TERRA TECHNOLOGIES

Old Longview Lake Rehabilitation/Restoration Study Lee Summit, Missouri

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Prepared For

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1. Project Overview

The intent of this general study is to evaluate alternatives to address dam safety and lake aesthetics for Old Longview Lake in Lee Summit, Missouri. This lake is located upon private property near the public Longview Lake and was part of the original Longview Farms. Records indicate the dam was constructed in 1914 with a surface area of approximately 20 acres. A pergola of unknown purpose is located at the northern end of the lake and it is assumed this pergola was part of the original lake construction. Subsequently, residential development has occurred along the eastern shoreline of the lake. This development appears to have occurred sometime immediately prior to 2000. No known work has been performed to or upon the lake, spillways, or dam since originally constructed. Consequently, there is concern for public safety should a failure occur and there is also a stated desire to restore nearby historical structures and to improve the general aesthetics of the lake. This study endeavors to review available options to achieve the intended goals for the lake and to make general recommendations for implementing those options.

2. Current Conditions

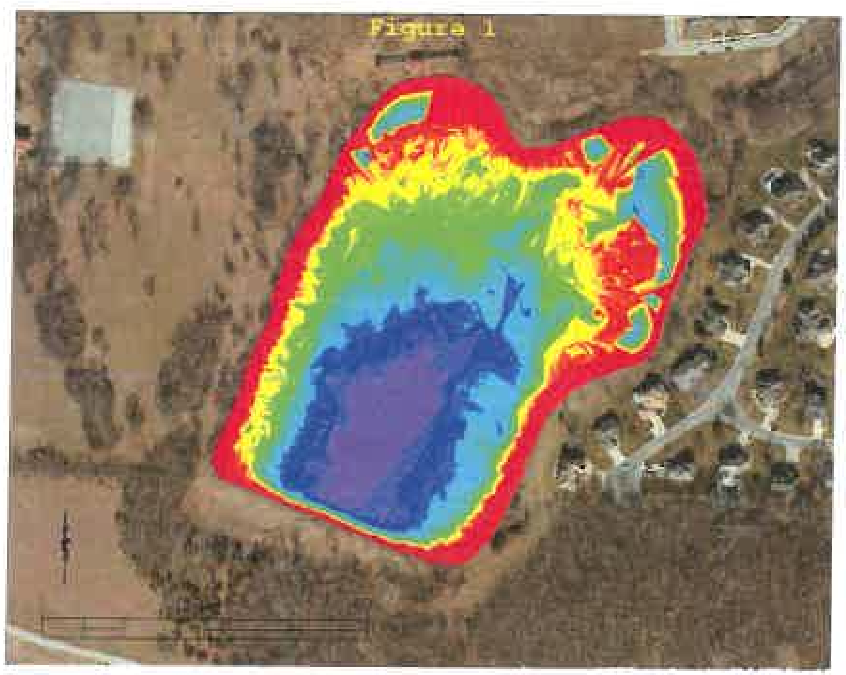
A geotechnical analysis of the lake dam was performed by Kansas City Testing & Engineering, LLC. That report is presented in Appendix A of this document. A hydrologic and hydraulic evaluation of the existing lake and watershed was performed by Olsson Associates. That report is presented in Appendix B. A review of these reports indicates several conditions that will be summarized here. Refer to the specific reports in the appendices for detailed information.

The dam meets all recommended geotechnical factors of safety within the limits of what the geotechnical evaluations can calculate. Limitations upon this analysis include knowing the effects of woody vegetation growing upon the dam and how that vegetation affects geotechnical stability. Typically, factors of safety are used to account for this type of unknown and as stated above, the dam meets all recommended factors of safety, but only by a small margin. Therefore, the geotechnical analysis has made some recommendations to increase factors of safety. Those recommendations will be presented later in this report.

The lake surface area is approximately 20 acres. The facility was originally constructed with a primary standpipe spillway near the center of the dam and a secondary weir type spillway flowing over the top of the dam on the eastern end of the dam. The primary spillway outlet is buried and assumed to no longer convey flows through the dam. Erosion has occurred around the secondary spillway such that primary flows now pass around the secondary spillway in an uncontrolled manner rather than utilizing the spillway to convey flows. For all intents and purposes, the dam no longer has a functioning spillway that controls flows and all through flows pass through the erosion channel around the secondary spillway. Olsson's report assumed these conditions to evaluate current and future flows relative to the existing conditions of the dam and reservoir. That analysis concluded the facility does not meet current design criteria. It shows overtopping of the dam in less than a 10 year return frequency event for both existing and future conditions modeling. Visual observations of the dam do not reveal that overtopping of the dam has ever occurred. Most likely such flows found a limited path around or over the dam such that additional erosion indicators were not formed. Nonetheless, the dam could overtop in a large precipitation event, a situation that is generally recognized as unsafe.

The lake is not affected by any regulatory floodplains. However, such a regulatory floodplain begins approximately 500 linear feet downstream of the dam, beginning on the southern side of SW County Park Rd. This regulatory floodplain is designated as a Floodway, requiring certification of a zero rise impact should any work be done in the area. This Floodway is also the flood pool limits of Longview Lake. Due to the relatively small inflows coming into Longview Lake from the channel exiting Old Longview Lake compared to the storage volume of Longview Lake, it is unlikely that changes or alterations to the Old Longview Lake dam or reservoir would have any measurable effect upon Floodway elevations in Longview Lake. Likewise, the large storage volume of Longview Lake would likely attenuate any downstream flooding should the Old Longview Lake dam ever breach. In that occurrence, the only threats from a dam breach would be to the SW County Park roadway itself or to any persons that might be on that roadway during a dam breach.

Old Longview Lake has received sediments along with inflows since original completion in 1914. Consequently, a significant volume of sediment has accumulated in Old Longview Lake over the past 100+ years. A bathymetric survey of the lake was completed by SKW Engineering revealing generally shallow depths. Figure 1 shows the results of this bathymetric survey. Red is shallowest and purple is the deepest. Depths range from 0 feet to 9 feet. As expected, sediments have accumulated in upstream and edge areas such that water depths are limited. A small area in the middle of the lake has generally acceptable depths greater than 5 feet, but most of the lake is shallower, particularly along the edges.



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3. Identified Problems

As previously discussed, there are concerns regarding public safety and aesthetics. These concerns are broken into three subgroups; dam stability and adequacy, hydraulic conveyance, and lake aesthetics.

a. *Dam Stability and Adequacy*
The dam in the current condition does technically meet all calculated factors of safety. However, the condition of the dam is suspect due to the overall age of the embankment and the quantity of vegetation that has been allowed to become established upon it. Additionally, any proposed improvement will likely add some height to the dam that will require analysis to determine if factors of safety are still met.

b. *Hydraulic Conveyance*
The existing dam spillways are non-functional. The primary standpipe spillway is buried at the downstream end indicating no flows have passed through this structure for a very long time. The secondary "over the top spillway", while still intact, has experienced erosion around it such that no flows utilize this spillway until the eroded bypass channel completely fills, backing up enough water that the spillway could be utilized. Additionally, site topography reveals the east end of the dam is somewhat lower than the rest of the dam, forming a third "emergency spillway" corridor that would allow overflows to pass around the dam rather than flowing over the top of the main dam embankment. If the dam has not previously overtopped as the visual evidence suggests, it would be because such flows would follow this path. Due to the limited size of the watershed and the large size of the lake and dam compared to that limited watershed size, it is unlikely there would ever be enough stormwater flow to exceed the capacity of the erosional bypass channel around the secondary spillway and the third "emergency spillway" corridor to convey the flows.

c. *Lake Aesthetics*
The high degree of sedimentation and accumulated debris in the lake greatly impact lake aesthetics. Larger trash and debris is readily observed above the water level. The shallow depths limit wave height, limiting oxygenation and the lake's ability to naturally control growth of filamentous algae. The small water volume will also become more readily hypoxic due to rotting vegetation, creating bad smells. During dry periods, the lake levels will also drop exposing shallow bars away from the shoreline. All of these factors tend to combine at various times to create less than desirable aesthetic conditions for the lake. Since the lake was intended to be an amenity, positive aesthetic conditions are desired.

4. Problem Causation

Dam stability and adequacy concerns have been caused by a lack of maintenance for a very long period of time. Woody vegetation has been allowed to grow on the dam with roots that potentially extend into the dam core. This has the potential to create hydraulic pathways within the soil, allowing greater volumes of water to seep through the structure. As hydraulic pressure builds up within these pathways, conditions can be created that can liquefy the embankment soils potentially causing a catastrophic failure of the dam. It is not readily possible to determine if this condition exists within the Old Longview Lake dam but the conditions that create the possibility can be avoided via routine maintenance.

Hydraulic conveyance concerns are also caused by a lack of maintenance for a very long time. The downstream end of the primary standpipe spillway being occluded was likely caused when the standpipe valve was closed, most likely because it was leaking. Once the valve was closed, flows no longer passed through this spillway allowing sediments to accumulate and bury the downstream end. Since the standpipe spillway was then no longer conveying stream flows through the dam, the only functioning spillway became the secondary spillway. Over the years, this structure was also not maintained and an erosional channel formed around it, bypassing the structure completely. Today there is no structure to control flows over or through the dam creating a potentially dangerous condition. The erosional channel has no controls whatsoever and could cause a catastrophic failure of the dam at some point in the future. Reconstruction of an engineered spillway system to control flows through the dam is required to address this concern.

Shallow water levels in Old Longview Lake are the primary cause of all lake aesthetic concerns. A greater amount of the water column can fill with vegetation during the summer months and the water becomes hypoxic more quickly. Waves generated by wind help oxygenate the water and prevent accumulation of excess algae growth, but maximum wave height by wind generation is a function of water depth with shallower water allowing smaller waves. Deeper water would also have a greater ability to mask submerged debris and shallow sediment bars would not be exposed as readily as lake levels go down due to limited inflows. Creating greater water depth would at least partially address these concerns if not eliminate them completely.

5. **<u>Range of Solutions</u>**

   a. *<u>Dam Stability</u>*

   Dam stability can be increased via the addition of soil as a buttress to the downstream face of the dam. The greatest benefits are achieved if the soil buttress is placed at the toe of the of the dam embankment slope but some additional stability can be created by increasing the overall thickness of the dam. Clearing and grubbing of the top and downstream face of the dam to remove woody vegetation will also increase dam stability. Large diameter trees should merely be cut off at ground level and the stumps buried so as to not create a temporary void in the dam that could create an uncontrollable leak through the embankment. Otherwise all woody vegetation should be removed from the exposed portions of the dam embankment. Since the downstream face of the dam requires general clearing and grubbing, the opportunity to add an additional soil buttress during this disturbance seems to be optimum. The amount of soil to add as a buttress will be discussed later in the report when costs of the proposed improvements are also discussed.

   b. *<u>Hydraulic Conveyance/Spillways</u>*

   Old Longview Lake has no current functioning engineered spillway and flows through the dam pass in an uncontrolled manner. This does not meet current design criteria and poses a threat to public safety via the potential of a catastrophic dam failure. There are two primary types of spillway systems, a through spillway with a standpipe and an over the top spillway. Old Longview Lake originally had both types, but both of these require rehabilitation or replacement. The benefits of a standpipe spillway are primarily the ability to allow water to be released through the dam at various lake water depths. There are typically openings at various elevations along the standpipe that can be opened or closed. However, a standpipe spillway is the most disruptive to construct as it requires draining of the lake to accommodate. A horizontal pipe must be laid through the dam embankment and that cannot be built without draining the lake. Due to the age of the existing standpipe system and the difficulty of access to evaluate current condition, it will not be recommended to try and rehabilitate the existing structure. If a new standpipe spillway is constructed, the existing standpipe spillway would be demolished and a new standpipe spillway would be constructed in the same location. If a new standpipe spillway is not to be constructed, the top of the existing spillway would be demolished after filling the below grade portions with a flowable fill.

Over the top spillways tend to be more economical to build but do not allow water releases when lake levels are lower than the spillway flowline elevation. Often reservoirs are constructed with both a standpipe spillway as the primary spillway and an over the top spillway as the secondary spillway. However, if lowering water levels below the spillway flowline is not a necessary consideration, a standpipe spillway is not required. Since water depths are already shallow, the benefit of a standpipe spillway on Old Longview Lake is questionable. The ability of an over the top spillway to convey water is a function of the width of the spillway and the allowable depth of water over the spillway. If limited freeboard is available and flow depths over the spillway must remain shallow, a very wide spillway might be required. If there is greater allowable freeboard and the flow depths over the spillway can be deeper, a narrower spillway can be accommodated. The purpose of all spillways is to allow flows through or over a dam in a controlled manner without overtopping the dam itself. If a dam overtops, the flows will be uncontrolled and the dam integrity could be jeopardized. Therefore, spillways must be designed to prevent that from happening. Since flow rates can vary widely, the spillway should be designed for some maximum flow rate that can never really be known. That uncertainty is addressed by the creation of additional freeboard. Freeboard is the difference between the maximum calculated water elevation and the actual elevation of the top of the dam. Freeboard of at least one to two feet is usually recommended to account for hydrologic and hydraulic uncertainty as well as waves that could sweep over the dam on a windy day. Since an over the top spillway is already near the top elevation of the dam, typically some portion of the calculated spillway capacity is lost to this freeboard even though that capacity still exists. As an example, if the flowline of a spillway is four feet lower than the top of the dam and two feet of freeboard is required, the calculated capacity of the spillway only accounts for flows occurring in the first two feet of the spillway flow path elevation. The capacity above that point still exists but only acts as a buffer against uncertainty or unknowns.

Often when the primary spillway is an over the top spillway, another emergency spillway will be constructed. While the primary over the top spillway can be designed to accommodate extreme flow events, typically the cost is too high to be worthwhile to build. In those situations an emergency spillway intended only for "emergency" conditions will also be built. Such a spillway would be similar to an over the top spillway except the flowline path would not occur near the dam embankment itself. This allows the emergency spillway to be constructed out of materials that are less resistant to erosion and scour. If the emergency spillway is ever needed, repairs to the flow path may be required afterward but the dam itself would not be threatened with failure. Often such emergency spillways are never actually utilized because the extreme flow event never occurs, but if they are utilized they will need repairs. Due to the low likelihood of their use, this is often considered to be a risk worth taking and worthwhile expense if incurred.

Since the Old Longview Lake dam has no functioning engineered spillway, a new spillway system will be required. A more detailed description of recommended spillway options will be discussed later in this report when cost considerations are presented and recommended.

c. *Aesthetics/Lake Depth*

The majority of aesthetic concerns are driven by water depths in the lake. Accumulated sediments have filled in a significant portion of the lake since it was originally constructed and the shallower depths have created undesirable conditions. Additionally, the lack of a functioning engineered spillway has allowed channel erosion to occur, lowering the water surface below historical elevations. To improve lake aesthetics, greater water depth in the lake is required. Creating greater water depth can be achieved via dredging of accumulated sediments within the lake, raising the dam and spillway elevations, or a combination of these two approaches.

A minimum lake depth of at least seven feet would be desirable, but achieving that goal presents challenges due to the quantity of dredged material required to be removed. A lesser goal for a minimum lake depth of five feet is likely the minimum dredging that could be accommodated for the entire lake due to the physical requirements of the dredge operations. A hydraulic dredge typically requires at least four feet of water depth to minimally operate. Therefore, dredging to water depths less than five feet are not viable except at the very edge of the dredge limits that could be reached by the boom arm of the dredge without floating the dredge barge into that area. The lesser dredge quantities for a minimum five foot depth are still problematic for onshore dredge operations and project budget. Spot dredging could be performed at critical locations, but this would not enhance overall lake aesthetics.

Raising the spillway elevations and dam height are an effective method for increasing lake depth but this approach has constraints. Adjacent infrastructure and buildings cannot be flooded and the maximum dam height also has geotechnical limits. Observations of existing facilities and surrounding land forms suggest the lake level was originally at an elevation higher than the 929.0' elevation it is at today. The over the top spillway on the east end of the dam has a flowline elevation of 930.20' and the non-functional standpipe riser spillway has an overflow elevation of 932.40'. The top of bank around the perimeter of the lake is also generally located at elevation 931'. Therefore it is assumed that a lake elevation of 930.2', 1.2 feet higher than the current lake elevation, could be accommodated. However, a variance from City regulatory requirements would likely be required to implement this approach. The residence at 3100 SW Pergola Drive has a low opening elevation of 932.97' and a lowest adjacent grade elevation of 932.90', so there would be insufficient freeboard to these elevations if the normal pool was raised to elevation 930.20'. Fortunately, the way that area is landscaped and graded requires water elevations to exceed 933.70' before water can reach these low areas. Therefore, a reasonable minimum freeboard of one foot could be provided to protect this residence if the grade protections beyond the low opening and lowest adjacent grade are considered. Raising the dam height would also entail placement of additional embankment and would limit the lesser options for increases in dam embankment geotechnical stability. Otherwise, spillway options and requirements would vary little from leaving the dam height at the current elevation of approximately 932', so the full range of spillway options would be possible.

Dredging can be performed hydraulically or mechanically. Mechanical dredging would involve dewatering the lake and excavating accumulated sediments via excavation equipment or a drag line. Typically this type of dredging is utilized on smaller dredging projects that do not entail sufficient dredge quantities to make the process of hydraulic dredging worthwhile to set up. The dredged material must be handled multiple times and accessing the center portions of the lake bottom with heavy equipment can be difficult. The approximate 20 acre size of Old Longview Lake likely rules out mechanical dredging as a cost effective option due to these limitations. If creating deeper water in only specific portions of the lake is worthwhile, mechanical dredging should be investigated, but dredging the entire lake uniformly via mechanical excavation cannot be performed economically.

Hydraulic dredging is the process of sucking up both sediments and water from a floating barge, and then piping that material to an alternate location to dewater and potentially reclaim the material. Pipe systems to accommodate this type of dredging can be up to a half mile long, allowing the dredged material to be economically transported in a single process. However, reclamation of the dredge material could entail handling of the dredged material multiple times, so costs associated with reclamation and haul off of the material are difficult to estimate unless the final disposition of the material is known. Such material requires days to weeks for sufficient water to leave the dredge material before handling of the material for reclamation could begin. Then the material must be further dried and worked until it can be placed in a permanent location in a proper manner. Hydraulic dredging would require construction of a settling basin sufficiently large to contain all of the proposed dredge materials so that the dredging process could continue unimpeded until complete. Smaller settling basins would require interruption of the dredging process for multiple weeks or months while the dredged material is dewatered to the point where it can be handled and removed. Such interruption would make hydraulic dredging grossly inefficient because the dredge equipment would be idled for extended durations. Another limitation to hydraulic dredging would be the quantity of water within the lake. Hydraulic dredging entails sucking water and sediments from the lake, so sufficient water would be required to continue the process without interruption. Frequently waiting for the lake to refill sufficiently to float the barge and resume operations would lessen efficiency and increase costs. To offset this concern, it may be possible for return water from the dewatering process to return directly to the lake or be pumped back to the lake. Another option might be to pump water from Longview Lake, but State and Federal approvals would be required before this approach could be considered.

Final disposition of any dredge material is not currently known and insufficient private property exists around the lake to accommodate the settling basins. If the dredge material can be wasted nearby, final disposition costs should be somewhat minimal since no hauling costs would be incurred. If dredge material must be hauled to an off-site location, that location would need to be identified before such costs could be calculated. There is sufficient space on adjacent federally owned property to facilitate construction of the settling basins and wasting of the dredge material, but approvals would need to be obtained before the viability of that approach could be determined.

6. **Alternatives**

A variety of alternatives exist to address the identified problems and concerns. Since such alternatives combine alternatives for the identified subtopics, geotechnical, hydrologic/hydraulic, and aesthetics, the approach will be to provide cost information for each subtopic alternate and make recommendations in the Recommendations portion of the report.

a. *Geotechnical Alternatives*

Geotechnical alternatives range from doing nothing to somewhat extensive stabilization of the dam embankment.

i. Do Nothing

This approach, as the name implies, would be to take no steps to stabilize the existing or future dam embankment. The implied cost is also zero, although long term liabilities could be incurred as a consequence. Such liabilities would be if a partial or complete dam breach occurred in the future. While this is unlikely, consultation with legal experts should occur relative to the potential magnitude of such liabilities if this approach is selected.

ii. Remove Woody Vegetation from Dam Embankment

Woody vegetation should not be allowed to grow and mature on dams. Roots can penetrate the embankment creating hydraulic pathways through the fill. Hydrostatic pressure can then build up within the embankment and create conditions whereby the dam may fail. Woody vegetation has been allowed to become established upon the dam top and downstream face. This vegetation should be removed and replaced with shallow rooted herbaceous vegetation such as turf grasses. Larger mature trees should be cut close to the ground and buried under fill. All other woody brush should be cleared and removed.

Clearing and Grubbing Costs = $5,000

iii. Increase Geotechnical Stability of the Dam

The Old Longview Lake dam meets current recommended factors of safety for geotechnical stability, but does not exceed such factors of safety by a very wide margin. Given the unknowns within the analysis relative to embankment age and degree of penetration of woody brush root systems, a cautious approach might recommend taking actions to increase geotechnical stability of the dam embankment. A variety of actions are possible, but the most definitive approach would be to add mass to the downstream face of the dam. The more mass added, the more stabile the embankment will be. Typically, mass added to the toe of the downstream dam embankment achieves the greatest effect so this analysis will evaluate costs of several such embankment thickness increases. If increasing the dam height is required to implement hydrology/hydraulics improvements to the spillway structure(s), increasing dam stability may then be required to meet current design standards. Adding mass to the toe of the dam embankment assumes the woody brush has been cleared and grubbed.

