MINUTES OF THE WARNER RANCH
COMMITTEE MEETING OF
VISTA IRRIGATION DISTRICT

August 4, 2010

A meeting of the Warner Ranch Committee of Vista Irrigation District was held on Wednesday, August 4, 2010, at the offices of the District, 1391 Engineer Street, Vista, California.

1. CALL TO ORDER

Chair Williams called the meeting to order at 11:18 a.m.

2. ROLL CALL

Committee members present: Williams and MacKenzie.

Committee members absent: None.

Staff present: General Manager, Roy Coox; Director of Water Resources, Don Smith; and Secretary of the Board, Lisa Soto. Also present was General Counsel Joel Kuperberg.

3. APPROVAL OF AGENDA

The Committee approved the agenda as presented.

4. PUBLIC COMMENT TIME

No public comments were presented on items not appearing on the agenda.

5. CLOSED SESSION WITH REAL PROPERTY NEGOTIATORS

Chair Williams adjourned the meeting to closed session at 11:18 a.m. for a conference with real property negotiators per Government Code section 54956.8, to discuss the following:

A. License and Lease Renewal for Navy Remote Training Facility
   a. Property: Approx. 4,300 acres at Warner Ranch, adjacent to State Highway 79 in northern San Diego County
   b. VID Negotiators: Roy Coox, Don Smith
   c. Negotiating Parties: United States Department of the Navy
   d. Under Negotiation: Price and Terms

B. Warner Ranch Hunting License
   a. Property: Portions of approx. 44,000 acres at Warner Ranch, in northern San Diego County
   b. VID Negotiators: Roy Coox, Don Smith
   c. Negotiating Parties: Lake Henshaw Resort, Inc.
   d. Under Negotiation: Price and Terms

The meeting reconvened in open session at 12:15 p.m. Chair Williams declared that no reportable action had been taken.

6. INDEPENDENT CONSULTANT SERVICES FOR HENSHAW DAM

See staff report attached hereto.

Director of Water Resources Don Smith stated that since this item was brought before the Warner Ranch Committee in June 2010, staff wanted to update the Committee on its status. Mr. Smith said that after reviewing carefully the four proposals for an Independent Consultant for Henshaw Dam, staff recommends engaging Mr. R. Craig Findlay of Findlay Engineering, Inc. Mr. Smith said that this firm, which is a one-man operation, is well known and respected, and should easily be approved by FERC. Mr. Smith said that once FERC approves of VID's nomination of Findlay Engineering, Inc. for the work, a contract would be executed. Mr. Smith added that since the contract will be within the General Manager's approval authority, staff did not plan to take this item to the Board for approval.

The Committee noted and filed this informational report.

7. ADJOURNMENT

There being no further business to come before the Committee, Chair Williams adjourned the meeting at 12:20 p.m.

Howard S. Williams, Chair

ATTEST:

Lisa R. Soto, Secretary
Board of Directors
VISTA IRRIGATION DISTRICT

VISTA IRRIGATION DISTRICT

WARNER RANCH COMMITTEE

STAFF REPORT

Agenda Item: 6

Meeting Date:	**August 4, 2010**
Prepared By:	**Don A. Smith**
Approved By:	**Eldon Boone**

SUBJECT: INDEPENDENT CONSULTANT SERVICES FOR HENSHAW DAM

RECOMMENDATION: Receive update from staff regarding the status of the District's nomination of an Independent Consultant for Henshaw Dam.

PRIOR BOARD ACTION: None. The Warner Ranch Committee received an informational update on this item on June 9, 2010.

FISCAL IMPACT: $35,000 estimate for basic services plus $10,000 allowance for as needed services.

SUMMARY: Based on the quality of the proposals received, the experience of the Independent Consultant proposed, and the fee estimate provided by the proposing firm, the District has selected R. Craig Findlay of Findlay Engineering, Inc. as its next Independent Consultant for Henshaw Dam, subject to approval by FERC.

DETAILED REPORT: As reported on June 9, 2010, pursuant to direction issued by the Federal Energy Regulatory Commission (FERC), the District sent a Request for Proposal for Independent Consultant Services for Henshaw Dam to six firms selected on the basis of their qualifications and recommendations. For various reasons two of those firms elected not to submit a proposal. The firms and their proposed fee for services are listed below:

Firm	Proposed Fee
AMEC Geomatrix, Inc.	$ 154,672
Black & Veatch	$ 45,770
Findlay Engineering, Inc.	$ 35,000
GEI Consultants	$ 167,264
HDR|DTA	No Proposal
MWH Global, Inc.	No Proposal

The District has nominated Mr. Craig Findlay as our next Independent Consultant for Henshaw Dam to FERC, as indicated in the attached letter. Upon approval by FERC, the District will execute a professional services agreement with Findlay Engineering, Inc. As the fee for this agreement falls within the approval authority of the General Manager, staff does not propose to take this agreement to the Board for approval.

ATTACHMENTS:

District Letter to FERC, July 28, 2010, Nominating R. Craig Findlay as Independent Consultant

VISTA IRRIGATION DISTRICT

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July 28, 2010

Mr. Wing Lee
Acting Regional Engineer
Federal Energy Regulatory Commission
Division of Dam Safety - San Francisco Regional Office
901 Market Street, Suite 350
San Francisco, CA 94103

Subject: **Nomination of Independent Consultant**
Henshaw Dam, FERC Project No. 176-CA

Dear Mr. Lee:

The Vista Irrigation District hereby nominates Mr. R. Craig Findlay, PE, GE, as our next Independent Consultant for Henshaw Dam. Upon your approval of this nomination, the District proposes to retain his services to comply with FERC's direction provided in your letter of February 5, 2010 and to prepare the Fifth Part 12D Independent Consultant Safety Inspection Report.

Your letter of February 5, 2010 included the requirement that the Independent Consultant we nominated for the Fifth Part 12D inspection "must have expertise in the area of seismic analysis of earth embankments." We have attached Mr. Findlay's resume for your reference, and note that his extensive experience in this area appears to satisfy this requirement.

Please inform us of your disposition regarding this nomination at your earliest convenience. You may contact me (dsmith@vid-h2o.org or 760-597-3168) if you have any questions regarding this matter.

Very truly yours,

Don A. Smith
Director of Water Resources

Attachment: Resume for R. Craig Findlay, Findlay Engineering Inc.

cc: Sam Lee, FERC
Roy Coox, VID
Angela Morrow, VID
Craig Findlay, FEI

R Craig Findlay, Ph.D., P.E., G.E.

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Web Page: www.findlayengineering.com

FINDLAY ENGINEERING INC.
GEOTECHNICAL AND WATER RESOURCES ENGINEERING

70 OLD FIELD ROAD, YARMOUTH, ME 04096

Education

- B.S., Civil Engineering, 1976, University of New Hampshire
- M.S., Civil Engineering, 1981, University of New Hampshire
- Ph.D., Engineering, 1991, University of New Hampshire

Professional Licensing/Registration

- Professional Civil Engineer: Alabama, California, Georgia, Idaho, Maine, Montana, New Hampshire, New York, Vermont and Washington
- Professional Geotechnical Engineer: California

Professional Affiliations

- Member, American Society of Civil Engineers
- Member, United States Society for Dams (USSD)
- Member, Association of Dams Safety Officials (ASDSO)
- Affiliate Member Advisory Committee, Association of State Dam Safety Officials (ASDSO)
- Editorial Board, Dam Safety Journal (ASDSO)
- Past Member, Subcommittee on Guidelines, Interagency Committee on Dam Safety (ICODS).
- Past Member, ASCE Task Committee on Guidelines for Instrumentation and Measurements for Monitoring Dam Performance.

