NOTE

Subject: EPA Comments on WI Power & Light Co - Edgewater Generating Station, Sheboygan, WI
Round 10 Draft Assessment Report

To: File

Date: April 24, 2012

1. On p. 3, last paragraph in section 1.2.3, please include the rationale for not assessing Ponds C and Pond E.

2. On p. 7, Section 1.2.11 "Hazard Potential Classification," Pond F, as well as "Pond E," is located directly adjacent to the west of Lake Michigan, abutting the lake. Pond F was classified as having a Low hazard potential based on no probably loss of human life and the low potential for environmental impacts outside of the Utility-owned property; Pond E was given neither a hazard rating nor mention in any capacity in the report. Is it GZA's contention that discharge of contents from within Pond F and Pond E resulting from a breach of the embankment would not have significant environmental impacts to Lake Michigan? If so, the reasoning for this conclusion should be elaborated upon.

3. On p. 7, Section 1.2.11 "Hazard potential Classification," The CCR management units within the Ash Disposal Facility (ADF) are located directly adjacent to County Road East, abutting the road directly to the west. County Road East is a public collector road. The CCR management units (i.e., Slag Pond, North Pond A, South Pond A, Pond B, Pond C) were rated as having Low hazard potential based on no probably loss of human life and the low potential for environmental impacts outside of the Utility-owned property. Given the proximity to the public road, is it GZA's contention that a breach of the embankment would cause limited impact outside of the owner's property? If so, the reasoning for this conclusion should be elaborated upon.

4. Please insert the pertinent figures and photos into the text so the reader is not moving to and from the text and the appendices. Keep the remainder of figures and photos in the appendices.

5. Although there appears to be a discussion in section 1.2 of the description of each unit and the materials in which each unit consists, it is requested that either in Appendix C-the checklist, or in section 1.2 there be a specific statement made to address the following question: "Is any part of the impoundment built over wet ash, slag, or other unsuitable materials (like TVA)?" Please correct for each impoundment.

6. On p. 14, section 2.4, no EAP specific to potential situations that may arise at the impoundments, section 3.3 ought to include the development of an EAP for actions related to potential hazards/failure from the impoundments.

7. In section 2.6 “Structural Stability,” it may be advantageous to provide a chart listing the respective CCR management units with corresponding calculated factors of safety from the Miller Evaluation, clearly denoting that the factors of safety represent those under static loading conditions.

8. On p. 15, section 3.1 for slag pond, remove the "and" at the end of bullet number 3 and move it to the end of bullet number 4. Same comment for each of the other ponds -- different bullet numbers.

9. Please include the Miller stability analyses report as an appendix.

RE: Comment Request on Coal Ash Site Assessment Round 10 Draft Report - Alliant Energy Stations

Fauble, Philip N - DNR to: Jana Englander, Jose Cisneros, Galloway, Meg M - DNR

Cc: "Lynch, Edward K - DNR", "Coakley, Ann M - DNR"

Jana,

Thank you for offering WDNR the opportunity to comment on the Draft Assessment Reports. We have reviewed the reports included here and offer some fairly brief comments. What follows are comments from one of our Regional field staff assigned to several of the facilities mentioned in the assessments:

The only comments I have in regards to the Nelson Dewey and Rock River reports are similar to those comments I previously made for the Columbia Generating Station:

The Executive Summaries of both reports generally state that all of the impoundments found at these two facilities (six in total) were constructed for "the purpose of storing and disposing non-recyclable coal combustion waste…"

I don't agree with that characterization. Even if the original intent for these structures was long-term storage and disposal of CCW, they have not been used for such a purpose in decades. To the best of my knowledge, none of the WPDES ponds were ever intended for use as anything other than settling and clarification of facility discharge water, not for storage of CCW (not even temporary storage) and certainly not for disposal of CCW. And while the slag ponds at each facility could be considered to be used for the temporary storage of CCW, neither has been used for the permanent disposal of CCW, as that material is/was removed from those structures on a regular basis and either beneficially re-used or landfilled at a licensed solid waste facility. I find it curious that there is absolutely no mention in either report that CCW sluiced to the respective slag ponds was/is permanently removed from said structures on a regular basis. If it had not been, these structures would have been filled to capacity many years ago.

I agree with these comments and would like to extend them also to the Alliant Edgewater Facility in Sheboygan, WI. We disagree that any of these ponds are, in fact, used for the disposal of coal combustion byproducts. The larger of the ponds are being used in accordance with their WPDES Permits for the treatment of cooling and contact water from the plants prior to surface water discharge. All coal fly ash in Wisconsin has been handled in dry form since the mid-1980's. The smaller (1-2 acre) ponds where bottom ash is sluiced are not considered disposal areas by the WDNR. They are classified as solid waste (all CCW's are considered solid wastes under WI law) storage/treatment facilities. The bottom ash is sluiced wet to these areas and dewatered prior to their excavation for beneficial use projects. The CCW beneficial reuse rate in Wisconsin is between 85-90 percent, so utilities have little

need for extensive disposal facilities. What CCW disposal facilities we do have permitted are all approved for dry disposal only.

These comments are similar to our previous comments regarding these and other ponds at coal-fired utility plants in Wisconsin. Again, we maintain that the State of Wisconsin does not have any active wet slurry CCW disposal sites, nor have any existed for decades.

Thank you again for considering our comments. If you have any questions, please feel free to contact me.

Philip Fauble, P.G.
Mining & Beneficial Reuse Program Coordinator
Bureau of Waste & Materials Management
Wisconsin Department of Natural Resources
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August 13, 2012

Via E-mail to: hoffman.stephen@epa.gov and kohler.james@epa.gov

Mr. Stephen Hoffman
U.S. Environmental Protection Agency (5304P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Response to Draft Assessment Report
Edgewater Generating Station

Dear Mr. Hoffman:

This letter is sent on behalf of Wisconsin Power and Light Company's ("WPL") Edgewater Generating Station in response to the United States Environmental Protection Agency's ("EPA") Draft Report, Round 10Dam Assessment – May 31, 2011 for the Edgewater Generating Station, dated March 2012 ("Draft Report"). The site assessment was conducted by EPA's contractor, GZA GeoEnvironmental, Inc. on May 31, 2011. EPA's cover email accompanying the Draft Report requests that comments be submitted within 30 days of receipt. EPA extended this date to August 13, 2012 for WPL. The email also provides for a business confidentiality claim covering all or part of the information submitted by WPL.

CONFIDENTIAL BUSINESS INFORMATION CLAIM

WPL is claiming business confidentiality for both the Draft and Final Reports associated with the site assessment of the coal combustion material management units at the Edgewater Generating Station and for the comments submitted in this letter in their entirety, a claim which is being made in accordance with 40 C.F.R. Part 2, Subpart B.

Per the criteria established by 40 CFR. Part 2, Subpart B, §2.208, the documents for which confidential treatment is requested are entitled to confidential treatment because: (1) this claim is timely and has not been waived, (2) WPL has taken reasonable measures to protect the confidentiality of the information and intends to continue to take such measures, (3) the information is not reasonably obtainable

without WPL's consent by other persons by use of legitimate means, (4) no statute specifically requires disclosure of this information, and (5) the disclosure of the information is likely to cause substantial harm to WPL's competitive position.

All of the documents for which confidential treatment is requested help WPL maintain its competitive position. WPL protects the confidentiality of this information by making it available only to those within the company with a legitimate need to know the information for purposes of performing their jobs.

COMMENTS ON THE DRAFT ASSESSMENT REPORT

Listed below are the comments associated with the Draft Report for the WPL – Edgewater Generating Station.

Italics indicate language in Draft Report. **Bold** indicates suggested language.

