HERITAGE
ENGINEERING INC

Post Office Box 923 • Blythewood, SC 29016

July 11, 2018

"via email to mcainjm@dhec.sc.gov"

Mr. John McCain, P. E., Manager
Dam Safety Program
SCDHEC - Bureau of Water
2600 Bull Street
Columbia, South Carolina 29201

RE: REPORT OF ASSESSMENT AND SUBSEQUENT PROPOSED ACTIONS FOR THE PRINCIPAL SPILLWAY CONDUIT AND ADJACENT EMBANKMENT AT SPRINGWOOD LAKE DAM (D-0558), RICHLAND COUNTY, S. C.

Dear John.:

We have made periodic visual assessments of the principal spillway conduit and adjacent embankment at the subject dam since the development of a sinkhole in the roadway and the subsequent discovery of water entering the conduit paper through openings in joints and the pipe wall itself. In the intervening period additional sinkholes have developed in the roadway above the area of the pipe. The results of these assessments and a discussion of a recommend path forward follow:

Spillway Conduit

The spillway conduit is a 120" diameter corrugated steel pipe which appears to have been aluminized or had a similar surface treatment applied. It is approximately 100 feet long and receives flow from a cast in place concrete riser. As viewed from the inside, the joint system appears to consist of bands with a compressible bead or gasket approximately 1 inch in diameter made of neoprene or similar material.

Immediately after the initial sinkhole developed, water was observed discharging under pressure at a joint approximately 30 feet from the riser at generally a ten o'clock position when viewed looking downstream. Smaller discharges under pressure were noted within the pipe wall generally on the upstream side of the compromised joint, primarily in the haunch area.

Lowering of the pool level in response to this condition was initially begun by flashboards being removed from the original smaller half round corrugated metal spillway by the Owner. Due to the slow rate of lowering, two 6" siphons and a pump were mobilized by forces retained by the Department. When the pool level dropped below the embankment adjacent to the upstream side of the riser, the rate of flow lessened very significantly. A hole in the embankment approximately 8 inches in diameter was observed very near the riser to the right (looking downstream) of the pipe centerline.

Further examination of the interior of the pipe revealed multiple modes of deterioration or failure. In the area of the pipe nearer the riser, evidence of water infiltrating through small to tiny openings in the pipe wall was observed. These openings appear to be the result of material deterioration. Near the riser, the invert of the pipe exhibits a failure geometry which appears similar to that associated with excessive loading. Small longitudinal openings about an inch or two long are present and the adjacent pipe material is curled slightly toward the pipe center resulting in a slight "W" shape at the invert. The displacement at these failures is measured in fractions of inches.

The integrity of several of the pipe joints appears questionable due to the asymmetrical butting of the pipe sections, apparently excessive annular space between the band and pipe, and exposed neoprene beading. A small flow of water continues to flow from the invert of a joint near the center of the run of pipe, even with the lowered pool level.

Perhaps the condition of most concern is the circumferential cracks which have developed at several locations along the length of the pipe. In some cases these cracks occur from the haunch to the crown and exhibit displacements ranging from a hairline opening to nearly an inch. The larger openings occur at the pipe crown and in least one instance embankment soil can observed beyond the crack.

It is our professional opinion that the pipe is no longer serviceable. Should pipe rehabilitation be considered in lieu of pipe replacement, the rehabilitation method cannot rely on the existing pipe to provide any permanent structural support, only as a form.

Pipe Zone Soils

Certainly as a result of the development of sinkholes and the pipe and joint conditions, one can infer that the soils in the pipe zone likely are not fully intact. Our initial approach was to engage a geotechnical engineer to conduct an exploration which would identify areas of voids or soft soils. The size and material construction of the pipe appears to reduce the feasibility of non-destructive testing for this purpose. As an alternative, the possibility of probing the adjacent soils through small opening made in the pipe wall was also considered. However, with the continued development of sinkholes indicating that the area of piping may not be limited to a direct route connected to the observed embankment opening, the uncertainty of the completeness and accuracy of available testing methods, and the embankment restoration required as part of the repair, it is our opinion that the assessment of the condition of the pipe zone soils is most appropriately made at the time of excavation during construction. We recognize that such an approach will require certain assumptions be made and contingencies be included during the development of the project budget as well as being addressed in the development of contract documents.

