Submitted to
NALCOR ENERGY

Independent Engineer

Lower Churchill Project

Reference No. RFP LC-PM-082
March 2012



3-4 Technical Proposal Questionnaire

PROSPOSAL

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BUILDING A BETTER WORLD

TABLE OF CONTENTS

Attachment 6

TECHNICAL QUESTIONNAIRE

The Technical Questionnaire must be completed and submitted as part of the Proposal. The questionnaire shall be referred to herein as the Technical Proposal. It will be evaluated by Company as part of Company's overall evaluation process.

Part II (Appendix A) – Scope of Work describes the scope of services. However, Appendix A is not a stand-alone description of the Agreement requirements. The entire Agreement contains obligations of the Successful Bidder and must be considered by Bidder in completing the Technical Questionnaire.

Questionnaire responses shall be presented in the same order, numbering system and format as presented in this questionnaire. Responses can be provided in the spaces provided herein if desirable.

Some of the information requested in this questionnaire might be repetitive to information requested in other sections of this RFP. It is important that Bidder's response to this questionnaire be complete. Accordingly, if necessary, Bidder should repeat any such information.

Where applicable, information provided in the Technical Questionnaire will form part of the Agreement.

Do not include manuals and procedures with the questionnaire responses unless specifically requested.

Company is committed to ensuring fairness in its vendor selection process. The information provided in this questionnaire is strictly confidential and solely for the use of the Project.

1.0 EXECUTION

1.1 General

Subsequent to award of the Agreement, Successful Bidder (Contractor) shall be required to submit an Execution Plan for Company's approval.

The Technical Proposal shall include a detailed outline complete with a summary of Bidder's Execution Plan. The submission shall describe how the Execution Plan will encompass the Scope of Work.

The submission shall provide sufficient detail so as to enable Company to fully assess Bidder's understanding of the Services and the Project, and to evaluate Bidder's approach, commitment and ability to provide the Services to the Project.

As a minimum, the detailed outline / summary of the Execution Plan should address the items noted below.

Response:

Execution Plan

The role of MWH Canada during Phase 1 is to review the principal aspects of the Project engineering design, hydraulics, hydrology and power generation estimates, cost and scheduling estimates, transmission systems and converter stations, and the technical provisions in the principal Project contracts as well as the permits and licenses. The Project consists of the Muskrat Falls Generating Station, the Labrador Island Transmission Link, and the Maritime Transmission Link.

MWH Canada will identify issues uncovered during the independent engineering review, may propose an approach to address those which are within its area of expertise, and will work with NALCOR and the Client to help resolve each issue. In general, the IE reviews work prepared by others and does not prepare original engineering design products. The work to be accomplished by the MWH team (the Independent Engineer) does not include any assessment, evaluation, review, testing, or discussion of facility security issues, including but not limited to, protection from terrorist acts, that may impact NALCOR and the Client's facilities, systems, or human life or those of other entities with which the Client has business or operation relations.

MWH Canada has dedicated a team of experienced engineers with many years of experience in the design and operation of hydroelectric plants, and who have performed numerous Independent Engineering reviews for other projects during their careers. The IE organization charts included with the Execution Plan indicates the specialized fields of expertise required to process the work and include specialists to allow the work to be processed relatively more quickly by providing several specialists in each of the main categories of Work. Also included with the Execution Plan is the MWH Global Organization Chart as required by the RFP. We

have included with the Execution Plan the resumes of personnel who will be dedicated to this Project during the course of the work along with the resumes of sub-consultants. The Work is outlined and discussed in Section 2, which include the Work required for Phase 1 and for Phase 2. We have attached to this Execution Plan the detailed Scope of Work to be performed under the Plan. The Detailed Scope of Work formed the basis for preparing our time estimates and budget estimates. The outline of the Scope of Work follows the Task numbering system as given in the RFP, PHASE 1: PROJECT TECHCNICAL REVIEW PRIOR TO FINANCIAL CLOSE, pages 33-44, and PHASE 2: CONSTRUCTION PERIOD, Pages 45 and 46.

The Execution Plan provides a summary schedule that allows the work to be implemented in an organized manner to allow all questions of NALCOR to be addressed during MWH's review of the Project documents, complimented by discussions with the parties and the site visit. Notes in the Execution Plan Summary Schedule indicate where we expect the work to be accomplished and the duration of the work. We have also designated on the schedule the expected dates for submittals (reports) to NALCOR and the Client. At this time we realize that the review of our Execution Plan is subjected to approval by NALCOR; as such, we would expect that any revisions to the Execution Plan can be made to accommodate the needs of NALCOR and the Project Schedule.

Work required to be performed by the Independent Engineer follows the requirements to address all of the tasks as presented in the RFP and will address each subject/topic outlined therein.

1. Work to be Accomplished by the Independent Engineer
   - a. Project Technical Review Prior to Financial Close—Phase 1
     - i. Detailed Scope of Work--attached
   - b. Project Construction Period---Phase 2
     - i. Detailed Scope of Work---attached

2. Professional Staff to Accomplish the Work
   - a. MWH Global Organization Chart
   - b. Project Feature Organization Charts
     - i. Muskrat Falls Generating Station
     - ii. Labrador Island Transmission Link and Maritime Transmission Link
   - c. Independent Engineer's Organization
     - i. Project Technical Disciplines
     - ii. Key Personnel
     - iii. Technical Specialists
     - iv. Resumes of Key Personnel
     - v. Resumes of Staff Supporting Key Personnel
     - vi. Sub-consultants/subcontractors

3. Work Schedule of Independent Engineer
   - a. IE Execution Plan Work Schedule
     - i. Work Schedule---attached
   - b. Reports (included on the IE Work Schedule)

1.2 Complete Scope of Work

The Technical Proposal shall fully detail and explain:

a) How the implementation of the work shall be organized and delivered;
b) How each of the Services will be provided;
c) When each of the Services will be started and completed;
d) Where each of the Services will be provided and completed;

Response:

DETAILED SCOPE OF WORK - PHASE 1

PHASE 1: PROJECT TECHNICAL REVIEW PRIOR TO FINANCIAL CLOSE

Task 1: Initial Project Scope Meeting and Obtain Project Documentation

The purpose of the initial Project Scope Meeting is to obtain information from the Owner and its advisors as required by the RFP to allow the Independent Engineer to perform the Project assessment as outlined in the RFP in an expeditious manner such that the schedule goals established during the meeting will be achieved. In addition to items mentioned in the RFP that will be included in the discussions, we have included other material, herewith, that will aid our discussions and data gathering of germane documents needed for our perusal. We have taken the opportunity to do this at this time because we deeply understand time-is-of-the- essence in accomplishing the preparation of the Independent Engineer's Report that will be used by the Client in preparing their term sheets and agreements with the Owners. The following items have been mentioned in the RFP or are included, as recommended by MWH, to enhance the level of detail for the first meeting:

1. List of items MWH would expect to be furnished for their review. The following items are required for our review and are listed, not necessarily in the order we would expect to receive them:

1.1 Project Feasibility Report

1.2 Summary of Geotechnical investigations and the Geotechnical Report (GBR) for the following: Muskrat Falls Generating Station: the switchyards; the shore sites for the crossing of the Strait of Belle Isle and Cabot Strait, and the crossing itself; and the transmission lines. Of particular interest to our civil/structural and geotechnical engineers and our geologist is the study associated with the treatment of the left abutment (knoll) and its geology at Muskrat Falls dam.