General Comment:

1. Remove all references to "*Alliant Energy*" and insert "**Wisconsin Power and Light Company ("WPL")**". This should include *"Alliant Energy"* references on Cover Page; Executive Summary (Page I and iii); The Footer of each page and note that on Page ii and iii the Footer references the *"Hutsonville Power Station"*; Table of Contents; Page 1 (Section 1.1.1); Page 2 (Section 1.2.2); Page 3 (Section 1.2.4); Page 4 (Section 1.2.5); Page 5 (Section 1.2.7); Page 6 (Section 1.2.8); Page 9 (Section 1.3.5).

Inspection Checklist:

1. Remove "*Illinois*" and insert "**Wisconsin**" as the location of the Wisconsin Department of Natural Resources location on the second page of each pond checklist.

Preface, Executive Summary, and Page 15 (Section 3.1 and 3.2):

1. Page ii and Page 10 – The Executive Summary and Section 3.0 contains a number of deficiencies and a recommendation for further studies and analyses. For the Slag Pond, Pond A (North and South Pond), Pond B, and Pond F the inspectors state *"the stability of the embankments was not evaluated under seismic loading"*. We believe these recommendations should be removed as the attached July 27, 2012 Miller Engineering and Scientist (Miller) Report address the stability of the embankments under seismic loading. At a minimum, please state *"additional studies were performed by WPL and Miller and EPA found this additional information satisfactory and the issue is resolved"*. In addition to the seismic studies, the Edgewater plant has been cutting and removing trees along the outside slopes of the A; B; and C Ponds. F Pond trees that are located on our property have been removed.. Please see the attached photo log of our ongoing tree/brush removal project around our ponds. Large trees that were removed were donated to local conservation group efforts to stabilize the banks and provide fish habitat for a local stream.

Ratings of the Ponds:

1. All ponds were rated as *"Poor"* because *"the stability of the embankments was not evaluated under seismic stability"*. We believe these ratings should be changed to **"Satisfactory"** based on our comments and the attached July 27, 2012 report from Miller that contains additional geotechnical analysis of the ash ponds. The ratings of the ponds can be found in the following areas of the Draft Report: Preface letter from GZA to EPA; Page ii and iii under the Assessments Section of the Executive Summary; Page 10 (Section 2.1.1 and Section 2.1.6); Page 11 (section 2.1.11); Page 12 (Section 2.1.16); Page 13 (Section 2.1.21) and Pages 15 and (Section 3.1). In addition to the Miller Report, we believe the development of the Corporate Operations and Maintenance Plan (Corp Plan) and the Site Specific Operations and Maintenance Plan (Site Plan) will address the other deficiencies, concerns, recommendations that support the **"Satisfactory"** ratings of our ponds. Additional information regarding the Corp Plan and Site Plan is provided on page 4.

Section 1.2.3

1. Page 2, Second Paragraph – We agree that *"Slag is the primary CCW received by the Slag Pond" however* the North and South A ponds receive plant process waters and not fly ash. Fly ash is collected dry and stored in silos. Only plant wastewaters are discharged into the North and South A Ponds as slag is sent to the slag pond and unit #5 utilizes a hydro-bin system. Please remove *"fly ash"*.
2. Page 2 and 3, Last Paragraph – Page 3, Third Paragraph – This paragraph does not acknowledge the site is authorized to discharge the effluent from Pond F through a State of Wisconsin issued WPDES Permit. After the sentence starting with "*Water is discharged from Pond F to Lake Michigan*" insert **"through Outfall 004 as regulated by WPDES Permit Number WI-0001589-07-0".**
3. Page 3, Last Paragraph, Ponds not Subject of EPA Scope – Since the closed ash landfill and Ponds C&E do not *"fall within our scope of work as the unit does not meet the criteria set forth by the U.S.EPA…"* Please remove the photos in Appendix F of the report.

Section 1.2.4

1. Page 3, Second Paragraph – The only material sent to the Slag Pond is slag from Units 3 and 4. Since this material is beneficially reused, the facility only sluices slag to the pond. Please remove *"ash transport water, boiler wash water, air heater wash waters, precipitator wash, steam grade production wastewaters, storm water runoff from the main switch yard, turbine room floor drains after processing through an oil/water separator, boiler room sumps, bottom ash hopper seals"*. These wastewaters are sent to Ponds A & B.

Section 1.2.5; Section 1.2.6

1. Please remove *"Fly Ash"* as fly ash is collected dry in the precipitators and is pneumatically conveyed to the silos and is beneficially reused or disposed of in an

approved landfill. In addition, please remove *"ash transport water"* since the slag pond receives slag from Units 3&4 and Unit 5 has a Hydrobin system where bottom ash is handled and is not sluiced to the ash pond system.

Executive Summary and Section 3.1

1. After the Round 8 Assessments by EPA at some of our other generating stations, WPL has prepared a Corp O&M Plan that outlines the proper operations and maintenance of coal combustion ash ponds based on the guidance documents readily available from the Corp of Engineers; FEMA; and OSHA. In addition to the Corp Plan, each generating station has a Site O&M Plan that defines the roles; responsibilities; and actions required by the generating station to ensure our ponds are maintained and operated in a safe manner now and in the future. As part of the Site Specific Operations and Maintenance Plan, a 3rd Party PE will inspect the site on an annual basis to evaluate the current conditions; evaluate maintenance activities; and provide additional guidance to improve the overall safety of the ponds. The items listed as *"deficiencies"* will be evaluated per the Site O&M Plan and action taken as necessary. With consideration for deficiencies that may require regulatory permitting or detailed engineering, WPL will resolve these in a timely manner. The inspection sheet has been revised accordingly to include monthly and a more detailed quarterly inspection. We anticipate having the Corp O&M Plan and Site Specific O&M Plan, including training; operational at the Edgewater Generating Station by December 31, 2012. Please see the attached photo log of our ongoing tree/brush removal project around our ponds.

2. F Pond Recommendations – Section 3.3

   The crest of the eastern embankment of the F Pond contains the site roadway around the pond and property. This roadway is travelled very frequently throughout the day and is at least 25 feet wide. Beyond the roadway crest, the embankment is another 20 feet wide and is lined with riprap to protect the wave action from Lake Michigan. WPL does not own the property on the shoreline of Lake Michigan beyond our fence. The trees within our property have been removed from the F Pond basin. A third party professional engineer (PE) will visit the site on an annual basis to review this area and determine if any action needs to be taken.

REQUEST FOR CONFERENCE CALL WITH GZA TO REVIEW COMMENTS

Finally, because of the technical complexity and factual detail contained in the Draft Report, WPL believes it would be efficient and helpful to conduct a conference call between WPL, EPA, Miller Engineers and Scientists; and GZA to review the details of these comments. WPL would be happy to coordinate the time and set up a call-in number. WPL specifically requests such a discussion take place prior to the preparation of a Final Report.

WPL appreciates this opportunity to provide comments on the Draft Report for the Edgewater Generating Station. If you have any technical questions, please contact William Skalitzky at (608) 458-3108. If you have any legal questions, please contact Jenna Wischmeyer at (319) 786-4843.

