance performed on them.

2. Although a healthy cover of grass is desirable as erosion protection, the growth of deep-rooted vegetation, such as large shrubs and trees, is undesirable. Note in this section any trees or large shrubs which are located on the dam. CORRECTIVE ACTION: If the trees and shrubs are less than 8" in diameter, note that the trees and shrubs must be removed from the dam, any holes must be filled in and compacted, and the area must be seeded. If the trees and shrubs are greater than 8" in diameter, then an EOR must be hired to determine the best way to safely remove the inappropriate vegetation.

3. If there is a road on the crest of the dam, it should be paved or layered in gravel. It should be relatively flat, with no major ruts, depressions, or cracking. CORRECTIVE ACTION: For solid surface roads (i.e., asphalt or concrete), identify any excessive cracking, ruts, or depressions. Note that the cracks must be sealed, and that ruts and depressions should be filled in to prevent ponding of water on the road. For gravel roads, identify any ruts or depressions. Note that these areas must be filled in with additional gravel to prevent erosion.

4. Depressions are low spots in the crest and may be localized or widespread. They may be caused by settlement in the embankment or foundation or internal erosion or piping and

subsequent collapse of overlying material. Some areas of the embankment surface that look like depressions may be the result of improper final grading during construction, however the cause of depressions should be determined. Depressions can be minor or they can be very serious. Sinkholes are a serious type of depression. A good way of distinguishing between localized settlement and sinkholes is to look at their profiles:

i) Localized settlement usually has gently sloping, bowl-like sides.
ii) Sinkholes usually have steep sides from the soil shearing as it collapses into an underlying void.

The bottom of depressions should be probed to determine if there is an underlying void, which would be caused by the removal of subsurface material by internal erosion or piping.

CORRECTIVE ACTION: Photograph and record the location, size or extent, and depth of any depression. Have a survey performed of the crest if there is a concern about loss of freeboard. Note that the depression should be inspected frequently to ensure it is not continuing to settle or enlarge. If after several months of inspection it is determined that the depression is stable, then note that the depression should be filled with top soil, compacted, and grassed. If the depression continues to settle or enlarge, then note an EOR must be hired.

5. Cracking in an embankment dam falls into the following three major categories:
   i) Longitudinal cracking occurs in a direction roughly parallel to the length of the dam. It is an indication of a potentially unstable slope.
   ii) Transverse cracking appears in a direction roughly perpendicular to the length of the dam. Deep transverse cracking can provide a pathway for water into the core of the dam.
   iii) Desiccation cracking is caused by the drying out of certain types of embankment soils, and usually develop in a random, honeycomb pattern.

   CORRECTIVE ACTION: *For longitudinal and transverse cracking*, photograph and record the location, depth, length, width and offset of each crack observed. Monitor these cracks for any changes. Note the Safe Dams Program must be contacted for major cracking, or if the cracks are changing. *For desiccation cracking*, probe the more severe cracks to determine their depth, especially if they are oriented in an upstream/downstream direction. Photograph and record the location, length, width, depth and orientation of any severe cracks observed. Compare these measurements with any past measurements to determine if the condition is worsening. Note the Safe Dams Program must be contacted if the desiccation cracking continues to worsen.

6. Note here any items on the crest which are not covered above. In particular, note if there is evidence of livestock or recreation vehicles using the crest, which can lead to erosion problems. CORRECTIVE ACTION: If practical, restrict usage of the dam by animals or vehicles which will damage the vegetative cover. Note any areas which must be reseeded to prevent further erosion.