10' of thickness added to lower 4' of dam embankment →700' X 10' X 4'
Results in 1,000 C.Y of fill placement @ $10/C.Y.
= $10,000

10' of thickness added to lower 6' of dam embankment →700' X 10' X 6'
Results in 1,500 C.Y of fill placement @ $10/C.Y.
= $15,000

10' of thickness added to lower 8'vof dam embankment →700' X 10' X 8'
Results in 2,000 C.Y of fill placement @ $10/C.Y.
= $20,000

Note: Fill costs assume appropriate material can be located nearby without substantial hauling expense. Costs may require upward adjustment if appropriate material cannot be located nearby or downward adjustment if the source of material allows more efficient transport to the site.

b. *Hydrology/Hydraulics Improvements*

As stated previously, Old Longview Lake has no currently functioning engineered spillway. A naturally formed erosional channel that bypasses one of the existing spillways is currently acting as the dam spillway. Therefore, a functioning engineered spillway system is required. The three types of spillways, standpipe, over the top, and emergency spillway, were discussed in the previous section of this report. The costs of implementation for each will be analyzed here.

i. Standpipe Spillway

A standpipe spillway consists of a vertical riser that allows excess flows to enter the spillway, connected to a horizontal storm drainage pipe that drains through the dam embankment. Since the horizontal storm drainage pipe penetrates the dam embankment, such pipe must have watertight joints and be completely backfilled with low transmissivity soils. Hydrologic and hydraulic calculations suggest the riser should be a 7 foot square box type structure connected to a 60 inch horizontal through pipe, although other combinations of shapes and size are possible. The vertical riser will be approximately 10 feet in height, unless dredge choices entail reducing the lake bottom elevation substantially. The horizontal storm drainage pipe would be approximately 180 linear feet in length. Installation costs are included with shown unit costs.

Dewatering and Construction Protection = $20,000
7' X 7' vertical spillway riser = L.S. $15,000
180 L.F. Class V 60 RCP @ $250/LF = $45,000
<u>Total Standpipe Spillway estimate costs = $75,000</u>

ii. <u>Over the Top (Weir) Spillway</u>
This type of spillway consists primarily of a weir located at an elevation lower than the top of dam such that water flows through the weir instead of overtopping the dam. This spillway type would be located upon the dam embankment, requiring sufficient armoring such that high flow rates cannot damage the dam embankment, threatening embankment geotechnical stability. Hydrologic and hydraulic calculations suggest that a spillway of this type as the only primary spillway should have a 38 foot wide weir. If utilized in conjunction with a standpipe spillway, the required weir length would be 25 feet. Due to the hydraulic forces that would be experienced and the need for some required vertical elements for the structure, the spillway is anticipated to require reinforced structural concrete composition, or an equivalent. For the purposes of this report, reinforced structural concrete will be estimated.

38' Weir:
Riprap armoring, 500 ton @ $100/ton = $50,000
Structural Concrete, 65 C.Y. @ $400/C.Y. = $26,000
<u>Total = $76,000</u>

25' Weir:
Riprap armoring, 500 ton @ $100/ton = $50,000
Structural Concrete, 50 C.Y. @ $400/C.Y. = $20,000
<u>Total = $70,000</u>

iii. <u>Emergency Spillway</u>
Typically an emergency spillway will be designed such that erosion and scour are expected if the spillway is utilized. However, such a spillway would only be utilized in an extreme situation which should not occur frequently. Since such a spillway is designed to potentially erode and scour, it is critical that any such erosion or scour not occur on or too the dam embankment, potentially threatening

dam stability. Emergency spillways are typically just graded, grass lined channels. Such a spillway already partially exists at the east end of the Old Longview Lake dam, although some portion of that drainage would threaten the dam embankment with erosion and scour. A new emergency spillway channel should be graded such that erosion and scour does not threaten the stability of the dam embankment.

300 LF of channel grading = $3,000

c. *Aesthetics*
Lake aesthetics are primarily driven by lake depth, although some factors like trash accumulation may be independent of that. Controlling trash accumulation cannot be readily addressed via engineered solutions so that issue will not be addressed in this report. The emphasis of this report will focus upon methods to increase lake depths. Increasing lake depth can be accomplished by dredging of accumulated sediments, by raising the spillway elevation and dam height, or a combination of these two approaches. Deeper water allows greater wave heights on windy days, limiting accumulations of filamentous algae. Deeper water also limits vegetation establishment for vegetation types that root into the lake bottom. Deeper water will also help support a stronger fishery, although that subject has not yet been raised as a project goal.

i. Raise Dam and Spillway Elevations
As previously discussed, raising the dam and spillway elevations approximately 1.2 feet is a viable approach to increasing water depth. Such an elevation increase will at least partially address many of the aesthetic concerns and makes lesser dredging projects more viable.

Raise dam height to elevation 935'
700' X 12' X 3' ≈ 933 C.Y. of embankment @ $10/C.Y.
$9,333

ii. Dredging
Three different dredging approaches will be analyzed in this report. The first option would be to raise the lake level two feet and then hydraulically dredge up to another three feet from the lake bottom to achieve a minimum lake depth of five feet. The second option would be to not raise the lake level and dredge the lake to a minimum depth of five feet. The third option would be to not raise the lake level and dredge the lake to a minimum depth of seven feet, since deeper water would help maintain higher lake aesthetics and create a better fishery.

Raise Lake Level 1.2' and Dredge for a minimum lake depth of 5'
Dredge quantity ≈ 40,000 C.Y. @ $12/C.Y. = $480,000

Maintain Current Lake Level at Elevation 929' and Dredge for a minimum lake depth of 5'
Dredge quantity ≈ 80,000 C.Y. @ $12/C.Y. = $960,000

Maintain Current Lake Level at Elevation 929' and Dredge for a minimum lake depth of 7'
Dredge quantity ≈ 135,000 C.Y. @ $12/C.Y. = <u>$1,620,000</u>

7. **<u>Recommendations</u>**

A variety of alternates have been analyzed previously in this report and budgetary costs for each have been determined. Based upon this information, a variety of combinations of the various approaches will considered and recommended.

A new engineered spillway system is required and the requirements for water depth and/or dam stability do not cause the requirements for the spillway system to change sufficiently to affect budgetary cost estimates. Therefore, recommendations for the optimum spillway system are largely independent of the other considerations. The least cost approach would be to construct a 38' over the top (weir) spillway in conjunction with an emergency spillway, however, this approach eliminates the possibility of controlling water elevations below the spillway threshold. Lake levels could be controlled via pumping if required. The additional costs of reconstructing the stand pipe spillway and constructing a narrower over the top spillway are approximately $49,000. Given that control of the lake elevation below the spillway threshold elevation has not created any known difficulties in the past 10-20 years, it seems reasonable to assume that future readily available control of such lake levels is not necessary. Therefore, the recommended spillway system configuration would be to abandon the existing riser pipe spillway in place, construct a new over the top spillway (weir type), and grade a new sacrificial emergency spillway channel around the east end of the dam such that any scour or erosion would not threaten the integrity of the dam embankment. The existing riser spillway would need to be investigated further to determine the most effective method for abandonment, but in the absence of that information it will be recommended to demolish that portion above the current water level and fill the remaining structure with a flowable fill. Costs for this approach are assumed to be approximately $10,000.

New Spillway System
38' weir type spillway = $76,000
Grass lined emergency spillway = $3,000
Demolition/abandonment of existing riser spillway = $10,000
<u>Total estimated recommended spillway costs = $89,000</u>

Stabilizing the existing dam embankment is a somewhat optional alternate given that the existing dam embankment is computed to meet all required factors of safety. Clearing and grubbing of the dam embankment is simply required maintenance that is needed in all potential alternates. Therefore, the remaining recommendations will focus upon lake aesthetic issues as related to water depth, with dam stabilization options to be determined based upon remaining budget and geotechnical requirements should the dam elevation be raised. As presented before, dredging options can only be implemented if access to the federally owned property is granted for dewatering and disposal of the dredge material. The process required to gain that approval is estimated to entail approximately 2 years, and it is possible that such approval requests may be denied altogether. Therefore, dredging is not a solution that could be rapidly implemented and it may not be possible to implement. However, the lake level could be raised to historic levels, creating an additional 1.2' of lake depth without any dredging being required. This additional depth would also help with a lesser dredging project by providing a greater volume of water for dredging before the water is depleted to the point that dredging would need to be suspended and by providing the first 1.2 of water, out of the four feet required to float the dredge. This would allow dredging to focus more specifically upon individual areas of concern rather than requiring the entire lake bottom to be dredged. A smaller dredging project could possibly be implemented upon adjacent private property only, potentially negating the need for access to federal property. Additionally, adjacent neighbors may find that the additional 1.2' of water sufficiently addresses their aesthetic concerns for the lake, making any dredging unnecessary. Therefore, the recommended solution is to raise the lake level approximately 1.2', stabilize the dam as required for the additional height, and continue to investigate dredging options moving forward. Whole lake dredging expenses, without raising the lake water level, are costly to perform with serious questions remaining about the actual ability to implement.

Raise dam elevation and lake levels 1.2'
Additional embankment to raise the dam ≈ 933 C.Y. @ $10/C.Y. = $9,333
Spillway costs (refer to earlier section) = $89,000
Clearing and Grubbing of Dam (refer to earlier section) = $5,000
10' Thickness added to lower 4' of Dam toe (refer to earlier section) = $10,000
Optional: Future dredge of lake to a minimum depth of 5' (refer to earlier section) = $480,000
Total required costs = $113,333 With dredging option = $593,333

These costs are intended to be budgetary in nature with many details yet to be determined. To account for unknown details, high unit costs were assumed with an additional contingency added. As designs are refined, costs should be updated.

8. **Summary**

A variety of alternatives have been reviewed within this report to study available options to address concerns with Old Longview Lake. The primary concerns are for public safety but lake aesthetics are also important. The existing dam embankment meets all required geotechnical factors of safety but some maintenance is required. Unknowns within the geotechnical analysis also pose some cause for concern because the required geotechnical factors of safety are barely being met. Therefore, some actions to address geotechnical stability are recommended. The dam and lake have no functioning engineered spillway system with the existing spillway consisting of an erosional feature that has bypassed the weir spillway on the eastern end of the dam. A new spillway system will be required to be designed and constructed. Finally, due to the erosional nature of the current spillway, lake levels are lower than historic levels by nearly two feet.

Lake depths need to be increased to address the aesthetic concerns. A minimum depth in the lake of at least seven feet would be optimum but that much dredging is cost prohibitive. The minimum amount of dredging possible if current lake levels are maintained is to a minimum 5' depth, due to barge requirements and the amount of water needed to float the dredge barge. Even that amount of dredging is likely cost prohibitive. Additionally, neither of these two dredging approaches is possible without access to the adjacent federally owned land. Approvals for such access are anticipated to require at least two years and such approvals may not even be granted. However, it is possible to raise the water level two feet via raising the dam and spillway elevations. That additional two feet is likely insufficient to fully address all aesthetic concerns, but would greatly enhance lake aesthetics and would also allow a substantially lesser dredging project to move forward in the future. If dredge quantities can be kept below 20,000 cubic yards, it is likely possible to dredge without access to the federally owned land.

The recommended approach is to raise the dam to elevation 935.2' and construct a new over the top weir type spillway with a flowline of approximately 930.2' in conjunction with a grass lined emergency spillway around the east end of the dam embankment. The existing standpipe vertical riser spillway would be abandoned in place and the dam embankment stability would be increased via the placement of a 6' thick layer of soil on the lowermost one third of the downstream dam embankment. Determination of whether dredging will occur, and to what extent, can be determined later once it is known whether access to the federally owned adjacent land would be granted for decanting and disposal of the dredge spoils. If such access cannot be granted, a smaller dredge project that could be accommodated on private property only should be considered. The estimate cost to implement these recommendations is $113,333 without dredging. If the lake is also dredged to a minimum 5' depth, total estimated costs would be $596,000. A lesser dredging project that focuses upon specific areas of the lake could also be considered. Dredging unit costs within the range considered by the project tend to remain constant, so these estimated costs can be utilized for larger and smaller dredging projects.

John M. Kahl, P.E.
President

Appendix A

OLD LONGVIEW LAKE HYROLOGIC AND HYDRAULIC EVALUATION MEMORANDUM

March 29, 2017

General Project Overview

This memorandum describes the hydrologic and hydraulic analysis of Old Longview Lake located in Lee's Summit east of Longview Lake. The analysis completed includes a hydrologic and hydraulic analysis of the existing pond, and future land use conditions in the watershed upstream. The analysis also included an evaluation of the County Park Road culvert crossing downstream of the lake.

The following figures and supporting documentation are also attached:

- Figure 1 – Watershed Map Existing Land Use Conditions
- Figure 2 – Watershed Map Future Land Use Conditions
- Figure 3 – Old Longview Lake Vicinity Map
- PondPack Model Output
- HY-8 Model Output

Hydrology

Flows to the lake were calculated using the following methods:

- Haestad Methods, Inc. "PondPack" v8.1
  TR-55 Unit Hydrograph Method
    - 2-year, 10-year, 25-year, 50-year and 100-year Return Frequency storms
    - AMC II Soil Moisture conditions
    - 24-Hour SCS Type II Rainfall Distribution
    - SCS Runoff Curve Numbers per Kansas City APWA Standard Specifications and Design Criteria, Section 5602.3.B.
    - SCS TR-55 Methods for determination of Time of concentration and Travel Time. Where specific data pertaining to channel geometry is not available, "length & velocity" estimates for channel-flow Travel Time is utilized per Section 5602.7.A, Kansas City APWA Standard Specifications and Design Criteria.

The 207.4-acre watershed was delineated using City of Lee's Summit topographic information. The existing land use for the watershed was calculated using recent aerial photos. Existing land use in the watershed can be seen on Figure 1 and future land use for the watershed can be seen on Figure 2. The flow path for the watershed was computed at 16.5 minutes. It was assumed that no detention is present in the watershed and that additional detention will not be constructed with future phases of development. The hydrology soil groups for the watershed area are rated at a soil group D. The land use and Curve Number for existing and future conditions can be seen in Table 1 and 2.

Table 1. Existing Land Use

Land Use	Area (acres)	CN
Single Family Residential	93.6	86
Single Family Residential (Dense)	25.8	92
Commercial	7.5	92
Elementary School	6.4	92
Park	7.5	80
Undeveloped	45.8	80
Lake	20.8	98
Weighted Curve Number		87

Table 2. Future Land Use

Land Use	Area (acres)	CN
Single Family Residential	115.5	86
Single Family Residential (Dense)	44.7	92
Commercial	7.5	92
Elementary School	6.3	92
Park	12.6	80
Lake	20.8	98
Weighted Curve Number		89

Hydraulics and Lake Routing

A survey of the lake and the surrounding area was completed by Olsson Associates in February of 2017. The survey consisted of detailed topographic data collected around the lake and information on the outlet structures and the top of the dam. The outlets for the lake consist of a concrete culvert outlet and a concrete riser. The existing culvert was field measured as a 11.48-foot by 2.8-foot concrete box culvert with wingwalls. The existing riser in the lake was surveyed, however the outflow pipe of the riser could not be located. For this analysis, it is assumed that the outlet pipe of the riser is in poor condition and does not convey flows from the lake. The existing dam overtopping elevation is 932.00 with variable elevations from 932.00 to 934.00 across the top of the dam. The existing top of the dam was input to the hydraulic model.

Modeling Results

The inputs into the model were computed and the results of the existing and future conditions can be seen in Table 3 and 4. Based on the existing conditions the dam is overtopped in the 10-year event by 0.04 feet (0.5 inches) by 0.82 feet (9.8 inches) in the 100-year event. The poor condition and ease with which the primary spillway can become clogged with debris could result in overtopping in more frequent storm events.

Table 3. Old Longview Lake - Existing Land Use

Return Frequency (yr)	Peak Pond Inflow (cfs)	Peak Pond Outflow (cfs)	Peak Pond Elevation
2	546	33	931.31
10	909	76	932.04
25	1,101	142	932.34
50	1,314	274	932.64
100	1,463	394	932.82

Table 4. Old Longview Lake - Future Land Use

Return Frequency (yr)	Peak Pond Inflow (cfs)	Peak Pond Outflow (cfs)	Peak Pond Elevation
2	584	37	931.40
10	948	94	932.12
25	1,140	163	932.44
50	1,351	322	932.71
100	1,499	443	932.89

As can be seen in the lake result tables the future development in the watershed does not have a significant impact on the water surface elevation in the lake. Based on MDNR Dam Safety Program the lake was constructed in 1914 and as such does not meet current APWA or City of Lee's Summit design requirements. Improvements to be considered include:

- Outlet structure rehabilitation or replacement.
- Riser structure rehabilitation or replacement.
- Armoring on the top and downstream side of the dam to resist erosion during overtopping events.
- Design and installation of an emergency spillway.
- Adding height to the dam to provide greater freeboard during storm events.
- Increasing the storage capacity of the lake by excavation or lowering the normal pool elevation.

Any repairs or alteration to the dam should consider the stability of the dam and the factor of safety for the embankment. Refer to "Subsurface Exploration and Geotechnical Engineering Report; Longview Dam- North" prepared by Kansas City Testing & Engineering, LLC, February 17, 2017.

Downstream Impacts

Downstream of the existing lake, County Park Road crosses over the tributary that is fed by Old Longview Lake, the tributary then flows into Longview Lake. As can be seen on Figure 3 the area downstream of the lake is uninhabited and is used as a camping area that is managed by Jackson County. The normal water surface elevation for Longview Lake is approximately 1,500 feet downstream of Old Longview Lake. During high flow events, it is likely that backwater from Longview Lake will set the controlling water surface elevation for the area between County Park Road and Longview Lake.

The existing culverts under the County Park Road are two 5.7-feet by 5.1-feet oval corrugated metal pipes. The culvert crossing was modeled using the Federal Highway Administration's model HY-8. The existing overtopping elevation of the culvert is 910.83. The existing culvert under County Park Road can convey the existing land use 100-year event with no roadway overtopping. The existing land use conditions culvert results are included in Table 5, and detailed modeling information is included in the HY-8 results.

Table 5. County Park Road - Culvert Results
Existing Land Use

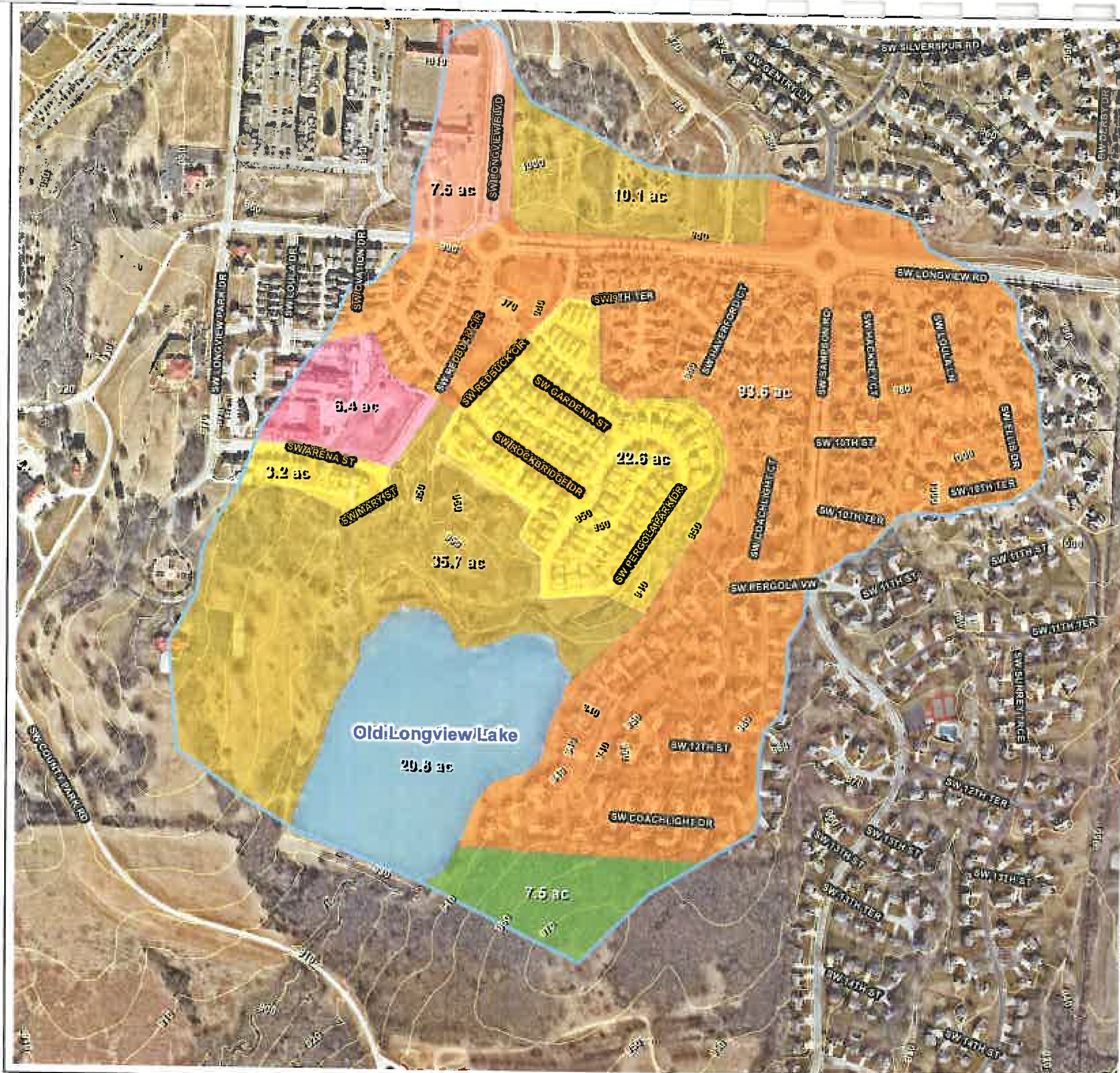
Return Frequency	Flow (cfs)	Headwater Elevation
2	66	904.03
10	130	905.00
25	168	905.50
50	309	907.83
100	445	910.12

The flows from the future land use on the roadway crossing were also evaluated. The culvert overtops in the 100-year event by 0.23 feet but passes the 50-year event. The future land use conditions culvert results are included in Table 6, and detailed modeling information is included in the HY-8 results.