Very truly yours,

Eric Sandvig
Plant Manager

Enclosures

cc: James Kohler - EPA
William Skalitzky - AECS
Jenna Wischmeyer – AECS
Terry Kouba - AECS

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July 27, 2012

10-18634 50-200

Mr. Bill Skalitzky
Alliant Energy Corporate Services, Inc.
c/o Edgewater Generating Station
3739 Lakeshore Drive
Sheboygan, WI 53081

Subject: **Edgewater Generating Station Ash Ponds Supplemental Report**
In Response to GZA Review of Miller Evaluation of Embankment Stability

Dear Mr. Skalitzky:

This letter supplements our March 18, 2011 stability evaluation of the above-referenced ash pond embankments in response to GZA's March 19, 2012 review of our report. GZA's review includes a recommendation to "evaluate the stability of the impoundment embankments under seismic loading" and to evaluate stability with regards to a cross-section through the cast-in-place concrete retaining wall in the northern side of the embankment forming the north side of the Slag Pond. Based on our recent conversation with you, we understand that GZA or their client, EPA, expects that "pseudo-static" (PS) analysis be included to evaluate "seismic loading". We do not agree with the applicability for PS analysis in this case, but include it in this supplemental report for the most critical slope case. We have also included analysis of the stability of the cast-in-place concrete wall, as recommended by GZA.

SLAG POND NORTH EMBANKMENT – DOWNSTREAM SIDE WITH CONCRETE RETAINING WALL

Our prior report included stability analysis of the most critical section of the north side of the Slag Pond, which is its inside slope under rapid drawdown condition. For that we had computed a factor of safety of 6.3. This is labeled Section P and is located east of the portion of this berm that has the retaining wall on its outside (north side), which we have labeled Section S. These features are shown in plan view on the attached *Figure 1*. *Cross Sections* are shown on an 11" x 17" sheet and the attached *Site Photographs* show the field conditions.

The four feet high concrete wall accommodates a wide haul road bed and is not a necessary element of the slag pond berm. The wall is in good condition, but has at least one vertical shrinkage crack that does not affect its stability. To comply with GZA's recommendation and demonstrate it is not a necessary element of the berm for purposes of containing water in the Slag Pond, **we performed stability analysis using Janbu's charts of Berm Section S under the presumption that the concrete retaining wall is not present; yielding a safety factor of not less than about 16.** This demonstrates that this section is not critical, irrespective of the condition or existence of the concrete wall.

GENERAL DESCRIPTION OF PSEUDO-STATIC (PS) SLOPE STABILITY ANALYSIS

Moderate to strong earthquake shaking of embankments can cause excessive deformation, typically realized as the amount of depression of the crest. The amount of deformation that develops is the result of many factors, but generally increases with the number and magnitude of ground acceleration cycles. Earthquakes are commonly described by Richter Scale numbers that index the amount of energy released. Each integer increase in Richter Scale magnitude represents a ten-fold increase in energy. Magnitudes less than 3 are typically imperceptible or are barely felt; 4's are mild, resulting in little or no damage. Mid 5's are moderate and cause varying amounts of damage to structures, while high 6's, 7's and 8's are strong to "great" and may have substantial to devastating effects .

Pseudo static (PS) analysis uses a "seismic coefficient" (k) that is applied to conventional, static equilibrium methods of slope stability analysis as a simplified representation of the potential for embankment displacement due to moderate to strong seismic shaking. Seismic coefficients represent an acceleration that is an appropriate fraction of the peak earthquake acceleration, which is attributed to the potential sliding mass in the PS analysis.

In PS analysis, a Factor of Safety (FOS) of less than 1 indicates that excessive displacement is likely to occur if the attributed magnitude of earthquake occurs, even without soil weakening due to cyclic strain. An FOS of more than 1 implies that crest deformation is likely to remain within the range selected as acceptable in the analysis, provided there is no soil strength reduction due to cyclic strain. PS analysis is often used as a preliminary screening tool in areas of moderate to high seismicity to asses if more detailed types of displacement analysis are warranted. Appropriate variations of it can also provide an expedient basis to identify potential instability in a wide range of situations where soil strength will not diminish with successive cycles of ground motion.

Seismic coefficients have been semi-empirically derived for a range of performance levels (embankment crest displacements ranging from several inches to several feet) for earthquakes ranging in magnitude from 6 to 8 ½ on the Richter Scale. Coefficients have not been developed for lesser events where only few and relatively weak cycles of ground motion are likely to occur and are not sufficient to cause excessive deformation. Consequently, in regions of low seismicity, **where the probable maximum ground accelerations do not exceed 25% or 30% of the acceleration of gravity, the commonly required Factors of Safety for PS analysis will be satisfied provided there is an adequate static Factor of Safety.**

In contrast, **liquefaction potential should be evaluated wherever loose, saturated, fine sand and silt are present** because there is potential for at least minor earthquakes nearly everywhere and there is also potential for man-caused ground vibration (blasting, or large machine or equipment vibration). It is for this reason **our prior report evaluated the potential for liquefaction as the most critical "seismic loading" effect for the specific soil conditions on this site**, and not PS analysis.

MOST CRITICAL SLOPE IN EDGEWATER ASH PONDS – STATIC AND SEISMIC CONSIDERATIONS

Because PS analysis does not consider reduction of soil strength due to cyclic strain, it should not be used in situations where there is potential for soil liquefaction, as is the case with the most critical of the Edgewater ash ponds. **PS analysis provides false confidence where liquefaction potential is the most critical failure mechanism.** However, **we include herein PS analysis for the most critical slope (Section E) of the Edgewater Ash site ponds in order to fulfill the apparent expectation by EPA.** The embankment at Section E (as shown in cross section on the attached 11" x 17" sheet) has a total height of about 33 feet with a slope cotangent of 2.1 (2.1 parts horizontal to 1 part vertical). The lower 12 feet of this slope is normally submerged in Pond C. This embankment is comprised of stiff, lean clay fill bearing on several feet thickness of stiff clay subgrade that is underlain by a stratum of loose, non-plastic silt. More detailed information is included in our prior report.

Embankment Section (E) has a computed Factor of Safety (FOS) of 1.85 for the most critical, non-seismic condition; which would be with rapid drawdown of Pond C. If this embankment were to fail, loss of life is not likely due to its location and limited impoundment volume. So 1.3 is an adequate FOS for the static condition and the estimated stability is considerably greater than that. In this (static) context, the FOS is defined as the ratio of the sum of net forces resisting sliding divided by the forces tending to cause bank instability.

The Edgewater Plant is located in a large region of low seismicity for which USGS maps a peak acceleration of 0.06g (6% of the acceleration of gravity) having a 2% probability of exceedance in 50 years (equivalent to a "return period" of 2,500). This corresponds to a Richter Scale magnitude 5.0 event having an epicenter about 20 miles from the site. Peak acceleration for a 500 year return period is mapped at just 0.03g. Refer to our prior report for detailed information on local seismicity.

These small accelerations fall well below the charts (one of which is attached) for which seismic coefficients have been developed (magnitudes 6 to 8.5). So in order to provide PS analysis as has been requested, we have used the larger event (0.06g maximum acceleration with a return period of 2,500 years) even though that is a much longer time than the ponds will remain in operation. That still requires extrapolation below the derived seismic coefficients.

Rapid drawdown in Section E, which we presented in our prior report as its most critical static condition, can only occur with active pumping. That would not be coincident with an earthquake. So, in this supplement, we include both static analysis without rapid drawdown along with PS analysis for this same section to directly show the small effect that the seismic coefficient has in an area such as this with low seismic potential:

Section E Static Factor of Safety = 2.35 (min. required 1.3)

Section E Pseudo Static (PS) Factor of Safety= 2.27 (min. required 1.1)

PS analysis on all the other sections presented in our prior report would indicate higher factors of safety.

SUMMARY

This supplemental report includes analysis that GZA recommended be performed. It is our opinion that the Edgewater Generating Plant ash ponds have adequate stability and should be given a SATISFACTORY rating using the USACE dam safety procedures.