B. Upstream Slope

The upstream slope is the inclined surface of the dam on the reservoir (lake/pond) side of the crest. The following items should be noted when inspecting the upstream slope of the dam:

1. The reservoir level affects many other areas of the dam. It is important when inspecting the dam to determine if it is at normal pool (the normal elevation of the water in the reservoir), above normal pool, or below normal pool. If the reservoir is above or below normal pool, the difference in elevation should be estimated (in feet) and included on the inspection form. CORRECTIVE ACTION: If the reservoir is above normal pool, it should be monitored to make sure it returns to normal pool. Note that the principal or emergency spillway (see Section E) may be blocked and may need to be cleaned out. If the reservoir is below normal pool, the downstream slope and principal spillway (see Sections C and E, respectively) should be monitored for flow which may indicate pending failure of the dam. If such flow is noted, the Safe Dams Program must be immediately notified to determine if the reservoir needs to be drawn down further to prevent failure. Additionally, an EOR must be hired to determine the scope of the internal erosion of the dam and if repairs will be needed.

2. The upstream slope of the dam should have a good cover of a low-growing grass. This vegetation should be regularly mowed to allow for easy identification of problems with the dam. Additionally, there may be slope protection, such as rip rap, on the slope. This is covered in item 7 below. CORRECTIVE ACTION: Note any areas that need to be reseeded or need to have maintenance performed on them.

3. A description of inappropriate vegetation can be found in Section A, Item 2.

   CORRECTIVE ACTION: If the trees and shrubs are less than 8" in diameter, note that the trees and shrubs must be removed from the dam, any holes must be filled in and compacted, and the area must be seeded. If the trees and shrubs are greater than 8" in diameter, then an EOR must be hired to determine the best way to safely remove the inappropriate vegetation.

4. A description of depressions can be found in Section A, Item 4 of these instructions.

   An additional issue on the slope of the dam is holes, such as animal burrows. In Georgia, these burrows are typically caused by groundhogs, muskrats, or beavers. Beavers are of particular concern because of their habit of building dams in spillways to raise water levels.

   CORRECTIVE ACTION: Photograph and record the location, size or extent, and depth of any depression. Have a survey performed of the crest if there is a concern about loss of freeboard. Note that the depression should be inspected frequently to ensure it is not continuing to settle or enlarge. If after several months of inspection it is determined that the depression is stable, then note that the depression should be filled with top soil, compacted, and grassed. If the depression continues to settle or enlarge, then note an EOR must be hired. IF ANIMAL BURROWS ARE FOUND, note the size and location of the burrows. Remove or eradicate the animals causing the problem. Note that the holes must be filled with soil, compacted, and reseeded.

5. Erosion on the upstream slope has several different causes, including wave action on the shoreline, livestock on the slope, and recreational vehicles driving on the slope. CORRECTIVE ACTION: If erosion is found, note the size, location, and severity of the eroded areas. IF THE EROSION IS CAUSED BY WAVE ACTION ON THE RESERVOIR, note that additional slope protection, such as riprap, may be required. The Safe Dams Program must be contacted prior to installation of riprap to determine acceptability of the material proposed to be used. IF THE EROSION IS CAUSED BY TRAFFIC ON THE DAM, note that the eroded areas must be filled in, compacted and grassed. Additionally, if possible, access to

the upstream slope of the dam should be limited to prevent future erosion. Note the slope must be monitored for further erosion, and any erosion found must be repaired as soon as possible.

6. A description of cracks typically found on dams can be found in Section A, Item 5 of these instructions.

   Of additional concern on the slopes of dams are sloughs or slides. These usually fall into two categories: shallow slides and deep-seated slides. Shallow slides in the upstream slope are often the result of an overly steep slope combined with a rapid lowering of the reservoir. Deep-seated slides are serious threats to the safety of a dam, and are typically characterized by a steep back slope, a soil bulge near the bottom of the slide, and arc-shaped cracks in the slope (which may also be signs of developing deep-seated slides.) CORRECTIVE ACTION: FOR SHALLOW SLIDES, photograph and record the location of the slide, including dimensions. Note any cracks which have developed uphill from the slide which could be signs of potential development of a deep-seated slide. Note the slide should be regularly monitored for changes in size or development into a deep-seated slide. FOR DEEP-SEATED SLIDES, contact the Safe Dams Program to discuss the potential need of lowering and restricting the reservoir, and the potential need to hire an EOR.