1.3 Hydrologic Reports and Studies of selected Muskrat Falls site and the Basin

- 1.3.1 Basis for Power Production Estimates---Hydrology,Generation Flow and Power Model
- 1.3.2 Hydrology and Power Estimates for the Planned Gulf Island upstream Project
- 1.3.3 Precipitation and Climatological Data for Site
- 1.3.4 Diversion and Spillway Flood Studies
- 1.3.5 Sedimentation Data and Reservoir Useful Life Determination for Sustainability

1.4 Basis of Design Criteria and Report

1.5 Drawings and Specifications

- 1.5.1.1.1 General Civil Works

1.5.1.1.2 Major Project Features of Muskrat Falls--Dam, Power Plant, Spillway, Switchyard
1.5.1.1.3 AC/DC Converter Stations
1.5.1.1.4 Submarine Cable Crossings: Strait of Belle Isle; Cabot Strait-Bathymetry along Selected Route
1.5.1.1.5 Switchyards
1.5.1.1.6 Transmission Lines

1.6 Contract with Design Engineer (EPCM contract) and Contact Names/Telephone/email/FAX
1.6.1.1.1 Design Engineer's Organization Chart
1.6.1.1.2 Resumes of the Project Manager, Engineering Manager and Lead Design Engineers/Specialists: Civil; Geology/Geotechnical; Hydrology and Hydraulic; Mechanical; Powerhouse Mechanical; Powerhouse Electrical; Environmental; Structural; Project Manager and Deputy Project Manager; Health and Safety Specialist
1.6.1.1.3 Resumes of the Lead Site Engineers: Project Manager; Geologist/Geotechnical; Civil; Structural; Mechanical; Electrical; Environmental; Health and Safety Specialist

1.7 Contracting strategy – List of Civil(Construction) and Electro-Mechanical contracts
1.8 Construction Contracts—General Provisions and Contact Names/Telephone and Fax numbers; email
1.9 Contract for Electrical and Mechanical Equipment and Contact Names/email/Telephone and Fax numbers
1.9.1.1.1 List of Equipment and Suppliers
1.9.1.1.2 Performance Criteria
1.9.1.1.3 Performance Testing Protocol
1.10 Proposed CPM Construction Schedule for the Project
1.10.1.1.1 Description of Construction Methodology
1.10.1.1.2 River Diversion and Care of Water
1.10.1.1.3 Source of Construction Materials
1.10.1.1.4 List of Critical Events and Dates
1.11 Current Construction Cost Estimate
1.11.1.1.1 Schedule of Payments to Contractor/Vendors
1.11.1.1.2 Estimate of Cost of Work Left to Complete
1.12 List of Construction Contractors and Subcontractors
1.13 Qualifications of Contractors and Principal Subcontractors and Equipment Suppliers
1.14 Permits and Licenses to Construct and Operate Project and Current Status
1.15 Power Sales Contract
1.16 Transmission and Interconnection Agreement (s)
1.17 Operation and Maintenance Agreement with EPCM Firm (SNC-Lavalin)
1.18 Projected Operation Results---Financial Pro Forma (Projection Model) with List of Assumptions and Description of Cases
1.19 Insurance Program
1.20 Safety Program
1.21 Environmental Checklist (World Bank Standards/Equator Principals)
1.22 Environmental Impact Statement and Project Handbook of Environmental Protection measures
1.23 Emergency Action Plan for Construction, and Emergency Action Plan for Operation

1.24 Load Flow/System Studies Associated with the Transmission System
1.25 Health and Safety Program
1.25.1 EPCM Firm Health and Safety Program
1.25.2 Contractor's Health and Safety Program
1.25.3 Major Equipment Suppliers/Vendors Health and Safety Program
1.26 Sustainability Plan for the Project

2 MWH proposes the following Members of their team partake in the meeting:
Project Manager, Rey Hokenson, P.E. and the Principal in Charge, Nik Agirov, P.Eng.

3 MWH proposes that the Outline of the Independent Engineers Report we intend to use, included at the end of this Task, will form the basis for discussions pertaining to report format and content.

4 MWH would be please to know who the Owner intends to invite to the meeting including parties from its own staff and that of its legal advisor/contract specialist, Lead economist, insurer, pro-forma economist, and team members. Some of the following Owner's team members would also be helpful to meet, including the following specialists: Project Manager, Engineering Manager, Lead Civil Engineer; Lead Structural Engineer; Lead Hydrologist and Hydraulics Engineer; Lead Mechanical Engineer; Lead Electrical Engineer; Lead Terrestrial Transmission Engineer: Lead Substation Engineer; Lead Submarine Cable Transmission Engineer; Lead Geologist; and Lead Contract Specialist.

5 MWH and the Owner and advisors will jointly discuss and proposed dates for the site visits to each of the sites mentioned in the RFP plus at least six typical sites along the transmission corridors. We have currently scheduled the site visit to occur during the fifth week of the program to allow MWH to receive and review about 90 percent of the data required to be reviewed. To facilitate the field trip, we recommend that helicopters be used; therefore, scheduling for their use usually is important to consider and plan for.

6 We will select the date of the first draft of the Independent Engineer's Report and an alternative date, if necessary to accommodate the lenders at the first meeting. We have indicated on our schedule the start of the 21st week, or 100-days from the start of the work, and ten weeks after receiving 100 percent of the data.

7 We need to jointly select the date at which MWH can expect to receive about 90 percent of the data we have requested. We have selected that this should occur at the end of the third week.

8 We will develop the protocol for the submittals of the IE Report and of receiving comments regarding the draft of the report. We note that lenders typically request a second draft report; we can discuss the need to plan for this request during our meeting.

9 To enable the meeting to be conducted with structure, MWH will propose a meeting Agenda to the Owner and the Owner will make revisions and issue the final Agenda to be followed at the Initial Project Scope Meeting. MWH will submit the Draft Meeting Agenda about 2-business- days prior to the meeting.

ACTION ITEMS

The following Action Items have been identified for this first Task 1 for promulgation:

1. Scope of services finalized and agreed
2. Data and documentation required to conduct the services of the IE will be defined
3. Proposed site visit date selected; arrangements will be made and finalized
4. Date of draft report (s) to be issued by IE will be agreed to.
5. Format of the IE report will be decided

6. Procedure for submission of drafts for comment, incorporation of comments, and production of the final report
7. Prepare the Initial Project Scope Meeting Agenda ---DRAFT by MWH and final by Owner
8. Establish protocol for contacting Owner and then the Lender(s)
9. MWH will prepare the Meeting Notes and submit a Draft to the Owner for comments within three- business days of the meeting; once the draft is received from the Owner, with comments, MWH will prepare the final Meeting Notes for disbursement to the Owner and parties designated to receive the notes. It is assumed that the Owner will send the draft to other parties who will be asked to submit comments.