Sincerely,

MILLER ENGINEERS & SCIENTISTS

WISCONSIN
ROGER G. MILLER
E-23756
SHEBOYGAN, WI
PROFESSIONAL ENGINEER

7/27/2012

Roger G. Miller, P.E.,
President

Enclosures:
Figure 1
Site Photographs
Cross Sections
Slope Stability Analyses
Selection of Seismic Coefficients

I:\DATA\2010\18000\10-1-18634 Alliant - Edgewater Pond Stab Analysis\This letter supplements our March 18 2010 report.docx

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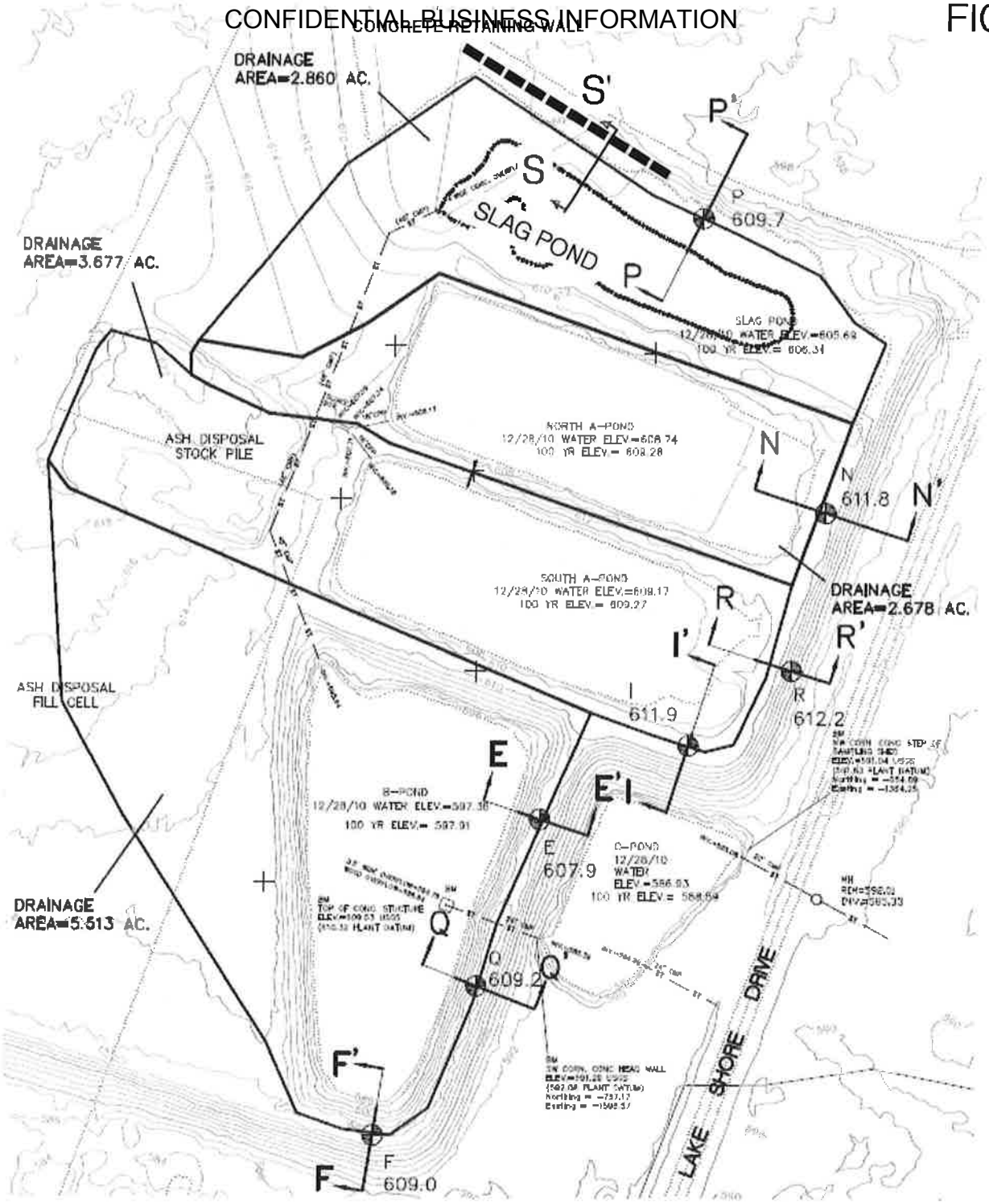
FIGURE 1