Table 6. County Park Road - Culvert Results
Future Land Use

Return Frequency	Flow (cfs)	Headwater Elevation
2	69	904.03
10	135	905.00
25	186	905.50
50	362	907.83
100	500	910.12

Existing Conditions
Land Use
Old Longview Lake
Lees Summit, Missouri



Legend

Watershed Boundary - 233.5 ac

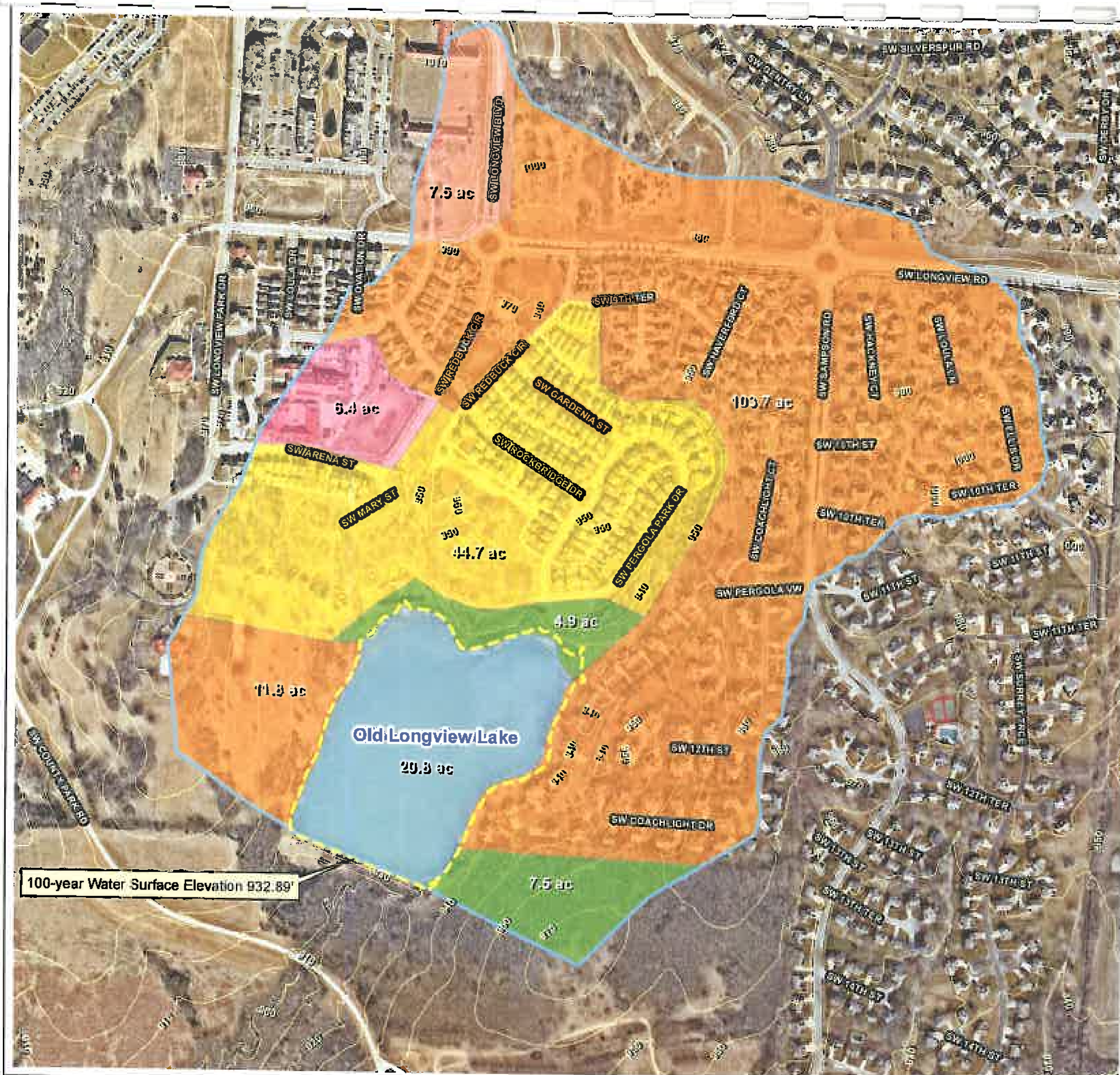
Existing Land Use

- Commercial
- Elementary School
- Lake
- Park
- Single Family Residential
- Single Family Residential (Dense)
- Undeveloped

0 500 1,000 Ft

OLSSON

Proposed Land Use
Old Longview Lake
Lees Summit, Missouri



Legend

Watershed Boundary - 207.4 ac

Proposed Land Use

- Commercial
- Elementary School
- Lake
- Park
- Single Family Residential
- Single Family Residential (Dense)
- Undeveloped

0 500 1,000 Ft

N

OLSSON

Legend

Stream Centerline

Current Effective DFIRM

Old Longview Lake
Lees Summit, Missouri

0 500 1,000 Feet

1 inch = 500 feet

N

OLSSON ASSOCIATES

Existing Conditions Land Use
Pond Pack Output

Table of Contents

Old Longview Lake Existing Land Use

Subsection: Time of Concentration Calculations
Label: Old LL Subarea

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.21 ft/s
Segment Time of Concentration	0.131 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	508.00 ft
Is Paved?	False
Slope	0.013 ft/ft
Average Velocity	1.84 ft/s
Segment Time of Concentration	0.077 hours

Segment #3: Length and Velocity	
Hydraulic Length	2,419.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.067 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.275 hours

Old Longview Lake Existing Land Use

Subsection: Time of Concentration Calculations
Label: Old LL Subarea

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc =	(Lf / V) / 3600
Where:	Tc= Time of concentration, hours Lf= Flow length, feet V= Velocity, ft/sec

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Old Longview Lake Existing Land Use

Subsection: Time of Concentration Calculations
Label: County Park Road DA

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.010 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.14 ft/s
Segment Time of Concentration	0.203 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	1,000.00 ft
Is Paved?	False
Slope	0.069 ft/ft
Average Velocity	4.24 ft/s
Segment Time of Concentration	0.066 hours

Segment #3: Length and Velocity	
Hydraulic Length	319.00 ft
Velocity	7.00 ft/s
Segment Time of Concentration	0.013 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.281 hours

Old Longview Lake Existing Land Use

Subsection: Time of Concentration Calculations
Label: County Park Road DA

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =
Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Old Longview Lake Existing Land Use

Subsection: Runoff CN-Area
Label: Old LL Subarea

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Residential Districts - 1/3 acre - Soil D	86.000	93.600	0.0	0.0	86.000
Residential Districts - 1/8 acre (town houses) - Soil D	92.000	25.800	0.0	0.0	92.000
Urban Districts - Commercial & Business - Soil D	95.000	7.500	0.0	0.0	95.000
School	92.000	6.400	0.0	0.0	92.000
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil D	80.000	7.500	0.0	0.0	80.000
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil D	80.000	45.800	0.0	0.0	80.000
Open Water	98.000	20.800	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	207.400	(N/A)	(N/A)	86.919

Old Longview Lake Existing Land Use

Subsection: Runoff CN-Area
Label: County Park Road DA

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Open Space HSG D	80.000	26.100	0.0	0.0	80.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	26.100	(N/A)	(N/A)	80.000

Old Longview Lake Existing Land Use

Subsection: Outlet Input Data
Label: With No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Requested Pond Water Surface Elevations	
Minimum (Headwater)	928.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	934.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Culvert-Box	Culvert - 1	Forward	TW	930.20	934.00
Irregular Weir	Weir - 2	Forward	TW	932.00	934.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Old Longview Lake Existing Land Use

Subsection: Outlet Input Data
Label: With No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Structure ID: Weir - 2
Structure Type: Irregular Weir

Station (ft)	Elevation (ft)
0.00	934.00
63.56	933.44
135.10	933.21
241.40	932.97
314.50	932.44
381.18	932.00
441.24	932.20
469.58	932.68
554.00	932.94
608.12	933.55
651.99	933.82
666.09	933.86
671.38	934.00

Lowest Elevation	932.00 ft
Weir Coefficient	3.00 (ft^0.5)/s

Structure ID: Culvert - 1
Structure Type: Culvert-Box

Number of Barrels	1
Width	11.48 ft
Height	2.80 ft
Length	27.87 ft
Length (Computed Barrel)	27.92 ft
Slope (Computed)	0.061 ft/ft

Outlet Control Data

Manning's n	0.013
Ke	0.500
Kb	0.004
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data

Equation Form	Form 1
K	0.0260
M	1.0000
C	0.0347
Y	0.8100
T1 ratio (HW/D)	1.148

Old Longview Lake Existing Land Use

Subsection: Outlet Input Data
Label: With No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Inlet Control Data	
T2 ratio (HW/D)	1.335
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	933.41 ft	T1 Flow	188.26 ft^3/s
T2 Elevation	933.94 ft	T2 Flow	215.15 ft^3/s

Old Longview Lake Existing Land Use

Subsection: Outlet Input Data
Label: With No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances

Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Old Longview Lake Existing Land Use

Subsection: Elevation-Volume-Flow Table (Pond)
Label: Old Longview Lake

Return Event: 2 years
Storm Event: 2-YEAR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	930.20 ft
Volume (Initial)	43.916 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
928.00	0.00	0.000	17.899	0.00	0.00	0.00
928.50	0.00	9.234	19.043	0.00	0.00	4,469.31
929.00	0.00	19.049	20.223	0.00	0.00	9,219.89
929.50	0.00	29.266	20.645	0.00	0.00	14,164.95
930.00	0.00	39.696	21.072	0.00	0.00	19,212.65
930.20	0.00	43.916	21.137	0.00	0.00	21,255.55
930.50	4.62	50.272	21.234	0.00	4.62	24,336.31
931.00	20.09	60.930	21.397	0.00	20.09	29,510.22
931.50	41.65	71.685	21.624	0.00	41.65	34,737.37
932.00	67.96	82.554	21.852	0.00	67.96	40,024.28
932.50	176.58	93.589	22.286	0.00	176.58	45,473.47
933.00	515.29	104.841	22.723	0.00	515.29	51,258.16
933.50	1,271.78	116.390	23.478	0.00	1,271.78	57,604.78
934.00	2,529.73	128.321	24.245	0.00	2,529.73	64,637.03

Old Longview Lake Existing Land Use

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Future Conditions Land Use
Pond Pack Output

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Old Longview Lake Future Land Use

Subsection: Time of Concentration Calculations
Label: County Park Road DA

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.010 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.14 ft/s
Segment Time of Concentration	0.203 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	1,000.00 ft
Is Paved?	False
Slope	0.069 ft/ft
Average Velocity	4.24 ft/s
Segment Time of Concentration	0.066 hours

Segment #3: Length and Velocity	
Hydraulic Length	319.00 ft
Velocity	7.00 ft/s
Segment Time of Concentration	0.013 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.281 hours

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =
Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Old Longview Lake Future Land Use

Subsection: Time of Concentration Calculations
Label: Old LL Subarea

Return Event: 2 years
Storm Event: 2-YEAR

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.150
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.6 in
Average Velocity	0.21 ft/s
Segment Time of Concentration	0.131 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	508.00 ft
Is Paved?	False
Slope	0.013 ft/ft
Average Velocity	1.84 ft/s
Segment Time of Concentration	0.077 hours

Segment #3: Length and Velocity	
Hydraulic Length	2,419.00 ft
Velocity	10.00 ft/s
Segment Time of Concentration	0.067 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.275 hours

Old Longview Lake Future Land Use

Subsection: Time of Concentration Calculations
Label: Old LL Subarea

Return Event: 2 years
Storm Event: 2-YEAR

==== User Defined Length & Velocity

Tc = (Lf / V) / 3600

Where:
Tc= Time of concentration, hours
Lf= Flow length, feet
V= Velocity, ft/sec

==== SCS Channel Flow

Tc =
R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =
Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Old Longview Lake Future Land Use

Subsection: Runoff CN-Area
Label: County Park Road DA

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Open Space HSG D	80.000	26.100	0.0	0.0	80.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	26.100	(N/A)	(N/A)	80.000

Old Longview Lake Future Land Use

Subsection: Runoff CN-Area
Label: Old LL Subarea

Return Event: 2 years
Storm Event: 2-YEAR

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Residential Districts - 1/3 acre - Soil D	86.000	115.500	0.0	0.0	86.000
Residential Districts - 1/8 acre (town houses) - Soil D	92.000	44.700	0.0	0.0	92.000
Urban Districts - Commercial & Business - Soil D	95.000	7.500	0.0	0.0	95.000
School	92.000	6.400	0.0	0.0	92.000
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil D	80.000	12.600	0.0	0.0	80.000
Open Water	98.000	20.800	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	207.500	(N/A)	(N/A)	88.641

Old Longview Lake Future Land Use

Subsection: Outlet Input Data
Label: No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Requested Pond Water Surface Elevations	
Minimum (Headwater)	928.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	934.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Culvert-Box	Culvert - 1	Forward	TW	930.20	934.00
Irregular Weir	Weir - 2	Forward	TW	932.00	934.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Old Longview Lake Future Land Use

Subsection: Outlet Input Data
Label: No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Structure ID: Weir - 2
Structure Type: Irregular Weir

Station (ft)	Elevation (ft)
0.00	934.00
63.56	933.44
135.10	933.21
241.40	932.97
314.50	932.44
381.18	932.00
441.24	932.20
469.58	932.68
554.00	932.94
608.12	933.55
651.99	933.82
666.09	933.86
671.38	934.00

Lowest Elevation	932.00 ft
Weir Coefficient	3.00 (ft^0.5)/s

Structure ID: Culvert - 1
Structure Type: Culvert-Box

Number of Barrels	1
Width	11.48 ft
Height	2.80 ft
Length	27.87 ft
Length (Computed Barrel)	27.92 ft
Slope (Computed)	0.061 ft/ft

Outlet Control Data

Manning's n	0.013
Ke	0.500
Kb	0.004
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data

Equation Form	Form 1
K	0.0260
M	1.0000
C	0.0347
Y	0.8100
T1 ratio (HW/D)	1.148

Old Longview Lake Future Land Use

Subsection: Outlet Input Data
Label: No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Inlet Control Data	
T2 ratio (HW/D)	1.335
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	933.41 ft	T1 Flow	188.26 ft³/s
T2 Elevation	933.94 ft	T2 Flow	215.15 ft³/s

Old Longview Lake Future Land Use

Subsection: Outlet Input Data
Label: No Riser

Return Event: 2 years
Storm Event: 2-YEAR

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Old Longview Lake Future Land Use

Subsection: Elevation-Volume-Flow Table (Pond)
Label: Old Longview Lake

Return Event: 2 years
Storm Event: 2-YEAR

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	930.20 ft
Volume (Initial)	43.916 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
928.00	0.00	0.000	17.899	0.00	0.00	0.00
928.50	0.00	9.234	19.043	0.00	0.00	4,469.31
929.00	0.00	19.049	20.223	0.00	0.00	9,219.89
929.50	0.00	29.266	20.645	0.00	0.00	14,164.95
930.00	0.00	39.696	21.072	0.00	0.00	19,212.65
930.20	0.00	43.916	21.137	0.00	0.00	21,255.55
930.50	4.62	50.272	21.234	0.00	4.62	24,336.31
931.00	20.09	60.930	21.397	0.00	20.09	29,510.22
931.50	41.65	71.685	21.624	0.00	41.65	34,737.37
932.00	67.96	82.554	21.852	0.00	67.96	40,024.28
932.50	176.58	93.589	22.286	0.00	176.58	45,473.47
933.00	515.29	104.841	22.723	0.00	515.29	51,258.16
933.50	1,271.78	116.390	23.478	0.00	1,271.78	57,604.78
934.00	2,529.73	128.321	24.245	0.00	2,529.73	64,637.03

Old Longview Lake Future Land Use

Index

County Park Road
HY-8 Output

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 1 - Summary of Culvert Flows at Crossing: County Park Road

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
904.03	2 year	66.36	66.36	0.00	1
905.00	10 year	130.28	130.28	0.00	1
905.50	25 year	168.00	168.00	0.00	1
907.83	50 year	309.00	309.00	0.00	1
910.12	100 year	445.00	445.00	0.00	1
910.83	Overtopping	473.67	473.67	0.00	Overtopping

Rating Curve Plot for Crossing: County Park Road

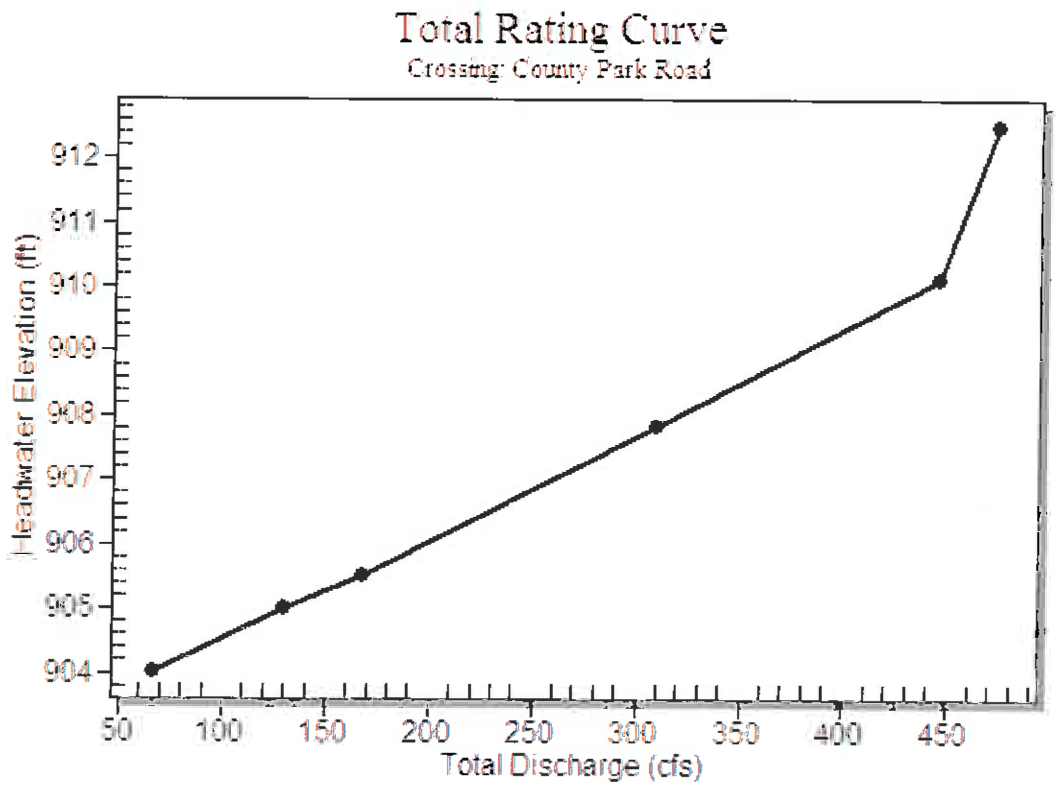


Table 2 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
2 year	66.36	66.36	904.03	1.909	0.0*	1-S2n	1.177	1.270	1.177	1.023	6.042
10 year	130.28	130.28	905.00	2.877	1.423	1-S2n	1.703	1.838	1.703	1.489	7.448
25 year	168.00	168.00	905.50	3.382	1.938	1-S2n	1.982	2.118	1.982	1.711	8.015
50 year	309.00	309.00	907.83	5.315	5.709	7-M2c	3.035	2.964	2.964	2.366	9.746
100 year	445.00	445.00	910.12	7.998	7.444	7-M2c	4.583	3.601	3.601	2.857	11.691

* Full Flow Headwater elevation is below inlet invert.