7. Slope protection is used along the shoreline of the reservoir to prevent wave action erosion, surface runoff erosion, and wind scour. Riprap (broken or angular rock) is typically used. It is important that riprap is large and durable enough to not be moved or broken down by wave action. Additionally, irregular sized and shaped rocks create an interlocking mass that prevents waves from passing between the larger rocks and eroding the underlying material. You should look for beaching, scarping, or degrading of the slope protection to determine if it is adequate. Additionally, vegetation should be regularly removed from the riprap to allow for easy inspection of the slope and to ensure the vegetation does not move the riprap. CORRECTIVE ACTION: Note if maintenance needs to be performed to remove vegetation from the riprap slope protection. Note any areas of the slope which are not adequately protected (slope protection is easily moved by the water, there is not enough to protect the dam from erosion, etc.) Additionally, note any areas where the slope protection has settled, as this is a sign that erosion may be occurring below its surface. Document the dimensions of all areas of inadequate protection. Note that all areas of inadequate protection must be repaired. Contact the Safe Dams Program to discuss the recommended approach to addressing this issue.

8. Note any issues with the upstream slope which are not mentioned elsewhere in this section.

C. Downstream Slope

The downstream slope is the inclined surface of the dam on the opposite side of the crest from the reservoir. The following items should be noted when inspecting the downstream slope of the dam:

1. The downstream slope of the dam should have a good cover of a low-growing grass. This vegetation should be regularly mowed to allow for easy identification of problems with the dam. CORRECTIVE ACTION: Note any areas that need to be reseeded or need to have maintenance performed on them.

2. A description of inappropriate vegetation can be found in Section A, Item 2.

CORRECTIVE ACTION: If the trees and shrubs are less than 8" in diameter, note that the trees and shrubs must be removed from the dam, any holes must be filled in and compacted, and the area must be seeded. If the trees and shrubs are greater than 8" in diameter, then an EOR must be hired to determine the best way to safely remove the inappropriate vegetation.

3. A description of depressions, ruts, and holes can be found in Section B, Item 4. Of additional concern on the downstream slope are bulges which can be caused by seepage through the dam, and may lead to a shallow or deep-seated slide (see Item 5 in this section.)

   CORRECTIVE ACTION: FOR SHALLOW SLIDES, photograph and record the location of the slide, including dimensions. Note any cracks which have developed uphill from the slide which could be signs of potential development of a deep-seated slide. Note that the slide should be regularly monitored for changes in size or development into a deep-seated slide. FOR DEEP-SEATED SLIDES, contact the Safe Dams Program to discuss the potential need of lowering and restricting the reservoir. Additionally, note that an EOR must be hired to perform an investigation to determine the magnitude and the cause of the slide. FOR BULGES, note the location and dimensions of the bulge. Additionally, note any wetness in the area of the bulge. Note the bulge should be monitored regularly for any changes.

4. Erosion on the downstream slope has several different causes, including runoff from the crest, livestock traffic on the slope, and recreational vehicles driving on the slope. Erosion is especially prevalent near the groins of the dam, which is where the dam makes contact with the natural river valley. This can be caused by runoff or seepage through the contact between the dam and natural ground. CORRECTIVE ACTION: If erosion is found, note the size, location, and severity of the eroded areas. IF THE EROSION IS CAUSED BY RUNOFF, note that the eroded area should be filled with soil, compacted, and grassed. If the area continues to erode, note that additional protection may be needed. The Safe Dams Program must be contacted prior to installation of additional protection to determine acceptability of the material proposed to be used. IF THE EROSION IS CAUSED BY TRAFFIC ON THE DAM, note that the eroded areas must be filled in, compacted and grassed. Additionally, if possible, access to the downstream slope of the dam should be limited to prevent future erosion. Note the slope must be monitored for further erosion, and any erosion found must be repaired as soon as possible.

5. A description of cracks typically found on the slopes of dams can be found in Section B, Item 5 of these instructions.