BORING & CROSS SECTION LOCATION PLAN
EDGEWATER GENERATING STATION
IMPOUNDMENT ANALYSIS – EXTERNAL BERMS

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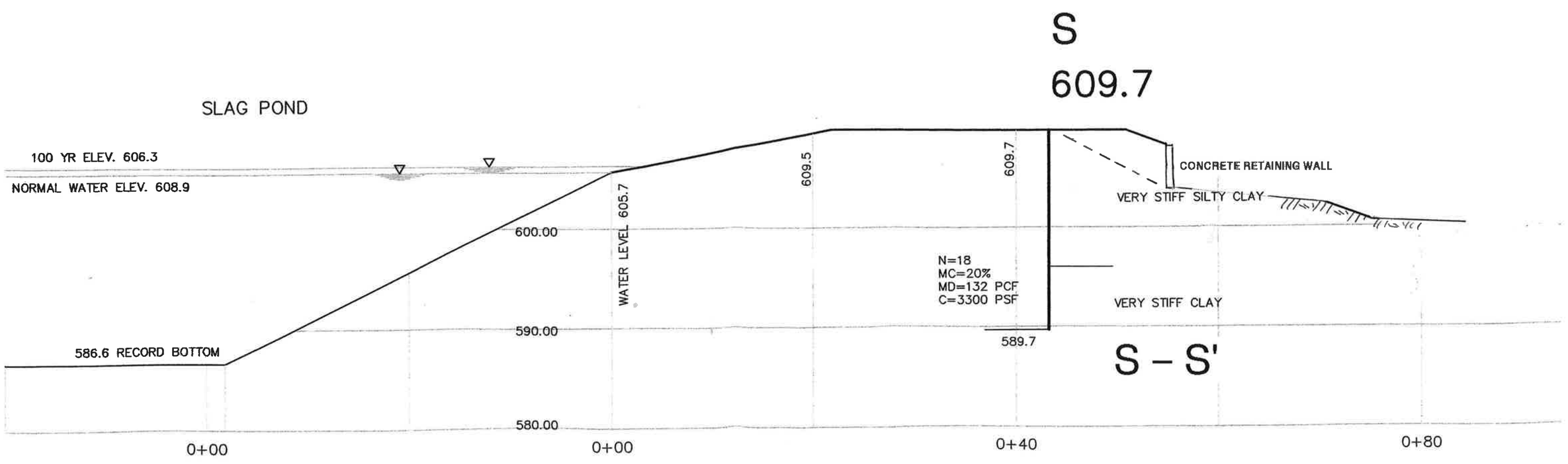
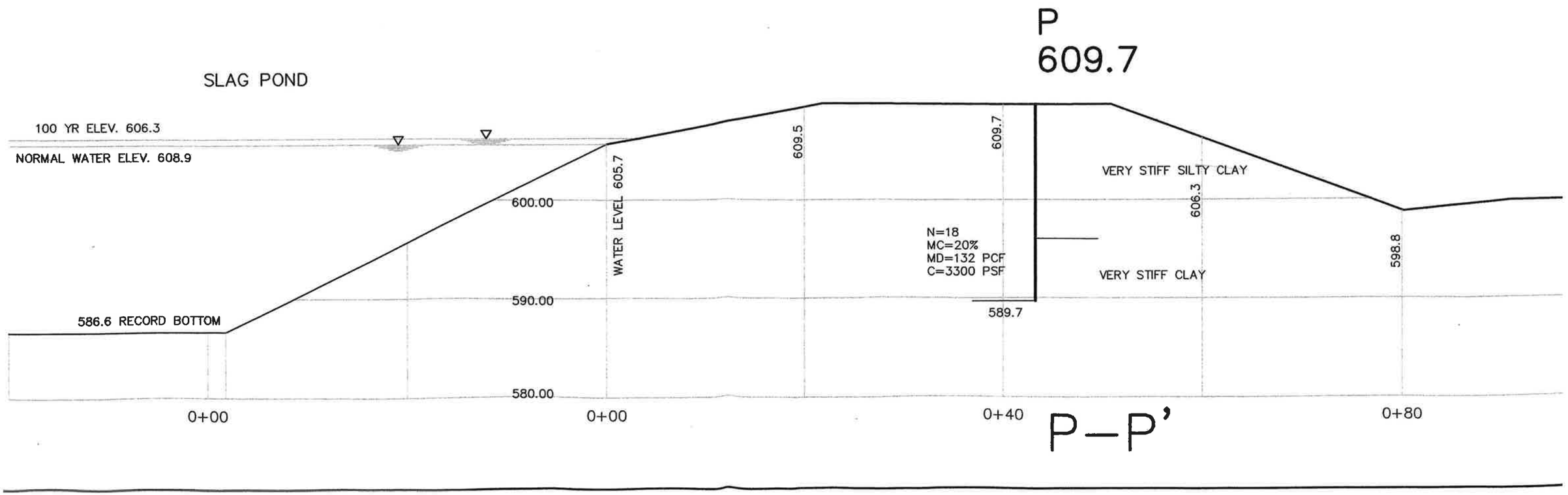
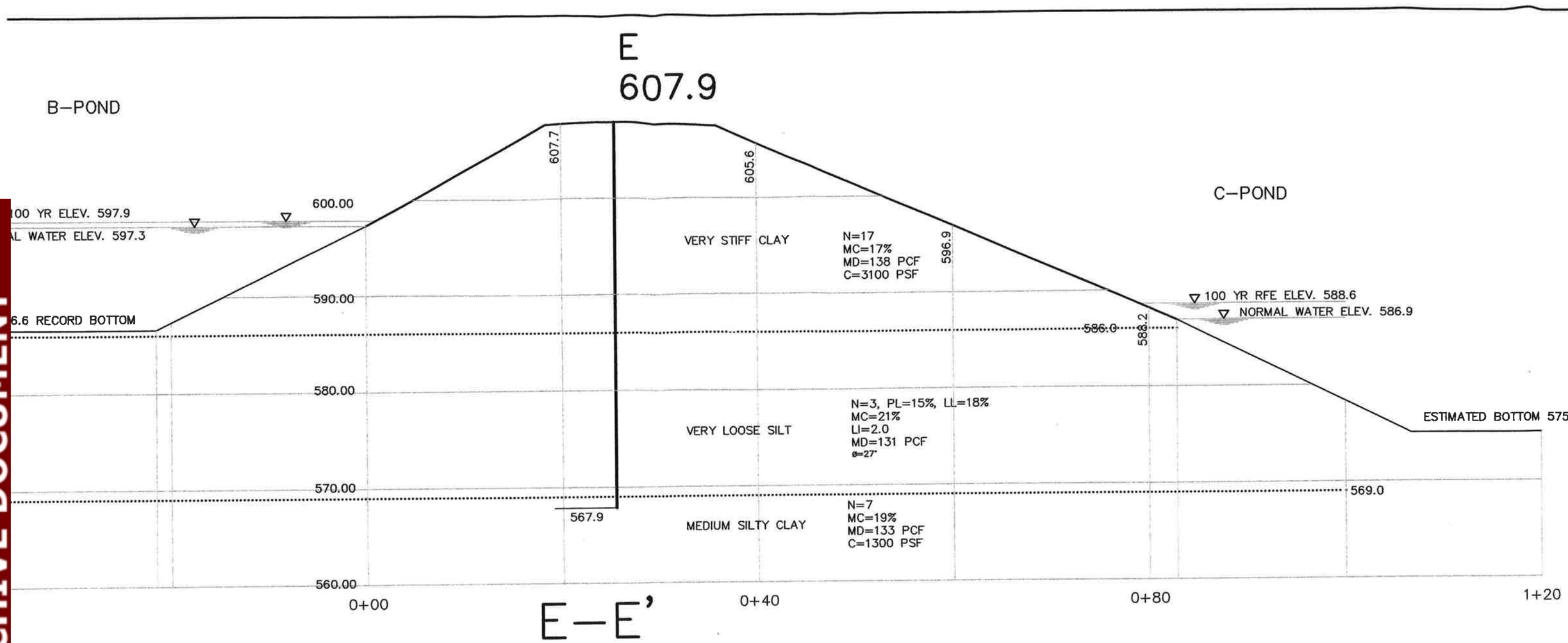
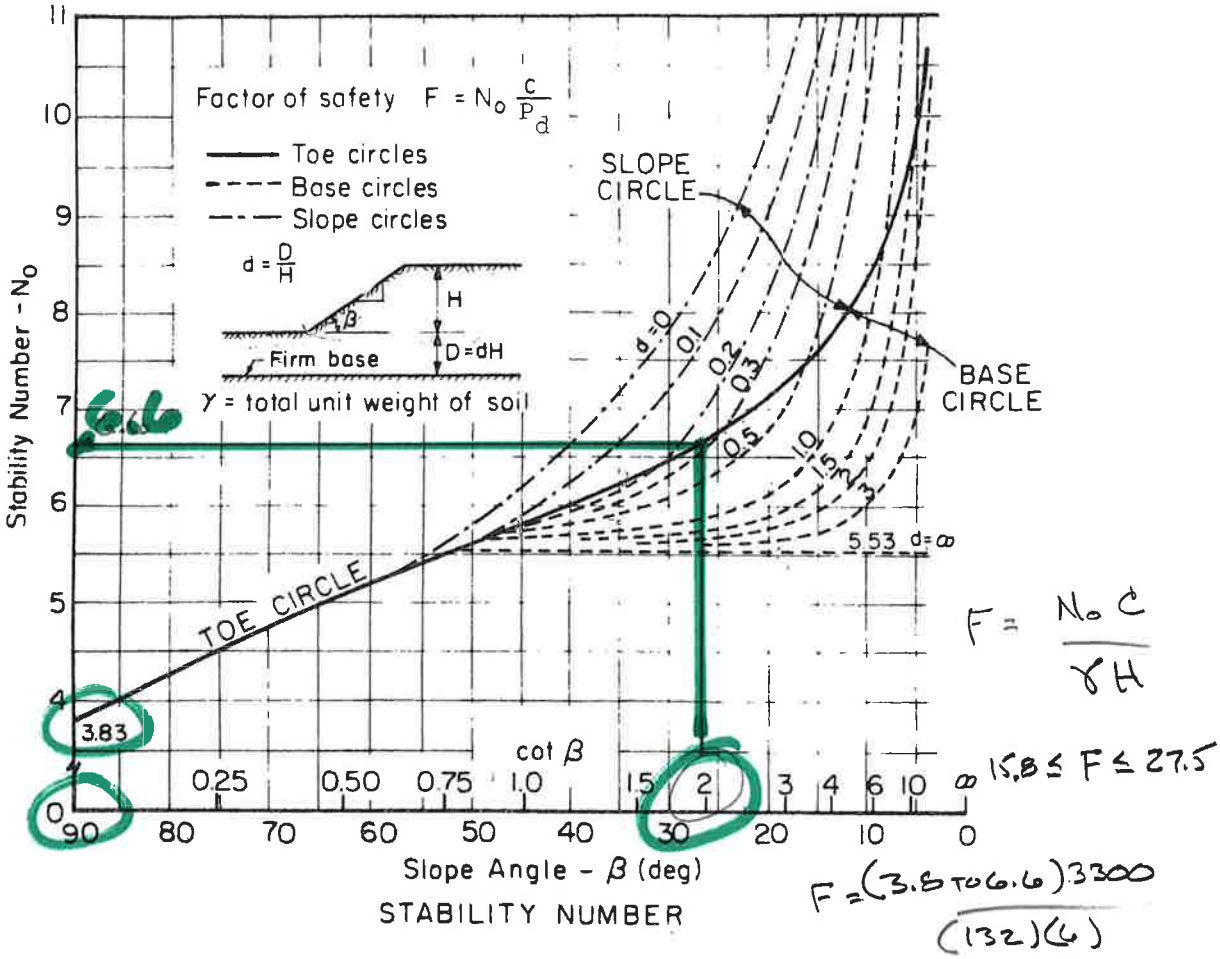