Employment History

1998 to Present:	Independent Consultant and Principal, Findlay Engineering, Inc.
1991 to 1998:	Director of Geotechnical Engineering, Duke Engineering & Services, Inc. (formerly Northrop, Devine & Tarbell, Inc.)
1990 to 1991:	Manager of Geotechnical, Civil and Solid Waste Engineering, ABB- Environmental Services (during completion of Ph.D. Dissertation)
1988 to 1991:	Principal Engineer, Findlay Geotechnical Consulting, Inc. (geotechnical engineering consultant during Ph.D. research)
1981 to 1988:	Senior Geotechnical Engineer, E. C. Jordan Company and Jordan Gorrill Associates, Inc.
1977 to 1981:	Assistant Roadway Foundation Engineer, New Hampshire Department of Transportation

Summary of Experience

Dr. Findlay's 33 years in the dam safety, water resources and geotechnical engineering profession includes a broad variety of consulting and project engineering experience, more that 28 years of which have included involvement with dams and hydroelectric projects. He has served as technical lead or lead geotechnical engineer on hundreds of dam related projects. Dr. Findlay has worked on several hydroelectric greenfield design and remediation projects which have given him broad experience with water resources projects including earth dam and embankment design and instrumentation; powerhouse, spillway and headworks foundations; stability, liquefaction and deformation analysis; seepage and piping assessments; finite element analysis of stresses in embankments, gravity dams, arch dams and radial gates; finite element analysis of earthquake response of embankments, gravity dams, and arch dams; unlined canal design; water retaining structure remediations; cement-bentonite cutoffs and slurry walls; grouting; anchor design; and dam safety inspections. Dr. Findlay has been a FERC approved Independent Consultant on almost 250 Part 12 Inspections and/or served as a Potential Failure Modes Analysis Facilitator for clients including AER-NY Gen, LLC, Alabama Power, Algonquin Power, American Electric Power, Avista Corporation, Brookfield Power, California Department of Water Resources, Central Nebraska PPID, City of Danville Virginia, Duke Power, Entergy, Florida Power & Light, Georgia Power, Henwood Energy Services, Inc., Idaho Power Company, Louisiana Hydroelectric, Manitoba Hydro, Niagara Mohawk Power Corporation, Northern Lights, Inc., PacifiCorp, Pacific Gas & Electric Company, PowerSouth, Reliant Energy, Southern California Edison Company, and Synergics Energy Services. He has also conducted numerous dam structural stability analyses for gravity, embankment and/or arch dams for many of the above clients, as well as Central Vermont Public Service, Progress Energy, and EGE Fortuna, SA in Panama. A listing of those projects as well as other non-FERC dam safety inspections is included at the end of this resume. Craig has presented and/or published several technical papers on seismic analysis of dams and rehabilitation, dam seepage, dam remediation, dam stability, reservoir erosion and in situ soil property measurement for technical societies including USCOLD, ASDSO, ASCE, the Canadian Geotechnical Society, American Society of Testing and Materials (ASTM) and the Transportation Research Board. These papers are listed at the end of this resume.

SAMPLING OF RELEVANT PROJECT EXPERIENCE

Swinging Bridge Dam **-** Dr. Findlay was the Part 12 Independent Consultant for the 2009 Part 12 Inspection of Swinging Bridge Dam, which underwent a high profile rehabilitation for development of a large sinkhole just upstream of the crest in 2005. Dr. Findlay participated in the post-remediation PFMA and prepared the PFMA Report. The PFMA was conducted concurrent with the final Board of Consultants Meeting for the rehabilitation.

Saluda Dam Part 12 Inspection **-** Dr. Findlay assisted on the first (2010) Part 12 Inspection of Saluda Dam following its high profile seismic rehabilitation. Dr. Findlay was responsible for geotechnical and instrumentation review of the project. The dam is a semi-hydraulic fill structure located in Columbia, SC, and underwent construction of a downstream secondary dam in the mid 2000's as part of a seismic rehabilitation.

Army Corps of Engineers, Independent External Peer Review Panel - During 2010, Dr. Findlay was selected to participate in the independent external peer review panel to review the East Branch Dam, Elk County Pennsylvania Dam Safety Modification Study for the USACE Flood Risk Management Planning Center of Expertise as a subcontractor to Battelle. He was one of three panel members of a multidiscipline team for this work.

Mammoth Pool Dam Fragility Analysis **-** Southern California Edison Company is embarking on a risk assessment program of their portfolio of dams. In support of that effort, Dr. Findlay is currently conducting a detailed seismic stability "fragility" analysis of the 400 foot high Mammoth Pool zoned embankment dam located on the Sam Joaquin River, about 50 miles northeast of Fresno California. A fragility analysis is an analysis that focuses on a potential failure mode of the dam, and investigates the resulting factor of safety under various levels of loading probability of recurrence. Review of the available project data and boring logs indicated that liquefaction was not anticipated to be an issue at the dam., leaving the potential seismic deformation as the key question to be investigated. For seismic loading, return periods of 1000, 2500, 5000 and 10000 years were considered. Seismic time histories (horizontal and vertical) were selected by another consultant for each of these return periods, along with appropriate scaling factors. With 24 sets of time histories for each return period, and four different distance/magnitude models, on the order of almost 100 analysis runs are required. Due to the very high number of time histories that must be considered, an approach to analysis that streamlines the data handling problems was critical. Because of their seemless integration, the GeoStudio (GeoSlope Inc, Alberta Canada) suite of computer programs (SEEPW, SIGMAW, QUAKEW, and SLOPEW is being used. These programs conduct a seepage and initial stress finite element analysis, an equivalent linear finite element response analysis (similar to QUAD4M), and a double integrated Newmark analysis. The work is to be completed in 2009.

Diversion Dam Seismic Issues, Beaver River, Niagara Mohawk Power Corporation **–** From 1997 through 2002, Dr. Findlay was a consultant to Erie Boulevard Hydroelectric, LP (now Brascan and formerly Niagara Mohawk Power Corporation) regarding seismic stability issues and assessment of the need for and approaches for remediation of Diversion Dam. The dam is an 80-foot high hydraulic fill structure, which is part of the Beaver River Project, located in New York State. Work included a major field investigation program using energy calibrated standard penetration testing on both the upstream (barge) and downstream slopes of the dam. The field investigation was conducted in the summer of 1998 to assess the relative density of a construction cofferdam observed on the upstream side of the dam in old 1924 construction photographs. The borings were also conducted using carefully controlled methods, in accordance with the published recommendations of Seed and others. The drilling procedure including prevention of the development of unbalanced hydrostatic head on the sample zone during drilling rod removal. The controlled drilling methods facilitated measurement of standard penetration test blow count values which were improved over those from previous field investigations made at the site. Because of the sensitivity of the field work, Dr. Findlay spent a significant amount of time in the field overseeing the drilling procedures and energy calibration of the SPT test equipment. The field work is the subject of a paper that Dr. Findlay co-authored and presented at the 1999 USCOLD Annual Lecture in Atlanta. Following the field work, an extensive seismic stability analysis was carried out by Dr. Findlay on the existing dam and later on the designed remediation cross section. Seismic analysis included liquefaction analysis, post-earthquake, and deformation analysis components of three separate cross sections of the dam. For the liquefaction analysis, seepage analysis (SEEP/W), static finite element analysis (SIGMA/W), dynamic response finite element (QUAD4M), and liquefaction triggering analyses (spreadsheet based) were conducted. Post-earthquake residual strengths and strengths reduced by seismically induced pore pressures were assessed and

post-earthquake slope stability analyses were conducted. Finally, QUAD4M acceleration time histories for selected potential sliding blocks were double integrated (Newmark-type deformation analysis method) to determine potential movement of the dam during seismic shaking. The analyses of existing conditions indicated a need to improve seismic stability. Dr. Findlay was involved in developing a remedial approach, which consisted of a foundation drainage system and downstream seismic berm. The work was conducted under review of the FERC and their consultant's A. J. Hendron and I.M. Idriss. Rehabilitation of the dam included construction of a downstream stability berm and toe drainage system, and was completed in the fall of 2002. This project is the subject of papers co-authored and presented by Dr. Findlay at the 2003 USSD and Waterpower Conferences. A paper summarizing the work was also published in the summer 2004 issue of the Journal of Dam Safety.

Post-Earthquake Analysis, West Embankment, Sinclair Dam, Georgia Power Company– *Between* 2003 through 2007, Dr. Findlay conducted a detailed seismic analysis of the 90 foot high West Embankment of Sinclair Dam, located on the Oconee River, near Milledgeville, Georgia, and assisted in addressing follow-on questions and analyses requested by the FERC. The dam has lower upstream core sections consisting of semi-hydraulic fill, and exhibited in old construction photographs (circa 1920s) and as determined by low SPT "N" values measured in test borings. The FERC has requested several dam owners in the southeast to re-evaluate the seismic stability of their semi-hydraulic fill dams, based on potentially loose conditions that could exist and the proximity of some of the dams to the 1886 Charleston, S.C earthquake epicenter. Georgia Power retained Dr. Findlay to conduct the seismic assessment. The assessment included assessing liquefaction potential based on SPT "N"-values, assessment of post-earthquake residual strength, and post-earthquake and seismic deformation analysis. The post-earthquake analysis was conducted using the program UTEXAS4, which required extensive review and assessment of drained and undrained triaxial test data to develop strength parameters for the two-step Lowe and Karafiath type undrained strength approach incorporated into the program. The analysis indicated adequate seismic stability. Deformation was computed using the Makdisi-Seed approach, and indicated that seismic deformation under the maximum credible earthquake would be tolerable. The analyses have been accepted by the FERC in 2007, and no rehabilitation of the West Embankment has been required.

Abbott Brook Dike Seismic Stability Assessment and Rehabilitation, Skelton Project, Florida Power & Light – Dr Findlay conducted an assessment of post-earthquake stability and deformation analysis for this 700 foot long, 40 foot high hydraulic fill dam located in Northern Maine. The analysis was based on SPT blow counts and the methods of Seed and Idriss, recently updated as summarized by Youd and Idriss. It was determined that the downstream lower core of the structure potentially susceptible to liquefaction, and the downstream slope had minimum computed factors of safety less than would be desirable, under the maximum credible earthquake loading event. As an additional complicating factor, the foundation soils for the dam (glacial till interlayered with sand) contained artesian pressure in excess of the ground surface at the toe of the dam. As a result, rehabilitation has been proposed, consisting of toe drainage and a stability berm to improve the post-earthquake stability of the dam as well as mitigating the potential of heave at the toe of the embankment. The rehabilitation scheme is currently under review of the FERC, and final design (to be completed by Dr. Findlay) and construction is anticipated in 2008-2009.

