BEFORE THE TENNESSEE REGULATORY AUTHORITY

NASHVILLE, TENNESSEE

IN RE:	)	
	)	
PETITION OF TENNESSEE	)	DOCKET NO. 14-00136
WASTEWATER SYSTEMS, INC.	)	
FOR APPROVAL OF	)	
CAPITAL IMPROVEMENT	)	
SURCHARGES AND FINANCING	)	
ARRANGEMENTS	)	

REBUTTAL TESTIMONY
OF
JOHN RAMI MISHU

ON BEHALF OF TENNESSEE WASTEWATER SYSTEMS, INC.

August 19, 2015

BEFORE THE TENNESSEE REGULATORY AUTHORITY

NASHVILLE, TENNESSEE

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PETITION OF TENNESSEE	)	
WASTEWATER SYSTEMS, INC. FOR	)	
APPROVAL OF CAPITAL	)	**DOCKET NO. 14-00136**
IMPROVEMENT SURCHARGES AND	)	
FINANCING ARRANGEMENTS	)	

REBUTTAL TESTIMONY OF JOHN RAMI MISHU

Q. Please tell us your name and occupation.

A. I am John Rami Mishu. I am a licensed engineer and geologist with Geotek Engineering Company, Inc. based here in Nashville. Attached as Exhibit A is my resume.

Q. What is the purpose of your testimony?

A. I am responding to the direct testimony of Mr. Britton Dotson concerning the cause of the formation of sinkholes in the deep cell effluent lagoon at the Maple Green wastewater treatment facility near Coopertown, Tennessee.

Q. Are you familiar with the Maple Green facility?

A. Yes. I performed a geotechnical study of the site in late 2001.

Q. Did you see the site shortly after the formation of the sinkholes on February 1, 2014?

A. Yes. At the request of Roy Denney, I visited the lagoon on February 4, 2014, three days after he told me the sinkholes formed. Based on my observations and information provided by Mr. Denney, it was my opinion as a professional engineer and geologist "that the sinkholes formed due to natural karst-sinkhole activity unrelated to any alleged maintenance issues or to the location of the drip lines," as stated in my letter to Mr. Denney of February 19, 2014. A copy of that letter is attached to TWSI's petition.

Q. Has that opinion changed?

A. No, it has not. In a letter to Mr. Denney dated June 29, 2015, attached as Exhibit B, I reiterated that conclusion and added that "the overwhelming nature of the evidence [is] that (a) the lagoon's originally-constructed 10-to 18-ft. deep excavation and (b) its 15-to-20-ft. deep near–constant body of water are what caused the sinkhole collapse."

Q. Did Mr. Dodson reach a different conclusion?

A. I don't think so. He does not state or imply that the sinkholes were caused by anything other than natural karst-sinkhole activity unrelated to any alleged maintenance issues or to the location of the drip lines. He does, however, say that my letter of February 19, 2014 did not discuss "what role drip line utilization along the lagoon berm may have played in the development of the collapse features other than the opinion the two are unrelated" and that I "provided no opinion on whether the presence or operation of the lagoon influenced the development of the sinkholes."

Q. Does your second letter, dated June 29, 2015, address those two points?

A. Yes, in detail. As I said in my letter, the construction of the deep lagoon and the constant presence of the water in it caused the sinkholes underneath the lagoon to form. There is no evidence that the location of the drip lines, which are on the exterior slope of the berm around the lagoon, caused the sinkhole collapses inside the lagoon. As I said in my letter,

> Construction of the lagoon itself is an overwhelming contributor to the formation of sinkholes along the lagoon bottom. The 2 major factors are the 10-to 18-ft deep excavation and the presence of water in the lagoon.
>
> The excavation removed a significant part of the stiff soil overburden which had been arching/bridging over deep-seated incipient sinkholes and voids. In our experience, earthen cuts are probably the single biggest cause of new sinkhole collapses.
>
> The lagoon water contributed by (a) adding weight to the lagoon-bottom surface and (b) introducing a constant source of groundwater (under 15 to 20 feet of hydrostatic head) to the underlying subgrade. Increased saturation weakens the soil and accelerates the sinkhole collapse process.
>
> These 2 factors (the excavation and lagoon water) explain why the sinkholes formed in the lagoon, as opposed to outside of the lagoon. The correlation of these sinkholes' locations to the inside of the lagoon is strong and clear.
>
> We find it very difficult to associate any other causal factor with the sinkholes. For example, TDEC inquired about the role that the drip lines on the exterior slope of the term might have played to the sinkhole collapses in the lagoon. The single biggest reason for us to discount this factor is simply because no sinkholes formed in (or near) this area. Additionally, although the drip-irrigation lines do introduce water to the soil along the exterior slope of the berm, the amount of water seeping underground is an insignificant fraction of that coming from the lagoon and its near-constant 15-to 20-ft hydrostatic head-pressure. Furthermore, the presence of wet ground and ponding water at the bottom of the berm's exterior slope implies that less water is infiltrating underground than is being discharged through the drip tubing.