****

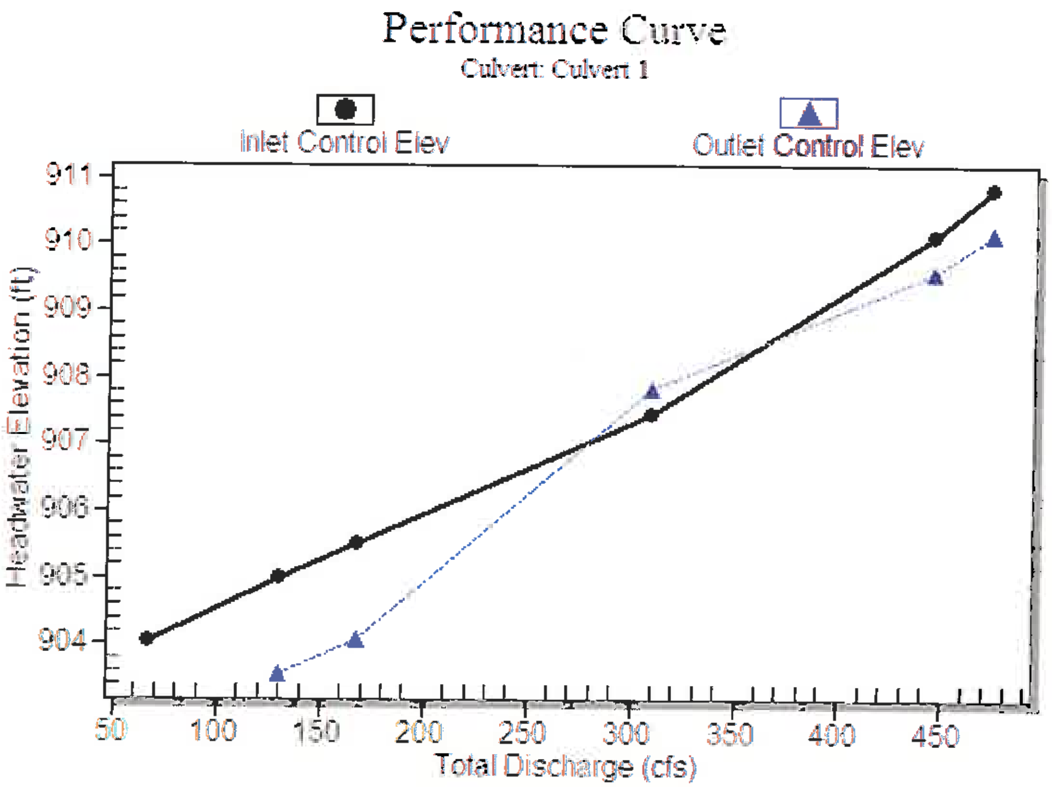
Straight Culvert

Inlet Elevation (invert): 902.12 ft,   Outlet Elevation (invert): 901.35 ft

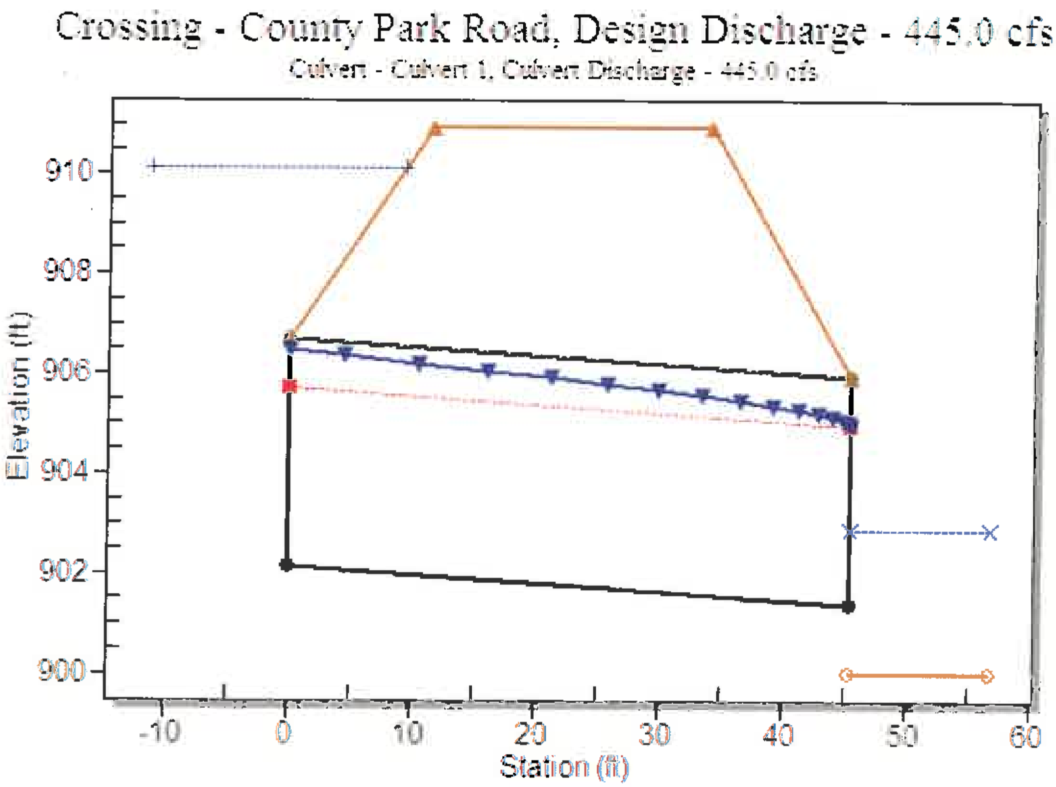
Culvert Length: 45.41 ft,   Culvert Slope: 0.0170

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 902.12 ft

Outlet Station: 45.40 ft

Outlet Elevation: 901.35 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Pipe Arch

Barrel Span: 73.00 in

Barrel Rise: 55.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0280

Culvert Type: Straight

Inlet Configuration: Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: County Park Road)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
66.36	901.02	1.02	5.17	0.89	0.99
130.28	901.49	1.49	6.37	1.30	1.04
168.00	901.71	1.71	6.88	1.49	1.06
309.00	902.37	2.37	8.20	2.07	1.10
445.00	902.86	2.86	9.08	2.50	1.13

Tailwater Channel Data - County Park Road

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.50 (_:1)

Channel Slope: 0.0140

Channel Manning's n: 0.0300

Channel Invert Elevation: 900.00 ft

Roadway Data for Crossing: County Park Road

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 22.55 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 1 - Summary of Culvert Flows at Crossing: County Park Road Future Land Use

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
904.07	2 year	69.00	69.00	0.00	1
905.06	10 year	135.00	135.00	0.00	1
905.73	25 year	186.00	186.00	0.00	1
908.41	50 year	362.00	362.00	0.00	1
911.06	100 year	500.00	482.61	17.24	9
910.83	Overtopping	473.68	473.68	0.00	Overtopping

Rating Curve Plot for Crossing: County Park Road Future Land Use

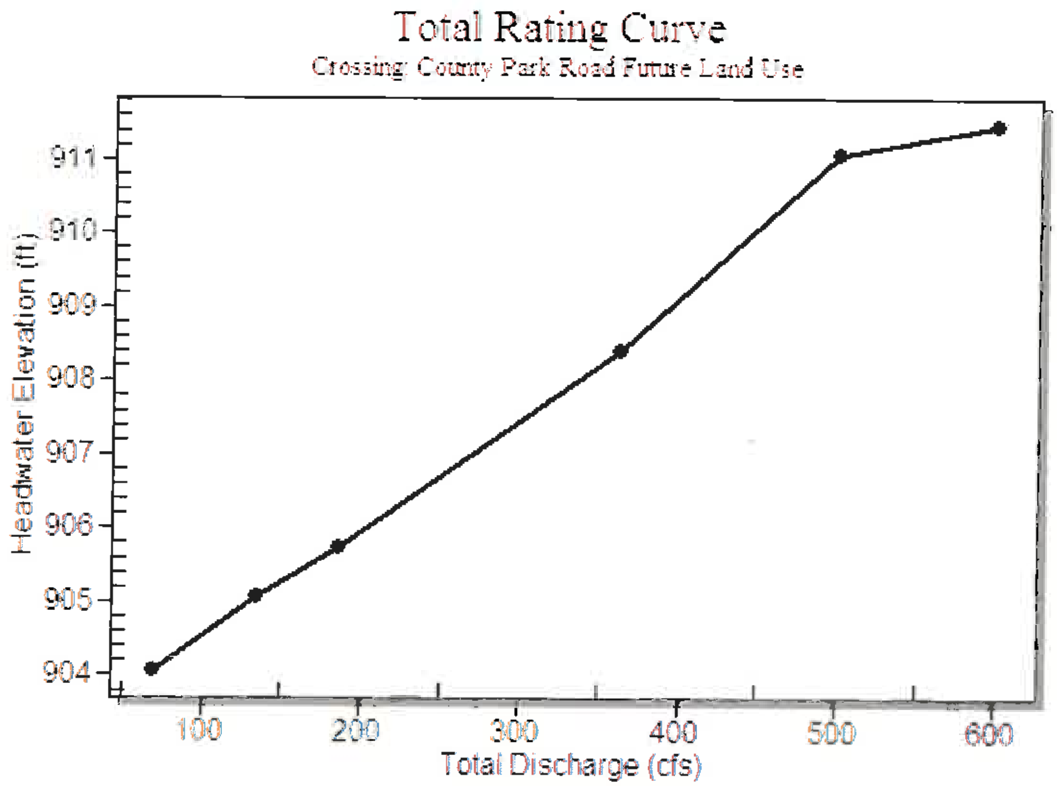


Table 2 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)
2 year	69.00	69.00	904.07	1.952	0.0*	1-S2n	1.200	1.297	1.200	1.045	6.123
10 year	135.00	135.00	905.06	2.942	1.487	1-S2n	1.739	1.875	1.739	1.519	7.526
25 year	186.00	186.00	905.73	3.614	2.192	1-S2n	2.112	2.238	2.112	1.808	8.242
50 year	362.00	362.00	908.41	6.231	6.290	7-M2c	3.540	3.234	3.234	2.570	10.481
100 year	500.00	482.61	911.06	8.943	8.212	7-M2c	4.583	3.745	3.745	3.032	12.274

* Full Flow Headwater elevation is below inlet invert.

****

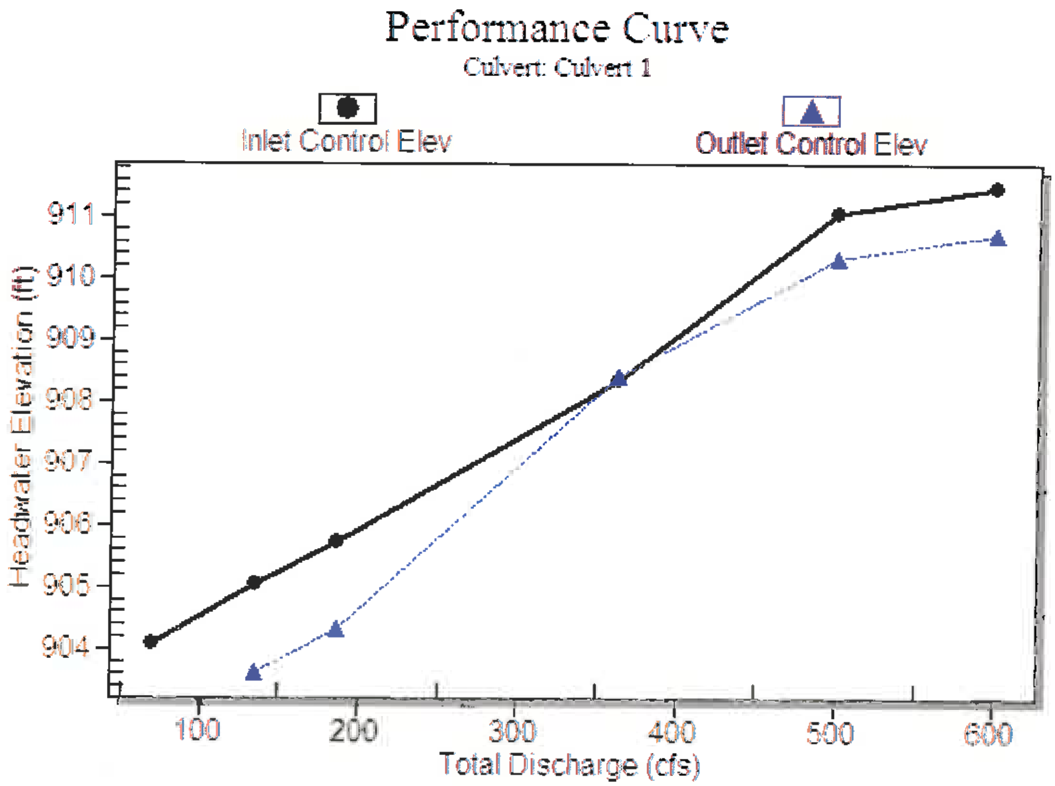
Straight Culvert

Inlet Elevation (invert): 902.12 ft,   Outlet Elevation (invert): 901.35 ft

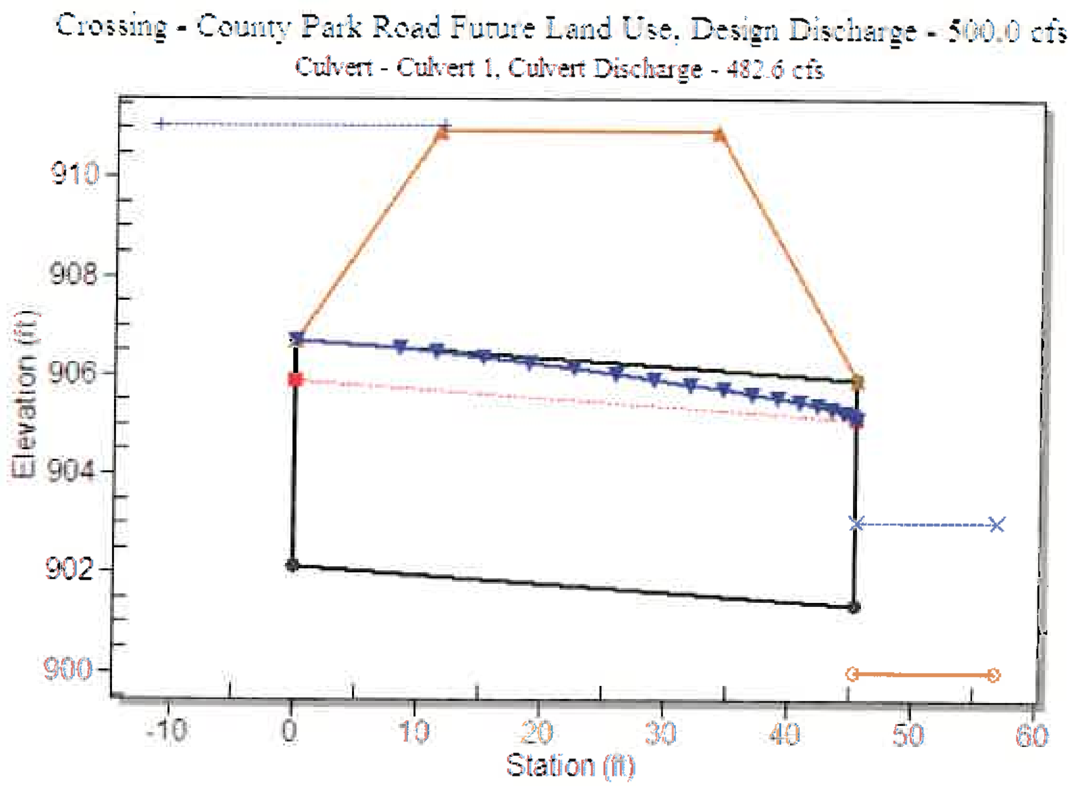
Culvert Length: 45.41 ft,   Culvert Slope: 0.0170

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 902.12 ft

Outlet Station: 45.40 ft

Outlet Elevation: 901.35 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Pipe Arch

Barrel Span: 73.00 in

Barrel Rise: 55.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0280

Culvert Type: Straight

Inlet Configuration: Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: County Park Road Future

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
69.00	901.05	1.05	5.23	0.91	0.99
135.00	901.52	1.52	6.44	1.33	1.04
186.00	901.81	1.81	7.09	1.58	1.06
362.00	902.57	2.57	8.58	2.24	1.11
500.00	903.03	3.03	9.38	2.65	1.14

Tailwater Channel Data - County Park Road Future Land Use

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.50 (_:1)

Channel Slope: 0.0140

Channel Manning's n: 0.0300

Channel Invert Elevation: 900.00 ft

Roadway Data for Crossing: County Park Road Future Land Use

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 22.55 ft

Appendix B

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams I Kansas City, Kansas 66103
913.321.8100 I kctesting.com

SUBSURFACE EXPLORATION
AND
GEOTECHNICAL ENGINEERING REPORT

LONGVIEW DAM - NORTH
LEE'S SUMMIT, MISSOURI

PREPARED FOR

Mr. Corey Walker
M-III Longview, LLC
4220 Shawnee Mission Parkway, #200B
Fairway, Kansas 66205

KCTE Project No. G20-16-310

February 17, 2017

SUBSURFACE EXPLORATION
AND
GEOTECHNICAL ENGINEERING REPORT

LONGVIEW DAM - NORTH
LEE'S SUMMIT, MISSOURI

KCTE No. G20-16-310

February 17, 2017

Submitted to:

Mr. Corey Walker
M-III Longview, LLC
4220 Shawnee Mission Parkway, #200B
Fairway, Kansas 66205

Submitted by:

Kansas City Testing & Engineering, LLC
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Kansas City, Kansas 66103

Benjamin Wilmes, E.I.
Staff Engineer

Steven M. Bruer, P.E.
Senior Geotechnical Engineer
Geotechnical Services Manager
Missouri P.E. Registration No. E-29050

STATE OF MISSOURI
STEVEN M. BRUER
NUMBER
E-29050
2-17-17
REGISTERED PROFESSIONAL ENGINEER

TABLE OF CONTENTS

1.0 INTRODUCTION

Kansas City Testing & Engineering, LLC (KCTE) has completed the authorized subsurface exploration and slope stability analysis for the existing earthen embankment dam in Lee's Summit, Missouri. The location of the dam is shown on the attached *Figure 1 – Site Location Plan*.

The purpose of this geotechnical exploration was to evaluate the subsurface conditions and physical properties of the soils comprising and underlying the existing dam, and based on that information, perform slope stability analysis on the existing dam.

The following information on the dam was obtained from Missouri Department of Natural Resources' (MDNR) *GeoSTRAT* website:

Dam Name:	Longview Dam – North
ID #:	MO20012
Ownership:	Private
Year Completed:	1914
State Regulated:	No (Agricultural Exemption)
Hazard Potential:	High
Hazard Class:	2
Dam Height:	20 feet
Length:	not known
Maximum Storage:	193 acre-feet
Surface Area:	18 acres (reservoir)
Drainage Area:	200 acres

No other information on the dam was available at the time of this report.

2.0 FIELD MEASUREMENT AND SUBSURFACE EXPLORATION

A two-person field crew from KCTE obtained measurements of the dam from the crest to the down-stream toe at _ locations in order to develop a typical cross section of the dam for stability analyses. Based on these field measurements, the downstream face of the dam has a slope of approximately 3 horizontal to 1 vertical (3H;1V). The measurements were not obtained by a professional survey, but are considered to be acceptable for the embankment stability analyses.

The site subsurface conditions were explored with four (4) borings at the approximate locations shown on the attached *Figure 2 – Boring Location Plan*. The boring locations were established in the field by a representative of KCTE based on existing site features. Elevations at the boring locations, shown on the boring logs, were estimated from Google Earth© and, therefore, should be considered as approximate. If more precise boring locations and elevations are desired, we recommend that the project surveyor locate the as-drilled locations of the borings.

The borings were drilled on December 22 and 27, 2016 and January 9, 2017 using a CME 55 truck-mounted drill rig and an ATV-mounted drill rig, both equipped with continuous flight augers. Soil samples were obtained during drilling using thin tube sampling techniques (ASTM D 1587) and standard penetration sampling (ASTM D 1586). Samples were generally obtained at 2-foot intervals until bedrock was encountered. A bulk sample of the auger cuttings was obtained from Boring B-2. The borings were backfilled with bentonite upon completion.

A field log was prepared for each boring. These logs contain visual classifications of the materials encountered during drilling as well as an interpolation of the subsurface conditions between samples. Final boring logs included in Appendix A represent our interpretation of the field logs and may include modifications based on laboratory observations and tests of the field samples. The final logs describe the materials encountered, their approximate thickness, and the depths at which the samples were obtained. This information includes soil descriptions, stratifications, penetration resistances, locations of the samples, and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual.

Field samples obtained from the borings were returned to our laboratory where they were visually classified and logged. Laboratory tests were performed in general accordance with ASTM procedures. The results of these tests are presented on the boring logs in Appendix A and in Appendix B of this report. The field and laboratory test results were utilized in the development of the geotechnical parameters used in this evaluation.

3.0 LABORATORY TESTING PROGRAM

Laboratory testing was performed on the soil and bedrock samples to estimate pertinent engineering and index properties of the materials. Results of the laboratory tests are presented on the boring logs in Appendix C. The laboratory testing program consisted of the following:

- Visual classification (ASTM D 2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*)
- Moisture content tests (ASTM D 2216, *Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*)
- Atterberg limits tests (ASTM D 4318, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*)
- Standard Proctor test (ASTM D 698, *Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort*)
- Unconfined compression tests on soils (ASTM D 2166, *Standard Test Method for Unconfined Compressive Strength of Cohesive Soil*)
- Triaxial Testing (ASTM D 4767, *Consolidated-Undrained Triaxial Compression Test on Cohesive Soil*)

4.0 SUBSURFACE CONDITIONS

In general, approximately 1 to 2 feet of topsoil material was encountered at the boring locations. In Borings B-1 and B-2, the topsoil material was underlain by clay embankment fill. In Borings B-3 and B-4, the topsoil material was underlain by approximately 1 foot to 1.5 feet crushed stone. The crushed stone was underlain by clay embankment fill.