Review of Embankment Instrumentation, Relief Wells, and Seismic Stability, Skelton Project, Florida Power & Light – Dr. Findlay is providing ongoing assistance to Florida Power & Light (FPL Energy Maine Hydro LLC) regarding the instrumentation and monitoring of a relief well system for its 75 foot high Skelton Embankment on the Saco River in Southern Maine. The dam is founded above a confined sand deposit which has experienced increasing artesian pressure since construction in the 1940's. Initial work included re-assessment of stability with regard to heave at the toe as well as general slope stability. Work has included a historic review of construction and maintenance records, review of historic monitoring data, slope stability analysis, post-earthquake analysis and planning and observing a program of video inspection and redevelopment of the existing system of 15 relief wells. Rehabilitation has included re-screening structurally deficient well screens, and design and installation of two new 80 foot deep, 12-inch diameter permanent pumped relief wells. A network of 50-year old metal standpipe piezometers was replaced with vibrating wire piezometers (in part, to prevent winter freezing/artesian water level problems) that are monitored from centralized locations. The rehabilitation and improvements have decreased confined foundation pressures well within acceptable levels. At the request of the FERC, FPL has had to review the seismic stability of the project. Dr. Findlay is conducted that assessment, including liquefaction triggering, post-earthquake, and deformation analyses of the embankment dam. He also analyzed the post-earthquake stability of the gravity

structure, including the post earthquake adequacy of the spillway piers if damaged by the MCE event.

Chittenden Dam Detailed Slope, Gravity and Seismic Stability Analyses – Central Vermont Public Service - In 2006, Dr. Findlay updated stability analyses on selected interpretive cross sections of Chittenden Dam. The dam is located in central Vermont, about eight miles northwest of the city of Rutland at the head of East Creek. The analyses included consideration of the west (main) embankment cross section, an east embankment cross section, and a concrete spillway section founded over a portion of the embankment dam. The cases of normal full pool loading, flood loading, normal plus seismic, and rapid drawdown were analyzed. The embankment slope stability analyses were conducted using the program SLOPE/W, licensed by FEI from GEOSLOPE International, Calgary Alberta, Canada. The analysis was completed using the Spencer Method. Analyses of the concrete gravity ogee spillway were made using the two-dimensional gravity analysis method, and the normal, PMF and post-earthquake loading cases were considered. The tailwater elevation at the spillway is an important consideration with regard to assessing uplift under the concrete gravity spillway. No previous analysis of the PMF tailwater elevation has been made for the project. For this analysis, a simple HECRAS model of the spillway discharge using the inline spillway feature of HECRAS. Three cross sections upstream of the spillway were developed to model the reservoir and three cross sections downstream of the dam were developed to model tailwater conditions. The upstream boundary condition of the model was a constant head elevation of the reservoir, and the downstream boundary condition (900 feet downstream of the spillway) was critical flow depth. The steady state model used downstream cross sections developed from interpretation of USGS topographic mapping, and the available near-dam project topography. The analyses found the structures were adequately stable under all considered loading conditions.

Upper and Middle Dam Remedial Measures, Androscoggin River Drainage, FPL Energy-Maine Hydro LLC – From 2005 through 2008, Dr. Findlay was responsible for the geotechnical aspects of the remediation of the embankments for Upper and Middle Dams located in the Western Mountains of Maine. This work was under review of the Federal Energy Regulatory Commission (FERC). The dams are owned and operated by FPL Energy and regulated by the FERC. The embankments were constructed in the early 1900's and in recent years were identified to have seepage, artesian pressure and slope stability problems that the FERC had directed the owner to remediate. The FERC had also directed the owner to assess if the embankments had any seismic stability/liquefaction issues. Dr. Findlay planned an extensive geotechnical investigations conducted by Findlay Engineering, Inc. to assess subsurface conditions for planning the remediations. Engineering evaluation included assessment of existing slope stability, seismic and liquefaction stability, and design analyses of several potential remedial approaches. The subsurface investigations determined that sections of the embankments are founded on pervious alluvial soils underlain by relatively impervious, dense glacial till. The pervious alluvial soils were assessed to be responsible for the artesian conditions identified at the toe of the embankments in at least one locations. To remediate the embankments, a 500 foot long sheet pile cutoff wall was installed at one embankment, and a downstream filter berm is planned at the other. The sheet pile approach was used where the alluvial layer was at a low elevation, to avoid the need to have a prolonged drawdown of the storage reservoir retained by the embankment or expensive dewatering measures which would otherwise been needed for other remediation approaches which would have required excavation of the downstream toe or slope. At other locations where the alluvial soils are at a higher elevation and would only be a problem with regard to embankment stability during extreme flood scenarios, a filter berm will be constructed. At present, the sheet pile cutoff has been completed, and design of the other remedial measures is underway.

Slope and Seismic Stability Analyses, Lake Robinson Dam, Lake Robinson Nuclear Station, Progress Energy - Dr Findlay conducted slope and seismic stability assessments of the embankment dam retaining Lake Robinson, which is adjacent to Robinson Nuclear Plant near Hartsville, S.C. The earth dam about 4,300 feet long and up to 50 feet in height. The dam and power plant are owned and operated by Progress Energy of Raleigh, NC. The analyses were prepared as required by the Nuclear Regulatory Commission (NRC) for inclusion in the plant's Facility Description and Safety Report on file with the NRC. The potential for foundation liquefaction needed to be assessed and embankment deformation was to be assessed using a Newmark approach. The original analysis details could not be found, and the analysis was required to be redone. Dr. Findlay reviewed available subsurface investigation information, soil profiles, geology reports and construction specifications to develop properties for use in the analyses and to characterize the appropriate seismicity of the project locations. The slope and seismic stability analysis was conducted using the Programs SEEP/W and SLOPE/W, which were developed by GeoSlope International, of Calgary, Alberta, Canada. Since phreatic surface conditions at the embankments are not known by the analyst, a finite element seepage analysis using SEEP/W was conducted

to define the steady state phreatic surface through the embankment, based on assumed hydraulic conductivity values. The results of the seepage analysis were then imported into the slope stability analysis program (SLOPE/W), and slope stability analyses, using the Spencer Method were conducted. The analyses found the embankment had adequate stability under all considered loading cases, that foundation liquefaction was not anticipated under the regional seismicity (as indicated by standard penetration test results), and that embankment deformation would be minimal under the operating basis earthquake.

Silver Lake and Sugar Hill Dams, Central Vermont Public Service – In 2006, Dr. Findlay served as an owner's representative for review of a field investigation and stability assessment for the two dams which are owned and operated by Central Vermont Public Service. The analyses and field work were conducted by another consultant retained by the owner. The field investigation encountered relatively loose, saturated soils under the upstream slope of one of the dams, triggering a more detailed assessment of liquefaction and potential seismic deformation under a maximum credible seismic event. Dr. Findlay reviewed and commented on the analyses performed by the other consultant and participated in discussions between the owner and the Federal Energy Regulatory Commission as a technical expert.

Seepage and Slope Stability Analysis of Vermilion Dam, Southern California Edison – Vermilion Dam is a 165 foot high, 4,234 foot long zoned embankment dam located at about elevation 7,650 feet in the Sierra Nevada Mountains of California. The dam is founded on a complex soil foundation of glacial moraine and interbedded alluvial materials. Seepage is controlled by numerous drainage systems, some of which were originally designed under the review of Dr. Karl Terzaghi. One of the key monitoring piezometers for a section of Vermilion Dam had elevated readings that were above the phreatic surface assumed in previous slope stability analyses, bringing the minimum computed factor of safety for slope stability into question. The previous analyses used a phreatic surface model consisting of a single phreatic surface. However, the piezometers at the dam are nested in sets of three piezometers each at various depths. Threshold values for each of the piezometers had not been established, and using phreatic surface assumptions of the previous slope stability analyses would not properly account for the flownet-like distribution of phreatic conditions actually indicated by the piezometer readings. Because the foundation layer was relatively thick, it was postulated that the single phreatic surface assumption of the previous analyses was overly conservative with regard to slope stability compared to the flownet-like conditions that actually exist. Dr. Findlay used the program SEEP/W to model the seepage through and within the foundation below the dam, calibrated using the piezometer readings. The resulting seepage model was then imported into the slope stability program SLOPE/W, and slope stability analysis was conducted. The dam was found to be adequately stable even with the elevated piezometer water level observed. An additional important aspect of the finite element seepage analysis and associated slope stability analyses conducted by Dr. Findlay was that they allowed a rational approach to developing threshold piezometer readings for the several sets of nested piezometers at the dam, satisfying requirements for the Performance Monitoring Plan for the dam.