E–E'

S – S'



$F = \frac{N_o c}{\gamma H}$

$15.8 \le F \le 27.5$

$F = \frac{(3.8 \text{ TO } 6.6)3300}{(132)(6)}$

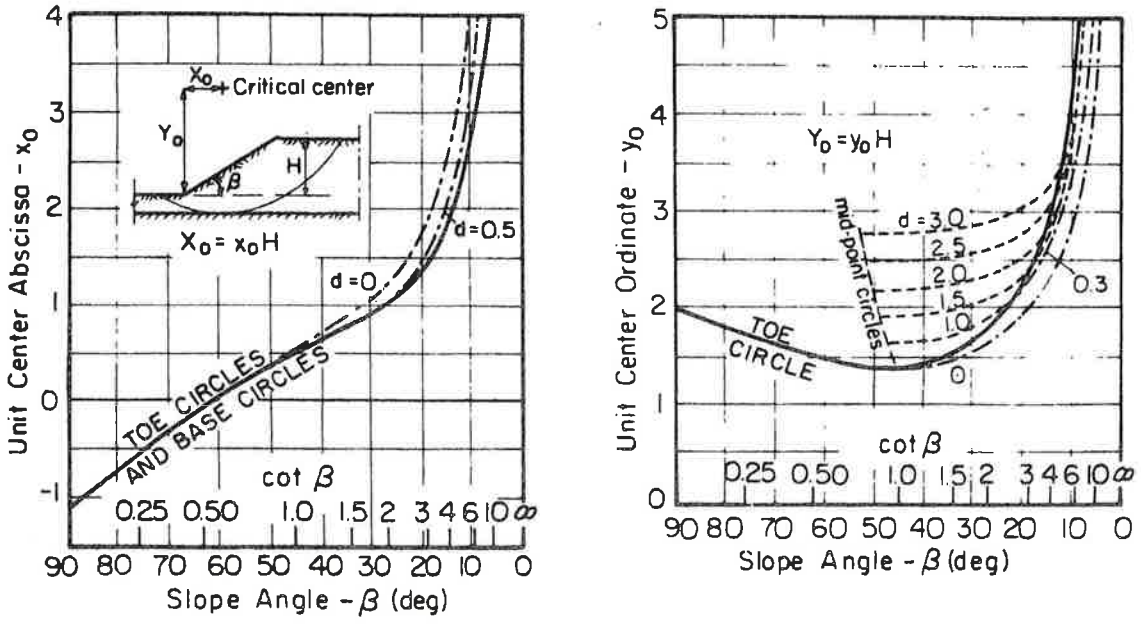
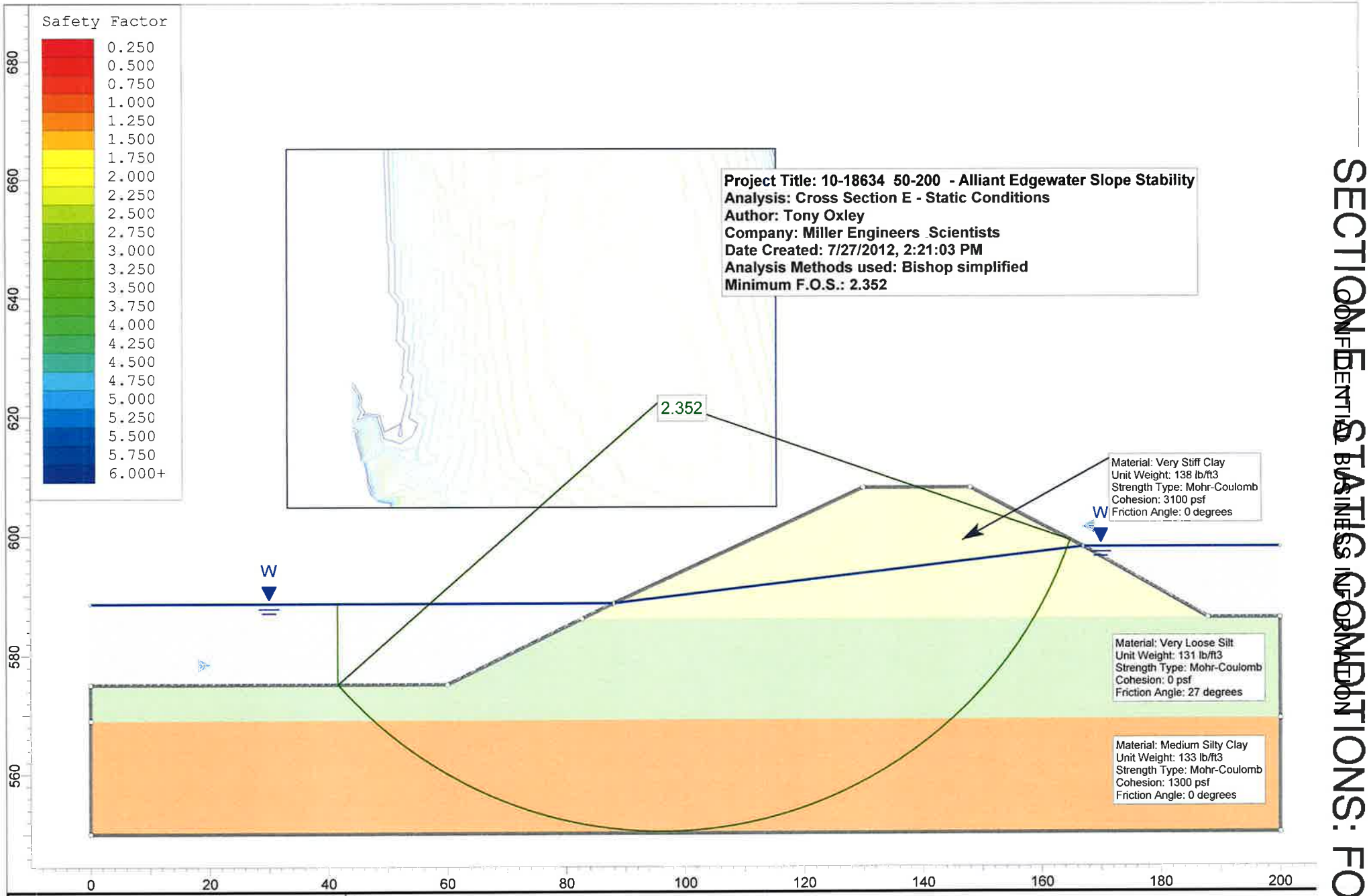