Q. Do you have a diagram of the lagoon showing the location of the sinkholes, the berm, and the drip lines?

A. Yes. That drawing is attached as Exhibit C. As shown in the drawing, the sinkholes formed underneath the lagoon, not underneath the drip lines. As I wrote, "the correlation of these sinkholes' locations to the inside of the lagoon is strong and clear."

Q. Do you believe that if the drip lines had been in a different location, the sinkholes would not have collapsed?

A. No. The excavation of the lagoon and the presence of the water in the lagoon caused the sinkholes to form underneath the lagoon. The evidence is overwhelming.

Q. Mr. Dotson also mentions that in September, 2013, TDEC found "large willow trees along the inside of the levee." Does that change your opinion?

A. No. But I did not observe "large willow trees." I did see some thin small dead trees lying against the inside bank of the berm, near the former water's edge. In any event, the presence or absence of trees or other woody vegetation "along the inside of the levee" would not have caused the sinkholes to form underneath the water inside the lagoon. To reiterate, it was the digging of the lagoon and the 15-to-20 feet of water that are the most likely causes of the formation of the sinkholes. I believe I have now addressed Mr. Dotson's concerns.

Q. Does this conclude your testimony?

A. Yes.

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AFFIDAVIT

I, John Rami Mishu, hereby certify that the attached testimony is true and correct to the best of my knowledge.

JOHN RAMI MISHU

Sworn to and subscribed before me,
this 18th day of August, 2015.

Delilah Sparks
NOTARY PUBLIC

My Commission Expires: June 21, 2016

DELILAH SPARKS
STATE OF TENNESSEE NOTARY PUBLIC
DAVIDSON COUNTY, TN

Exhibit A
Resume for John Rami Mishu

JOHN RAMI MISHU, P.E., P.G.

Principal Engineer with over 32 years of experience in geotechnical engineering, geoenvironmental studies, and construction materials testing. Has completed more than 6,000 projects. Services include design, evaluation, and testing for building foundations, retaining walls, pavements, and forensic studies such as landslides, sinkholes, wall failures, building-settlement, etc. Has concentrated his experience in Tennessee, Kentucky, and nearby parts of the contiguous states.

EDUCATION:
- Massachusetts Institute of Technology, MSCE Geotechnical Engineering, 1982.
- Vanderbilt University, BE Civil Engineering, 1980 summa cum laude.

SPECIALIZATION:
- Geotechnical Engineering
- Geo-Environmental Engineering
- Construction Materials Testing
- Hydrogeology

CERTIFICATION:
- Professional Licensed Civil Engineer in Tennessee, Kentucky, Alabama, Virginia, Georgia, and Mississippi.
- Registered Geologist in Tennessee.

PUBLICATIONS:

"Evaluation of Compositional and Engineering Properties of Off-Shore Venezuelan Soils: Tuy Cariaco Clays", with Ladd, Martin, and others. Massachusetts Institute of Technology Research Report, June 1982.

"Design and Construction of Low-Level Radioactive Waste Storage Site in East Tennessee", with Prewett. Proceedings of 8th Annual Symposium on Geotechnical and Geohydrological Aspects of Waste Management, Colorado State University, February 1986.

"Case History-Remediation of Portland City Lake Dam, Tennessee," Mishu et al. Proceedings of Association of State Dam Safety Officials, Southeastern Regional Conference, Nashville, Tennessee, June 1996.

"Foundation Remedies for Residential Construction over Karst Limestone in Nashville, Tennessee," Mishu et. al., Sixth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst, Springfield, Missouri, April 1997.