Annual Inspections (2001 through 2006) and Seismic Stability Assessment, Fortuna Dam, EGE Fortuna SA – Dr. Findlay has conducted several annual inspections and analysis reviews of Fortuna Dam, as mandated by the government of Panama (the next scheduled for February, 2005). The project is located near David Panama, adjacent to the Costa Rican border which is a relatively active seismic area. The project was completed in 1994 and includes a 341 foot high concrete face rockfill dam, over 10 kilometers of tunnels and an underground powerhouse. The project has a total generation capacity of 300 MW, and provides about 40 percent of the generation capacity of the country. The project included slope stability, post-earthquake slope stability and seismic deformation analyses that were conducted by Dr. Findlay, using simplified approaches as a first cut. Stability of the dam was found to be adequate.

Post-Earthquake Analysis, Lundy Lake and Vermilion Dams, Southern California Edison – In 1999 and 2004, respectively, Dr. Findlay conducted post-earthquake analyses of these two dams for Southern California Edison. The analysis approach included the assumption of liquefaction of suspected relatively looser zones of the embankment cross sections, assessment of appropriate post-earthquake residual strength values, and post-earthquake slope stability analysis using the program SLOPEW. The embankments were found to be adequately stable with regarding the loading under the maximum credible earthquake.

Post-Earthquake Analysis, Gulf Island Dam, Florida Power & Light – Dr. Findlay conducted post-earthquake analyses of this dam for FPL Energy Maine Hydro, LCC at their Gulf Island Project located on the Androscoggin River, in Lewiston, Maine. The analysis approach included the assumption of liquefaction of suspected relatively looser zones of the embankment cross sections, assessment of appropriate post-earthquake residual

strength values, and post-earthquake slope stability analysis using the program SLOPE/W. The embankment was found to be adequately stable with regarding the loading under the maximum credible earthquake.

Supplemental Seismic and Flood Analyses of Tioga Lake Dams, Southern California - In 2004, Dr. Findlay conducted slope stability analysis of the timber crib rockfill dam and small concrete arch dam at Tioga Lake, located in Tioga Pass, California. The slope stability analysis was conducted using the program SLOPE/W, and the arch analysis was conducted using SAP2000 NL, using a response spectrum approach. Both dams were found to be adequately stable to resist the maximum credible earthquake loading case.

FERC Part 12 Dam Safety Inspection and Slope Stability Analysis, Oswegatchie Project, Orion Power – Dr. Findlay conducted the 2000 Part 12 inspection of the Oswegatchie Project on the Oswegatchie River in upstate New York. The project includes four developments, including concrete gravity dams and earthen and concrete saddle dikes and sections. Follow up work conducted in 2002 included slope stability analysis of a previously unanalyzed embankment structure. The program SLOPE/W was used. The analysis considered the normal, pseudostatic and flood cases.

Soil Founded Ambersun Dam Stability and Seepage FEM Analysis, Sugar River Dam 1, Sugar River, Newport, NH – In 1999, Dr Findlay conducted a gravity analysis of a concrete Ambursen structure founded on alluvial soil. The analysis included finite element flow net analysis (using SEEP/W) to assess uplift on the base of the structure, HECRAS analysis to develop a tailwater curve (calibrated from flood observations), and a finite element stress analysis of the stability of the face slab under flood and seismic loading. The latter analysis was conducted by Dr. Findlay using the finite element program SAP2000NL. The gravity analyses of several intermediary flood cases were conducted to find out the critical loading condition for the dam. An intermediate flood case (significantly less than the PMF) was found to be the critical loading case, and the dam was found to be adequately stable for all loading cases.

Penstock Replacement Geotechnical Issues and Slope Stability Analyses, Schaghticoke Project, Hoosic River, New York, Niagara Mohawk Power Corporation – Dr. Findlay was retained by Orion Power – NY (and formerly Niagara Mohawk Power Company) to serve as their liaison and peer reviewer of the geotechnical aspects for the design and replacement of the aging 1,100 foot long penstock. The penstock ruptured during the spring of 1998 under full hydrostatic load. The penstock traverses a pipe bridge across the Hoosic River, and steep slopes which have had historic slope stability problems. To complicate geotechnical issues, a confined zone of artesian pressure was identified by Niagara Mohawk under the penstock alignment, which is being considered in the review of slope stability. Work conducted by FEI includes independent laboratory testing and review of significant subsurface investigations by both the designer and Niagara Mohawk, independent detailed slope stability analysis conducted with SLOPE/W, participating in weekly design review meetings, and detailed review and comment on the design criteria, drawings and specifications. The work was summarized in a paper presented by Dr. Findlay at the 2000 ASDSO conference in Providence, Rhode Island and published in the conference proceedings.

Big Creek Dam 4, Dam 5 and Dam 6 Abutment Rock Slope Stability Analyses, Big Creek, California, Southern California Edison Co. - The Federal Energy Regulatory Commission was concerned with the abutment slope stability of these 50 and 75 foot high concrete arch dams supported by exfoliated granite abutments. To address this issue, FEI completed a detailed analysis of the stability of the granite abutments of Big Creek Dams 4 and 5. The developments are part of Southern California Edison's historic Big Creek Project located in the Sierra Nevada Mountains of California. Dr. Findlay first mapped the bedrock features of both abutments, involving access by technical climbing. The mapping identified the critical blocks of the exfoliating granite for analysis, as well as the strikes and dips of the joints defining the blocks. Joint roughness was estimated by measuring the asperities of an exposed surface of the potential sliding plane of the most critical block. The analyses were made using the sliding block approach as outlined by Hoek and Bray as well as by using a spreadsheet coding of the two plane wedge (with tension crack) approach, also outlined by Hoek and Bray. The analyses found the abutments to be stable under normal gravity and seismic loading (0.15g) and PMF flooding, except on the left abutment of Dam 4. At that abutment, a large block was found to be marginally unstable if the tension crack was surcharged with water (such as might occur under PMF overtopping during an extreme flood). A recommendation is that the vertical and near vertical joints defining the left abutment block of dam 4 be dry pack grouted to mitigate surcharging with water. The project was the subject of a paper presented at the 2000 ASDSO Annual Conference and in a recent ASDSO (winter 2000-2001) news letter article.

Slope Stability Analyses and FERC Part 12 Dam Safety Inspections, Upper Raquette River Project, New York, Niagara Mohawk Power Corporation – In 1998, Dr.

Findlay was the Independent Consultant for conducting the FERC Part 12 Inspections for the Upper Raquette River Project which includes five developments and a mix of concrete gravity dams and earthfill dikes up to about 70 feet in height. The inspection identified that the numerous dike structures on the project had only undergone pseudo-static analysis considering a seismic coefficient of 0.05g. Since the projects are located in FERC Seismic Zone 2, a minimum seismic coefficient of 0.1g should have been considered. FEI re-analyzed the seismic stability of the most critical dike (based on the previous analyses) of each of the five developments of the project. The dikes were found to be adequately stable under the required design loading.

Dam Safety Inspection, Murphy Dam Project, Connecticut River, New Hampshire Department of Environmental Services - Water Resources Council – In 1998, Dr. Findlay was the Project Manager, Lead Dam Inspector, and Lead Geotechnical Engineer for a detailed review of the condition of this 100 foot high zoned earthfill dam in northern New Hampshire. The project consists of a review of project seismicity since two Magnitude 5 earthquakes have occurred within about 10 kilometers of the dam within the past 35 years. In addition, work included installation of monitoring piezometers, assessment of liquefaction potential, a review and update of the structural stability of the dam and spillway, review and update of the PMF, a dam break analysis and preparation of inundation mapping for preparation of an Emergency Action Plan, and preparation of a list and cost estimate of capital improvements anticipated to be necessary to maintain the facility into the future.

Buzzard's Roost Project, Dam Safety Inspection, Saluda River, South Carolina, Duke Power Company – In 1993, Dr. Findlay participated in the FERC Part 12 on-site inspection and prepared the summary report for Duke Power Company's Buzzards Roost Project. The project is located on the Saluda River, near Chappels, South Carolina. The project consists of a 2,400-foot-long, 80-foot-high earth embankment, a 200-foot-long fuse plug, and an 80-foot-high gated spillway/ogee, and integrated intake and 15 MW powerhouse. As a follow up to the 5-year inspection, Dr. Findlay provided a peer review of a liquefaction analysis conducted by Duke Power as ordered by the FERC. The analysis is on the 80-foot earth embankment which is founded on alluvial sands.

