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## CIVIL, ENVIRONMENTAL & STRUCTURAL ENGINEERING

March 15, 2013

Fulton County Commissioners  
Attn: Dan Swain  
116 West Market Street  
McConnellsburg, PA 17233

Subject: Meadow Grounds – Dam Inspection

Dear Mr. Swain:

At your request, we performed a visual observation/inspection of the Meadow Grounds Dam, PADEP Dam No. D29-32 located in Ayr Township, Fulton County. The dam is an earthen zoned dam that is 39 feet in height, 530 feet in length and has a normal pool capacity of 3,130 ac-ft. The dam is classified as a High Hazard (Category 1) size class B structure. Recently, as of February 14, 2013, the Pennsylvania Fish & Boat Commission (PFBC) has determined to drawdown the reservoir due to concerns of possible dam failure.

### **Inspection:**

CES engineering, LLC, (CES) performed an onsite inspection of the referenced dam on Thursday, March 14, 2013. A complete inspection checklist is attached to this letter of the individual components of the dam that were visually inspected during this onsite inspection. The dam inspection was performed by Lee Zeger, P.E. and Carl Boyer P.G. During the inspection, the dewatering of the reservoir had begun. The water level during the inspection was approximately 3' to 4' below normal pool and the discharge pipe was operating at near full capacity. According to a local resident we met at the site, PFBC representatives had just removed four (4) stop logs from the control tower before our arrival.

During the inspection we found that for the most part, the dam was visibly in good service condition. The crest of the embankment was in good alignment, the embankment had consistent slopes and no bulging and or sliding was observed. The vegetation on the embankment of the dam structure was in good mowed condition and no unwanted vegetation was evident. The overall embankment showed little to no warning signs of failure.

The emergency spillway was also found to be in good service condition. There were small cracks in the concrete liner structure but none were severe. Some of the sealed joints will need to be repaired in the near future. The outlet channel however requires dead vegetation and debris removal and it also needs to be stabilized. The downstream channel is severely eroded and should be protected from additional future erosion.

### **Seepage Issues :**

The only significant dam structure issue determined during the investigation was a moderate wet/seepage area found on the west side of the embankment that was located on the downstream face of the dam at a



Meadow Grounds  
Dam Inspection (Cont'd)

point about 2/3 of the height of the dam and along the natural raised terrain on the western side of the dam. This area is shown on the photograph below and is illustrated on the attached referenced report.



Seepage/wet area on west side of embankment



View of west side embankment

6765 Brown Lane Petersburg, PA 16669  
(717) 491-9730

905 Loring Lane, Mechanicsburg, PA 17055  
(717) 574-4345



Meadow Grounds  
Dam Inspection (Cont'd)

At this location, the ground was soft and showed visual signs of long term seepage. The ground vegetation included moss and other wetland type grasses. The stone gravel seepage collection trench has been eroded from larger and assumed previous seepage rates that were not evident during the inspection. However, small collection pools of water downslope of the seepage area were observed during the inspection. It was noted that the pool elevation of the reservoir appeared slightly above the height of the opposing seepage area during the inspection.

From our observations, the west side seepage has not affected the alignment or stability of the dam by erosion or dislocation of dam materials at this time. The water from the seepage appeared to be clear and small in flow volume; however during normal pools the volume and turbidity may have been greater. We can only speculate at this however. Although it is noteworthy that the past inspection report by PFBC and PADEP dated December 21, 2012, indicate that that the seepage was clear at that time as well, and that a future action would need to be planned. We agree, over time, this seepage area could create a future issue for the dam embankment and should be addressed as soon as possible.

The remaining areas of the dam embankment structure appeared to be in satisfactory condition. We did note that the east-side seepage collection outfall had a moderate flow rate of 50 to 60 gpm. The flow was clear and from the past PFBC dam inspection report, it appears that this volume of flow is normal. The seepage collection system seems to be functionally satisfactory since no surficial wet areas were found on the embankment face during the inspection.

A small area of seepage was observed between the outlet control structure of the dam and the west side seepage collection system outfall. This was small in flow rate and was clear in color as well.

**Seepage Analysis:**

As explained above, seepage is a major concern for this dam structure. However, by design, earthen dam embankments are typically partially saturated and some uncontrolled or uncollected seepage is not abnormal. However, if not properly collected and controlled, it can become detrimental. Collection systems are installed to mitigate the surface effects of this flow in earthen dams. The uncontrolled seepage area on the west side of the embankment discussed above is an example of an area that should be repaired. Over time this seepage may result in dam failure by the gradual weakening of the embankment soil at its contact with the rock/natural soil, possibly causing a shift or destabilization of the western embankment end-wall.

There are no surficial indications at this time that such an occurrence is imminent. However, as referenced in the February 14, 2013 letter from PFBC, in the 1979 Phase 1 Inspection Report completed by the US Army Corps of Engineers (USACE), a seepage analysis in compliance with USACE EM 1110-2-1901 Chapter 13 "Monitoring Performance of Seepage Control Measure" should be performed at the current pool elevation. This analysis will assist in determining the cause of the seepage and more precisely locate the problem points and provide the information required to determine the solution for the repair.