CONTINUING EDUCATION:

Geotechnical Engineering of Land Disposal Systems. University of Wisconsin-Extension, October 1984. Course work included legal aspects, leachate properties, slurry walls, containment liners, hydrogeologic principles, chemical reactions, pollutant attenuation, system design and operation, geological monitoring and mapping, and computer modeling.

Fundamentals of Asphalt Paving. Memphis State University, March, 1987. Program included material selection, mix design, analysis, production, paving operations, quality control, and inspection.

Karst Geology and Hydrology. Western Kentucky University. Summer 1993. Classes included study of caves, Karst features, geomorphology, Karst aquifers, Karst environmental problems, and groundwater monitoring techniques. Numerous field trips were performed.

Exhibit A
Resume for John Rami Mishu

SELECTED TYPICAL PROJECT EXPERIENCE:

Nashville International Airport, Multiple Expansions, Nashville, TN. Mr. Mishu provided geotechnical engineering and supervised drilling and construction materials testing services for several major expansions at the Nashville International Airport. Projects included 2 new runways, several aprons, and 3 runway extensions, one of which included a cut-and-cover tunnel for a 4-lane auto underpass at Murfreesboro Road.

Cumberland River Pedestrian Bridge; Nashville, TN. Mr. Mishu provided geotechnical services for this project on the Cumberland River, near Opry Mills and Shelby Bottoms. Subsurface conditions across the alignment were very complex. The east bank consisted of a semi-stable limestone bluff and an underwater boulder-debris wedge. The west bank was comprised of thick alluvial sediments and a large fill mount. The fill mount required geosynthetic reinforcement to maintain stable slopes. Foundations included drilled piers, micropiles, and drive H-piles.

DOE Facilities, Oak Ridge, Tennessee and Paducah, KY. Mr. Mishu provided geotechnical investigations, hydrogeologic evaluations, environmental assessments, on-site monitoring during construction, geotechnical laboratory testing, field testing services, and monitor well installation. Geotechnical recommendations were provided for piles, caissons, mat foundations, standard shallow foundations, pavements, slabs, slope stability, and retaining walls.

Omohundro 60-in. Water Main, Nashville, TN. Mr. Mishu provided geotechnical services for a 60-in. diameter water transmission main which was constructed near the Omohundro Water Treatment Plant in Nashville. The project was complicated by a slope failure that took place beside the alignment during the May, 2010 flood and a sinkhole that formed below the completed pipe in 2013. Mr. Mishu provided geotechnical services regarding (a) the slope failure, (b) the design of water-main thrust blocks elsewhere along the alignment, and (c) sinkhole remediation below the 60-in. line.

Metro Fire Station No. 39, Nashville, TN. Mr. Mishu provided geotechnical engineering services to evaluate building distress and pavement failures occurring at this fire hall in north Nashville. The study included concrete testing, soil-shrink-swell evaluation, and construction-log review. Assisted Metro Nashville Legal Department in forensic engineering role.

Aerojet Heavy Metals Company, Jonesborough, Tennessee. Mr. Mishu provided geotechnical and geoenvironmetnal design recommendations for remediation and closure of a low-level radioactive landfill at a major ordnance facility. He assisted with the installation of monitor wells and conducted annual groundwater surveillance.

Tennessee SR 50 Widening, Lewisburg, Marshall County, Tennessee. Mr. Mishu provided geotechnical engineering services for a 5-mile widening of State Route 50 near Lewisburg, Tennessee. The site contained sinkholes, 1 cave, existing fills, slope instability, and low-strength soils. The geotechnical design addressed 2 retaining walls, sinkhole-repairs, differential settlement related to thick fills, and tall fill slopes.

Bridges over Caney Fork and Rocky Rivers for Hwy 70 South, Tenn. Mr. Mishu supervised and provided geotechnical design for a large geotechnical and drilling contract for the Tennessee DOT on the Caney Fork and Rocky Rivers. Barge-mounted and ATV-mounted drill rigs were used to auger, sample, and core drill up to 100 feet deep in cavernous limestone and boulder-laden soils. The project was further complicated by extreme fluctuations in the river level.

Well Installation at DOE Gaseous Diffusion Plant, Paducah, KY. Mr. Mishu managed and supervised a large soil sampling and well installation contractor at the DOE facility in Paducah, KY. More than 5 rigs and 20 men were used. Drilling methods included auger, mud-rotary, and cable tool. Depths of more than 220 feet were drilled in a complex geology of clays, sands, and gravels. Stainless steel wells were installed in telescoping holes. Drillers were OSHA trained and radiation-safety trained.