Lake Blackshear Dam, Dam Breach Repair, Flint River, Georgia, Crisp County Power Commission - During July 1994, Tropical Storm Alberto released torrential rains which caused overtopping of the 3,400-foot-long north embankment of Lake Blackshear Dam, causing a breach about 650 feet in length. Dr. Findlay was retained by the Crisp County Power Commission to provide geotechnical engineering services to investigate subsurface conditions, design a repair of the breached section, and assess the integrity of the intact portion of the northern embankment. The subsurface investigation program consisting of 15 borings. Because the dam is founded on alluvial sands which are loose at some locations, liquefaction analysis was conducted using the approach developed by Seed, et al. A 2-dimensional transient finite element seepage model was used to assess the cause of boils observed during the flood at locations of the dam that remained intact. As a result of the investigation, a cutoff wall consisting of a cement-bentonite slurry was constructed using slurry trench methods along the axis of the entire northern embankment. The cutoff was determined to be necessary to remediate potential seepage damage to the intact portions of the dam and to mitigate the potential for future piping through the alluvial sands below the breached section. The project included close coordination with the Federal Energy Regulatory Commission and the Federal Emergency Management Agency. The geotechnical aspects of the project were the subject of papers presented by Dr. Findlay at Waterpower '95 in San Francisco in July 1995, the Association of State Dam Safety Officials Annual Convention in Atlanta in September 1995, and the Maine Section of ASCE in March 1996.

Graham Lake Dam, Graham Lake Dam Remedial Measures Project, Union River, Maine, Bangor Hydro-Electric Company – In 1992, Dr. Findlay was the lead geotechnical engineer for the Graham Lake Dam Remedial Measures Project, undertaken to improve dam stability and spillway capacity. Stability analysis and liquefaction analysis indicated the dam had deficient downstream slope stability, and the upstream slope was susceptible to liquefaction. This project consisted of building a new flood control structure just downstream of an existing semi-hydraulic fill dam in Ellsworth, Maine for Bangor Hydro-Electric Company. One aspect of involvement included design of a deep well dewatering system to intercept seepage through the existing dam which served as the upstream cofferdam for the work. This design included three-dimensional groundwater flow modeling using the USGS program MODFLOW to assess the effectiveness and number of wells needed to accomplish dewatering. After installation of the wells, pumping tests were conducted and the results incorporated into the model to verify expected performance. In addition to the dewatering aspects of the project, the existing dam was founded on soft clay, making excavation for the new flood control structure a potentially risky situation. Dr. Findlay developed an innovative excavation stabilization system

which consisted of a cellular-constructed granular stabilization berm which was significantly reduced costs over an originally proposed tie-back wall system. The project was completed in the spring of 1994, and was the subject of technical papers presented by Dr. Findlay at the 1993 ASCE Specialty Conference on Dam Rehabilitation in Raleigh, North Carolina, and the 1994 Association of State Dam Safety Officials (ASDSO) Annual Convention in Boston, Massachusetts, and the 1996 ASDSO Annual Convention in Seattle, Washington.

Pontook Hydroelectric Project, New Hydroelectric Development, Androscoggin River, New Hampshire, Combustion Engineering – In the early 1980s, Dr. Findlay was the lead geotechnical engineer for development of a new hydroelectric project under contract to Combustion Engineering. The project included geotechnical investigation, design, and construction consultation for a new 11.4 MW hydroelectric facility on the Androscoggin River in mountainous northern New Hampshire. Included was design and construction of a 6,000-foot unlined canal in glacial till to transport water to a new powerhouse. The canal construction involved full cut sections up to 70 feet in depth, as well as hill side embankment sections up to 30 feet in height. Excavation for the canal and the powerhouse involved deep well depressurization of artesian layers within the till to mitigate excavation instability. Unlined canal design included assessment of ability of the glacial till to self-armor to limit channel erosion. A 700-foot-long timber crib dam with a shear key to increase sliding stability was constructed across the Androscoggin River, downstream of the canal intake, to raise river levels sufficiently for power production. The project was selected by the Consulting Engineers of Maine to receive the "Award for Engineering Excellence" in January of 1988 and was the subject of a technical paper authored by Dr. Findlay for the 1988 Second International Conference on Case Histories in Geotechnical Engineering, sponsored by the University of Missouri Rolla, St. Louis, Missouri.

Baldwin Hydroelectric Project, New Hydroelectric Development, Connecticut River, New Hampshire, Baldwin Hydro Corporation – in 1991, Dr. Findlay was the Project manager and lead geotechnical engineer in the development and design of a 4.4 MW hydroelectric facility on the Connecticut River in Pittsburg, New Hampshire. The project includes construction of a 170-foot-wide concrete gravity dam, canal headworks, a 4,600-foot-long unlined canal requiring excavation up to 50 feet deep, a penstock intake, and 450-foot-long penstock, a powerhouse and tailrace. It was determined that construction of the powerhouse would require deep dewatering using drilled gravel packed wells to depressurize a confined aquifer to allow excavation up to 50 feet in depth. The project has not yet been constructed.

Hydro-Kennebec Project, Increased Headpond Level, Kennebec River, Maine, Scott Paper Company – In 1987, Dr. Findlay was the lead geotechnical engineer for assessment of several miles of shoreline which were to be impacted by raising the normal water elevation of the existing dam at Scott Paper Company's (now Kimberly Clark) Winslow, Maine paper making facility. This increase in dam height resulted in a substantial increase in the impoundment elevation, affecting the shoreline at several industrial and residential areas. Assessment was made in two phases; a preliminary phase to evaluate the impact at individual locations based on observation, and a follow-up phase which included subsurface investigation and additional assessment at critically impacted areas. The assessment resulted in delineation of areas and recommended methods for slope stabilization. Work included development of contract plans and specifications for implementation of the recommendations. Involvement included consultation and monitoring services through construction.

Keowee Hydroelectric Project, Finite Element Seepage Analysis, Keowee River, South Carolina, Duke Power Company – In 1994, Dr. Findlay developed a finite element model and preliminary input parameters for seepage analysis of an 80-foot-high intake dike for the Keowee Hydroelectric Project/Oconee Nuclear Project in Oconee County, South Carolina. The dike is for the intake of the nuclear project, and is also a water retaining structure for Duke's Keowee Hydroelectric Project. Work included setting up and debugging the model so that Duke Power could use the model for a parametric study of the effect of varying hydraulic conductivity on seepage. The program SEEP/W (Geoslope International) was used to develop the model.

Drawdown Effects on Bank Stability – In 1993, a confidential client was interested in determining how the nominal 2-foot-daily drawdown at one of their reservoirs might safely be interpreted to mitigate reservoir bank stability. For example, if a one-foot rise followed by a three-foot draft in 24 hours could be interpreted as a "net" 2-foot-daily drawdown, some optimization of reservoir operation could be realized, provided such operation did not exacerbate bank erosion. Reservoir fluctuations can impact bank stability if the groundwater does not immediately equilibrate with reservoir level changes. In other words, the greater the lag time of groundwater response, the greater impact on slope stability of the reservoir banks. As a result, the study planned and conducted by Dr. Findlay included field samples and testing, laboratory testing, and groundwater

modeling of the response of the water table in the reservoir banks to various reservoir fluctuation scenarios at three selected critical sites. Field work included in situ permeability testing. The USGS groundwater flow model MODFLOW was used to assess groundwater response to fluctuations. The resulting groundwater information was then used to analyze impacts on slope stability. Slope stability analysis was completed using the program STABRD (developed at the University of California at Berkeley) to compute the effects of the groundwater lag on slope stability. Preliminary results of the study indicate the "net" interpretation will have no significant impact on bank stability up to incremental level changes of 4 feet.

Brassua Hydroelectric Project, Expert Witness for Piping Failure, Rockwood, Maine - Dr. Findlay was retained in 1990 as an expert witness for the contractor during post-construction litigation of a piping failure which developed during construction. The piping developed underneath an existing concrete gravity dam founded on glacial till. Dr. Findlay thoroughly reviewed the project design and construction documentation and provided a deposition during the discovery period. The litigating parties decided to attempt mediation to settle the case. Dr. Findlay made a technical presentation for a mediation hearing on the mechanics of piping and a review of the chronology of events leading to the piping failure.

Technical Publications and Presentations

Findlay, R.C., Knarr, Michael, Hawkins, P.G., Yen, John, (2010), **"Fragility Analysis of Mammoth Pool Dam"**, a paper accepted to be presented at the 2010 ASDSO Annual Convention, Seattle, WA, September.

Findlay, R.C., (2009), **"Fragility Analysis of Mammoth Pool Dam, Status Report"**, Presented at the 2009 Western Regional Dam Safety Forum, Sponsored by the FERC, Pacific Gas & Electric, and Southern California Edison, San Francisco, California.

Findlay, R.C., Hawkins, P.G., Yen, John, (2008), **"Use of a Net Instead of a Line when Fishing for Threshold Values for Deviant Piezometers"**, Presented at and Published in the Proceedings of the Association of State Dam Safety Officials Annual Convention, in Indian Wells, California.

Findlay, R.C., Pelletier, Michael A., (2006), "**Rehabilitation to Reduce Piping Potential in the Skelton Dam Artesian Pressure Drainage System**", Presented at and Published in the Proceedings of the Association of State Dam Safety Officials Annual Convention, in Boston, Massachusetts.