Task 2: Site Visit (and MWH Proposed Office Interviews)

Selected members of the MWH team will visit the Project sites to view first-hand the geography, geology, access, and conditions of the sites. Additionally, MWH is proposing that an Office Interview and Presentations will be conducted to further gain knowledge about the project and the personnel who will be leading the teams responsible for the design and construction of the Projects. The Office interviews also serves as the first opportunity to personally meet some of the MWH key team members whose resumes have been included in MWH's comprehensive proposal, and which are further highlighted in MWH's Project Team Organization Chart. The particular items to be viewed are listed below where the Independent Engineer is required to comment on the requested conditions in the Independent Engineer's Report. The sites that were identified in the RFP to be visited along with the second cable crossing of Cabot Strait include the following:

Sites to Visit:

1. Muskrat Falls Generation Project
2. AC/DC Converter Stations (assumed 4)
3. Switchyards (assumed 5 including the Churchill Falls Switchyard)
4. Sites for the crossing of Strait of Belle Isle (both ends)
5. Sites along the transmission corridors (we have assumed 6)
6. Sites for the crossing of Cabot Strait (both ends)
7. Borrow areas for the following: RCC aggregate and conventional concrete aggregate for the power station and the spillway

The Purpose of the site visit is for the MWH team to become familiar with the sites; to verify and confirm whether any unusual characteristics of the sites that could present significant obstacles to successful completion of each project exist; and to make inquiries of the Owners technical staff and that of the EPCM contractor and the main Construction Contractor. We have assumed that Lead discipline Engineers from the Design Engineer (EPCM Contractor - SNC-Lavalin) will be present when the site visits are conducted and that the Construction Contractor will also have its Project Site Manager and representative Lead construction engineers present to address the MWHs team questions. MWH also requests that representatives of the turbine supplier, the generator supplier, and the AC/DC Converter Station's equipment be present in St John's for meetings either prior to the site visits or after the site visits to entertain questions and to present to the MWH team the details of their supply contracts and to discuss the contract schedules for the design, manufacturing, testing, delivery, and installation of their equipment. We also desire to listen to a presentation by the submarine cable supplier and the contractor (s) who will be responsible for the installation of the submarine cables to include discussions pertaining to the construction schedule and the safeguards to be used during inclement weather conditions. We would also

expect that the Design Engineer, jointly with the Contractor, as appropriate, will make presentations to the Independent Engineer on aspects of the project that involve the following topics: river diversion and control of water; foundation treatment of the left abutment and its stabilization; RCC design and construction (with particular attention to cold weather engineering) and protection of the upstream face of the dam from ice and debris; design of the submarine cable to protect against scour, waves and ocean currents, geologic conditions, and ice conditions and the methods selected to monitor QA/QC during construction and deterioration occurring during its design life.

MWH also expects that the Owner and the Design Engineer (EPCM Contractor) will have their Environmental Engineer/Permit Specialist available to present an overview of the permit status and items of work that will require monitoring during the course of the work. Additionally, the Contractor's Health and Safety Engineer would be expected to attend a meeting with the IE Team to discuss the Health and Safety Plan that will be followed during construction and the means available to administer to injured personnel and site personnel during the course of the work and during the operation and maintenance period. Since the work is spread out, we will be looking for a comprehensive and innovative way to provide for the H&S of all workers.

The IE is required to comment on the following specific items:

1. General topography, condition of ground, equipment---5 sites and more
2. Storage and lay-up procedures for installed and yet to be installed equipment
3. Location for storage for uninstalled equipment
4. Confirm current status of construction completion and major items to be completed
5. Access to and status of construction of off-site facilities for interconnection to electric power, water, waste disposal, fuel supply for equipment and heating

Proposed MWH Participants:

1. PM/Civil Engineer
2. Transmission line/substation engineer
3. Construction Engineer
4. Environmental Engineer
5. Geologist

ACTION ITEMS:

1. MWH Team to visit all of the sites2. MWH Team to gather information and take photographs of the specific items listed in the RFP and other items that are germane to the successful preparation of the Independent Engineer's Report

2. The IE will interview Owner's technical staff and that of the Design Engineer and the Construction Contractor and listen to presentations from Lead specialists.

3. The IE will listen to presentations of the principal vendors/suppliers of the hydrogenating equipment and submarine cable and interview the representatives to gain a full understanding of their supply contracts and of their design techniques.

4 The IE will attend a presentation by the Design Engineer's Environmental Engineer and Owner's Environmental Engineer/Permit specialist to understand the environmental and permit requirements of the Project.

5 The IE will attend a presentation by the Health and Safety Engineer to understand the how the provisions of the Safety Plan will be implemented and monitored during construction and during the operation and maintenance period.
6 The IE will prepare germane text to be included in the Independent Engineer's Report to memorialize the findings of the Site Visit and Office Interviews.
7. The Site Visit will occur four weeks after the Scope Meeting, or one week after 90 percent of the data is
8. MWH will visit the borrow areas, not mentioned in the documents.

Task 3: Review Project Design and Projected Performance

The objective of the task is to ensure that the Independent Engineer will review all of the available Project's documents for the purpose of identifying missing, inconsistent or unresolved information. The IE will then be better able to assess the compatibility of the basis of design with the project operating requirements, site characteristics, hydrology characteristics, geologic constraints, environmental restrictions and constraints, and the off-site transportation requirements. As required by the RFP, it is important that the design review be comprehensive, and therefore, MWH has delegated a contingent of their most senior hydropower engineers and geologic and environmental practioneers to perform these reviews to ensure that the major equipment systems and components are capable to perform as required; that the designs are robust to ensure that the equipment meets the availability and reliability requirements; and that all of the designs meet good engineering practice and meet utility prudent practice and acceptability standards. The RFP is very clear that MWH must identify equipment components that would appear to not be able to meet these given requirements, and we acknowledge this responsibility and fully support this position of the Owner. We have the expertise and the experience to do this since we having been performing these same types of services for all of the major government entities who own and operate hydroelectric facilities (USBR; TVA; USACOE, and NOAA) as well as numerous investor owned utilities in the USA and world-wide, and in particular all of the provincial government -controlled Canadian utilities.

We will include in our IE Report comparisons from our vast in-house data base to assess the likelihood that the proposed equipment for Muskrat Falls will provide the performance guarantees that have been contracted for in the performance guarantees.