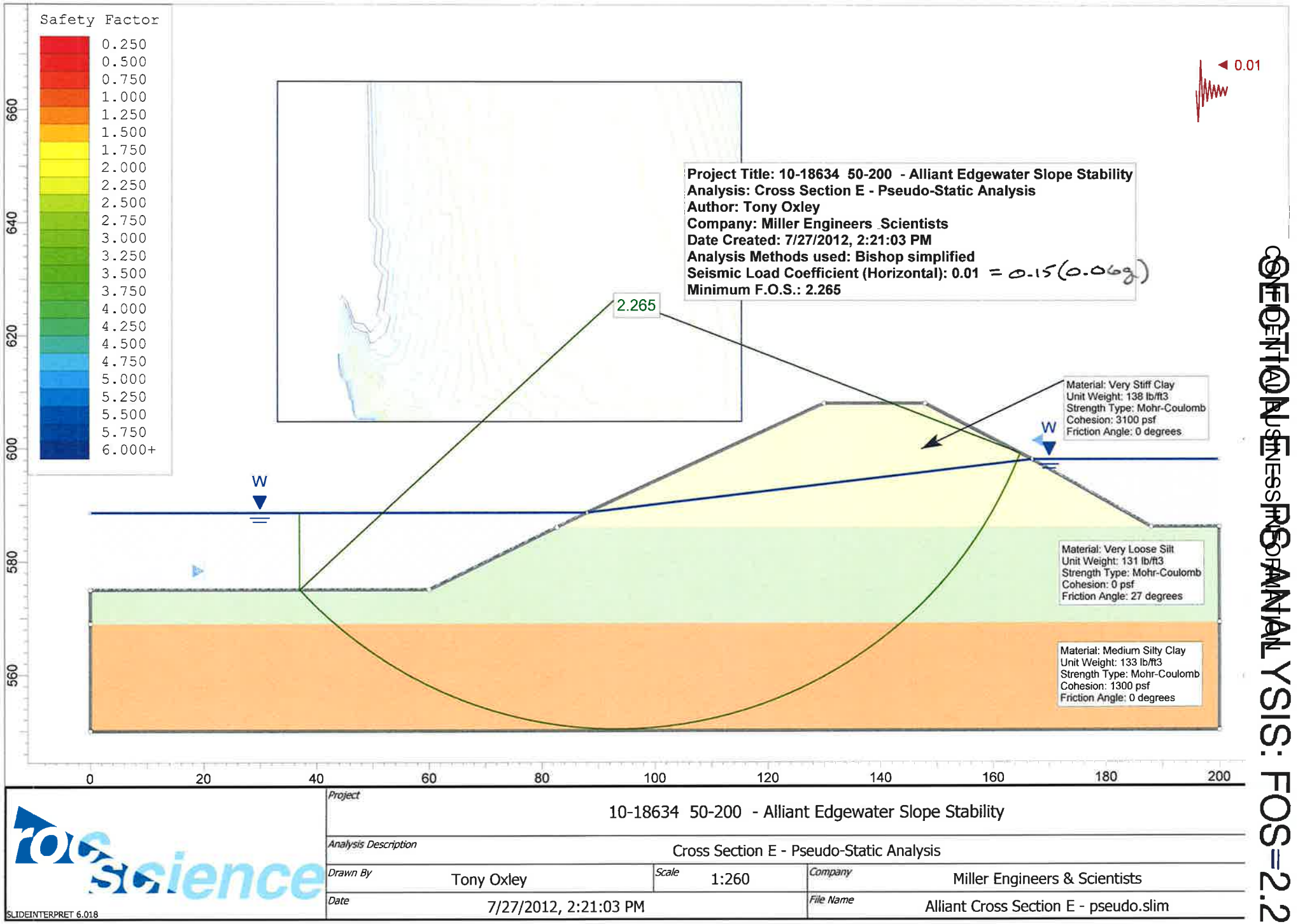
Fig. 6 SLOPE STABILITY CHARTS FOR $\phi = 0$ SOILS. (after Janbu, 1968)



rocscience	Project	10-18634 50-200 - Alliant Edgewater Slope Stability		
	Analysis Description	Cross Section E - Static Conditions		
	Drawn By	Tony Oxley	Scale 1:260	Company Miller Engineers & Scientists
	Date	7/27/2012, 2:21:03 PM		File Name Alliant Cross Section E.slim

SLIDEINTERPRET 6.018

SECTION E STATIC CONDITIONS: FOS=2.35



rocscience	Project	10-18634 50-200 - Alliant Edgewater Slope Stability		
	Analysis Description	Cross Section E - Pseudo-Static Analysis		
	Drawn By	Tony Oxley	Scale 1:260	Company Miller Engineers & Scientists
	Date	7/27/2012, 2:21:03 PM		File Name Alliant Cross Section E - pseudo.slim

SLIDEINTERPRET 6.018

CONFIDENTIAL BUSINESS INFORMATION

SLOPE/W ANALYSIS: FOS=2.27

Selection of Seismic Coefficients for Use in Pseudo-Static Slope Stability Analyses

by Robert Pyke, Consulting Engineer, Lafayette CA bobpyke@tagasoft.com.

Analyses of seismic slope stability problems using limit equilibrium methods in which the inertia forces due to earthquake shaking are represented by a constant horizontal force (equal to the weight of the potential sliding mass multiplied by a coefficient) are commonly referred to as pseudo-static analyses. They are relatively simple to perform but involve many approximations. They should not be used at all when the materials involved might undergo a significant loss of strength under earthquake shaking and should always be used with caution. The most common mistake made in using such analyses does not in fact yield unconservative results, but rather the opposite. This mistake consists of using the expected peak horizontal acceleration as the seismic coefficient. In the absence of a dramatic loss of strength, this must yield excessively conservative results since the peak acceleration acts only momentarily in one direction. However, if it is overly conservative to use the expected peak acceleration, what value should be used and can it be related to the peak acceleration?

In recent years a basic point of reference has been the U.S. Army Corps of Engineers manual for seismic design of new dams (which are generally considered to be among the more critical civil engineering facilities). This requires use of a seismic coefficient of 0.1 in Seismic Zone 3 and 0.15 in Seismic Zone 4, in conjunction with a minimum factor of safety of 1.0. In California, many state and local agencies also require the use of a seismic coefficient of 0.15 but impose the slightly more conservative requirement that the minimum computed factor of safety be not less than 1.1. Clearly, however, engineering judgement must still be applied as to the applicability of pseudo-static analyses and the acceptable factor of safety might be varied with the uncertainties involved in a particular analysis.

Further, it is now possible to make an approximate but rational connection between the seismic coefficient that is used in a pseudo-static stability analysis and the expected amplitudes and duration of ground motion by working backwards through the method for computing displacements of slopes that was originally suggested by Newmark (1965). This approach was first explored by Seed (1979) who drew the general conclusion that for embankments composed of materials which show no significant loss of strength as a result of cyclic loading, *"it is only necessary to perform a pseudo-static analysis for a seismic coefficient of 0.1 for magnitude 6.5 earthquakes or 0.15 for magnitude 8.25 earthquakes and obtain a factor of safety of the order of 1.15 to ensure that displacements will be acceptably small".*

While Seed simplified his conclusion to make it independent of the peak acceleration, the procedure that he suggested can be used to make more site specific evaluations of appropriate seismic coefficients by referring to Figure 1, which is based on the same study by Makdisi and Seed (1978) that Seed used in his 1979 lecture and paper.