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Rabasca, S.J., and Findlay, R.C. (2003) "**Seismic and Seepage Remediation of Diversion Dam**", Presented at the USSD Annual Lecture, Charleston, South Carolina.

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Findlay, R. C., and Millikan, D.L., (2000), "**Arch Dam Abutment Stability at Big Creek Dam 4**", ASDSO Newsletter, Nov./Dec. 2000, Vol.16, No.6.

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the Association of State Dam Safety Officials Annual Convention, Seattle, Washington.

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Findlay, R.C., Northrop, J., Crisp, R., and Rentfrow, S. (1995), "**Repair of Lake Blackshear Dam**", Proceedings of the Association of State Dam Safety Officials Annual Convention, Atlanta, Georgia.

Findlay, R.C., Northrop, J., Crisp, R., and Rentfrow, S. (1995), "**Effects of the Georgia Flood of 1994 on Lake Blackshear Dam**," Proceedings of Waterpower '95, ASCE Conference, San Francisco, California.

Findlay, R.C., Tarbell, J., and Carrington, G., (1995), "Beaver River Project Shoreline Erosion Study," published in **Sediment Management and Erosion Control**, the proceedings of the 1995 USCOLD Annual Meeting and Lecture, San Francisco, California.

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SELECTED DAM INSPECTION EXPERIENCE
DR. R. CRAIG FINDLAY, P.E., G.E.

									DAM TYPE																
PROJECT/DEVELOPMENT	CLIENT	REGULATORY AGENCY	RIVER / CREEK / STREAM	Number of Times Conducted	Part 12 Indepencent Consultant	PFMA Independent Consultant	PFMA Facilitator	State	Number of Dams	Homogeneous Embankment	Zoned Embankment	Hydraulic Fill	Zoned Rockfill	Concrete Faced Earthfill	Concrete Faced Rockfill	Concrete Gravity	Stone Masonry or Timber Crib	Timber Faced Rockfill	RCC or RCC Capped Earthfill	Slab and Buttress	Multiple Arch	Concrete Arch	Height (feet)
Oroville Dam Pumped Storage	California Department of Water Resources	FERC	Feather R	1	X			CA	3		X					X							770
Mammoth Pool Dam	Southern California Edison Company	FERC	San Joaquin R	3	X	X		CA	1		X												411
Pyramid Dam	California Department of Water Resources	FERC	--	1	X			CA	1		X												386
Jocassee Pumped Storage	Duke Power	FERC	Keowee R	2	X	X		SC	1	X						X							385
Bad Creek Pumped Storage	Duke Power	FERC	Keowee R	3	X	X		SC	3				X										367
Fortuna Dam	EGE Fortuna SA	REP. OF PANAMA	Chiriqui R	6				_	1						X								341
Salt Spring Dam	Pacific Gas & Electric Company	FERC	Mokelumne R	1	X			CA	1						X								332
Lewis Smith Dam	Alabama Power	FERC	Black Warrior R	2	X	X		AL	1				X										300
Wyman Dam	Florida Power & Light	FERC	Kennebec R	1	X	X		ME	1		X					X							280
Brownlee Dam	Idaho Power Company	FERC	Snake R	1	X			ID	1				X										277
Noxon Rapids Dam	Avista Corporation	FERC	Clark Fork R	1	X	X		MT	1		X					X							260
Lower Bear River Dams	Pacific Gas & Electric Company	FERC	Bear R	1	X			CA	2						X								253
Big Creek Dam 7	Southern California Edison Company	FERC	San Joaquin R	3	X	X		CA	1							X							250
Smith Mountain Pumped Storage	American Electric Power	FERC	Roanoke R	1			X	VA	2							X						X	237
Cedar Springs Dam	California Department of Water Resources	FERC	--	1	X			CA	1		X												236
McCloud Dam	Pacific Gas & Electric Company	FERC	McCloud R	1	X			CA	1		X												235

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									Number of Dams	Homogeneous Embankment	Zoned Embankment	Hydraulic Fill	Zoned Rockfill	Concrete Faced Earthfill	Concrete Faced Rockfill	Concrete Gravity	Stone Masonry or Timber Crib	Timber Faced Rockfill	RCC or RCC Capped Earthfill	Slab and Buttress	Multiple Arch	Concrete Arch	
Del Valle Dam	California Department of Water Resources	CA DSOD / DWR	CA Aqueduct	1				CA	1				X										235
Pit 7 Dam	Pacific Gas & Electric Company	FERC	Pit R	2	X			CA	1							X							228
Bear Creek Dam	Duke Power	FERC	Tuckasegee R	1	X		X	NC	1				X										215
Iron Canyon Dam	Pacific Gas & Electric Company	FERC	Iron Canyon C	1	X			CA	1		X												214
Long Lake Dam	Avista Corporation	FERC	Spokane R.	2	X	X		WA	2							X						X	213
Hells Canyon	Idaho Power Company	FERC	Snake R	1	X			ID	1							X							213
Saluda Dam	SCE&G	FERC	Saluda R	1	X			SC	1			X				X			X				211
Cabinet Gorge Dam	Avista Corporation	FERC	Clark Fork R	1	X	X		ID	1							X						X	208
Shaver Lake Dam	Southern California Edison Company	FERC	Stevenson C	3	X	X		CA	1							X							185
Pit 6 Dam	Pacific Gas & Electric Company	FERC	Pit R	2	X			CA	1							X							183
Castaic Project	California Department of Water Resources	FERC	--	1	X			CA	1		X												179
Wolf Creek Dam	Duke Power	FERC	Tuckasegee R	1	X		X	NC	1				X										175
Martin Dam	Alabama Power	FERC	Tallapoosa R	2	X	X		AL	1							X						X	175
Harris Dam	Florida Power & Light	FERC	Kennebec R	1	X			ME	1							X							175
Iron Gate Dam	PacifiCorp	FERC	Klamath R	1	X			CA	1		X												173
Cedar Cliff Dam	Duke Power	FERC	Tuckasegee R	1	X		X	NC	1				X										173

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Huntington Dam 1	Southern California Edison Company	FERC	Big Creek	3	X	X		CA	1							X							170
Bouldin Dam	Alabama Power	FERC	Coosa River	1	X	X		AL	1		X					X							170
Vermilion Dam	Southern California Edison Company	Annual Inspection Board	Mono C	7				CA	1		X												165
Vermilion Dam	Southern California Edison Company	FERC	Mono C	3	X	X		CA	1		X												165
Huntington Dam 3	Southern California Edison Company	FERC	Big Creek	3	X	X		CA	1							X							165
Kingsley Dam	Central Nebraska PPID	FERC	N. Platte R	1			X	NE	1			X											163
Keowee Project	Duke Power	FERC	Keowee R	3	X	X		SC	4	X													160
Tugalo Dam	Georgia Power Company	FERC	Tugalo R	1	X	X		GA	1							X							155
Big Creek Dam 6	Southern California Edison Company	FERC	San Joaquin R	3	X	X		CA	1													X	155
Harris Dam	Alabama Power	FERC	Tallapoosa R	1	X			AL	1		X					X							152
Bartletts Ferry Dam	Georgia Power Company	FERC	Chattahoochie R	2	X	X		GA	1		X					X							150
Florence Lake Dam	Southern California Edison Company	FERC	San Joaquin R	3	X	X		CA	1												X		149
Talbot	City of Danville, Va	FERC	Dan R	2			X	VA	1													X	143.5
Thermalito Diversion Dam	California Department of Water Resources	FERC	Feather R	1	X			CA	1		X					X							143
Main Strawberry Dam	Pacific Gas & Electric Company	FERC	Stanislaus R	1	X			CA	1						X								143
Relief Dam	Pacific Gas & Electric Company	FERC	Stanislaus R	1	X			CA	1						X								141

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East Fork Dam	Duke Power	FERC	Tuckasegee R	1	X		X	NC	1				X										140
Bliss Project	Idaho Power Company	FERC	Snake R	1	X			ID	1							X							140
Piney Dam	Brookfield Power	FERC	Clarion R	1	X	X		PA	1							X						X	139
Claytor Dam	American Electric Power	FERC	New River	1	X	X		VA	1							X							139
Swinging Bridge Dam	AER NY Gen	FERC	Mongaup R	1	X	X		NY	1	X						X							135
Townes Dam	City of Danville, Va	FERC	Dan R	2	X		X	VA	1													X	133
Lyons Dam	Pacific Gas & Electric Company	FERC	Stanislaus R	1	X			CA	1													X	132
Tuxedo Project	Duke Power	STATE OF NC	Green R	2				NC	2	X												X	130
Cowans Ford Dam	Duke Power	FERC	Catawba R	2	X	X		NC	2	X						X							130
Wateree Dam	Duke Power	FERC	Catawba R	1	X	X		SC	1	X						X							129
Tallulah Dam	Georgia Power Company	FERC	Tallulah R	1	X	X		GA	1													X	129
Wallace Dam Pumped Storage	Georgia Power Company	FERC	Oconee R	1	X		X	GA	1	X						X							127
Jordan Dam	Alabama Power	FERC	Coosa River	1	X			AL	1							X							125
Tabeaud Dam	Pacific Gas & Electric Company	FERC	Jackson C	1	X			CA	1	X													123
Burton Dam	Georgia Power Company	FERC	Tallulah R	1	X	X		GA	1							X							123
Balsam Meadow Pumped Storage	Southern California Edison Company	FERC	Balsam C	3	X	X		CA	1						X								123

SELECTED DAM INSPECTION EXPERIENCE
DR. R. CRAIG FINDLAY, P.E., G.E.