   CORRECTIVE ACTION: FOR SHALLOW SLIDES, photograph and record the location of the slide, including dimensions. Note any cracks which have developed uphill from the slide which could be signs of potential development of a deep-seated slide. Note that the slide should be regularly monitored for changes in size or development into a deep-seated slide. FOR DEEP-SEATED SLIDES, contact the Safe Dams Program to discuss the potential need of lowering and restricting the reservoir. Additionally, note an EOR must be hired to perform an investigation to determine the magnitude and the cause of the slide.

6. Seepage is the passage of water through a dam. Seepage passes through all embankment dams. Many embankment dams have internal drains to intercept this seepage and discharge it safely. These drains are discussed in Section F of these instructions. Of greater concern is uncontrolled seepage, which can carry with it soil from within the dam, leading to erosion from the inside of the dam and eventual failure of the dam. This seepage may exit the ground

through the dam, or it may appear downstream of the dam. Items 6, 7, and 8 in this section are intended to document this uncontrolled seepage.

Wet areas on or at the toe of the dam can be caused by uncontrolled seepage or an area poorly graded to drain. Wet areas can be identified either by water on the surface, areas of water-loving vegetation (such as cattails, reeds and mosses), or areas of vegetation which are much greener than the vegetation around it. CORRECTIVE ACTION: Note the size and location of the wet areas. If the wet area appears to be caused by a low area, note that the area should be drained, filled with soil, compacted, and grassed.

7. Seepage through the dam which is causing erosion will typically appear rust-colored or stained. Additionally, the soils in Georgia will often cause the seepage to have what appears to be an oily sheen on its surface. CORRECTIVE ACTION: Note the size and location of any areas of seepage which exhibit any of the signs listed in this item. Note if the area is new or existing. If it is a new area, document the extents of the area. If it is an existing area, note if the size of the area or the appearance of the seepage has changed.

8. Seepage visibly flowing out of the slope or beyond the toe of the dam is of great concern. These areas can appear to be springs or sand boils, and may appear to have a cone of sediment around them. This sediment is most likely being eroded from within the dam. Of additional concern is water flowing along the outside of the principal spillway pipe or other drains, which can be a sign of a leak in the pipe or water using the outside of the pipe as a conduit. Seepage flowing through the dam, whether through the embankment or along a pipe, can lead to a type of dam failure called piping, which is internal erosion of the dam which can lead to failure. CORRECTIVE ACTION: Contact the Safe Dams Program to discuss the potential need of lowering and restricting the reservoir. Additionally, note that an EOR must be hired to perform an investigation to determine the source and severity of the seepage.

9. Note any issues with the downstream slope which are not mentioned elsewhere in this section.

D. Plunge Pool

The plunge pool is a natural or artificially created pool at the base of a dam that dissipates the energy of free-falling water. It is the location where the principal spillway exits the dam, and the water is returned to the natural flowing stream.

1. Erosion protection is often used around the plunge pool to prevent erosion caused by falling water. Additionally, it provides energy dissipation to the water before it is returned to the natural channel. Riprap is typically used. It is important that it is large and durable enough to not be moved or broken down by the energy of the falling water. It is desirable to have irregular sized and shaped rocks that create an interlocking mass to protect the underlying material. You should look for beaching, scarping, or degrading of the slope protection to determine if it is adequate. Additionally, vegetation should be regularly removed from the riprap to allow for easy inspection of the plunge pool. CORRECTIVE ACTION: Note if maintenance needs to be performed to remove vegetation from the riprap protection. Note any areas of the plunge pool which are not adequately protected (erosion protection is easily moved by the water, there is not enough to protect the plunge pool from erosion, etc.) Additionally, note any areas that the erosion protection has settled, as this is a sign that erosion may be occurring below its surface. Document the dimensions of all areas of inadequate protection.

Note that areas of inadequate protection must be repaired. Contact the Safe Dams Program to discuss the recommended approach to addressing this issue.