As required further in the RFP, ***"the IE will review the technical design of the Project, projected performance for compliance with generally accepted industry standards and prudent utility practices, and the ability to operate in accordance with Pro Forma projections and contract requirements."*** As specifically requested, MWH will perform the following services and include our responses in the Independent Engineer's Report:

3.1 MWH will compare the projected performance to the design conditions, vendor guarantees and known performance of other similar facilities. In order to do this, MWH will review the power model to ensure that appropriate efficiencies are utilized and that the headloss in the water conveyance system and at the exit of the draft tube is appropriately determined. Tailwater levels for both winter conditions where ice cover exists and during the remaining months when ice effects are not present will be reviewed to ensure ice effects are accounted for, as appropriate. The design should also be reviewed

for suitability in preventing the formation of frazil ice blockage of power intakes and obstruction of generation.

3.2 MWH will review the hydrology of the site to ensure that the period of record is sufficient to be used in the power model; this period should be at least 30-years of record and should preferably be longer and daily records should be used in modeling power output. Where gaps in the record have been estimated from hydrologic studies with other gages in the basin or similar basins, or with rainfall records, the basis for the derivation of the monthly and daily values will be reviewed. It is expected that the Hydrology Report will be robust and well documented, meeting industry standards for similar projects of size and complexity. Tailwater and headwater rating curve derivations will also be reviewed along with predicted models of reservoir evaporation. Sedimentation studies will be reviewed to determine if sufficient storage will be available during the design life of the project to accommodate the expected regulation rule curve live storage proposed for operating the reservoir prior to the Gull Island plant being in service and after it is in service.

3.3 MWH will review the design and expected performance of the major systems of the power station to judge their compatibility with each other and their intended purpose. We also note that we must opine on the projected reliability and operations of the systems under various operating conditions. The reservoir rule curve and tailwater curves will be used to establish hydraulic operating levels for the hydrohydrohydro-generating equipment and auxiliary systems, and the electrical requirements of the transmission system will be used to determine system restraints on the plant. Tailrace constraints and the downstream river channel will also form constraints on peaking operations and times when releases must be curtailed (ramped) due to nesting of birds and fish spawning and rearing.

3.4 MWH will review if the plant, as designed, will be able to meet its operating and contractual requirements as found in the applicable agreements (power sales agreement; transmission line agreement).

3.5 MWH will review the major systems and equipment design criteria along with the expected performance to confirm 'their suitability, compatibility and completeness for the intended service of the equipment, and in particular that the design is conservative.' We will also opine as to the selection of the equipment as to its proven reliability based on historic data and use in similar plants with similar environments and operating parameters and are well within industry established parameters.
One item that is worthy of consideration which multilateral lenders and large commercial banks are normally interested in is the major equipment's suppliers reputation with respect to bribery and the subsequent banning of such firms from bidding on World Bank projects. Since there are now two leading suppliers of hydro-generating equipment that are on the World Bank's list, if the Lenders are honoring World Bank principals when it comes to not only Equator principals but ethical issues, this must be taken into consideration during the IE's review.

3.6 Coupled with our review discussed in 3.5, above, we will discuss the operating history of the major equipment being used in comparable applications, as well as the expected Project-specific equipment performance.

3.7 MWH will review the proposed electrical interconnections between each project. We will review the load flow studies to determine if there would be any reasons why the system could not perform, as designed and recommend any areas where stability issues may occur, requiring further study. We will also review the SCADA system and the control system for the transmission lines and substations and

converter stations to ensure that it is robust, and that backup systems, in case of the primary system is not performing properly, will be able to control the devices or systems being employed at the Project facilities.

3.8 "Review the projected water supply, wastewater disposal systems and other applicable waste disposal plans, historical performance and projected performance;" MWH will review the proposed waste disposal system for the Muskrat Falls plant as well as the one for the construction camp site to ensure that they are suitable and would meet standard Canadian codes; we will also review the potable water supply for the camp as well as the different water supply systems (including cooling water supply) for the plant to determine if is suitable for a sustainable system since sediment loads, ice conditions, and woody debris issues may require relocating the intake

3.9 MWH will review the various technical criteria and other provisions within the technical documents and, if available, contracts for consistency. MWH will review each of the contracts that are available to determine if the technical criteria being used in one document is the same as that being used for another contract and opine on its consistency. The MWH team will also review other provisions of the contract to determine if it is consistent between documents and if the contracts are consistent. Inconsistency appears when there are several groups of engineers and contract specialists who have worked on separate aspects of the project and have not taken the internal time to verify the consistency (some lack of quality control). The IE usually finds that projects have inconsistent documents for Owners which will require, sometimes, contract modifications after they have been accepted by both parties. Fortunately, most well crafted contracts have provisions for making these adjustments in pricing that have already been 'spelled-out' as to how this can be accomplished, helping to expedite the corrective process. When such occurrences are found, the IE will immediately inform the Owner or Lender to allow the appropriate remedial action to occur.

3.10 MWH will review the experience and capability of the major Project participants to perform their roles in each Project and to support the successful execution and completion of the Project. To enable MWH to perform this assessment, we have requested that resumes of key individuals within the Construction Contractor's firm as well as the Design Engineer's firm to be supplied for our perusal and to opine on the design and construction teams. We have also asked to be supplied the suppliers/vendors of the major mechanical and electrical systems for the Projects and contact information to follow-up with key individuals who will be the companies project manager and project engineer. Most of the firms that will be supplying equipment for the project are already known to MWH and possibly have worked on one of MWH's hydro projects; we therefore, bring additional experience in possibly having dealt with the company and know, first hand, of the success and failures of their past performance. As mentioned above, we will also note if any of the firms have been blacklisted (debarment) by the World Bank for further consideration by the Owner and the Lender(s).

ACTION ITEMS:

1. For each of the items listed in Task 3., MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.
2. The answers to the Task 3. questions and opinions will be included in the Independent Engineer's Report.

3. Items of particular interest that the IE believe need immediate attention by the Owners and Lenders will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
4. Usually, not all information will be available for the IE's use in a timely manner, or that it was missing from the documents being reviewed. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 4: Review Construction Plan and Schedule

MWH will review the construction plan for each of the Projects, which include the following: Muskrat Fall Generation Project; Labrador-Island Link Project; and the Labrador Transmission Assets project.

4.1 EPCM Contract

MWH will review the scope of services and technical provisions of the EPCM contract and will specifically identity the following:

4.1.1.1 MWH will review the terms of the contract to ensure that the responsibilities of the parties are clearly define for the Owner and the EPCM Contractor.

MWH will also verify that the following are clearly delineated:

4.1.2 Scope of Work, Communications and interface requirements between the EPCM Firm, Owner, and other contractors

4.1.3 Dispute resolution provisions are clearly defined.

Note: "*The EPCM is currently a single contract, and it is intended to be separately applicable to each Project*"

4.1.4 MWH will review and report on the EPCM Contract as it is applicable to the relevant Project, and its ability to integrate each Project with the other Projects. We would expect that this will be the case since there appears to be some concern that this may not have been accomplished as desired, but we will verify that it appears to be applicable to all of the Projects and give our opinion that will be included with the Independent Engineer's Report.