The seepage noted on the east side of the dam at this time is under control using the designed collection system. The rate of flow appears significant, but not extreme and possibly within design parameters. An evaluation of design limits and as-built dam records would be appropriate and necessary to evaluate this further. Depending upon the increase of that flow rate over the years of service, this area may need to be part of the overall seepage analysis as well. The recommended analysis could also address the small seepage observed next to the outlet structure.

A seepage analysis would not be that expensive. By reviewing the existing design and construction data of the dam and soil reports, if available, we could determine the locations and depths of water level monitoring piezometers, observation wells and possible relief wells. If existing design and construction documents do not exist, or do not contain sufficient information, a refraction seismic survey could also be performed to assist in the analysis.

**Seepage Remediation:**

If reasonable and cost-effective steps to examine and repair the dam structure were to be performed now, a complete replacement of the earthen dam structure would probably not be required to alleviate concerns for dam safety. A much more economical fix, after performing the seepage analysis, would be the use of either a combination of relief wells, storage restriction, grouting and/or an upstream impervious blanket. From our observations, the main cause of seepage is probably occurring at the contact of the earthen embankment fill material and the prepared foundation/sidewall material.

Geologically, the bedrock beneath the site consists of shale and siltstones of the Mississippian-age Mauch Chunk formation, based on regional mapping provided by the Pennsylvania DCNR. The bedrock type is typically reasonably competent and not prone to dissolution or sinkhole development. A detailed geologic survey of the bedrock or soils was not performed, however, based on an observed small and assumed in-situ outcrop to the west of the western terminus of the dam, the exposed rock has a shaley texture with bedding planes lying at a near vertical angle and striking near perpendicular to the trend of the dam. This orientation, if reflective of the bedrock type and orientation beneath the dam structure, could encourage hydraulic piping within bedrock bedding plane separations, particularly if in contact with embankment materials. This relationship could either create or exacerbate the seepage issues observed. A review of the design and as-built records for the dam structure would certainly shed more light on the subject.

If this speculation is confirmed by further analysis of the seepage, it could easily be addressed by either or both pressure grouting of the dam in this area, and/or an upstream impervious blanket on the reservoir side of the dam embankment. Preliminarily, the overall costs of installing clay at an approximate depth of 18" over an approximate length of 650' and an approximate width of 100' would be approximately \$100,000. These types of repairs are found in USACE EM 1110-2-1901 Chapter 12 "Remedial Seepage Control" and have case studies proving of their success.

Another possible solution could be to simply limit the reservoir storage, by reducing the overall storage height of the water behind the dam. From our inspection and review of current referenced agency correspondence, it appears that the main seepage concern is found at the upper level of the dam on the west side. It appears that the amount of seepage has already decreased with the 3 to 4' of dewatering that has recently occurred. There is every reason to conclude that continued reservoir dewatering of the dam over the next 3-4' of water level decline will effectively diminish or even completely stop this small seepage.

**Emergency Spillway Issues:**

According to the February 14, 2013 PFBC letter, it is noted that the emergency spillway has insufficient capacity for the reservoir. Being that the spillway is a completely separate hydraulic structure from the dam embankment, this spillway and outlet channel could be easily increased to provide the adequate capacity required to meet current standards.

**Conclusions:**

Based on review of the past inspection report performed by PFBC, PADEP and the February 14, 2013 PFBC letter, and our independent visible inspection, we conclude that the dam is not currently in poor condition or displaying any signs of imminent or catastrophic failure. We do feel that the seepage issues must be addressed immediately or the dam could and most probably will be in danger of becoming the so called "sunny day failure". However, at this time, the embankment is in good condition and does not need to be replaced. Several relatively small and cost-effective repairs as explained in the USACE Engineering Manuals could be sufficient for minimizing the seepage issues and addressing the concerns shown in both referenced letters.

We recommend that the PFBC and PADEP reevaluate their findings and consider reversing their decision to dewater the impoundment completely. The reservoir dewatering itself may have detrimental effect, both economically and environmentally, particularly when considering the restoration of the drained reservoir area and the impact of sustained increased flows to the stream downstream of the dam. Clearly the stream life downstream has and will be affected as the reservoir continues to dewater. The large amounts of sediment that have been stored in the reservoir over the past 50 years could be an issue when the dam reaches the lower elevations of dewatering, as will the costs and duration of re-vegetation and reclamation of the area for subsequent use. Also to be considered is the impact on established fish and wildlife in the reservoir area that is a valuable resource to the local community.

We are also concerned that continued high volume dewatering and diminishment of the reservoir in itself could render embankment stability issues, especially if a decision is made at a later date to restore the reservoir. The rapid dewatering may cause instability by removal of moist and saturated conditions and hydrostatic pressures in the dam and promote movement and re-settling of drying earthen materials within the dam.

In essence, we submit that the real risk potential for dam instability and costs for effective rehabilitation of the facility should be adequately presented in contrast to the continued and post-dewatering environmental impacts above and below the dam and the economic losses and reclamation costs for both the Commonwealth and the community. As these issues will have impact to the local community and the Commonwealth as a whole, they should be publicly discussed and considered before any further action is taken or continued.

Thank you very much for the opportunity to provide this evaluation. If there are any questions or concerns pursuant to the matters discussed in this letter or the attached dam inspection report, please do not hesitate to contact us at your convenience.

Respectfully Submitted,  
CES Engineering, LLC.

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Lee S. Zeger III, P.E.  
Project Engineer