2. Erosion at the plunge pool is typically caused by runoff from around the plunge pool or from the energy of the water falling from the principal spillway. Seepage, which is discussed in Section C, Items 6-8, will often come to the surface within the plunge pool. CORRECTIVE ACTION: If erosion is found, note the size, location, and severity of the eroded areas. Note that additional erosion protection is needed to protect the area from erosion. Contact the Safe Dams Program to discuss the recommended approach to addressing this issue. If seepage is found, document the size and any of the signs exhibited in Section C, Item 7. For any seepage which is actively flowing, contact the Safe Dams Program to discuss the potential need of lowering and restricting the reservoir. Additionally, note that an EOR must be hired to perform an investigation to determine the source and severity of the seepage.

3. Note any issues with the plunge pool which are not mentioned elsewhere in this section.

E. Principal and Emergency Spillways

A principal (also known as primary) spillway is a pipe, channel, etc. which is designed to provide continuous or frequent releases from a reservoir in order to maintain the normal pool. An emergency spillway is designed to provide additional protection against overtopping of a dam intended for use under extreme conditions such as malfunction of the principal spillway or extreme rainfall. Water flowing through the emergency spillway should be a rare occurrence. Generally, the principal spillway should be able to carry most normal storm events.

1. Principal spillways on earthen dams in Georgia have typically been made of corrugated metal, concrete, plastic, or iron, and can either be a traditional spillway (where water falls into a riser in the lake and flows out of the pipe) or a siphon spillway (where water is pulled up out of the lake via pressurized flow). The spillway may also be a concrete channel. Emergency spillways are typically an earthen or concrete channel at one or both ends of the dam, but they can take other forms depending on the construction of the dam. While corrugated metal pipe has been used in the past for spillways in earthen dams, it has been determined to not be appropriate in this application and is no longer considered an acceptable option for use in dams. CORRECTIVE ACTION: Note in this section the type of primary and emergency spillways at your dam. If you are not sure what kind of spillways your dam has, please contact the Safe Dams Program to discuss.

2. As indicated previously, the emergency spillway should not activate regularly. However, there are occasionally storm events which cause this spillway's activation. CORRECTIVE ACTION: Note if there has been flow in the emergency spillway since the last inspection. Note the date(s) it occurred, what caused the spillway to flow, and how deep the flow was in the spillway.

3. One concern with pipe spillways is that they can become obstructed by various items, including excessive debris (tree limbs, logs, etc.) This leads to reduced flow through the spillway. It is important that obstructions be removed from pipe spillways regularly so they may carry their full design flow. CORRECTIVE ACTION: Note if there is debris at the entrance to the spillway pipe. If there is debris, note that the debris must be removed.

4. The entrance to pipe spillways should have some form of trash rack to prevent debris from entering the pipe and becoming lodged in the pipe. The trash rack is typically a metal grate. CORRECTIVE ACTION: Note if a trash rack is installed. If a trash rack is not installed, note that a trash rack should be added to the pipe spillway entrance. If a trash rack is installed, note its condition, including if it adequately covers the pipe, if it is broken, etc. If the trash rack is damaged, note that it will need to be repaired or replaced.

5. Pipe spillways are typically shorter lengths of pipes which are joined together in various ways. Over time, these joints can become separated. Additionally, cracks or holes may develop in the pipes due to rusting or damage from outside forces, including heavy equipment. CORRECTIVE ACTION: Note any separations, cracks, or holes in the pipe, including location, the dimensions of the damage, and if water is flowing through the damaged area. Note that these areas must be monitored for any changes. Contact the Safe Dams Program to determine what additional actions must be taken.

6. In general, there should be no leaks in a spillway pipe. Leaks can be visible or can be internal to the dam. If water is flowing into the pipe but not flowing out of it, or if no water is flowing into a pipe but is flowing out of it, there is an issue with the pipe within the dam. CORRECTIVE ACTION. Note if there are any leaks in the spillway pipe. If there are leaks, note their locations, sizes, and the rate of flow. (Rate of flow determination is discussed in Section F, Item 3 of these instructions.) Note that an EOR must be hired to determine if the leaks adversely impact the spillway pipe.

7. This item provides a general overview of the pipe(s). Check the items which are appropriate for the pipes in your dam based on your inspection.