4.2 Construction Contracts (other than EPCM Contract)

MWH will review the construction plan for each Project, including:

4.2.1 Review the scope of the supply and the technical provisions in the supply and construction contracts including:

4.2.1.1 MWH will review the qualifications of the contractor(s)

4.2.1.2 MWH will review the qualifications and selection of major subcontractors

4.2.1.3 MWH will review the completeness of scope of work

4.2.1.4 MWH will review the extent to which the contracts can be performed independent of other contracts and the clarity of the battery limits of each contract

4.2.1.5 MWH will review the Contractor and Owner's responsibilities
4.2.1.6 MWH will review the provisions for guarantees, warranties and latent defect periods
4.2.1.7 MWH will review change order procedures

4.2.2 MWH will review the Transportation Plan for delivery of equipment and materials to the site(s)
4.2.3 MWH will review the logistics and storage of construction materials on and off-site
4.2.4 MWH will comment on the conformity of the proposed contracts relative to industry standards and prudent utility practice
4.2.5 MWH will review compensation terms and methods of payment relative to industry standards and loan document requirements

The RFP is silent on the number of construction contracts and procurement contracts that require MWH's review. We have assumed that the following construction contracts will be reviewed: Muskrat Falls Power Station, Dam, Spillway, and Diversion Facilities; Power Station Mechanical/Electrical Erection and Testing of Hydro-Generating Equipment; Transmission System-Towers and Conductors; Submarine Cable Installation; Substations, Switchyards, and Convertor Stations: and Installation, Testing, and Commissioning of Balance of Plant Mechanical and Electrical Equipment and Systems.

4.3 Guarantees and Liquidated Damages

4.3.1 MWH will review the completion and where applicable, the performance guarantees and associate liquidate damages and bonus payments, buydown and buyout provision, liquidate damage caps, and total liability provided by the contractors and major equipment suppliers. To enable the MWH Team to perform these services, we will need to have data, provided by the Owner, to support the fees and bonus provisions being reviewed which would mean the value of power and capacity to verify that the amounts cited in the documents would be appropriate for use in court. Only justifiable payments for the items listed above have normally been found to be appropriate when such damages or bonus payments are brought into question by one party. It is also helpfully to show sample computations to further illustrate what is said in words to eliminate any misunderstanding that occur when two different parties make a computation without following a sample computation.
4.3.2 MWH "*will review and comment on the guarantees provided by each of the construction contractors and major equipment suppliers to assess the potential for compliance with the applicable Project contracts, permits and performance expectations.'*
4.3.3 MWH "will also review and comment on guarantees provided by each major equipment manufacturer, to the extent that his information is available, to assess the level of support hat these equipment guarantees provide to the Owner."

ACTION ITEMS:

1. For each of the items listed in Task 4.3, MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.
2. The answers to the Task 4.3 questions and opinions will be included in the Independent Engineer's Report.
3. Items of particular interest that the IE believe need immediate attention by the Owners and Lenders will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.

4. Usually, not all information will be available for the IE's use in a timely manner, or that it was missing from the documents being reviewed. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner(s) and MWH.

4.4 Construction Schedule

4.4.1 MWH will review the Project schedule and each of the construction schedules and determine whether adequate provisions have been made for the design; equipment procurement; fabrication; shipment and installation; and start-up, shakedown, testing and commission of the Project. Unknown or variable elements detected by MWH in the schedule will be identified along with associated potential risks.

4.4.2 MWH will also perform the following services:

4.4.2.1 Review and assess the Project construction, engineering and procurement schedules and critical paths including an analysis of the major third party deadlines

4.4.2.2 Comment on the likelihood of achieving Project construction milestones in accordance with the completion requirements of the Project

4.4.2.3 Review the major equipment supply contracts with regard to performance guarantees to assess the level of support provided to the contract guarantees

4.5 The RFP is silent on the number of supply contracts that are required to be reviewed by MWH. We have assumed that the following procurement contracts will be reviewed: Powerhouse Major Hydro-Generating Equipment (Turbine, Generator, Governor, Power Transformer, High Voltage Switchgear); Submarine Cable and Anchorage Systems; Switchyards, Substations, and AC/DC Convertor Stations; Powerhouse Balance of Plant Mechanical and Electrical Equipment. We realize that there could be further breakouts of additional contracts for the equipment, but we have not considered this in our scheduling or budgeting of time and costs. We have further assumed that the EPCM engineer, SNC-Lavalin is the author of the contracts and has conformed all of the contracts MWH will be reviewing, such that there will be similar sections of each contract where the principal items we are required to review and opine on will be found.

4.6 Performance Test Criteria

MWH will review the performance test criteria for each contract and major equipment supply package, as applicable, and review the performance test criteria for the Project, and also where applicable its integration with the other Projects, as provided by the Owner, and will comment on the following:

4.6.1 Reasonableness of the performance test criteria

4.6.2 Adequacy of the test duration

4.6.3 Ability to extrapolate test results over the expected life of the Project

4.6.4 Conformance of test procedures to established codes and standards for testing Project equipment

4.6.5 Ability to achieve all conditions required by the EPCM Contract and by each of the individual contracts

ACTION ITEMS:

1. For each of the items listed in Task 4.5, MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.
2. The answers to the Task 4.5 questions and opinions will be included in the Independent Engineer's Report.
3. Items of particular interest that the IE believe need immediate attention by the Owners and Lenders will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
4. Usually, not all information will be available for the IE's use in a timely manner, or that it was missing from the documents being reviewed. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 5: Review Capital Budget

5.1 Total Project Cost Estimate

MWH will perform the following services with respect to the review of the Total Project Cost Estimate which will generally include the following services:

5.1.1 Review the scope of supply and corresponding cost estimate methodology for all Project costs including the following: engineering, procurement and construction contracts. The review will include project management services, spare parts, working capital and start-up costs.

5.1.2 Evaluate costs that are based on estimates and those costs based on fixed pricing. The costs of the items that are based on estimates shall be further reviewed to determine the apparent risk associated with the variables. Additionally, MWH will evaluate the level of contingency budgets compared to those of similar Projects with which MWH is familiar.

5.1.3 Review the cost estimate for any remaining facilities to assess the methodology used to develop the total Project cost estimate

MWH will review and comment on the construction scope and the cost estimate methodology used to determine the Project construction cost, including the following:

5.1.4 Project Manager and construction contractor experience, compensation and budgets.
5.1.5 Major equipment procurement costs
5.1.6 Interconnection and infrastructure completion costs
5.1.7 Spare parts
5.1.8 Contingencies
5.1.9 Start-up and commissioning costs
5.1.10 Camp costs
5.1.11 Ancillary infrastructure and services, including access and construction power, required to support the Project and furnished by the Contractor
5.1.12 Schedule of equipment delivery and work to be performed taking into account the issues associated with the site layout and location
5.1.13 Schedule of values and construction cash flow

5.1.14 Allowances for contractor performance bonuses

5.1.15 MWH will highlight critical areas of cost structure and identify high sensitivity areas for further consideration.