Hydrologic and Hydraulic Considerations

Hydraulic and hydrologic analyses are beyond the present scope of our engagement. We note that as an existing high hazard dam, the statutory Spillway Design Flood is one-half of the Probable Maximum Flood. It will be necessary to perform incremental analyses of the response of downstream improvements, specifically Interstate 20, to rainfall events of varying intensities, with an without a dam failure. to determine whether additional spillway capacity is necessary to meet regulatory requirements imposed during permitting.

We have performed hydraulic calculations to determine if the capacity of the 120" corrugated pipe can be fully utilized within the range of heads up to top of dam given the geometry of the riser. These calculations show that pipe flow controls upon the reservoir elevation reaching one-half foot below the top of dam. As a result, it does not appear that consideration of a reduction in pipe diameter is appropriate.

Given the difficulties and delays encountered in lowering the pool level in response to an emergency situation, we recommend that construction of a low level outlet be included in plans to repair the dam.

Proposed Actions

We have developed three conceptual repair scenarios and have prepared an estimated general cost for each. This information is being provided concurrently with this report to the Springwood Lake Company Board. These scenarios are described generally below and are differentiated by exposure to risk during construction and possible permitting hurdles apart from permitting through the Dam Safety Section.

Conceptual Repair Alternative A: Removal of the existing pipe, pipe zone excavation with bedding improvements, installation of an 8' x 8' concrete box culvert, and embankment core construction in the area of the excavation.

Conceptual Repair Alternative B: Rehabilitation of the existing pipe with structural concrete cast centrifugally, pipe zone excavation with bedding improvements, and embankment core construction in the area of the excavation.

Conceptual Repair Alternative C: Removal of the existing pipe, pipe zone excavation with bedding improvements, installation of a replacement 120" dia. 8 ga. corrugated aluminum pipe, and embankment core construction in the area of the excavation.

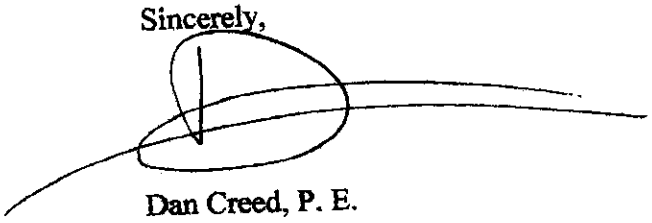
Identifying and securing the resources necessary to repair the dam and restore the reservoir may well be a challenging task for the leadership of the Company, as it would be for any similarly constructed Owner in the same predicament. The purpose of our efforts to date has been to develop a reasonably realistic budget for the repair to assist the Company in their evaluation of whether to repair or remove the dam, and to do so in a way which minimizes initial costs.

After researching available funding mechanisms and subsequent deliberations, should the Company elect to move forward with the repair, we propose that our next step be the commissioning of a survey and the performing of the incremental analyses to identify an appropriate SDF in consultation with the Department. If the analyses support the scope of improvements included in the budget estimates, then we propose to proceed with the preparation and submittal of construction drawings. Should the Company elect to remove the dam we will be available to assist with that as well.

We recommend in the interim that the Owner maintain the lowered reservoir level and take action to lower it further in advance of forecast heavy rains.

Should you have questions or require additional information, please do not hesitate to contact me at 803-714-9632 or via email at heritagesc@mindspring.com.

Sincerely,



Dan Creed, P. E.

cc: Springwood Lake Company Inc, c/o Al Murphy (advance copy via email to asgcm@aol.com)
Jerel Lee, SCDHEC (via email to leejo@dhec.sc.gov)

SPRINGWOOD LAKE DAM
CONCEPTUAL REPAIR ALTERNATIVE A
PIPE REPLACEMENT WITH 8 x 8 BOX CULVERT
ENGINEERS OPINION OF COST
July 9, 2018

ITEM	QUANTITY		UNIT PRICE			EXT.
Construction						
Staking & Mobilization		LS			$	10,000.00
Site Demolition/Control of Water		LS			$	18,000.00
Excavation	860	CY	$12.00	/CY	$	10,320.00
Bedding Improvements	330	CY	$30.00	/CY	$	9,900.00
8' x 8' Concrete Box Culvert	100	LF	$1,800.00	CY	$	180,000.00
Connection to Riser		LS			$	10,000.00
Core Construction	220	CY	$35.00	CY	$	7,700.00
Embankment Backfill	540	CY	$15.00	CY	$	8,100.00
Filter Diaphragm		LS			$	6,000.00
Riprap	100	SY	$100.00	SY	$	10,000.00
Low Level Outlet in Ex. Concrete Riser		LS			$	16,000.00
Repair of Slope Damaged in 2015 Overtopping		LS			$	12,000.00
Sediment Control and Grassing		LS			$	10,000.00
			Subtotal		**$**	**308,020.00**
Engineering and Surveying						
Surveying		LS			$	4,000.00
Incremental H & H Analyses to Support SDF		LS			$	5,000.00
Civil Engineering Plans and Submittals		LS			$	10,000.00
Structural Engineering		LS			$	3,000.00
Flood Study and Submittal (if req'd by County)		LS			$	15,000.00
Geotechnical Observation and Testing		LS			$	12,000.00
					$	**49,000.00**
			Subtotal		**$**	**357,020.00**
			15% Contingency		**$**	**53,553.00**
				Total	**$**	**410,573.00**