The clay embankment fill encountered in the borings generally consisted of lean or fat clay. The clay was medium stiff to very stiff and moist to wet. The embankment fill continued to depths of approximately 13 to 18 feet below existing grades. The embankment fill was underlain by native clay. The native clay was generally stiff to very stiff and continued to depths of approximately 18 feet to 27.7 feet. The native clay was underlain by shale or limestone bedrock.

Groundwater was observed in the borings during and upon completion of the borings. Groundwater levels were also obtained a minimum of 24 hours after completion of drilling. Water levels were not measured in Boring B-1. In Borings B-2 through B-4, measurements made after drilling indicated water levels at approximately 6.5 feet to 10.3 below existing grades. The observed water levels are included on the boring logs.

Groundwater levels may not have stabilized prior to backfilling the borings. Consequently, the indicated groundwater levels, or lack thereof, may not represent present or future levels. Groundwater levels generally vary significantly over time due to seasonal variation in precipitation, recharge or other factors not evident at the time of exploration.

5.0 DAM EMBANKMENT STABILITY ANALYSES

Engineering analyses were performed to evaluate the structural stability of the Longview Dam - North embankments. The analyses were performed in accordance with the Missouri Department of Natural Resources (MDNR) Division of Geology and Land Survey's Dam and Reservoir Safety Program document titled *Rule and Regulations of the Missouri Dam and Reservoir Safety Council, revised 1994.*

The cross-section through the dam used in our stability analyses is based on our field measurements, not a survey completed by a professional surveyor.

The engineering analyses for the embankment stability were performed using the Spencer Method in the *SLIDE 6.0* software developed by Rocscience. The embankment was analyzed for the following loading conditions:

- Steady seepage – full reservoir
- Steady seepage – maximum reservoir
- Sudden drawdown
- Earthquake

Fully softened shear strength parameters were used for the embankment fill. The fully softened shear strength was evaluated from equations developed by Stark and Hussain (2013) and Gamez and Stark (2014) and the results of the triaxial compression shear strength test. A liquid limit of 55% and clay-size fraction of 95% were used as input parameters in evaluating the fully softened shear strength. A summary of the soil and bedrock parameters used for the embankment stability analyses is presented in Table 1. A summary of the results is presented in Table 2. Copies of the embankment stability analyses are presented in Appendix C.

The results of the embankment stability analyses indicate that the required MDNR minimum Factor of Safeties (FSs) are satisfied for all conditions analyzed.

Table 1
Summary of Parameters for Embankment Stability Analyses

Material	Unit Weight (pcf)	Cohesion (psf)	Φ (degrees)
Embankment Fill	121	50	27*
Native Clay Soil	123	50	26
Shale Bedrock	125	200	24

*Fully softened friction angle

Table 2
Summary of Embankment Stability Analyses

Condition	Calculated Minimum Factor of Safety	MDNR Required Minimum Factor of Safety
Steady Seepage – Full reservoir	1.6	1.5
Steady Seepage – Max reservoir	1.4	1.3
Sudden Drawdown	1.2	1.2
Earthquake, a = 0.20g	1.1	1.0

6.0 LIMITED OBSERVATIONS OF EXISTING CONDITIONS

Limited observations of the existing conditions were made of the dam during the subsurface exploration by a professional engineer from KCTE. Not all appurtenances were accessible at the time of our observations. It appears that routine maintenance for the dam has not been performed for several years. Photographs of our observations are included in Appendix C. The following observations were noted:

1) Three (3) relatively large diameter trees were observed growing on the down-stream face of the dam near the crest.
2) The approximately eastern half of the down-stream face of the dam is covered with small diameter trees and other vegetation.
3) Trees of various diameters were also observed on the upstream face of the dam.
4) Some locations of the upstream face near the crest of the dam show indications of severe erosion.
5) The concrete overflow/spillway structure near the east abutment has severely deteriorated. The concrete, although generally intact, has degraded on the edges of the structure exposing the steel reinforcement (rebar). Observations of the exposed steel reinforcement indicate the rebar has a square cross section, suggesting that the structure may be a part of the original construction.

6) A relatively deeply incised erosion channel has formed on the west side of the overflow/spillway structure.
7) Thick vegetation and miscellaneous obstructions were observed in the spillway channel.
8) Water was observed seeping at the toe of the dam in the approximate center of the dam where it reaches its maximum height. The water flow was relatively light in terms of volume and was continuous. This water has made a channel that empties into the spillway.
9) A probable intake structure and gate house was observed in the reservoir approximately 50 feet from the upstream face of the dam near the maximum height of the dam. This structure could not be accessed for closer observation.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The construction of Longview Dam – North, according to the MDNR Dam Safety Program, was completed in 1914, approximately 103 years ago. The dam was constructed before rational design procedures were developed in the 1930s. The typical design life of an earthen dam is generally accepted to be 50 years; however, with proper maintenance earthen dams can safely function for much longer.

The hazard classification system categorizes dams according to the degree of adverse consequences of a failure or mis-operation of a dam. A dam's hazard potential is classified as either Low, Significant, or High. The MDNR Dam Safety program has classified this dam as a High Hazard dam. A High Hazard classification indicates that if a failure or mis-operation of the dam occurs, loss of human life is probable and there is a high potential for economic loss, environmental damage, and/or disruption to lifelines.

The embankment stability analyses performed for this evaluation indicate that appropriate factors of safety required by the MDNR Dam Safety Program are met for the conditions analyzed. However, the calculated factors of safeties were at or near the minimum required. Furthermore, any future modifications to the dam will impact its stability.

It is important to note, that the model developed for the embankment stability analyses is likely not entirely representative of the actual conditions with respect to the assumed water seepage through the dam due to the woody vegetation present on the dam which alters seepage paths. The seepage assumed for our analyses is based on the method recommended in the MDNR Dam Safety Program's document titled *Engineering Analysis of Dams* (1989), which cannot account for the affects that vegetation and possible animal burrows have on water seepage through the dam.

The following recommendations are provided based on our observations and analyses:

1) Given the age and current condition of the dam and its appurtances, KCTE recommends that a dam remediation design be implemented following the recommendations presented in *Technical Manual For Dam Owners – Impacts of Plants On Earthen Dams*, prepared by the Federal Emergency Management Agency, (FEMA 534) and dated September 2005. This document was developed in collaboration with the Association of State Dam Safety Officials (ASDSO).

2) A thorough structural and operational inspection of all appurtenances to include the spillway structure, spillway channel, an intake/gate house structure should be performed to evaluate their current conditions.

3) The dam should have a thorough topographic survey performed by a professional surveyor. If the topographic survey indicates the dam cross-section used in our stability analyses is significantly different than that developed by KCTE for this evaluation, then revised analyses should be performed using the results of the topographic survey prepared by the professional surveyor.

4) KCTE recommends that a permanent instrumentation and monitoring program be designed and implemented in order to evaluate the long-term stability of the dam. The program should include surveying and installation of inclinometers to monitor deformation and vibrating wire piezometers to monitor pore water pressures in the embankment.

5) A maintenance and inspection program should be developed specific to this dam. Although not required under the MDNR Dam Safety program, given the age and High Hazard classification given to this dam, KCTE recommends following their requirements for dam inspections.

6) If modifications are planned for the dam, additional stability analyses must be performed to evaluate the impact of the modification(s).

8.0 LIMITATIONS

This report is presented in broad terms to provide an assessment of the subsurface conditions and their potential effect on the adequate design and economical construction of the proposed structure. Any changes in the design or location of the proposed structure should be assumed to invalidate the conclusions and recommendations given in this report until we have had the opportunity to review the changes and, if necessary, modify our conclusions and recommendations accordingly. It is recommended that the geotechnical engineer be afforded the opportunity of a general review of the final design plans and specifications prior to construction in order to determine if they are consistent with the conclusions and recommendations given in this report. For this project, these geotechnical document review services will be provided as part of the geotechnical report cost. Particular details of foundation design, construction specifications or quality control may develop, and we would be pleased to respond to any questions that you may have regarding these details.

This report has been prepared with generally accepted geotechnical engineering practices used in this area at the time the report was prepared. No other warranty, expressed or implied, is made. The conclusions and recommendations are based upon the data obtained from the borings drilled at the approximate locations shown in *Figure 2 – Boring Location Plan*. The nature and extent of the subsurface variations between borings may not become evident until excavation is performed. If during construction, soil, bedrock, fill, or groundwater conditions appear to be different than described in this report, we should be notified immediately so that re-evaluation of our recommendations may be made. On-site observation of foundation construction and sub-grade preparation by KCTE is recommended. The scope of our services did not include any environmental assessment or investigation for the presence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site.

NORTH

Note: Figure adapted from a Google Earth image.

Not to Scale

Site Location Plan			Project No. G20-16-310
KCTE KANSAS CITY TESTING & ENGINEERING, LLC			1308 Adams Street Kansas City, Kansas 66103 www.kctesting.com
Drawn By: BW Checked By: SB	Date: 1/15/17	Longview Dam - North Lee's Summit, Missouri	Fig. No: 1

LEGEND: B-1 - Approximate Boring Location and ID

NORTH

Not To Scale

Note: Figure adapted from a Google Earth aerial photograph.

Boring Location Plan	Project No.: G20-16-301
KANSAS CITY TESTING & ENGINEERING, LLC	1308 Adams Street, Kansas City, Kansas 66103, www.kctesting.com
Drawn By: SW; Checked By: SB / Date: 1-15-17 / Longview Dam - North, Lee's Summit, Missouri	Fig. No. 2

APPENDIX A

BORING LOGS

GENERAL NOTES

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

Kansas City Testing and Engineering, LLC
1308 Adams Street
Kansas City, KS 66103
Tel: 913-321-8100
Fax: 913-321-8181

BORING NUMBER B-1

CLIENT M-III Longview, LLC
PROJECT NAME Longview Dam - North
PROJECT NUMBER G20-16-310
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 12/27/16 **COMPLETED** 12/27/16
GROUND ELEVATION 936 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR KCTE
GROUND WATER LEVELS:
DRILLING METHOD CME 55, 4.25 HSA, Mud Rotary
AT TIME OF DRILLING ---
LOGGED BY JW **CHECKED BY** SB
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF COMPR. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	Pocket Pen. (tsf)
0	TOPSOIL Material (embankment fill)	ST 1	71								
	FAT CLAY - medium stiff, dark bown (embankment fill)										
5		SPT 2	100	4-4-5 (9)			28.4				
		ST 3	75		1769	98	28.9				
10		ST 4	79					55	22	33	
15	- very stiff below 13.5 feet (probable native clay)	ST 5	67		4352	105	24.6	51	23	28	
		ST 6	90		6141	110	18.9				
20	SHALE BEDROCK - moderately hard, moderately weathered, olive, silty	SPT 7	100	24-25-24 (49)			22.6				

Bottom of borehole at 21.2 feet.

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BORING NUMBER B-2

CLIENT M-III Longview, LLC	**PROJECT NAME** Longview Dam - North
PROJECT NUMBER G20-16-310	**PROJECT LOCATION** Lee's Summit, Missouri
DATE STARTED 12/22/16 **COMPLETED** 12/27/16	**GROUND ELEVATION** 936 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR KCTE	**GROUND WATER LEVELS:**
DRILLING METHOD CME 55, 4.25 HSA, Mud Rotary	▽ **AT TIME OF DRILLING** 8.00 ft / Elev 928.00 ft
LOGGED BY JW **CHECKED BY** SB	**AT END OF DRILLING** ---
NOTES	▼ **AFTER DRILLING** 7.50 ft / Elev 928.50 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF COMPR. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	Pocket Pen. (tsf)
0	TOPSOIL Material (embankment fill)										
	LEAN CLAY - very stiff, dark brown, trace gravel, moist (embankment fill)	SPT 1	100	17-17-7 (24)							
5	- medium stiff and very moist to wet below 5 feet	SPT 2	100	3-3-4 (7)			30.9				
	▼ ▽										
10		ST 3	33		1819	93	30.0				
15		ST 4	50		1564	92	30.5				
20	- very stiff, gray brown and very moist below 18 feet (probable native clay)	ST 5	100		3399	95	28.8	39	22	17	
25	FAT CLAY - very stiff, gray brown, moist	ST 6	79		4626	101	25.9	49	21	28	

(Continued Next Page)

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BORING NUMBER B-2

CLIENT M-III Longview, LLC
PROJECT NAME Longview Dam - North
PROJECT NUMBER G20-16-310
PROJECT LOCATION Lee's Summit, Missouri

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF COMPR. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	Pocket Pen. (tsf)
25		FAT CLAY - very stiff, gray brown, moist *(continued)*										
		SHALE BEDROCK - highly weathered, moderately hard, gray brown, moist	SPT 7	100	25-9-12 (21)			17.9	39	18	21	
30												

Bottom of borehole at 30.2 feet.

Kansas City Testing and Engineering, LLC
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BORING NUMBER B-3

CLIENT M-III Longview, LLC
PROJECT NAME Longview Dam - North
PROJECT NUMBER G20-16-310
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 1/9/17 COMPLETED 1/9/17
GROUND ELEVATION 936 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR KCTE
GROUND WATER LEVELS:
DRILLING METHOD ATV
AT TIME OF DRILLING 12.00 ft / Elev 924.00 ft
LOGGED BY KB CHECKED BY SB
AT END OF DRILLING 11.50 ft / Elev 924.50 ft
NOTES
24hrs AFTER DRILLING 10.30 ft / Elev 925.70 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMPR. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	Pocket Pen. (tsf)
0	TOPSOIL Material (embankment fill)										
	CRUSHED STONE (embankment fill)	ST 1	42		2513	129	28.4				
	LEAN CLAY - very stiff, red brown, moist (embankment fill)										
5		ST 2	96		6392	105	21.4				
	- medium stiff and very moist to wet below 6 feet	ST 3	67		1163	90	30.5	46	23	23	
	- stiff below 8 feet	ST 4	54		3538	100	28.6				
10											
15		ST 5	67			85	32.2	40	24	16	
	- probable native clay below 18 feet	ST 6	79		2097	90	29.5				
20											
25		ST 7	100			102	24.6				

(Continued Next Page)

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BORING NUMBER B-3

CLIENT M-III Longview, LLC
PROJECT NAME Longview Dam - North
PROJECT NUMBER G20-16-310
PROJECT LOCATION Lee's Summit, Missouri

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMPR. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	Pocket Pen. (tsf)
25		- stiff below 8 feet *(continued)*										
		LIMESTONE BEDROCK - hard										

Refusal at 27.4 feet.
Bottom of borehole at 27.4 feet.

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 2/10/17 10:10 - R:\2.0 KCTE ACTIVE PROJECTS\0.0 PRIOR YEAR PROJECTS\2016 ACTIVE PROJECTS\3.0 GEO 2016\G20-16-310 OLD LONGVIEW LAKE DAM\LONGVIEW DAM BORINGS.GPJ

Kansas City Testing and Engineering, LLC
1308 Adams Street
Kansas City, KS 66103
Tel: 913-321-8100
Fax: 913-321-8181

BORING NUMBER B-4

CLIENT M-III Longview, LLC
PROJECT NAME Longview Dam - North
PROJECT NUMBER G20-16-310
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 1/9/17 COMPLETED 1/9/17
GROUND ELEVATION 936 ft HOLE SIZE 4 inches
DRILLING CONTRACTOR KCTE
GROUND WATER LEVELS:
DRILLING METHOD ATV
AT TIME OF DRILLING 7.90 ft / Elev 928.10 ft
LOGGED BY KB CHECKED BY SB
AT END OF DRILLING 7.50 ft / Elev 928.50 ft
NOTES
24hrs AFTER DRILLING 6.50 ft / Elev 929.50 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF COMPR. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	Pocket Pen. (tsf)
0		TOPSOIL Material (embankment fill)										
		CRUSHED STONE (embankment fill)	ST 1	0								
		FAT CLAY - stiff, brown and gray-brown, moist (embankment fill)	ST 2	54		2999	104	24.6	49	28	21	
5		- medium stiff, dark brown and very moist to wet below 6 feet	ST 3	100		1257	95	31.3				
			ST 4	54			95	29.0	47	22	25	
10		- stiff below 13 feet (probable native clay)	ST 5	75		2926	93	31.4				
15		SHALE BEDROCK - highly weathered, relatively hard, gray brown, moist	ST 6	96			103	22.3	47	28	19	

Bottom of borehole at 19.3 feet.

General Notes

KANSAS CITY TESTING & ENGINEERING, LLC

DRILLING NOTES

DRILLING AND SAMPLING SYMBOLS

AS	Auger Sample
CS	Continuous Sampler
HA	Hand Auger
HS	Hollow Stem Auger
PA	Power Auger
CF	Continuous Flight Auger
WB	Wash Bore
RB	Rock Bit
SS*	Split Spoon
ST	Shelby Tube

* The Standard Penetration Test (SPT) is conducted in conjunction with the split-spoon sampling procedure. The "N" value corresponds to the number of blows required to drive the the last 1 foot of an 18-inch-long, 2-inch O.D. split-spoon sampler with a 140-lb hammer falling a distance of 30 inches. The Standard Penetration Test is carried out according to ASTM D 1586.

WATER LEVEL MEASUREMENTS

ATD	At Time of Drilling
EOD	End of Drilling
AD	After Drilling

SOIL PROPERTIES & DESCRIPTIONS

TEXTURE

PARTICLE	*SIZE*
Clay	<0.002 mm
Silt	<#200 Sieve
Sand	#4 to #200 Sieve
Gravel	3 inch to #4 Sieve
Cobbles	12 inch to 3 inch
Boulders	> 12 inch

COMPOSITION

SAND & GRAVEL	
trace	< 15%
with	15% - 29%
some	> 30%
FINES (clay & silt)	
trace	< 5%
with	5% - 12%
some	> 12%

Soil descriptions are based on the Unified Soil Classification System (USCS) as outlined in ASTM D 2487 and D 2488. The USCS group symbol on the boring logs corresponds to the group names listed below. The descriptions include soil constituents, consistency or relative density, color and other appropriate descriptive terms. Geologic description of bedrock, when encountered, also is shown in the description column.

COHESIVE SOILS

CONSISTENCY	*UNCONFINED COMPRESSIVE STRENGTH* (psf)	(kPa)
Very Soft	< 500	< 24
Soft	500-1000	24-48
Medium Stiff	1001-2000	49-96
Stiff	2001-4000	97-192
Very Stiff	4001-8000	193-383
Hard	> 8001	> 384

PLASTICITY	Liquid Limit, %
Lean	< 45
Lean to Fat	45 - 49
Fat	> 50

COHESIONLESS SOILS

RELATIVE DENSITY	*N VALUE*
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 49
Very Dense	> 49

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)**

QUALITY	*RQD, %*
Very Poor	0-25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

**RQD is defined as the total length of sound core pieces, 4 inches (102 mm) or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

DEGREE OF WEATHERING

Slightly Weathered	Slight decomposition of parent material.
Weathered	Well developed and decomposed.
Highly Weathered	Highly decomposed, may be extremely broken.

SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy	Containing small cavities < 1/2 " (13mm)
Porous	Containing numerous voids, may be interconnected.
Cavernous	Containing cavities, sometime large.

When classification of bedrock materials has been estimated from disturbed samples, core samples and petrographic analysis may reveal other rock types.

HARDNESS & DEGREE OF CEMENTATION

LIMESTONE	
Hard	Difficult to scratch with knife.
Moderately Hard	Scratch with knife but not fingernail.
Soft	Can be scratched with fingernail.
SHALE	
Hard	Scratch with knife but not fingernail.
Moderately hard	Can be scratched with fingernail.
Soft	Can be molded easily with fingers.
SANDSTONE	
Well Cemented	Capable of scratching with a knife.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken easily with fingers.

BEDDING CHARACTERISTICS

TERM	*THICKNESS, INCHES (MM)*
Very Thick Bedded	> 36 (915)
Thick Bedded	12-36 (305-915)
Medium Bedded	4-12 (102-305)
Thin Bedded	1-4 (25-102)
Very Thin Bedded	0.4-1 (10-25)
Laminated	0.1-0.4 (2.5-10)
Thinly Laminated	< 0.1 (<2.5)

Bedding Planes - Planes dividing layers, beds or strata of rocks.
Joint - Fracture in rock, usually vertical or transverse to bedding.
Seam - Applies to bedding plane with unspecified weathering.

KANSAS CITY TESTING & ENGINEERING, LLC

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation: D 2487 – 11
(Based on Unified Soil Classification System)

MAJOR DIVISIONS				GROUP SYMBOL	GROUP NAME
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12% fines	Fines classify as ML or MH	GM	Silty gravel [F G H]
			Fines classify as CL or CH	GC	Clayey gravel [F G H]
	Sands 50% or more of coarse faction passes No. 4 sieve	Clean Sands Less than 5% fines	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines More than 12% fines	Fines classify as ML or MH	SM	Silty Sand [G H I]
			Fines classify as CL or CH	SC	Clayey sand [G H I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line	CL	Lean clay [K L M]
			PI < 4 or plots below "A" line	ML	Silt [K L M]
		Organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay [K L M N] Organic silt [K L M O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [K L M]
			PI plots below "A" line	MH	Elastic silt [K L M]
		Organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay [K L M O] Organic silt [K L M O]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc=(D_{30})^2 / (D_{10} \times D_{60})$

[F] If soil contains ≥15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥15% gravel, add "with gravel" to group name.
If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K]. If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

[L] If solid contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A: line.