PROJECT/DEVELOPMENT	CLIENT	REGULATORY AGENCY	RIVER / CREEK / STREAM	Number of Times Conducted	Part 12 Indepencent Consultant	PFMA Independent Consultant	PFMA Facilitator	State	DAM TYPE															Height (feet)
									Number of Dams	Homogeneous Embankment	Zoned Embankment	Hydraulic Fill	Zoned Rockfill	Concrete Faced Earthfill	Concrete Faced Rockfill	Concrete Gravity	Stone Masonry or Timber Crib	Timber Faced Rockfill	RCC or RCC Capped Earthfill	Slab and Buttress	Multiple Arch	Concrete Arch	
Oxford	Duke Power	FERC	Catawba R	1	X	X		NC	1							X							122
Tiger Afterbay Dam	Pacific Gas & Electric Company	FERC	Mokelumne R	1	X			CA	1													X	120
Oxbow Dam	Idaho Power Company	FERC	Snake R	1	X			ID	1				X										120
Huntington Dam 2	Southern California Edison Company	FERC	Big Creek	3	X	X		CA	1							X							120
Holt Lock & PH	Alabama Power	FERC	Black Warrior R	1	X	X		AL	1							X							120
Bridgewater	Duke Power	FERC	Catawba R	1	X	X		NC	3	X						X							120
Beaver River Project	Brookfield Power	FERC	Beaver R	3	X	X		NY	5	X		X				X							120
Rocky Creek/Cedar Creek Dam	Duke Power	FERC	Catawba R	1	X	X		SC	1							X							117
Mathis Dam	Georgia Power Company	FERC	Tallulah R	1	X	X		GA	1	X						X				X			115
Lay Dam	Alabama Power	FERC	Coosa River	1	X	X		AL	1		X					X							115
Copco 1 Dam	PacifiCorp	FERC	Klamath R	1	X			CA	1													X	115
C. J. Strike Dam	Idaho Power Company	FERC	Snake R	1	X			ID	1		X												115
Great Falls/Dearborn Dev.	Duke Power	FERC	Catawba R	2	X	X		SC	3							X							113
Pit 3 Dam	Pacific Gas & Electric Company	FERC	Pit R	1	X			CA	1							X							112
Bankhead Lock & PH	Alabama Power	FERC	Black Warrior R	1	X	X		AL	1							X							111
Tiger Regulator Dam	Pacific Gas & Electric Company	FERC	Tiger C	1	X			CA	1											X			110

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PROJECT/DEVELOPMENT	CLIENT	REGULATORY AGENCY	RIVER / CREEK / STREAM	Number of Times Conducted	Part 12 Indepencent Consultant	PFMA Independent Consultant	PFMA Facilitator	State	Number of Dams	Homogeneous Embankment	Zoned Embankment	Hydraulic Fill	Zoned Rockfill	Concrete Faced Earthfill	Concrete Faced Rockfill	Concrete Gravity	Stone Masonry or Timber Crib	Timber Faced Rockfill	RCC or RCC Capped Earthfill	Slab and Buttress	Multiple Arch	Concrete Arch	Height (feet)
Lower Salmon Falls Project	Idaho Power Company	FERC	Snake R	1	X			ID	1							X							110
Pit 4 Dam	Pacific Gas & Electric Company	FERC	Pit R	1	X			CA	1											X			108
Carpenter Dam	Entergy Arkansas, Inc.	FERC	Ouachita R	1			X	AR	1							X							108
Mitchell Dam	Alabama Power	FERC	Coosa River	1	X			AL	1							X							106
Sinclair Dam	Georgia Power Company	FERC	Oconee R	2	X	X		GA	1		X	X				X							104
Wylie	Duke Power	FERC	Catawba R	1	X	X		SC	1							X							103
Toronto Dam	AER NY Gen	FERC	Mongaup R	1				NY	1	X													103
Murphy Dam	NHDES-Water Division	STATE OF NH	Connecticut R	1				NH	1	X													100
Logan Martin Dam	Alabama Power	FERC	Coosa River	1	X			AL	1		X												100
Lloyd Shoals Dam	Georgia Power Company	FERC	Ocmulgee R	2	X	X		GA	1	X						X							100
Henry Dam	Alabama Power	FERC	Coosa River	1	X	X		AL	1		X					X							100
Buzzard Roost Dam	Duke Power	FERC	Saluda R	2	X			SC	2	X						X							100
Bethany Dam	California Department of Water Resources	CA DSOD / DWR	CA Aqueduct	1				CA	1	X													100
Gulf Island	Florida Power & Light	FERC	Androscoggin R	1	X		X	ME	1	X						X							99
Mountain Island Dam	Duke Power	FERC	Catawba R	2	X	X		NC	1	X						X							96
Thermalito Forebay Dam	California Department of Water Resources	FERC	Feather R	1	X			CA	1	X													91

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PROJECT/DEVELOPMENT	CLIENT	REGULATORY AGENCY	RIVER / CREEK / STREAM	Number of Times Conducted	Part 12 Indepencent Consultant	PFMA Independent Consultant	PFMA Facilitator	State	Number of Dams	Homogeneous Embankment	Zoned Embankment	Hydraulic Fill	Zoned Rockfill	Concrete Faced Earthfill	Concrete Faced Rockfill	Concrete Gravity	Stone Masonry or Timber Crib	Timber Faced Rockfill	RCC or RCC Capped Earthfill	Slab and Buttress	Multiple Arch	Concrete Arch	Height (feet)
Yonah Dam	Georgia Power Company	FERC	Tugalo R	1	X	X		GA	1							X							90
Weiss Dam	Alabama Power	FERC	Coosa River	1	X	X		AL	1	X	X					X							90
Hawks Nest Dam	Brookfield Power	FERC	New River	1	X	X		WV	1							X							90
Yates Dam	Alabama Power	FERC	Tallapoosa R	1	X	X		AL	1							X							88
Lookout Shoals Dam	Duke Power	FERC	Catawba R	1	X	X		NC	1	X						X							88
Thurlow Dam	Alabama Power	FERC	Tallapoosa R	1	X	X		AL	1							X							85
Gem Lake Dam	Southern California Edison Company	FERC	Rush C	3	X	X		CA	1												X		84
Upper Bear River Dam	Pacific Gas & Electric Company	FERC	Bear R	1	X			CA	1						X								82
Rainbow Dam	Brookfield Power	FERC	Raquette R	3	X	X		NY	1	X						X							82
Hillside Dam	Southern California Edison Company	FERC	Bishop C	3	X	X		CA	1									X					81
Blake	Brookfield Power	FERC	Raquette R	3	X	X		NY	1	X						X							80
Post Falls HED	Avista Corporation	FERC	Spokane R.	2	X	X		ID	4							X							77
Carrys Falls Project	Brookfield Power	FERC	Raquette R	3	X	X		NY	1	X						X							76
Skelton Project	Florida Power & Light	FERC	Saco River	2	X	X		ME	1							X							75
Nacoochee Dam	Georgia Power Company	FERC	Tallulah R	1	X	X		GA	1							X							75
Big Creek Dam 4	Southern California Edison Company	FERC	Big Creek	3	X	X		CA	1													X	75

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Aziscohos Project	Florida Power & Light	FERC	Abbot B	2	X	X		ME	2	X		X				X				X			75
Pit 5 Open Conduit Dam	Pacific Gas & Electric Company	FERC	Sugar Pine C	1	X			CA	1		X												71
Supply Canal	Central Nebraska PPID	FERC	N. Platte R	1			X	NE	2	X						X							70
Sabrina Dam	Southern California Edison Company	FERC	Bishop C	3	X	X		CA	I									X					70
Rhodhiss Dam	Duke Power	FERC	Catawba R	2	X	X		NC	1	X						X							70
Flat Rock Dam	Brookfield Power	FERC	Oswegatchie R	2	X	X		NY	1							X							70
Browns Falls Dam	Brookfield Power	FERC	Oswegatchie R	2	X	X		NY	1							X							69
Nine Mile HED	Avista Corporation	FERC	Spokane R.	2	X	X		WA	1							X							68
JC Boyle Dam	PacifiCorp	FERC	Klamath R	1	X			OR	1	X						X							68
Murphys Forebay Dams	Utica Power Authority	FERC	Angels C	1	X			CA	2	X													67
Portal Forebay	Southern California Edison Company	FERC	Camp 61 C	3	X	X		CA	1	X													65
Ninety-Nine Islands Dam	Duke Power	FERC	Broad R	1	X	X		SC	1	X						X							62
Grigg Falls Dam	Algonquin Power	FERC	Piscataquog R	1			X	NH	1	X						X							62
Gaston Shoals	Duke Power	FERC	Broad R	1	X	X		NC	1							X							62
Silver Lake Project	CVPS	FERC	Sucker Brook	1	X	X		VT	3	X						X							61
Remmel Dam	Entergy Arkansas, Inc.	FERC	Ouachita R	1			X	AR	1											X			60