5.1.16 MWH will provide a comparison relative to the public electrical utility industry and compare to facilities of similar size and technology taking into consideration such items as location, available infrastructure, and labor costs

5.1.17 MWH will focus on price risks, since the Project is not being constructed under a single EPC contract.

ACTION ITEMS:

1. For each of the items listed in Task 5.1, MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.
2. The answers to the Task 5.1 questions and opinions will be included in the Independent Engineer's Report.
3. Items of particular interest that the IE believe need immediate attention by the Owners and Clients will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
4. Usually, not all information will be available for the IE's use in a timely manner, or that it was missing from the documents being reviewed. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

5.2 Drawdown Schedules

MWH will review the drawdown schedule that will generally be appended to the contracts, or an estimated schedule, and comment on whether each monthly cash drawdown amount is consistent with the Project schedule. We will use as a basis the data to be furnished as listed in our information request, item1.10.1.

ACTION ITEMS

1. For each of the contracts that we review, we opine on if the monthly cash drawdown amount is consistent with the Project schedule.
2. Items of particular interest that the IE believe need immediate attention by the Owners and Clients will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
3. If the drawdown amount is not furnished in a timely manner, or that it was missing from the documents being reviewed, the IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 6: Review Commercial Operation and Maintenance Services

6.1 Review Commercial Operation Services

MWH will perform an engineering review of the Operations and Maintenance Plan. MWH will also review contracts and agreements for operation and maintenance if these have been prepared. NOTE: MWH review will not address legal or regulatory issues associated with the Project.

6.2 Operations and Maintenance ("O&M") Plan

MWH will review the Operations and Maintenance Plan and comment of the following specific items:

6.2.1 Adequacy of the start-up and long-term operating procedures
6.2.2 Reasonableness of the annual O&M budgeting process
6.2.3 Reasonableness of the O&M fee structure and its ability to cover 'non-extraordinary' expenses
6.2.4 Proposed training program
6.2.5 Proposed preventative maintenance program

6.3 Operating and Maintenance Cost Estimate

MWH will review the list of O&M and major maintenance cost estimate components and comment on the following items:

6.3.1 Comment on the completeness of the maintenance cost estimate
6.3.2 Comment on the assumption upon which each component was calculated
6.3.3 Comment on the reasonableness of the assumptions

The review by MWH will include the following items:

6.3.4 Staffing
6.3.5 Maintenance provisions
6.3.6 Spare parts
6.3.7 Water
6.3.8 Waste disposal
6.3.9 Administrative costs
6.3.10 Management fees
6.3.11 Usually, not all information will be available for the IE's use in a timely manner, or that it was missing from the documents being reviewed. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH Consumables

ACTION ITEMS:

1. For each of the items listed in Task 6.1, 6.2, and 6.3, MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.

2. The answers to the Task 6.2 and 6.3 questions and opinions will be included in the Independent Engineer's Report.
3. Items of particular interest that the IE believe need immediate attention by the Owners and Clients will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
4. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 7: Review of Project Agreements

7.1 General Requirements

MWH will review the ability of the Project, based on the design criteria, to meet the operating and technical requirements of the applicable operating agreements and the financial goals for the Project. The following items have been specifically requested to be reviewed by the Independent Engineer:

7.1.1 Power Purchase Agreements
7.1.2.1.1 Interconnection Facility agreements
7.1.3 Water Management Agreement
7.1.4 Water supply and wastewater disposal agreements
7.1.5 Fuel supply and transportation agreements (This could be applied to the fuel for the construction equipment, the temporary power station for construction power, and rental of trucks, air flights to the project—needs clarification)
7.1.6 Operation and Maintenance Agreements

MWH will comment on contract provisions to market norms with respect to the following items:

7.1.7 Term and termination
7.1.8 Budget review and control
7.1.9 Owner/Operator responsibilities
7.1.10 Operations and maintenance plans
7.1.11 Environmental compliance
7.1.12 Reporting procedures
7.1.13 Compensation and incentive bonus and penalty structure to determine cost effectiveness and compatibility with long term operations and maintenance objectives
7.1.14 Consistency amongst construction, operation and maintenance, service, capacity and energy sales, water management, both amongst each other and compliance with the environmental permits and requirements

7.2 Power Purchase and Interconnection Agreement(s)

MWH will review the technical aspects of the agreements to determine if the provision are compatible with the expected output of the Project and that the design conforms to the interconnection requirements of the contracts. Specifically, MWH will perform the following reviews:

7.2.1 Review the conditions that must be satisfied to qualify for full energy and capacity payments
7.2.2 Review the conditions under which the utility can dispatch the Project or limit its power output

7.3 Water Usage Agreements

MWH will review the Water management Agreement and determine whether it allows the Project to perform to its projected capacity.

7.4 Loan Documents

MWH will review the technical aspects in the financial agreements to ensure consistency with Project contracts and performance assumptions. In particular, MWH will perform the following services:
7.4.1 Review the terms of a budget review and the approval process
7.4.2 Review the Owner/Operator reporting requirements

ACTION ITEMS:

1. For each of the items listed in Task 7.1, 7.2, and 7.3, MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.
2. The answers to the Task 7.1, 7.2 and 7.3 questions and opinions will be included in the Independent Engineer's Report.
3. For each of the items contained in 7.4, MWH will opine on the suitability and completeness of the terms of the budget review and the approval process. MWH will also review the reporting process and requirements to verify that it meets the requirements of the loan documents which require close attention and diligence of the staff which perform the work. MWH would be please to assist the Owner and Clients in reviewing under aspects of the term sheets which are within their areas of expertise, but have not budgeted to do so at this time.
4. Items of particular interest that the IE believe need immediate attention by the Owners and Clients will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
5. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 8: Review of Permits and Licenses

8.1 General

8.1.1 MWH will assess the ability of the project, based on design criteria and intended modes of operation, to meet and maintain compliance with technical requirements of the applicable major permits. The review will include reviewing the conditions pertaining to reporting requirements and other operating restrictions.
8.1.2 MWH will review the schedule of permits, licenses and approvals required from authorities having jurisdiction for construction and operation and all available permits or permit applications. MWH will furthermore perform the following services:
8.1.2.1 MWH will assess the capability of the Project as designed to meet the technical requirements and constraints specified in the Project's permits, licenses and approvals
8.1.2.2 Only at the direction of the Owner, MWH will establish contact with the appropriate provincial and federal environmental or energy regulatory agencies for the purpose of independently identifying and determining the current status of the major permits, licenses and approvals to construct and operate the Project. This work will be performed in strict compliance with the Owner's wishes and oversight and close contact with the Owner.