[P] PI plots on or above "A: line.

[Q] PI plots below "A: line.

KANSAS CITY
TESTING & ENGINEERING, LLC

APPENDIX B

LABORATORY TEST REPORTS

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Fax: 913-321-8181

SUMMARY OF LABORATORY RESULTS

CLIENT M-III Longview, LLC
PROJECT NAME Longview Dam - North
PROJECT NUMBER G20-16-310
PROJECT LOCATION Lee's Summit, Missouri

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	3.5							28.4			
B-1	6.0							28.9	98.4		
B-1	8.5	55	22	33							
B-1	13.5	51	23	28				24.6	105.0		
B-1	18.5							18.9	110.3		
B-1	19.7							22.6			
B-2	5.5							30.9			
B-2	8.0							30.0	93.1		
B-2	13.5							30.5	91.5		
B-2	18.5	39	22	17				28.8	94.5		
B-2	23.5	49	21	28				25.9	101.1		
B-2	27.7	39	18	21				17.9			
B-3	0.0							28.4	129.1		
B-3	3.0							21.4	105.0		
B-3	6.0	46	23	23				30.5	90.4		
B-3	8.0							28.6	100.4		
B-3	13.0	40	24	16				32.2	85.2		
B-3	18.0							29.5	89.6		
B-3	23.0							24.6	101.6		
B-4	3.0							24.6	103.5		
B-4	3.5	49	28	21							
B-4	6.0							31.3	94.9		
B-4	8.0	47	22	25				29.0	94.6		
B-4	13.0							31.4	93.5		
B-4	18.0	47	28	19				22.3	103.3		

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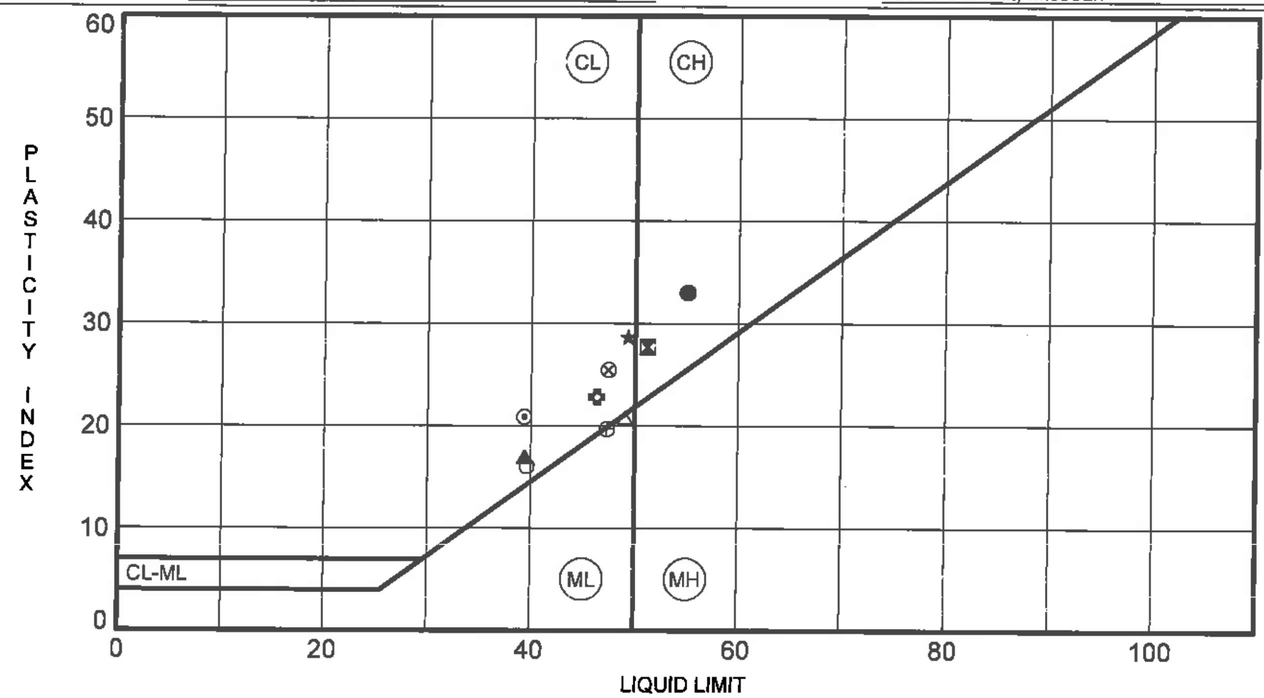
ATTERBERG LIMITS' RESULTS

CLIENT M-III Longview, LLC

PROJECT NAME Longview Dam - North

PROJECT NUMBER G20-16-310

PROJECT LOCATION Lee's Summit, Missouri



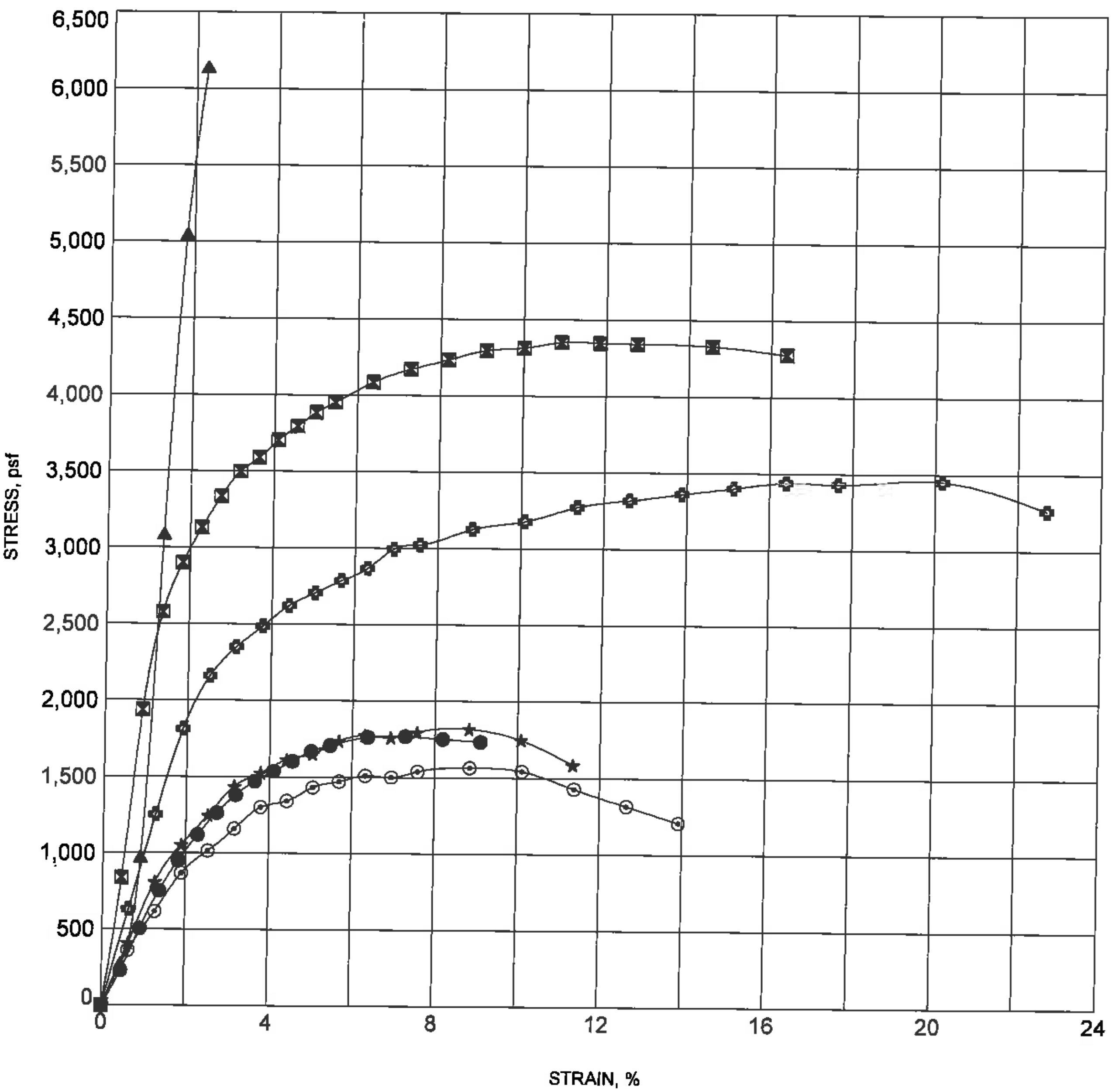
	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	B-1	8.5	55	22	33		
⊠	B-1	13.5	51	23	28		
▲	B-2	18.5	39	22	17		
★	B-2	23.5	49	21	28		
⊙	B-2	27.7	39	18	21		
✿	B-3	6.0	46	23	23		
○	B-3	13.0	40	24	16		
△	B-4	3.5	49	28	21		
⊗	B-4	8.0	47	22	25		
⊕	B-4	18.0	47	28	19		

Kansas City Testing and Engineering, LLC
1308 Adams Street
Kansas City, KS 66103
Tel: 913-321-8100
Fax: 913-321-8181

UNCONFINED COMPRESSION TEST

CLIENT M-III Longview, LLC | **PROJECT NAME** Longview Dam - North

PROJECT NUMBER G20-16-310 | **PROJECT LOCATION** Lee's Summit, Missouri



	BOREHOLE	DEPTH	Classification	γ_d	MC%
●	B-1	6.0		98	29
⊠	B-1	13.5		105	25
▲	B-1	18.5		110	19
★	B-2	8.0		93	30
⊙	B-2	13.5		92	31
✪	B-2	18.5		95	29

UNCONFINED - GINT STD US LAB.GDT - 2/10/17 13:06 - R:\2.0 KCTE ACTIVE PROJECTS\0.0 PRIOR YEAR PROJECTS\2016 ACTIVE PROJECTS\3.0 GEO 2016\G20-16-310 OLD LONGVIEW LAKE DAM\LONGVIEW DAM BORINGS.GPJ

Kansas City Testing and Engineering, LLC
1308 Adams Street
Kansas City, KS 66103
Tel: 913-321-8100
Fax: 913-321-8181

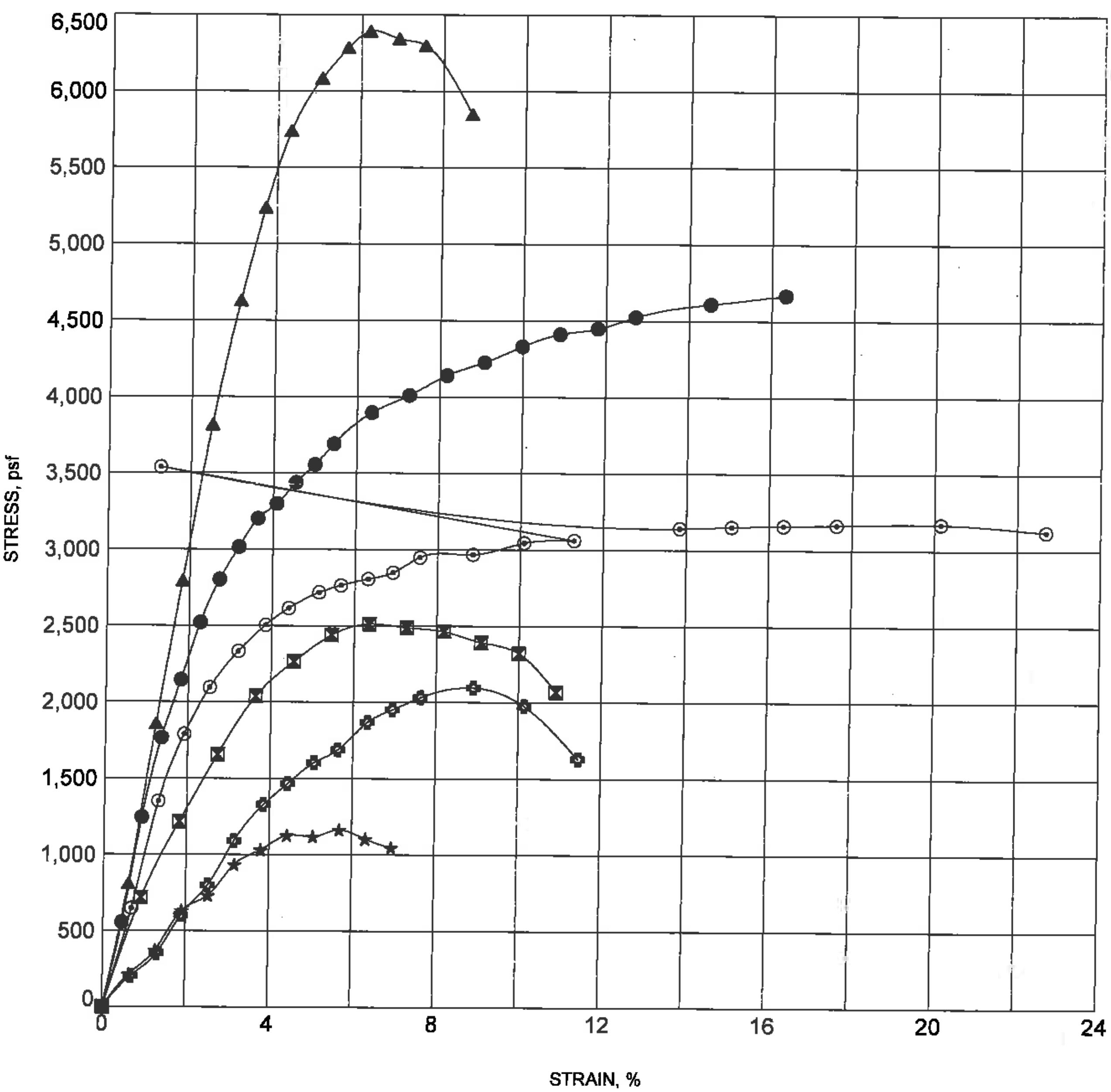
UNCONFINED COMPRESSION TEST

CLIENT M-III Longview, LLC

PROJECT NAME Longview Dam - North

PROJECT NUMBER G20-16-310

PROJECT LOCATION Lee's Summit, Missouri



	BOREHOLE	DEPTH	Classification	γ_d	MC%
●	B-2	23.5		101	26
⊠	B-3	0.0		129	28
▲	B-3	3.0		105	21
★	B-3	6.0		90	31
⊙	B-3	8.0		100	29
✪	B-3	18.0		90	30

Kansas City Testing and Engineering, LLC
1308 Adams Street
Kansas City, KS 66103
Tel: 913-321-8100
Fax: 913-321-8181

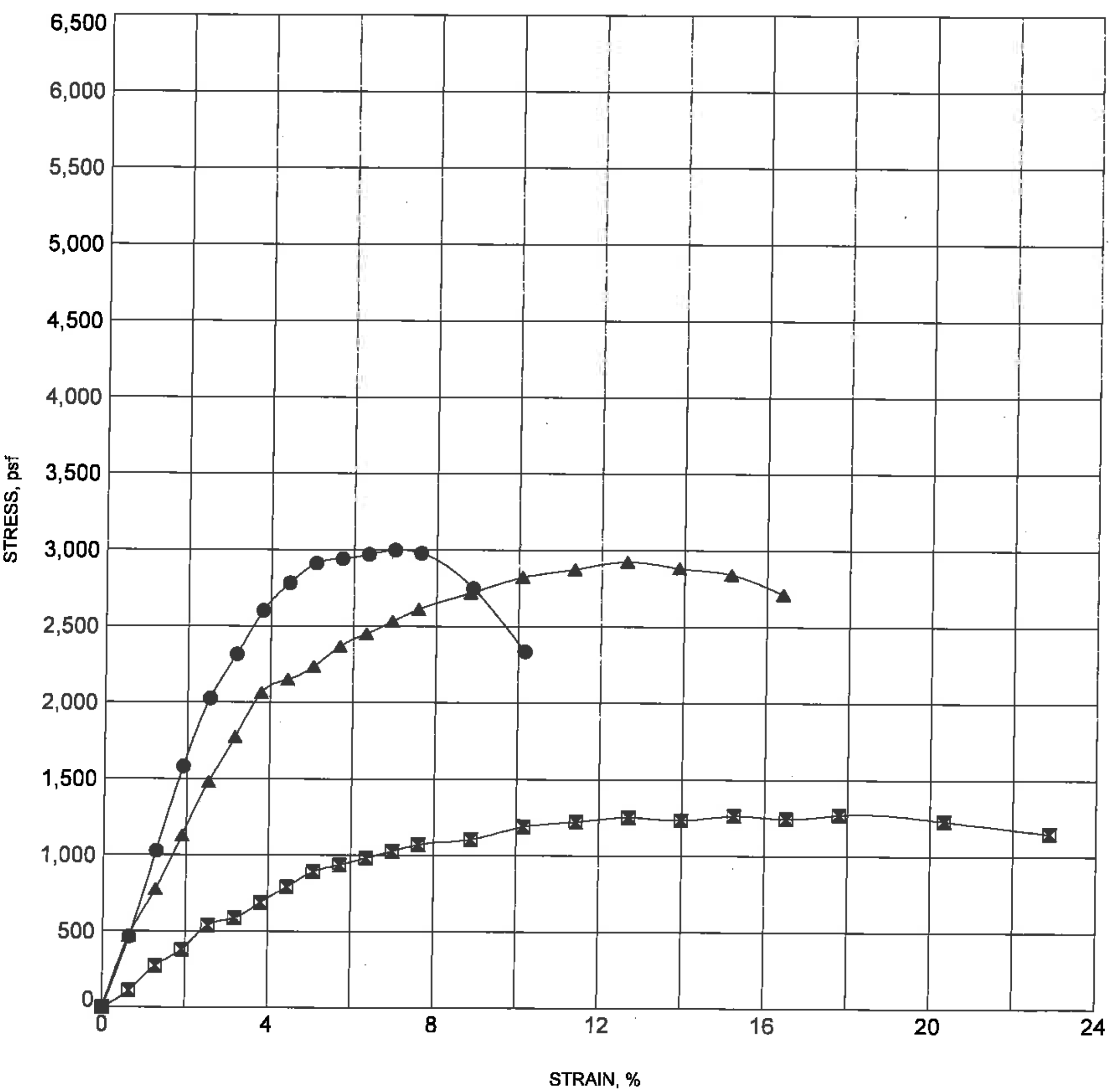
UNCONFINED COMPRESSION TEST

CLIENT M-III Longview, LLC

PROJECT NAME Longview Dam - North

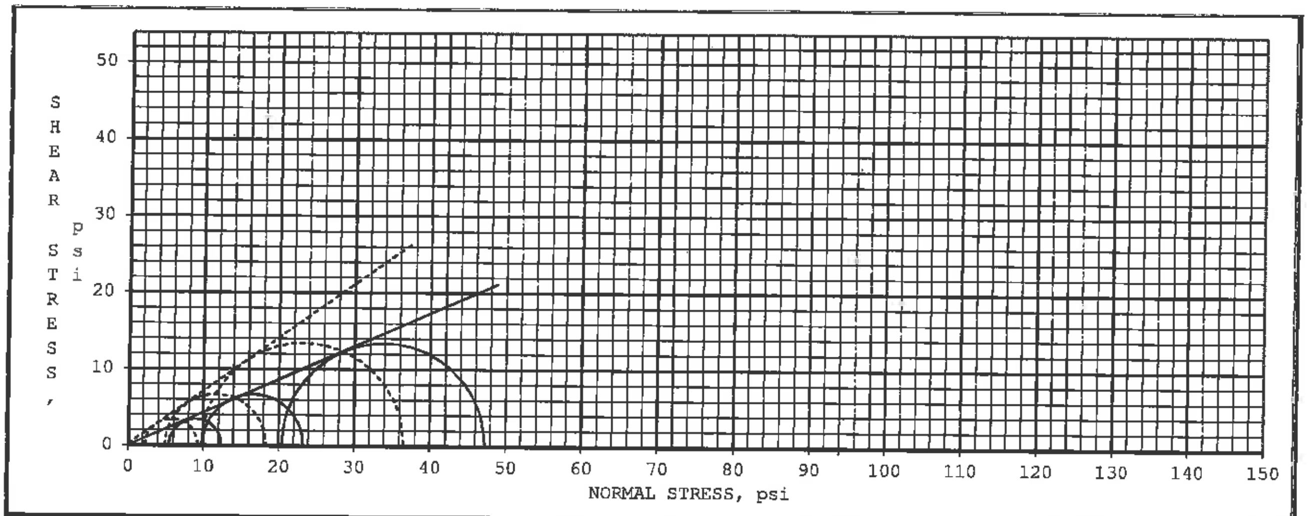
PROJECT NUMBER G20-16-310

PROJECT LOCATION Lee's Summit, Missouri

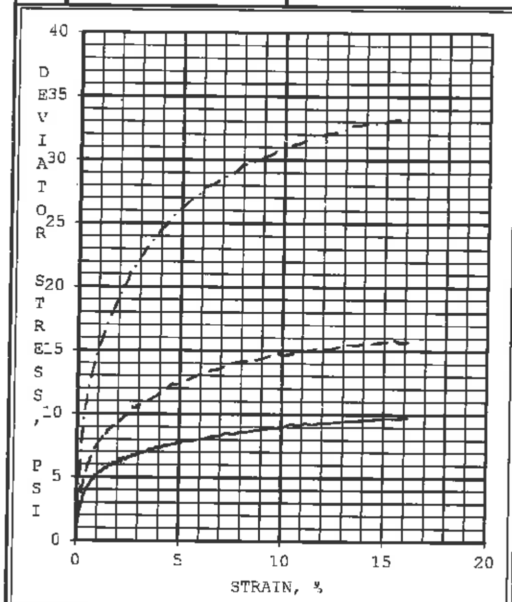


BOREHOLE		DEPTH	Classification	γ_d	MC%
●	B-4	3.0		104	25
⊠	B-4	6.0		95	31
▲	B-4	13.0		93	31

UNCONFINED - GINT STD US LAB.GDT - 2/10/17 13:06 - R:\2.0 KCTE ACTIVE PROJECTS\10.0 PRIOR YEAR PROJECTS\2016 ACTIVE PROJECT\3.0 GEO 2016\G20-16-310 OLD LONGVIEW LAKE DAM\LONGVIEW DAM BORINGS.GPJ



EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	35.0	COHESION, psi	0.2
TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	23.5	COHESION, psi	0.0



SPECIMEN ID:		A	B	C
INITIAL	WATER CONTENT, %	28.8	30.1	28.4
INITIAL	DRY DENSITY, pcf	91.7	91.6	97.6
INITIAL	SATURATION, %	93	97	105
INITIAL	VOID RATIO	0.84	0.84	0.73
BEFORE SHEAR	WATER CONTENT, %	30.6	29.8	25.3
BEFORE SHEAR	DRY DENSITY, pcf	92.2	93.3	100.1
BEFORE SHEAR	SATURATION (B PARAMETER)	0.98	1.00	0.99
BEFORE SHEAR	VOID RATIO	0.83	0.81	0.68
BEFORE SHEAR	FINAL BACK PRESSURE, psi	98.8	99.2	98.7
MINOR PRINCIPAL STRESS, psi		5.4	9.8	20.3
EFFECTIVE STRESS PEAK AT % STRAIN		3.1	6.5	5.5
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		7.0	13.5	26.9
TOTAL STRESS PEAK AT % STRAIN		3.1	6.5	5.5
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		7.0	13.5	26.9
ULTIMATE DEVIATOR STRESS (15% STR), psi		9.7	15.8	33.0
TIME TO 50% PRIMARY CONSOLIDATION, min		11.00	9.30	24.00
STRAIN RATE, % / hour		0.74	0.73	0.73
INITIAL DIAMETER, inch		2.791	2.791	2.838
INITIAL HEIGHT, inch		5.415	5.867	5.678
AREA AFTER CONSOLIDATION, inch2		6.112	6.048	6.219

CONTROLLED - STRAIN TEST

SAMPLE TYPE: 3" SHELBY TUBE

DESCRIPTION OF SPECIMENS:
FAT CLAY, DARK OLIVE WITH YELLOWISH BROWN AT THE BOTTOM CHANGING TO VERY DARK GRAY

LL 55	PL 22	PI 33	Gs 2.7 EST.