8. For open channel spillways, including earthen and concrete-line spillways, there should be no obstructions to prevent the flow of water in the event the spillway activates. CORRECTIVE ACTION: Note if there are any obstructions within the spillway, including fences, buildings, etc. If there are obstructions, note that they must be removed.

9. Earthen spillway must have a good cover of a low-growing grass. This vegetation should be regularly mowed to allow for easy identification of problems within the spillway. CORRECTIVE ACTION: Note any areas that need to be reseeded or need to have maintenance performed on them.

10. Although a healthy cover of grass is desirable as erosion protection, the growth of deep-rooted vegetation, such as large shrubs and trees, is undesirable. Note in this section any trees or large shrubs which are located within the spillway. CORRECTIVE ACTION: If the trees and shrubs are less than 8” in diameter, note that the trees and shrubs must be removed from the spillway, any holes must be filled in and compacted, and the area must be seeded. If the trees and shrubs are greater than 8” in diameter, then an EOR must be hired to determine the best way to safely remove the inappropriate vegetation.

11. Eroded areas within earthen spillways must be dealt with to prevent further erosion in the event of spillway activation. CORRECTIVE ACTION: Note the location and extent of the damage, including depth of erosion. Contact the Safe Dams Program to discuss options to address the damage.

12. Concrete channel spillways should not be cracked or have holes in them. Cracks and holes can allow water to get under the concrete and erode away the material beneath the concrete, thus undermining the spillway. Also, this water can lead to uplift which can possibly break the concrete. CORRECTIVE ACTION: Note the location and size of any cracks or holes in the concrete. Contact the Safe Dams Program to discuss options to address the cracks and/or holes.

13. As mentioned previously, water under concrete channel spillways can potentially lead to erosion and undermining of the spillway. If water flows in the spillway and then disappears at a crack or joint, or if water suddenly appears at a crack or joint, this is a sign that water is flowing under the concrete. Additional signs could be if a section of the concrete has collapsed or if water is visibly flowing from under the concrete at the end of the spillway. CORRECTIVE ACTION: Note the location and rate of flow of the leak. If unable to measure the leak, note the reason that you believe water is flowing under the spillway. Note that an EOR must be hired to determine the extent of undermining of the spillway and to determine the best method of repair.

14. This item provides a general overview of the earthen or concrete channel spillway(s). Check the items which are appropriate for the earthen or concrete channel spillway(s) on your dam based on your inspection.

15. Note any issues with the spillways which are not mentioned elsewhere in this section.

F. Instrumentation

Instrumentation is defined as any device installed into or near a dam which are used to monitor the performance of the dam. Typical instrumentation on an earthen dam includes piezometers and toe drains. A piezometer is an instrument that measures hydraulic pressures within an earthen dam. They typically will be pipes that extend vertically out of the dam, or they may be set in the surface of the dam with a cover similar to a groundwater well. A toe drain is a system of pipe and/or pervious material along the downstream toe of a dam used to collect seepage from the foundation and embankment and convey it to a free outlet. These typically come out near the toe of the dam, and can often be found near the plunge pool. They are smaller pipes than the spillway pipe.

1. As indicated previously, toe drains are located along the toe of the dam, often near the plunge pool. The area around the drains should be cleaned out to allow for easy inspection and measurement of the flow from the pipes. CORRECTIVE ACTION: Note if there are toe or other seepage drains on the dam. If there are toe drains, describe their condition, including if they are visibly clogged, if water is flowing from them, and if they have deteriorated (rusted, broken, etc.) If the drains are clogged, note that they should be flushed to remove sediment so they flow freely. If the toe drains are overgrown or have sediment built up under them, note that the area around them needs to be maintained. If the drains have deteriorated to the point of having holes in them, then note that an EOR must be hired to determine how to repair the pipes.

2. Animal guards are installed on the ends of toe drains to prevent animals from climbing into the pipe, while at the same time allowing water to freely flow out of the drains. All toe drain outlets should have animal guards installed on them. CORRECTIVE ACTION: Note if all toe drain outlets have animal guards installed. If the drains do not have animal guards, note which toe drains are missing them. Also, note that these toe drains must have animal guards installed on them.