Water Loss from Lakes at Springhouse Golf Club, Nashville, TN. Mr. Mishu performed an evaluation of seepage losses from 2 man-made lakes at Gaylord Entertainment's Springhouse Golf Club facility along the banks of the Cumberland River. Work included drilling, sampling, permeability testing, pipe inspection, seepage analysis, grouting, and other geotechnical services.

GEOTEK

Exhibit B
Letter of June 29, 2015

Geotek Engineering Company, Inc. • 2909 Elizabeth Street • Nashville, Tennessee 37211-2302
(615) 833-3800 • Fax (615) 833-4097

June 29, 2015

Roy Denney, P.E.
Adenus Operations, LLC
849 Aviation Pkwy.
Smyrna, TN 37167

SUBJ: Sinkholes at Maple Green Wastewater Treatment Lagoon
Coopertown, Tennessee
GPN: 01-5668-B

Dear Mr. Denney:

We read the testimony of the TDEC representative, Mr. Britton Dotson, which is dated April 30, 2015. In this testimony, TDEC addressed the karst features (i.e., sinkholes) in the Maple Green lagoon. They cited some concerns about our report of February 19, 2014. We present the following additional comments which may help with some of their concerns.

We generally agree with TDEC's characterization (on Pages 11 and 12 of the testimony) of how the sinkholes formed. Regarding their statement on Page 12 about "saturated soil conditions," we would add that, in most of the sinkhole collapses we have seen, the deeper-seated soils are more saturated than the near-surface soils. The near-surface soil is typically stiff and dry, but then transitions with depth to a soft wet soil, particularly as the bedrock surfaced is neared.

Construction of the lagoon itself is an overwhelming contributor to the formation of sinkholes along the lagoon bottom. The 2 major factors are the 10- to 18-ft deep excavation and the presence of water in the lagoon.

The excavation removed a significant part of the stiff soil overburden which had been arching/bridging over deep-seated incipient sinkholes and voids. In our experience, earthen cuts are probably the single biggest cause of new sinkhole collapses.

The lagoon water contributed by (a) adding weight to the lagoon-bottom surface and (b) introducing a constant source of groundwater (under 15 to 20 feet of hydrostatic head) to the underlying subgrade. Increased saturation weakens the soil and accelerates the sinkhole collapse process.

These 2 factors (the excavation and lagoon water) explain why the sinkholes formed in the lagoon, as opposed to outside of the lagoon. The correlation of these sinkholes' locations to the inside of the lagoon is strong and clear.

We find it very difficult to associate any other causal factor with the sinkholes. For example, TDEC inquired about the role that the drip lines on the exterior slope of the berm might have played to the sinkhole collapses in the lagoon. The single biggest reason for us to discount this factor is simply because no sinkholes formed in (or near) this area. Additionally, although the drip-irrigation lines do introduce water to the soil along the exterior slope of the berm, the amount of water seeping underground is an insignificant fraction of that coming from the lagoon and its near-constant 15- to 20-ft hydrostatic head-pressure. Furthermore, the presence of wet ground and ponding water at the bottom of the berm's exterior slope implies that less water is infiltrating underground than is being discharged through the drip tubing.

TDEC mentioned a few other concerns about our report which, in our opinion, are largely irrelevant or inapplicable because of the overwhelming nature of the evidence that (a) the lagoon's originally-constructed 10- to 18-ft deep excavation and (b) its 15- to 20-ft deep near-constant body of water are what caused the sinkhole collapses.

We maintain and reiterate the same opinions stated in our report of February 19, 2014. Based on our observations and the information provided, we believe that the sinkholes formed due to natural karst-sinkhole activity unrelated to any alleged maintenance issues or to the location of the drip lines.

Should you have any questions or need additional information, feel free to contact us.

Sincerely,

GEOTEK ENGINEERING COMPANY, INC.

John Rami Mishu, P.E., P.G.