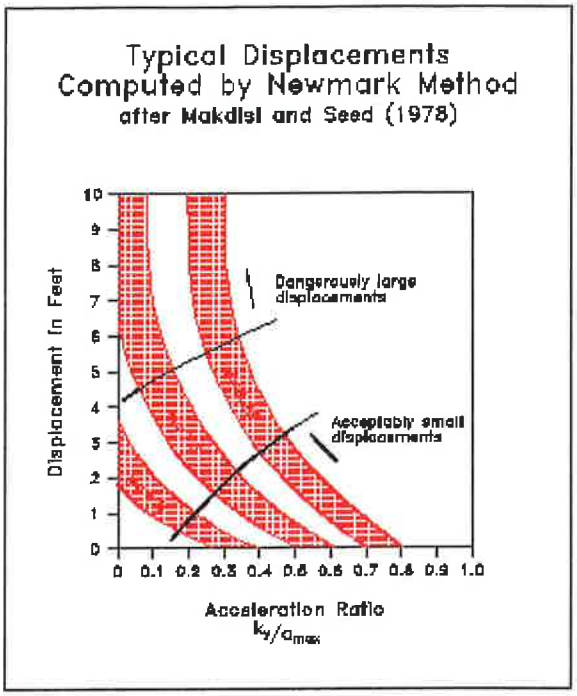


Figure 1

The figure shows displacements computed by the Newmark method (specifically for embankments ranging in height from 50 to 250 feet, but generally applicable to earth slopes with depths to bedrock in that order, and generally conservative for shallower depth to bedrock) as a function of the acceleration ratio, k_y/a_{max}, where k_y is the critical seismic coefficient (that is, the seismic coefficient that reduces the factor of safety to unity) and a_{max} is the expected peak acceleration. Ranges of the most likely displacements are indicated for magnitudes 6.5, 7.5, and 8.25 (magnitude being an indicator of duration of strong shaking) and likely displacements for intermediate magnitudes can be interpolated. The predicted displacements should necessarily be small for magnitudes less than about 6.5 since field experience indicates that smaller magnitude, shorter duration earthquakes do not usually cause significant slope failures. While there are a number of approximations made in the Newmark method and in the construction of Figure 1, if the acceleration ratio and magnitude are such that they fall below the line marked 'acceptably small displacements', the slope involved might generally be considered to be safe from failure. Thus, for a magnitude 8.25 earthquake, non-failure conditions are indicated if the critical seismic coefficient is at least equal to half the expected peak acceleration. Conversely, if a pseudo-static analysis using a seismic coefficient equal to one-half the peak acceleration yields a factor of safety greater than 1.0, the displacements are likely to be acceptably small. Similarly, for magnitude 7.5, 7.0, and 6.5, if the seismic coefficient is taken as one-third, one-forth and one-fifth of the expected peak acceleration, and the computed factor of safety is greater than 1.0, the displacements are likely to be acceptably small. The seismic coefficients obtained this way are shown as a function of peak acceleration and magnitude in Figure 2.

Selection of Seismic Coefficients for Use in Pseudo-Static Slope Stability Analyses

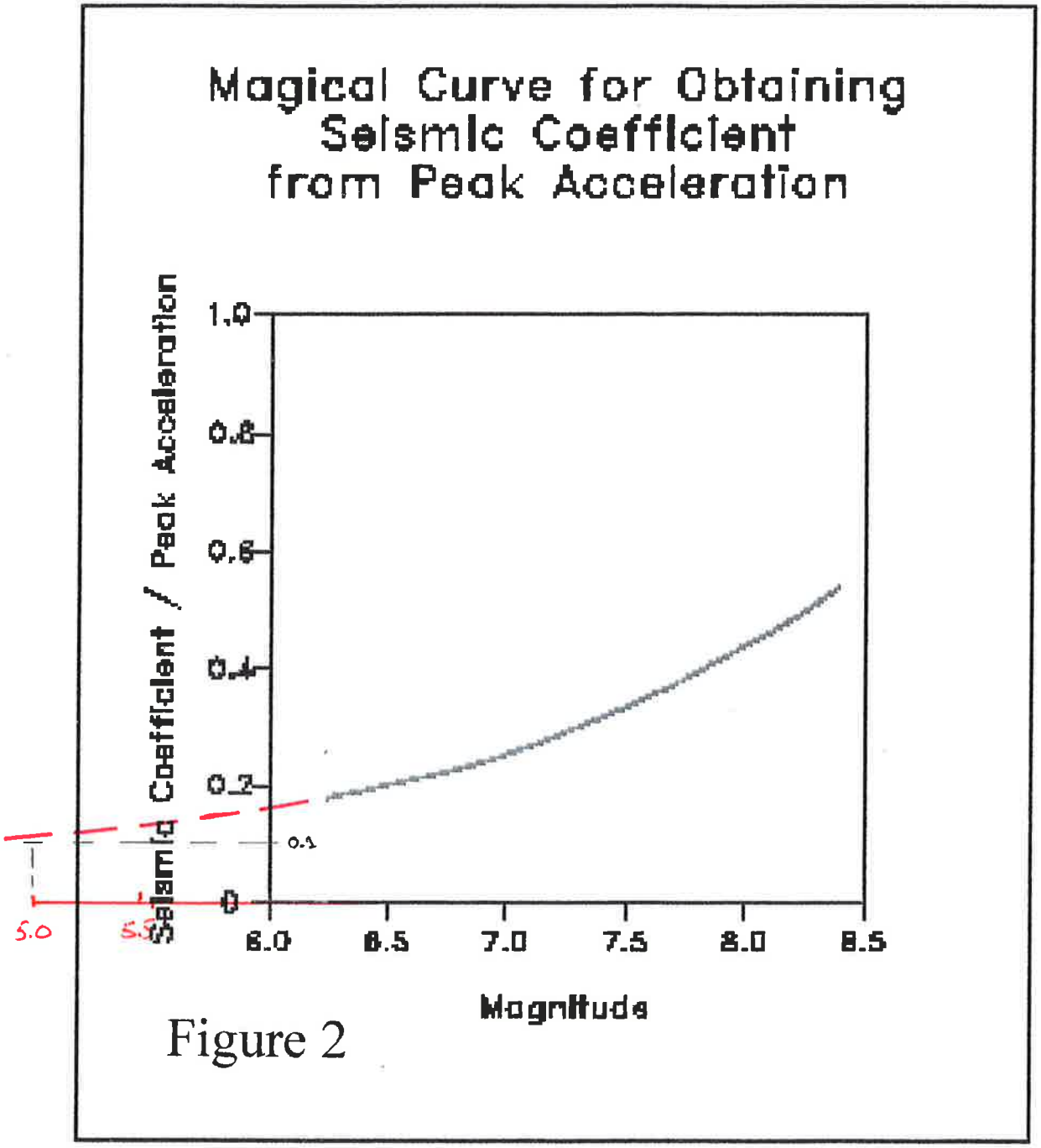


Figure 2

CONFIDENTIAL BUSINESS INFORMATION

WPL – Edgewater Generating Station

F- Pond Site Activity Pictures

Tree/Brush Removal Southern and Western Embankment

CONFIDENTIAL BUSINESS INFORMATION

WPL – Edgewater Generating Station

F- Pond Site Activity Pictures

Tree/Brush Removal on Eastern Embankment

NOTE: Fence Line is our property. Large trees removed right next to fence. Large trees were donated to a local conservation group for improving a local stream bank stabilization project.

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WPL – Edgewater Generating Station

A- Pond(s) Site Activity Pictures

Northern A Pond Tree Removal Activity

NOTE: Tree removal in process as of date of picture

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WPL – Edgewater Generating Station

A- Pond(s) Site Activity Pictures

Eastern embankment of A Ponds. Large trees removed from embankment along roadway. Interior embankment trees will be removed

WPL – Edgewater Generating Station

A- Pond(s) Site Activity Pictures

Tree removal on interior embankment separating Northern and Southern A Ponds

WPL – Edgewater Generating Station

A- Pond(s) Site Activity Pictures

Tree removal on eastern embankment on B Pond.