8.1.2.3 MWH will identify the major permits, licenses and approvals that have not been obtained and comment, from a technical perspective, on the likelihood that they may or may not be able to be obtained in a timely manner to support the Project schedule.
8.1.2.4 MWH will review the adequacy of budgeted amount in the capital budget to obtain and maintain compliance with the permits, licenses and approvals, including the cost of habitat compensation measures and meeting commitments made by the Owner in its application(s) for the document(s)
8.1.2.5 MWH will address technical and commercial issues arising from zoning, local municipality requirements or other agencies having jurisdiction over the Project.
8.1.2.6 MWH will review environmental site assessment report (s) prepared by others and comment on such issues as the following ones:
8.1.2.6.1 Documentation and support for the conclusions reached in the report
8.1.2.6.2 Unusual circumstances or locality specific issues
8.1.2.6.3 Status and cost of any required remedial activities

ACTION ITEMS:

1. For each of the items listed in Task 8.1, MWH will review the appropriate documents with the MWH team specialist, Brian LeDrew, and then prepare an opinion and answer to the request for information.
2. The answers to the Task 6.1 questions and opinions given by MWH will be included in the Independent Engineer's Report.
3. Items of particular interest that the IE believe need immediate attention by the Owners and Clients will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.
4. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 9: Review of Pro Forma Assumptions

MWH will review and comment on the technical assumptions and data input to the Owner's Project pro forma financial model which sets forth the projected revenue, expenses and debt service costs of the Project. The RFP notes that because payments will be based on fixed monthly payments, extensive review of market studies by MWH is not required. MWH will not perform any market studies under this contract, but would be happy to furnish a separate proposal to do so, if the Owner and Client (Lenders) requires this to be accomplished. In particular, MWH will perform the following services:

9.1 Review the performance model that was used to estimate annual water usage and operating costs and annual revenues from the sale of power will be evaluated to determine if it accurately reflects the material Project contracts and expected operating environment.
9.2 MWH will determine how well the assumptions and projects made in the pro forma are supported by contract guarantee, performance testing, quality of the design and equipment, and the experience of the Project participants
9.3 MWH will verify that the following assumptions are reasonable and consistent with the design of the Project, expected operating scenarios and project agreement:
9.3.1 Project performance and reliability
9.3.2 Revenue projections

9.3.3 Facility performance degradation
9.3.4 Dispatch constraints as per the power purchase agreement including curtailments and part load operation
9.3.5 Escalation assumptions
9.3.6 Annual operating and maintenance expense inputs to the pro forma, including major maintenance and capital replacement
9.3.7 Bonus/penalty arrangements
9.3.8 Working capital requirements of the Project
9.3.9 Cost for establishing inventories
9.3.10 Adequacy of pre-operating expense budget (operator training, consumables, lubricants and testing)

9.4 MWH will propose and review a set of typical pro forma sensitivity cases. The sensitivity cases will be selected to test the impacts of variances in key operating assumptions, such as: interest rates; inflation; operating expenses.

MWH usually is asked to input the following data, based on our reviews of many pro forma:

9.4.1 Average annual generation
9.4.2 Variability in annual generation (usually a rolling average for a certain number of years) – the critical factor in financing is the early years of generation while debt is being paid; for a long-term perspective, the long- term average would be appropriate
9.4.3 O&M Staffing Plan / Maintenance Program
9.4.4 Annual O&M Budget (and O&M Agreement)
9.4.5 Major Renewals and Replacement Program
9.4.6 Annual CAP EX budget
9.4.7 Valuation of power from the project
9.4.8 Any anomalies or red flags we observe

9.5 MWH will also review and comment on sensitivity cases to the base case pro forma.
9.6

ACTION ITEMS:

1. For each of the items listed in Task 9.1, 9.2, and 9.3, MWH will review the appropriate documents with the MWH team specialists and then prepare an opinion and answer to the request for information.
2. The answers to the Task 9.1, 9.2 and 9.3 questions and opinions will be included in the Independent Engineer's Report.
3. MWH has indicated in Task 9.4 items they normally suggest to be considered to be inputted into the pro forma, based on their investigations and past experience. Other items that may be required by certain lenders such as risk assessments for insurance purposes have not been included, since they would require special studies beyond what we have budgeted. If such studies are being contemplated by the insurers, these extra tasks should be discussed early-on to determine how they could be implemented in the schedule presented.
4. Items of particular interest that the IE believe need immediate attention by the Owners and Clients will be discussed via email and telephone to ensure that the appropriate action can be made to address the issue cited.

5. The IE will notify the Owner in writing, usually by email followed by a telephone call, if deemed necessary to discuss the missing information to prevent a delay in the delivery schedules established between the Owner (s) and MWH.

Task 10: Prepare Independent Engineer's Report

MWH will prepare a draft and final Independent Engineer's report in a suitable format as agreed to by the Owner.

The report will provide a brief description of the Project Facilities and key agreements and will set forth the principal assumptions, opinions, conclusions and summarized pro forma operating results.
During the course of the review, MWH will bring to the Owner's and Lender's attention areas of risk that is discovered as a result of the technical review and any mitigation options to be considered by the Lender (Client) and the Owner.

A draft of the Independent Engineer's Report setting forth preliminary opinions, conclusions and pro forma results, including discussions of any unresolved issues and associated risks identified during the review will be prepare and submitted to the Lenders (Client) for review and comment. MWH will incorporate the Client's comments and Owners comments, and present the status of each issue in the final Independent Engineer's Report.

In keeping with our intent to communicate with the Owner as early as we can, on what MWH will be proposing, we have included with this section the outline we propose to use for the Project IE Report:

Letter of Transmittal
Table of Contents
Executive Summary

1. General
2. Report Section 1
3. Report Section 2
4. Report Section 3
5. Report Section 4
6. Report Section 5
7. Report Section 6
8. Report Section 7
9. Report Section 8
10. Report Section 9

SECTION 1 PROJECT SCOPING MEETING AND SECURING PROJECT DOCUMENTATION

1. Communication Protocols
2. Project Data
3. Project Data Request
4. IE Milestone Schedule

SECTION 2 SITE VISIT AND OFFICE INTERVIEWS

1. Muskrat Falls Generation Project Site Visit

2. Labrador Island Transmission Link Site Visit
3. Maritime Transmission Link Site Visit
4. Office Visits with IPCM Firm (SNC-Lavalin)
5. Office Visits with the Contractor(s)
6. Office Visits with Principal Hydrogenerating Equipment Suppliers
7. Office Visit with Owner's Environmental Engineers/Permit Specialists
8. Office Visit with Owner's Safety Engineer

SECTION 3 PROJECT DESIGN AND PROJECTED PERFORMANCE

1. Projected Project Performance
2. Project Hydrology
3. Expected Performance of Major Structures and Systems
4. Major Systems Compatibility and Completeness
5. Operating History of Major Equipment
6. Electrical Interconnections Between Projects
7. Water Supply and Wastewater Disposal Systems
8. Technical Criteria Consistency
9. Experience and Capability of Major Project Participant

SECTION 4 CONSTRUCTION PLAN AND SCHEDULE

1. EPCM Contract
2. Construction Contracts
3. Guarantees and Liquidated Damages
4. Construction Schedule
5. Performance Test Criteria