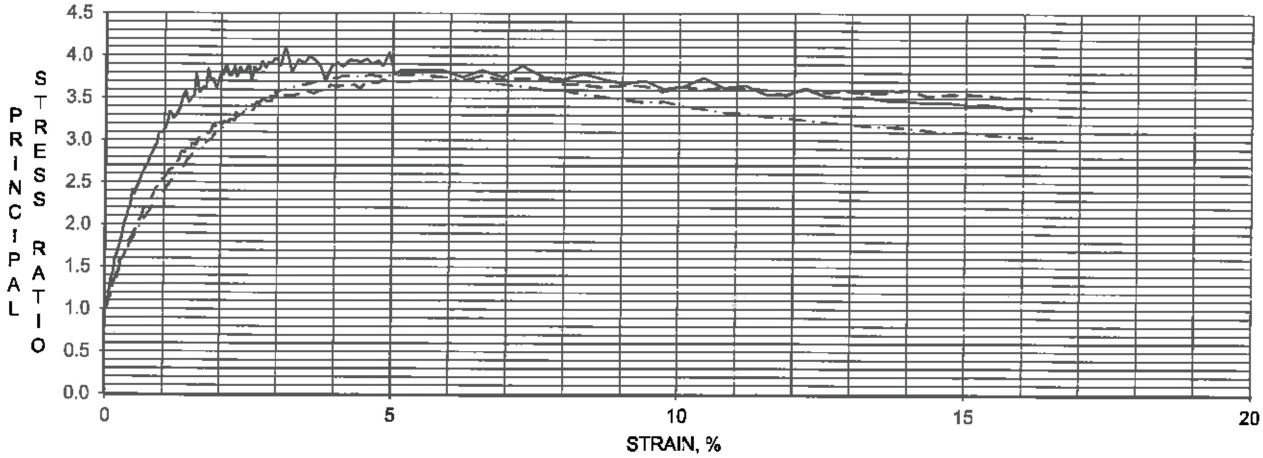
PROJECT NO. 02171004	PROJECT: KANSAS CITY TESTING LONGVIEW DAM G20-16-310
	BORING #: B-1
LABORATORY: TERRACON - LENEXA	SAMPLE #:
DATE: 1/24/2017	DEPTH, feet: 8.5 - 11.0

PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS

Terracon

KANSAS CITY TESTING

02171004 B-1 8.5 - 11.0



FAILURE SKETCH	FAILURE SKETCH	FAILURE SKETCH
		
SPECIMEN A	SPECIMEN B	SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON PEAK PRINCIPAL STRESS RATIO % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT PEAK PRINCIPAL STRESS RATIO % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON PEAK PRINCIPAL STRESS RATIO % STRAIN.

TOTAL STRESS MOHR'S CIRCLES DRAWN AT PEAK PRINCIPAL STRESS RATIO % STRAIN.

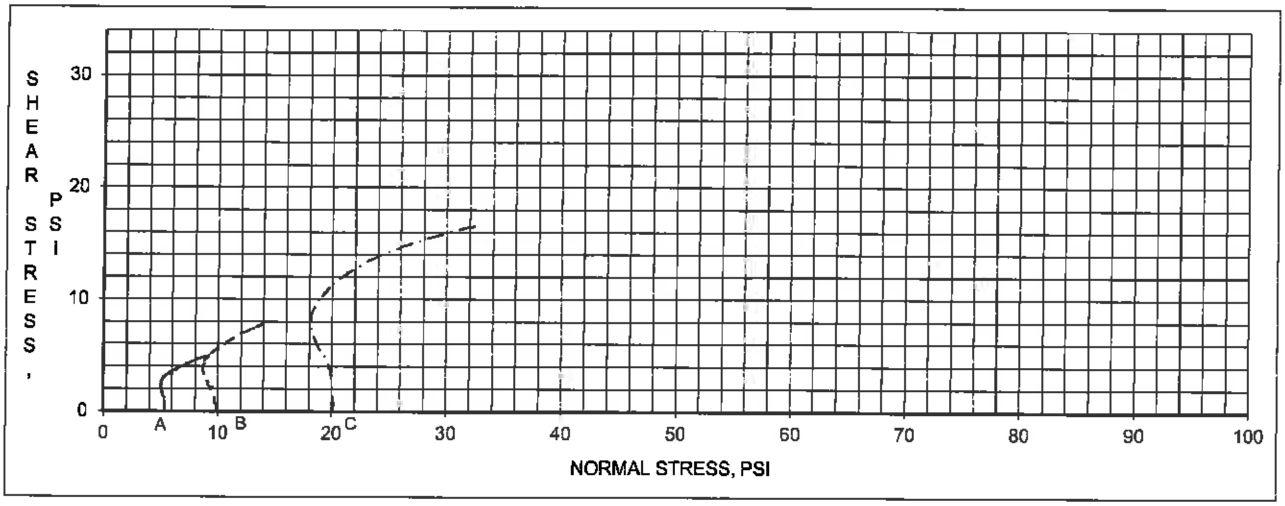
DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

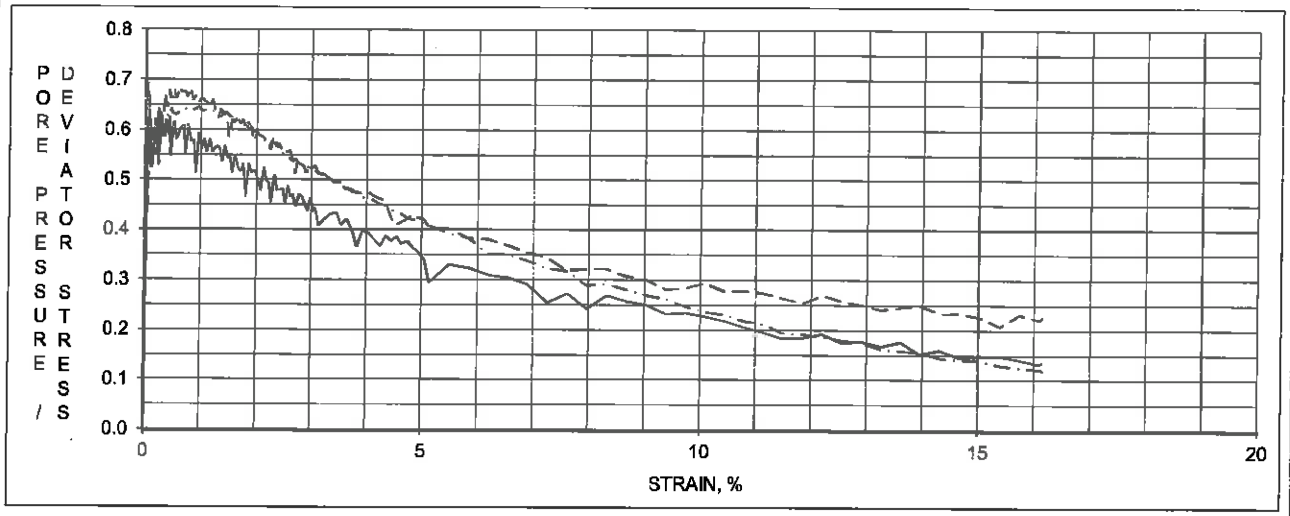
AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

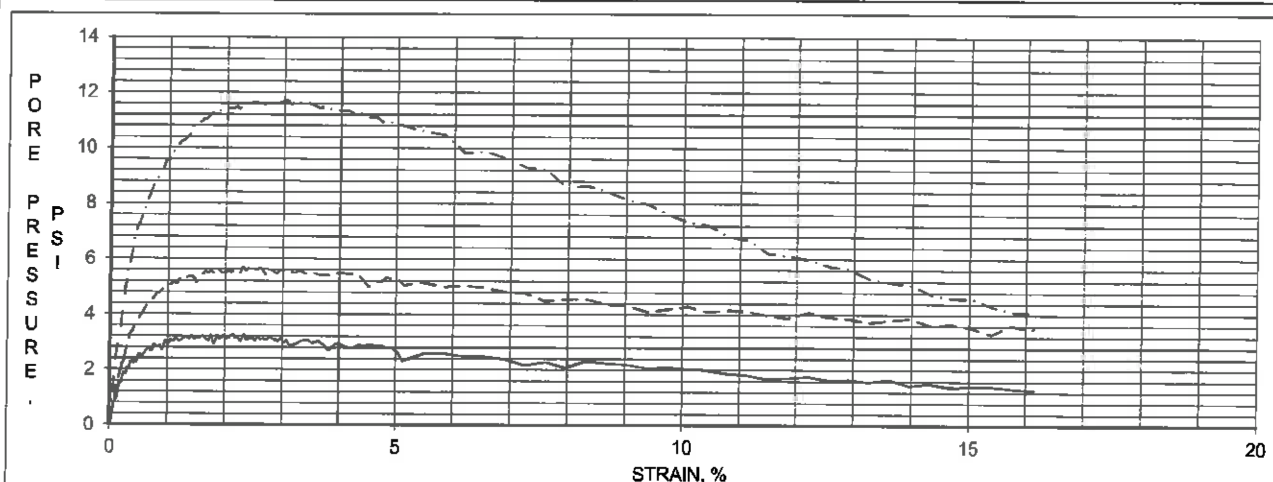
Terracon

KANSAS CITY TESTING

02171004 B-1 8.5 - 11.0







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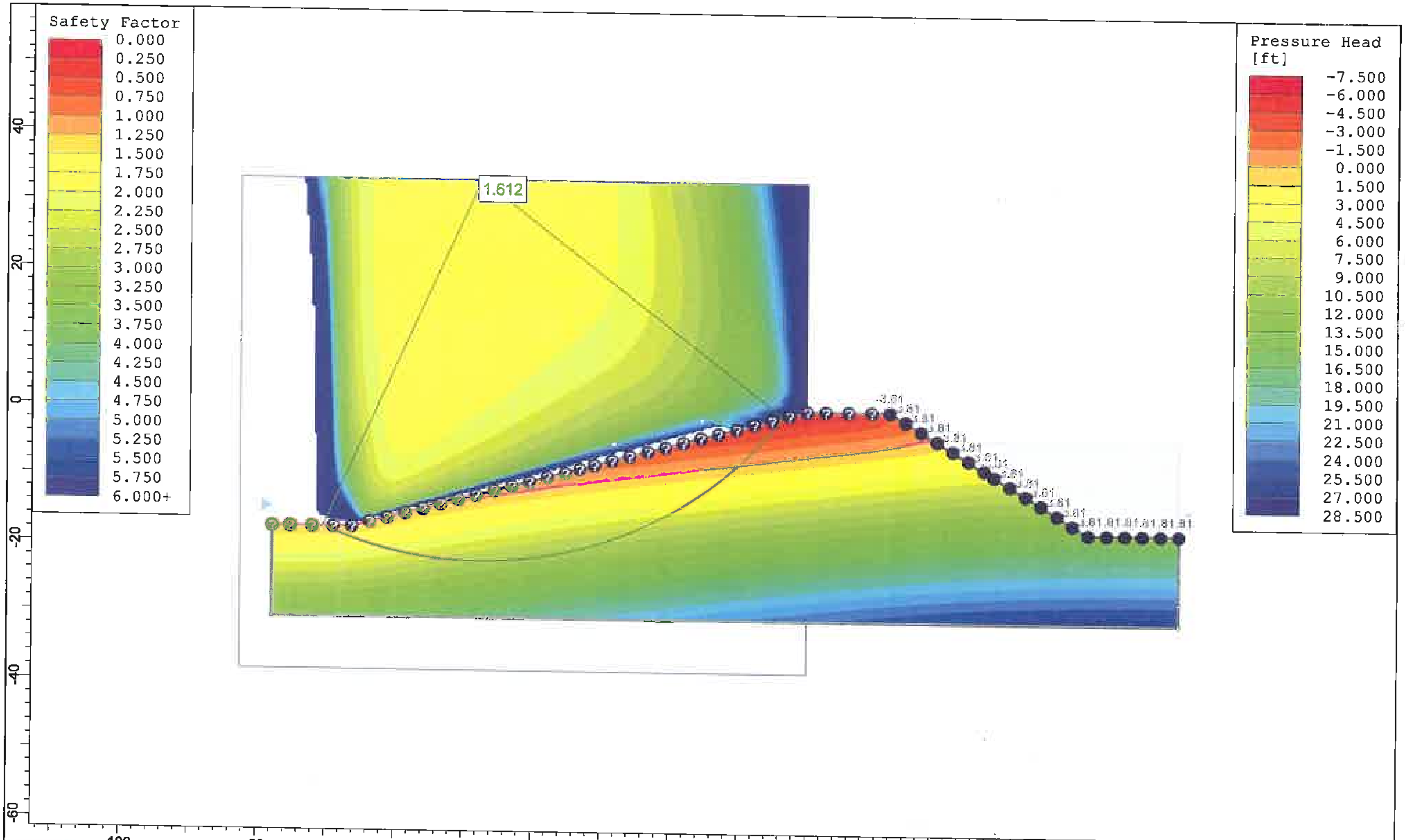
N:\Projects\2017\02171004\Working Files\Laboratory-Field Data-Boring Logs\[02171004 Triaxial CU B1-8.5.xlsx]REPORT

KANSAS CITY
TESTING & ENGINEERING, LLC

APPENDIX C

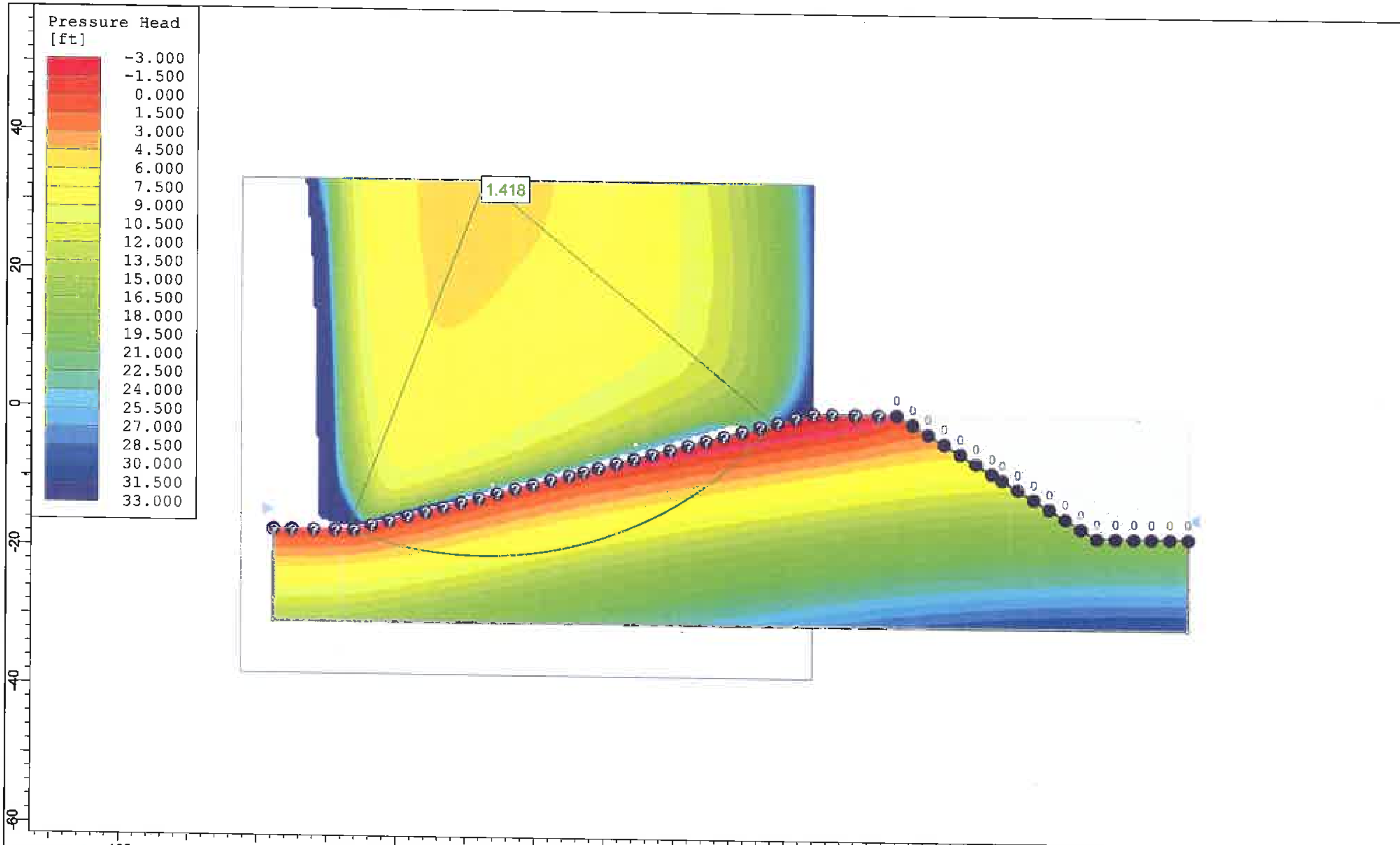
RESULTS OF EMBANKMENT STABILITY RESULTS



KANSAS CITY TESTING & ENGINEERING, LLC

1308 Adams Street
Kansas City, Kansas 66103

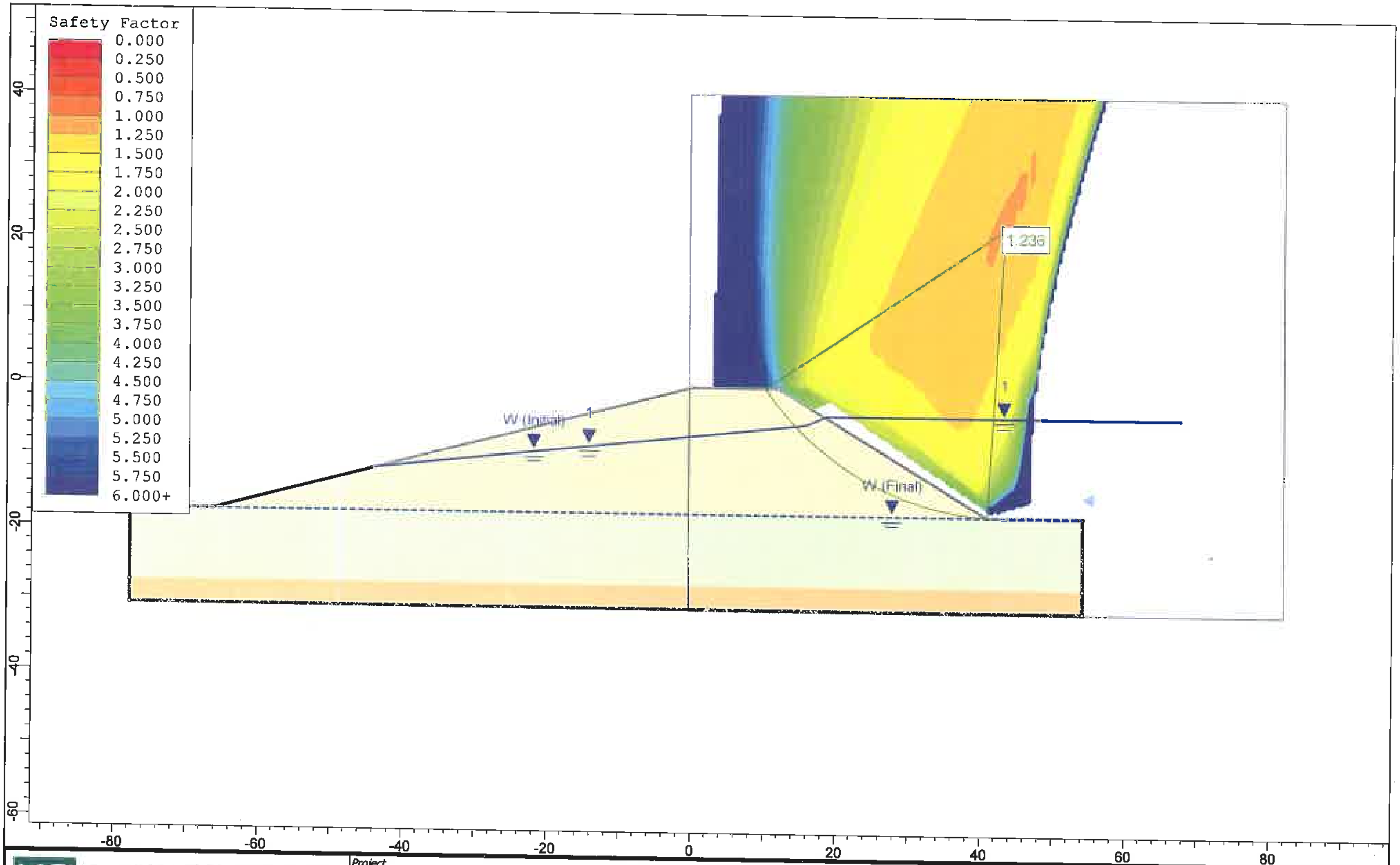
Project	G20-16-310 Old Longview Dam
Analysis Description	Steady State - Full Reservoir
Drawn By: BW	Scale: 1:231	Company:
Date: 2/9/2017, 1:32:51 PM	File Name: Global Stability Analysis