Note: This preliminary opinion of the cost of certain aspects of construction has been made without the benefit of a fully engineered and permitted design and is, therefore, subject to change as additional information becomes available. No warranty, expressed or implied, is made as to the accuracy of this opinion as compared to the actual cost of construction.

SPRINGWOOD LAKE DAM
CONCEPTUAL REPAIR ALTERNATIVE B
PIPE REHABILITATION BY CENTRIFUGALLY CAST LINER
ENGINEERS OPINION OF COST
July 9, 2018

ITEM	QUANTITY		UNIT PRICE		EXT.
Construction					
Staking & Mobilization		LS		$	10,000.00
Site Demolition/Maint. Of Utilities		LS		$	15,000.00
Pipe Liner Installation	100	LF	$1,150.00	/LF $	115,000.00
Excavation	1020	CY	$25.00	/CY $	25,500.00
Bedding Improvments	440	CY	$50.00	/CY $	22,000.00
Concrete Bedding Cradle	80	CY	$250.00	CY $	20,000.00
Core Construction	290	CY	$40.00	CY $	11,600.00
Embankment Backfill	650	CY	$18.00	CY $	11,700.00
Filter Diaphragm		LS		$	6,000.00
Riprap	100	SY	$100.00	SY $	10,000.00
Low Level Outlet in Ex. Concrete Riser		LS		$	16,000.00
Repair of Slope Damaged in 2015 Overtopping		LS		$	12,000.00
Sediment Control and Grassing		LS		$	10,000.00
			Subtotal	**$**	**284,800.00**
Engineering and Surveying					
Surveying		LS		$	4,000.00
Incremental H & H Analyses to Support SDF		LS		$	5,000.00
Civil Engineering Plans And Submittals		LS		$	10,000.00
Flood Study and Submittal (if req'd)		LS		$	15,000.00
Geotechnical Observation and Testing		LS		$	12,000.00
				$	**46,000.00**
			Subtotal	**$**	**330,800.00**
			15% Contingency	**$**	**49,620.00**
			Total	**$**	**380,420.00**

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SPRINGWOOD LAKE DAM
CONCEPTUAL REPAIR ALTERNATIVE C
PIPE REPLACEMENT WITH 120" CORRUGATED ALUMINUM PIPE
ENGINEERS OPINION OF COST
July 9, 2018

ITEM	QUANTITY		UNIT PRICE			EXT.
Construction						
Staking & Mobilization		LS			$	10,000.00
Site Demolition/Control of Water		LS			$	18,000.00
Excavation	860	CY	$12.00	/CY	$	10,320.00
Bedding Improvements	330	CY	$30.00	/CY	$	9,900.00
120" Corrugated Aluminum Pipe	100	LF	$1,400.00	/LF	$	140,000.00
Connection to Riser		LS			$	5,000.00
Concrete Bedding Cradle	80	CY	$250.00	CY	$	20,000.00
Core Construction	200	CY	$40.00	CY	$	8,000.00
Embankment Backfill	540	CY	$18.00	CY	$	9,720.00
Filter Diaphragm		LS			$	6,000.00
Riprap	100	SY	$100.00	SY	$	10,000.00
Low Level Outlet in Ex. Concrete Riser		LS			$	16,000.00
Repair of Slope Damaged in 2015 Overtopping		LS			$	12,000.00
Sediment Control and Grassing		LS			$	10,000.00
					$	**284,940.00**
Engineering and Surveying						
Surveying		LS			$	4,000.00
Incremental H & H Analyses to Support SDF		LS			$	5,000.00
Civil Engineering Plans And Submittals		LS			$	10,000.00
Structural Engineering		LS			$	2,000.00
Geotechnical Observation and Testing		LS			$	12,000.00
					$	**33,000.00**
			Subtotal		**$**	**317,940.00**
			15% Contingency		**$**	**47,691.00**
				Total	**$**	**365,631.00**

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