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Laurie 2	Manitoba Hydro, Manitoba Canada	Manitoba Hydro, Manitoba Canada	Laurie R	1	X		X	MB	3	X						X							60
Big Creek Dam 5	Southern California Edison Company	FERC	Big Creek	3	X	X		CA	1													X	60
Hunters Dam	Utica Power Authority	FERC	Mill C	1	X			CA	1							X						X	59
Bennetts Bridge Dam	Brookfield Power	FERC	Salmon R	1	X	X		NY	1	X						X							57
Morgan Fall Dam	Georgia Power Company	FERC	Chattahoochie R	2	X		X	GA	1							X							56
Lighthouse Hill Dam	Brookfield Power	FERC	Salmon R	1	X	X		NY	1	X						X							55
Five Falls Dam	Brookfield Power	FERC	Raquette R	2	X	X		NY	1	X						X							55
Grace Dam	Pacificorp	FERC	Bear R	1	X			ID	1							X	X						52
South Edwards Dam	Brookfield Power	FERC	Oswegatchie R	2	X	X		NY	1							X							51
North Battle Creek Dam	Pacific Gas & Electric Company	FERC	North Battle C	1	X			CA	1								X						51
Rush Meadow Dam	Southern California Edison Company	FERC	Rush C	3	X	X		CA	1						X							X	50
Newton Upper Falls Dam	Brookfield Power	FERC	Oswegatchie R	1	X	X		NY	1							X							50
Laurie 1	Manitoba Hydro, Manitoba Canada	Manitoba Hydro, Manitoba Canada	Laurie R	1	X		X	MB	1	X						X							50
Cliff Lake Dam	AER NY Gen	FERC	Mongaup R	1				NY	1	X						X							50
Burt Dam	Algonquin Power	FERC	18 Mile Creek	1	X	X		NY	1							X							50
Brassua Project	Florida Power & Light	FERC	Moose R	2	X	X		ME	1							X				X			50

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Borel Canal	Southern California Edison Company	FERC	Kern R	3	X	X		CA	1	X													50
Allens Falls Project	Brookfield Power	FERC	St. Regis R	2	X	X		NY	1							X				X			50
Lundy Lake Dam	Southern California Edison Company	FERC	Mill C	3	X	X		CA	1					X									48
Pit 1 Dam	Pacific Gas & Electric Company	FERC	Fall R	1	X			CA	1					X									46
Lake Creek Project	Northern Lights, Inc.	FERC	Last Creek	2	X	X		MT	1							X							46
Slave Falls Dam	Manitoba Power, Manitoba Canada	NA	Winnipeg R	1			X	_															45
Saddlebag Dam	Southern California Edison Company	FERC	Lee Vining C	3	X	X		CA	1									X					45
London Dam	AEP	FERC	Kanawha R	1			X	WV	1							X							43
Flagstaff Project	Florida Power & Light	FERC	Dead River	2	X	X		ME	1							X							43
Winfield Dam	AEP	FERC	Kanawha R	1			X	WV	1							X							42
South Colton Dam	Brookfield Power	FERC	Raquette R	3	X	X		NY	1							X							42
Point A Dam	PowerSouth	FERC	Conecuh R	1	X			AL	1	X						X							42
Murphys Afterbay Dam	Utica Power Authority	FERC	Angels C	1	X			CA	1					X									42
Loon Dam	Manitoba Hydro, Manitoba Canada	Manitoba Hydro, Manitoba Canada	Laurie R	1	X		X	MB	1	X	X												40
Bishop Creek Intake 2 Dam	Southern California Edison Company	FERC	Bishop C	3	X	X		CA	1	X					X				X				40
Thermalito Afterbay Dam	California Department of Water Resources	FERC	Feather R	1	X			CA	1	X													39

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Marmet Dam	AEP	FERC	Kanawha R	1			X	WV	1							X							38
Gantt Dam	PowerSouth	FERC	Conecuh R	1	X			AL	1	X						X							38
Twin Branch Dam	American Electric Power	FERC	St Joseph R	2	X	X		IN	1							X							37
Feather River Fish Barrier	California Department of Water Resources	FERC	Feather R	1	X			CA	1							X							37
North Highlands Dam	Georgia Power Company	FERC	Chattahoochie R	1	X	X		GA	1							X	X						36
White Rapids Dam	WE Energies	FERC	Menomonee	1	X			MI	2	X						X							35
Stark	Brookfield Power	FERC	Raquette R	3	X	X		NY	1	X						X							35
Reusens Dam	American Electric Power	FERC	James R	1			X	VA	1							X							35
Chalk Hill Dam	WE Energies	FERC	Menomonee	1	X			MI	1	X						X							35
Swan Falls Project	Idaho Power Company	FERC	Snake R	1	X			ID	1	X						X							34
North Gorham Dam	Florida Power & Light	FERC	Presumpscot R	1			X	ME	1	X						X							34
Higley	Brookfield Power	FERC	Raquette R	2	X	X		NY	1							X							34
Colton	Brookfield Power	FERC	Raquette R	1	X		X	NY	1							X							33
Piercefield Dam	Brookfield Power	FERC	Raquette R	1	X	X		NY	1	X						X							32
Weston	Florida Power & Light	FERC	Kennebec R	1	X			ME	2							X							30
Way Dam	WE Energies	FERC	Monomonee R	1	X			MI	1	X												X	30

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Hannawa	Brookfield Power	FERC	Raquette R	2	X	X		NY	1	X						X							30
Elkhart Project	American Electric Power	FERC	St. Joseph R	2	X	X		IN	1							X							30
Clifton Court Forebay	California Department of Water Resources	CA DSOD / DWR	CA Aqueduct	1				CA	1	X													30
Agnew Dam	Southern California Edison Company	FERC	Rush C	3	X	X		CA	1												X		30
Shaghticoke	Brookfield Power	FERC	Hoosick R	1				NY	1							X							28
East Norfolk	Brookfield Power	FERC	Raquette R	1	X		X	NY	1							X							28
Tioga Dam	Southern California Edison Company	FERC	Lee Vining C	2	X	X		CA	2	X												X	27
Constantine Dam	American Electric Power	FERC	St Joseph R	1	X	X		MI	1	X						X							27
Upper Dam	Florida Power & Light	FERC	Androscoggin R	1			X	ME	1	X						X							25
Patterson Dam	California Department of Water Resources	CA DSOD / DWR	CA Aqueduct	1				CA	1	X													25
Norwood	Brookfield Power	FERC	Raquette R	2	X	X		NY	1	X						X							23
Minetto Dam	Brookfield Power	FERC	Oswego R	2	X	X		NY	1							X							23
Buchanan Dam	American Electric Power	FERC	St Joseph R	1	X	X		MI	1	X						X							23
Middle Dam	Florida Power & Light	FERC	Androscoggin R	1			X	ME	1	X						X							22
Huntington Dam 3A	Southern California Edison Company	FERC	Big Creek	3	X	X		CA	1							X							22
Cranberry Lake Dam	Algonquin Power	FERC	Oswegatchie R	1	X			NY	1	X						X							22

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Upper Blue Lake Dam	Pacific Gas & Electric Company	FERC	Blue C	1	X			CA	1	X													21
Feeder Dam	Brookfield Power	FERC	Hudson R	2	X	X		NY	1							X							21
Russell Dam	Manitoba Hydro, Manitoba Canada	Manitoba Hydro, Manitoba Canada	Laurie R	1	X		X	MB	1	X						X							20
Moosehead Project	Florida Power & Light	FERC	Kennebec R	1	X	X		ME	2	X						X							20
Eager Dam	Manitoba Hydro, Manitoba Canada	Manitoba Hydro, Manitoba Canada	Laurie R	1	X		X	MB	1	X						X							20
Sugar River 1	William B Ruger, Jr.	FERC	Sugar R	1			X	NH	1							X				X			18
Oswego Falls Project	Niagara Mohawk Power Corporation	FERC	Oswego R	2	X	X		NY	1							X							18
Rhiendollar Dam	Southern California Edison Company	FERC	Lee Vining C	1	X	X		CA	1					X									17
Hewittville	Brookfield Power	FERC	Raquette R	1			X	NY	1	X						X							17
Mottville Project	American Electric Power	FERC	St. Joseph R	2	X	X		MI	1	X						X				X			15
Phoenix Dam	Algonquin Power	FERC	Oswego R	1	X			NY	1							X							14
Messalonskee Dam	Synergics Energy Services	FERC	Messalonskee S	2	X	X		ME	1							X							12