KANSAS CITY TESTING & ENGINEERING, LLC

1308 Adams Street
Kansas City, Kansas 66103

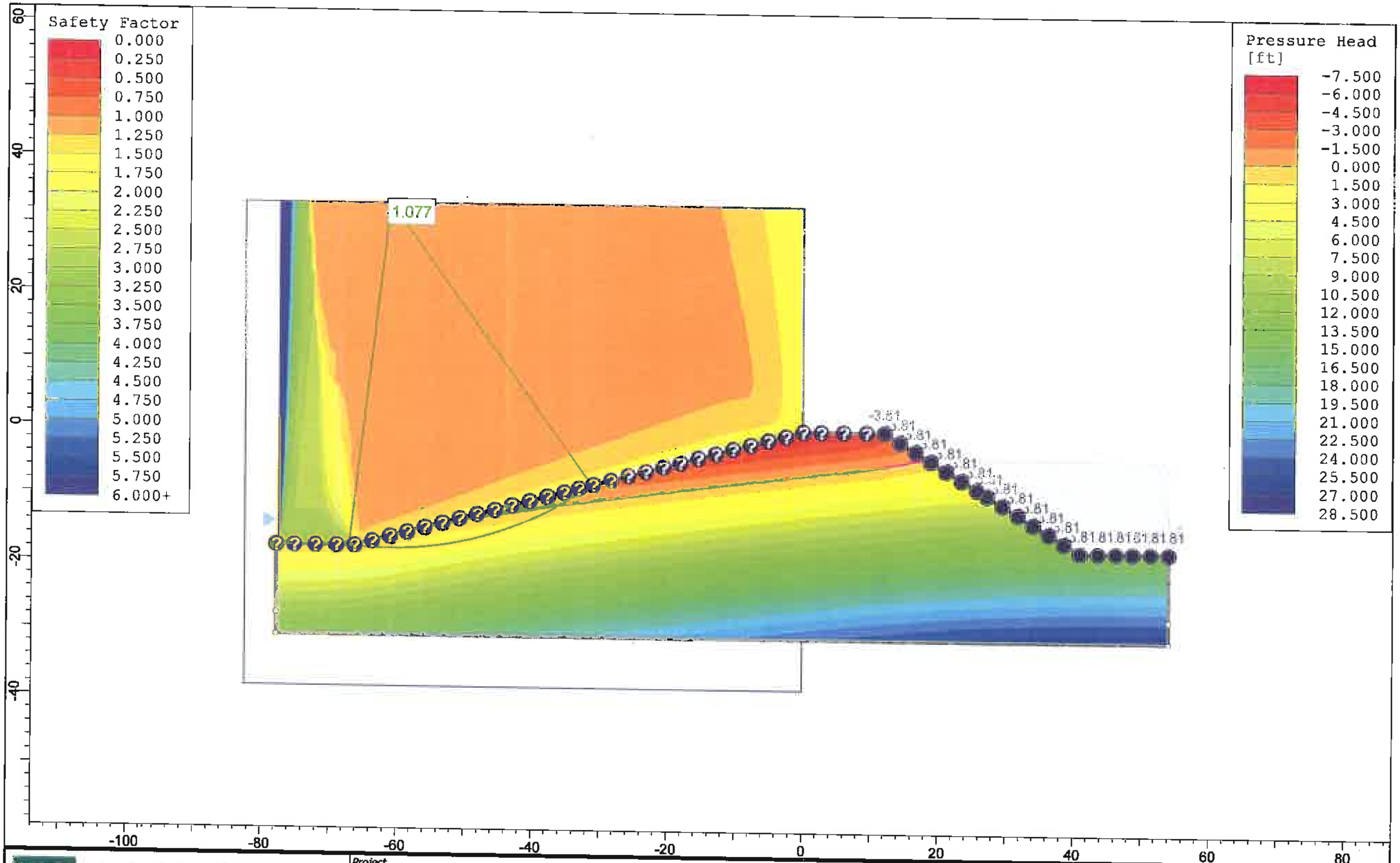
Project	G20-16-310 Old Longview Dam		
Analysis Description			
Drawn By		Scale 1:231	Company
Date	2/9/2017, 1:32:51 PM		File Name Global Stability Analysis



KANSAS CITY TESTING & ENGINEERING, LLC

1308 Adams Street
Kansas City, Kansas 66103

Project	G20-16-310 Old Longview Dam		
Analysis Description	Sudden Drawdown		
Drawn By BW	*Scale* 1:219	*Company*	
Date 2/9/2017, 1:32:51 PM		*File Name*	Global Stability Analysis



KANSAS CITY TESTING & ENGINEERING, LLC

1308 Adams Street
Kansas City, Kansas 66103

Project	G20-16-310 Old Longview Dam		
Analysis Description	Earthquake		
Drawn By: BW	Scale: 1:234	Company	
Date: 2/9/2017, 1:32:51 PM		File Name: Global Stability Analysis	

KANSAS CITY
TESTING & ENGINEERING, LLC

APPENDIX D

SITE PHOTOGRAPHS

Typical view of dam crest looking west.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #1
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Typical view of woody growth on downstream face of eastern portion of dam.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #2
Boring B-4
Metcalf 108 Redevelopment
Overland Park, Kansas
KCTE Project No. G10-17-015

Typical view of downstream face in western portion of dam, looking east.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #3
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Typical view of spillway structure, looking downstream from reservoir.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #4
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Typical view of spillway structure, looking upstream from spillway channel.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #5
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Typical view of erosional channel adjacent to spillway structure.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph # 6
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Typical view of intake / gate house structure.

KANSAS CITY
TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #7
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Typical view of water seepage at toe of dam.

KANSAS CITY TESTING & ENGINEERING, LLC
1308 Adams Street
Kansas City, Kansas 66103
www.kctesting.com

Site Photograph #8
Longview Dam - North
Lee's Summit, Missouri

KCTE Project No. G20-16-310

Terracon

Reference Number: P02185014

MASTER SERVICES AGREEMENT

TASK ORDER

This **TASK ORDER** is issued under the **MASTER SERVICES AGREEMENT** (dated 09/24/2015, agreement reference number 2013-122) between City of Lee's Summit MO ("Client") and Terracon Consultants, Inc. ("Consultant") for Services to be provided by Consultant for Client on the Old Longview Dam Review project ("Project"), as described in the Project Information section of the Consultant's Task Order Proposal dated 01/16/2018 ("Task Order Proposal") unless the Project is otherwise described below or in Exhibit A to this Task Order (which section or Exhibit are incorporated into this Task Order). This Task Order is incorporated into and part of the Master Services Agreement.

1. Project Information

The project is the rehabilitation of Old Longview Lake Dam, located at 38.8998°N, 94.4484°W.

2. Scope of Services The scope of Services to be provided under this Task Order are described in the Scope of Services section of the Consultant's Task Order Proposal, unless Services are otherwise described below or in Exhibit B to this Task Order.

The initial scope of services will include a third-party review of the report entitled "Old Longview Lake Rehabilitation/Restoration Study, Lee Summit, Missouri," prepared by Terra Technologies, Dated August 2017, which includes as an appendix a geotechnical reported entitled "Subsurface Exploration and Geotechnical Engineering Report, Longview Dam – North, Lee's Summit, Missouri," Project Number G20-16-310, dated February 17, 2017.

Our scope of work is to review and comment on the above referenced reports and identify any geotechnical related risk that may affect the long-term performance of the proposed project. Our fee includes the time to visit the site, review the reports, prepare a summary letter.

3. Compensation Client shall pay compensation for the Services performed at the fees stated in the Task Order Proposal unless fees are otherwise stated below or in Exhibit C to this Task Order.

For a lump-sum fee of $2,500.

All terms and conditions of the **Master Services Agreement** shall continue in full force and effect. This Task Order is accepted and Consultant is authorized to proceed.

Consultant:	**Terracon Consultants, Inc.**	Client:	**City of Lee's Summit MO**
By:	Date: **1/16/2018**	By:	Date:
Name/Title:	**Michael W Laney / Senior Associate**	Name/Title:	**Ryan Elam / Development Services Director**
Address:	**13910 W 96th Ter**	Address:	**220 Southeast Green St**
	Lenexa, KS 66215-1228		**Lee's Summit, MO 64063**
Phone:	**(913) 492-7777** Fax: **(913) 492-7443**	Phone:	**(816) 969-1202** Fax: **(816) 969-1202**
Email:	**Mike.Laney@terracon.com**	Email:	**ryan.elam@cityofLS.net**

Reference Number: P02185014

Laney, Michael W

From: Ryan Elam <Ryan.Elam@cityofls.net>
Sent: Thursday, January 4, 2018 4:20 PM
To: Laney, Michael W
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

Hi Mike,

I'm open at 3:30. The call shouldn't take long.

Essentially we have an old pond (100 years or so) that needs some work done to the dam. There's a developer that has taken the area over and is planning on making some improvements. These improvements potentially include adding a soil buttress to the downstream face of the dam, increasing the height of the dam, improving the outlet structure, and adding a new spillway. We have received a preliminary report from Terra Technologies that outlines some of these possibilities. A final direction for the improvements has not been determined at this time. We are requesting Terracon's assistance with reviewing the geotechnical aspects of the Rehabilitation/Restoration Study, and ultimately review of the final design chosen for the dam improvements.

An aerial view of the lake is below. It is located South of View High and 3rd ST in Lee's Summit.

Thanks,
Ryan

From: Laney, Michael W [mailto:Mike.Laney@terracon.com]
Sent: Thursday, January 4, 2018 3:47 PM
To: Ryan Elam <Ryan.Elam@cityofls.net>

Cc: Smith, Andrew L <Andrew.Smith@terracon.com>; Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

***** This email is from an external source, use caution before clicking on links or opening attachments. *****

Hi Ryan

I am open at 3PM to talk about this project. If you have any details you need to me review before the call, please send them to me when you get a chance.

Thank you,

Mike

Michael W. Laney, PE, GE, P. Eng
Senior Associate
Department Manager | Geotechnical Services- Lenexa Office

Terracon 50

13910 West 96th Terrace | Lenexa, KS 66215
D (913) 202-7592 | F (913) 492-7443 | M (805) 340-2075
mwlaney@terracon.com | terracon.com

PE: AZ, CA, CO, CT, FL, HI, ID, IA, KS, ME, MA, MI, MO, MT, NE, NH, NM, NV, OK, OR, RI, SD, TX, UT, VT, WA and WY; GE: CA; P. Eng.: AB, BC, ON and SK

From: Smith, Andrew L
Sent: Thursday, January 4, 2018 3:45 PM
To: Laney, Michael W <Mike.Laney@terracon.com>
Subject: FW: LS Bid #2017-043 - On-Call Geotechnical Services

See Ryan's availability for a phone conversation tomorrow.

Andrew L. Smith, PE
Project Engineer | Materials

Terracon
D (913) 998 7439 | M (913) 530 1456
andrew.smith@terracon.com

From: Ryan Elam [mailto:Ryan.Elam@cityofls.net]
Sent: Thursday, January 4, 2018 8:42 AM
To: Smith, Andrew L <Andrew.Smith@terracon.com>
Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

I have not heard from anyone from your geotech group. I am available to talk tomorrow from 10:30 – 1:30 and 2:30 – 4. Can we setup a quick call during one of those times?

Thanks,
Ryan

From: Smith, Andrew L [mailto:Andrew.Smith@terracon.com]
Sent: Thursday, January 4, 2018 8:31 AM
To: Ryan Elam <Ryan.Elam@cityofls.net>
Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

***** This email is from an external source, use caution before clicking on links or opening attachments. *****

Hi Ryan,

I just got back from vacation and wanted to circle back with you. Has someone from our geotechnical group contacted you about your earth dam project?

Thanks,

Andy

Andrew L. Smith, PE
Project Engineer | Materials

Terracon
D (913) 998 7439 | M (913) 530 1456
andrew.smith@terracon.com

From: Ryan Elam [mailto:Ryan.Elam@cityofls.net]
Sent: Thursday, December 28, 2017 4:51 PM
To: Smith, Andrew L <Andrew.Smith@terracon.com>
Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

That's funny, the copy I'm seeing shows it good until March 31, 2019.

http://cityofls.net/Portals/0/Files/main/purchasing/2017-043%20REVISED%20FINAL%20CONTRACT.pdf?ver=2017-02-22-110635-563.

Thanks,
Ryan

From: Smith, Andrew L [mailto:Andrew.Smith@terracon.com]
Sent: Thursday, December 28, 2017 4:40 PM
To: Ryan Elam <Ryan.Elam@cityofls.net>

Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

***** This email is from an external source, use caution before clicking on links or opening attachments. *****

Sounds great to me. I've attached our copy of the contract. It shows an effective date of 3/22/2016 through 2/22/2017.

Andrew L. Smith, PE
Project Engineer | Materials

Terracon
D (913) 998 7439 | M (913) 530 1456
andrew.smith@terracon.com

From: Ryan Elam [mailto:Ryan.Elam@cityofls.net]
Sent: Thursday, December 28, 2017 4:24 PM
To: Smith, Andrew L <Andrew.Smith@terracon.com>
Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

Let's move forward with renewing the piggy-back agreement if we can.

Do you have documentation indicating the agreement expired in February? If so, can you send that to me as well?

Let me know when you would like to discuss the project further.

Thanks,
Ryan

From: Smith, Andrew L [mailto:Andrew.Smith@terracon.com]
Sent: Thursday, December 28, 2017 3:57 PM
To: Ryan Elam <Ryan.Elam@cityofls.net>
Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: RE: LS Bid #2017-043 - On-Call Geotechnical Services

***** This email is from an external source, use caution before clicking on links or opening attachments. *****

Hi Ryan,

We'd be happy to help you with this project. Cale and I can bring this to our geotechnical department to get the ball rolling.

I should point out that the contract you're referencing is a special contract that piggy-backs off of our standing on-call agreement with the City of Belton. We were working with Steve Aldridge and Jeff Thorn on a scope of inspections and testing work for your new Water Utilities facility, and the city awarded your current on-call contract to another firm before we could finalize a task order. Steve and Jeff wanted to keep us on board for that specific project, so they set up this piggy-back contract. We used it for a couple other small jobs with the city, but unfortunately it expired in February.

The good news is that our on-call agreement with Belton is good through February of 2019. If you'd prefer to work with Terracon on this project, we would be happy to reestablish this piggy-back agreement.

Let me know if you have questions.

Thanks,

Andy

Andrew L. Smith, PE
Project Engineer | Materials

Terracon
D (913) 998 7439 | M (913) 530 1456
andrew.smith@terracon.com

From: Ryan Elam [mailto:Ryan.Elam@cityofls.net]
Sent: Thursday, December 28, 2017 3:24 PM
To: Smith, Andrew L <Andrew.Smith@terracon.com>
Cc: Wilson, Cale J. <Cale.Wilson@terracon.com>
Subject: LS Bid #2017-043 - On-Call Geotechnical Services

Hi Andrew,

The City of Lee's Summit has a development project in review right now that contains some potential earth dam reconstruction and rehabilitation, and I was hoping to utilize the on-call engineering contract mentioned above for some review expertise. The project is associated with the New Longview area in Lee's Summit, and your review would focus primarily on dam safety and the geotechnical aspects of the dam itself. Is this something you can assist us with? Please let me know and we can setup a time to talk about the project.

Thank you,
Ryan

Ryan A Elam | Director of Development Svcs.
220 SE Green Street | Lee's Summit, MO 64063
816.969.1202 | cityofLS.net | Ryan.Elam@cityofls.net

Out as Shown determination, an Amend-In and Deny (non-removal) determination may be issued.

Before issuing an Amend-In and Deny determination, the potential for naturally occurring intervening high ground is explored to ensure that no high ground prevents the conveyance of the base flood from the flooding source to the subject of determination. See Section 4.10 for more information on the review of naturally occurring intervening high ground.

4.10 Intervening High Ground Considerations

Naturally occurring high ground can, in limited situations, provide protection from the base flood by preventing conveyance of the base flood from the flooding source to the subject of determination. To determine if intervening high ground provides protection from the base flood, several conditions must be met:

- The intervening high ground cannot be based on fill material or on any kind of manmade structure, such as a floodwall, berm, retaining wall, etc. It must be naturally occurring.
- Sufficient data must be submitted to show both the extent and elevation of the intervening high ground. This may require detailed topographic data and/or spot elevations extending beyond the subject property to clearly demonstrate the high ground is sufficient to prevent flood water from going around the high ground and continuing to inundate the subject.
- The elevation for the subject must show the LLE or LAG elevation on the submitted form and not the elevation of the intervening high ground for either of these items. Certified comments must be added to the form explaining the presence of naturally occurring intervening high ground and referencing the data submitted in support of the intervening high ground.

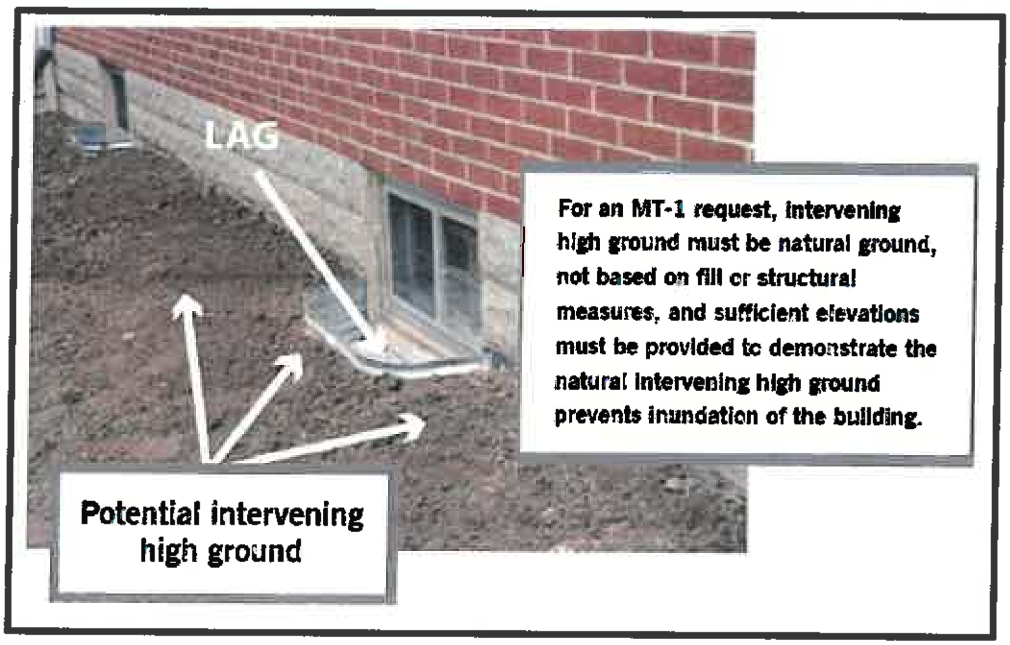


Figure 17: Use of Intervening High Ground – Window Well