3. Measurements of the flow from each drain are very important to understanding your dam. The flow from the toe drains, when looked at over time, can be indicative of potential problems within the dam. It is good to plot the flow of water over time on a graph to see if there is a sudden change in the flow.

   To measure the flow from a toe drain, choose a container for which you know the volume. Place the container under the toe drain, and time how long it takes for the container to fill. Divide the volume of the container by the amount of time necessary to fill it, and that is the flow rate. For example, if you have a one gallon bucket, and it takes two minutes to fill it, then your flow rate would be (1 gallon)/(2 minutes), or 0.5 gallons per minute (gpm). If your container is measured in ounces or milliliters, then measure the time taken to fill the container in seconds. Divide the container volume (in ounces or milliliters) by the time taken to fill it (in seconds.) If your flow is in ounces/second, then multiply the flow by 0.4688 to get the flow in gallons per minute. If your flow is in milliliters/second, then multiply the flow by 0.01585 to get the flow in gallons per minute.

   In addition to the flow, it is important to look at how clear the flow is. This gives an indication of the amount of erosion within the dam.

   CORRECTIVE ACTION: Take the flow measurement at each toe drain, and convert it to gallons per minute, if necessary. Note the location, flow measurement, and how clear the water is on the inspection form. Compare the flow with previous flows from the toe drains. If the flow has significantly dropped, note that the drains should be cleaned out. If the flow has significantly increased, contact the Safe Dams Program to discuss.

4. Piezometers are usually found on the slope of the dam, and can occasionally be found beyond the toe of the dam. They are used to measure how far the water level in the dam is below the surface of the dam. CORRECTIVE ACTION: Note if there are any piezometers located on or near the dam. Note if the piezometers have been damaged (broken, bent, etc.) If the piezometers have been damaged, note that an EOR must be hired to determine if the piezometer can be repaired.

5. Since the piezometers are used to measure the water level inside the dam, it is important that outside water not be introduced. Therefore, all piezometers must have caps to prevent rain water from entering the pipe. Also, if the piezometers are accessible to the public, the caps should have locks to prevent tampering with them. CORRECTIVE ACTION: Note if the piezometers all have caps with locks. If the piezometers do not have caps, note that caps must be installed. If the piezometers do not have locks and they are accessible to the public, then note that locks must be installed on the caps.

6. It is important that the piezometers be read regularly to ascertain the depth of the water within the dam. Much as the flow from toe drains, the depth of water below the surface of the dam should be looked at over time to watch for any drastic changes. This is best done by plotting the values on a graph over time. It is best to also note the reservoir level on the graph as lake level can impact the readings. CORRECTIVE ACTION: Note the values for the water level at each piezometer and compare it to previous readings. If there has been a drastic change in the level of the water within the dam, contact the Safe Dams Program to determine what steps should be taken. If you do not know how to read the piezometers, please contact an EOR either to take the readings for you, or to show you how to read them.

7. Other monitoring devices may exist on the dam, including monitoring wells and settlement plates. These will vary from dam to dam. CORRECTIVE ACTION: Note any additional monitoring devices located on the dam. Provide readings for the monitoring devices if available. Note the condition of the monitoring device.

8. Note any issues with the instrumentation which are not mentioned elsewhere in this section.

G. Photographs

Photographs provide a good way for the health of the dam to be monitored from inspection to inspection. Often changes will be noticed in photographs that may not be noticed otherwise. Photographs should be taken of the crest, upstream slope, and downstream slope. Additionally, photographs should be taken of any problems which are noted (erosion, cracks, etc.), and an item of a generally known size (a piece of paper, ruler, shoe, clipboard, etc.) should be included in these photographs to provide a perspective on the size of the problem. All photographs should be date stamped. Additionally, it is a good idea to take pictures from the same general area during each inspection, as this allows for easier comparison of photographs between inspections. List the photographs taken, and attach color copies of the photos to the report.