JRM/*ds/01-5668-B Maple Green

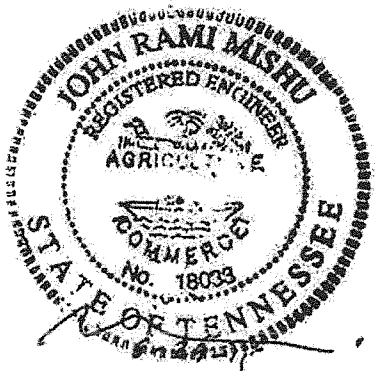
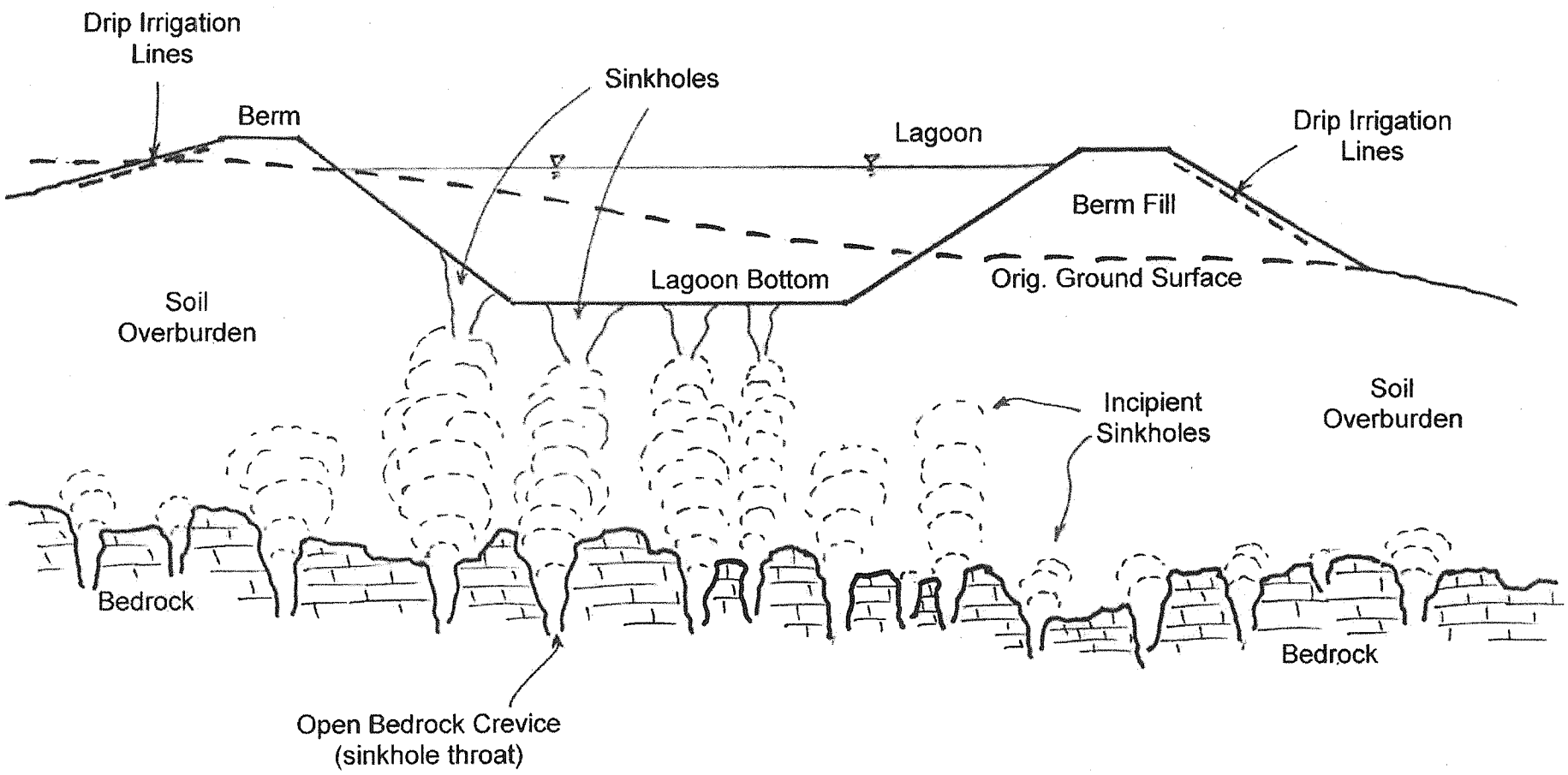


Exhibit C
Lagoon Subsurface Cross-Section

Hypothetical Subsurface Cross-Section



Note: This hypothetical cross-section is based on observations of February. 4, 2014.

Maple Green Lagoon
GPN: 01-5668-B

GEOTEK