SECTION 5 CAPITAL BUDGET

1. Total Project Cost Estimate
2. Drawdown Schedules

SECTION 6 COMMERCIAL OPERATION AND MAINTENANCE SERVICES

1. Operations and Maintenance Plan
2. Operations and Maintenance Cost Estimate

SECTION 7 PROJECT AGREEMENTS

1. POWER PURCHASE AGREEMENT
2. INTERCONNECTION AGREEMENT
3. WATER USAGE AGREEMENT
4. LOAN DOCUMENTS

SECTION 8 PERMITS AND LICENSES
SECTION 9 PROJECT PRO FORMA
SECTION 10 FINANCIAL CLOSING SUPPORT SERVICES
SECTION 11 LIST OF DOCUMENTS REVIEWED

APPENDICES

Appendix A Location Map
Appendix B Site Plans
Appendix C Technical Characteristics
Appendix D Transmission Line Routes

Appendix E List of Information Needed to Perform the IE Technical Evaluation Contract
Appendix F List of Questions to be Investigated During the Site Visit and Office Interviews
Appendix G Evaluation for Environmental Impacts and Schedule for Environmental Actions
Appendix H Liquidated Damages Calculations
Appendix I Construction Budget
Appendix J Construction Schedule
Appendix K Bathymetry Profile of Submarine Cables for Labrador Island and Maritime Transmission Links

MWH has assumed that only a consolidated IE report will be provided to the Clients and the Owner, as typical for project financing, since the details contained in this task ONLY MENTION ONE REPORT that will include the three separate 'projects'. We have prepared our schedule and budget for one consolidated report, both draft and final, to be furnished. However, if three separate reports and a consolidated report are actually required, we will need to revise our schedule and budget to accommodate this request.

ACTION ITEMS:

1. MWH will prepare a Draft Independent Engineers Report and furnish 30 copies for review and comment. We have assumed that the Owner and Client will need about two weeks to review the report and combine their comments into one 'conformed' report that can be used by the Independent Engineer to complete the final IE report. We recognize that for certain parts of the report this may not be possible to combine all of the thoughts and edits and, therefore, a telephone conversation would be necessary to resolve differences of opinions with MWH's help/assistance to allow one comment to be presented for MWH's consideration.
2. MWH will prepare a final independent Engineers Report and furnish 30 copies for the Owner's and Clients' use.

Task 11: Financial Closing Support Services

11.1 MWH will support financial close by providing information on the Project to the Lenders, prospective investors, hedge providers and the federal guarantor, either in person or via conference call.

11.2 MWH will participate in rating agency meetings and syndication presentations as requested by the Client.

11.3 MWH will prepare the typical and customary certificates required at financial closing to verify the accuracy of the information provided in its report.

11.4 MWH has assumed the following times, as given in the estimate we provide, to be reasonable. We realize that these services can vary considerably for each project; as such, we would be able to vary these times as would be provided for in our contract with the Owner.

11.5 MWH has assumed that our services will be required during the 25th week of the project and will require early verification as to when they will be scheduled.

ACTION ITEMS:

1. MWH will perform the services outlined in Task 11.1 by telephone to supply information to the Lenders and prospective investors and has budgeted 28 hours of time to do so.

2. MWH will participate in rating agency meetings and syndication presentations, having budgeted for 72 hours of senior level time to do so, assuming the meetings will occur on one day and in St John's.
3. MWH will provide the typical certificates required in Task 11.3.

DETAILED SCOPE OF WORK - PHASE 2

PHASE 2: CONSTRUCTION PERIOD

MWH will perform the following tasks following financial close and during the construction of the Project:

Task 1: Attend Project Review Meetings

MWH will attend Project review meetings with the Owner and Contractor at either the Owners office or Contractor's offices to assess progress in engineering, procurement and construction activities and to review the contractors' presentation of areas of concern and change orders.

The number and frequency of meetings will be decided in consultation with the Client and the Owner. We have provided in our work break down, assumed times that generally are reasonable to present at this time which may vary from the times and number of meetings actually required. Our contract with the Owner is assumed to accommodate these support services that may be additional to those given herein. Following review meetings, we have assumed at one day each, visits to the project sites will be conducted allowing 2 days for these visits. We have scheduled many meetings since the Project will require close monitoring because of its complexity and high value to protect the interest of all parties.

ACTION ITEMS:

1. Attend during the first four years monthly project review meetings as given in the schedule with the project manager in attendance of all scheduled meetings. During the last two years, the PM will attend 6 meetings a year and other senior staff will attend the other 6 meetings.
2. Review meeting notes will be taken and letter reports will be issued to the Clients. Twelve reports will be issued each year.

Task 2: Services Relating to the Engineering

MWH will review the progress of the remaining engineering for compliance with the milestone schedule. We assume this will be done on a monthly basis.

ACTION ITEMS:

1. MWH will review and report on milestone schedule each month to ensure it is in compliance with the schedule and in accordance with the Contract. The basis for the IE's review will be data supplied by the EPCM engineer and the Owner, where appropriate.
2. A letter report will be furnished to the Client every month over the six years of Project Work assumed by MWH.

Task 3: Services Relating to Procurement

MWH will review the progress of the award of major procurement contracts and delivery commitments for conformity with the milestone schedule.

ACTION ITEMS:

1. MWH has assumed that the following separate contracts will be required: powerhouse civil, dam, and spillway; mechanical and electrical erection; mechanical and electrical procurement; maritime link transmission; Labrador link transmission; transmission equipment; and submarine cable procurement. We would expect that we will be advised as to the actual contracts required to be monitored to allow us to refine our estimate prior to our agreement signing with the Owner.
2. A letter report will be furnished to the Client every month over the six years of the Project Work assumed by MWH outlining our observations in tracking the schedule.

Task 4: Services Relating to Construction and Start-Up

MWH will perform the following services:

4.1 Review proposed work and quality control plans

4.2 Perform on-site visits for observation of the work in progress to determine that the Project is proceeding in general accordance with the milestone schedule and with the agreed-upon design concepts

4.3 Perform periodically reviews of the quality control reports and field laboratory test reports

4.4 Consult with the Owner and contractors in advance of scheduled major inspections, tests or the start of important work phases

4.5 Review compliance to the Project schedule on a monthly basis through reports submitted by the construction contractors, and on-site observation

4.6 Review, during the on-site visits, the contractors' monthly invoice with the Owner and construction contractors to verify accuracy.

ACTION ITEMS:

1. MWH for Tasks 4.2 and 4.6 will perform these services while at the site during our regularly scheduled monthly meetings and site visits; budget for performing this work is included under Task 1
2. MWH for Tasks 4.1, 4.3, 4.4, and 4.5 will be performed as required and reported on in a monthly report pertaining to this task. Reports will be issued for the six years assumed for Project duration.
3. MWH will alert the Client to any major issues via phone and email before our reports are issued to allow the Client to reflect on our observations, findings and opinions prior to receiving the reports.

Task 5: Review Change Order(s) to the Construction Contracts

MWH will review major change orders to the construction contracts.

The review will include the following:

5.1 Verification of the impact of the changes on the construction cost and schedule of the Project and on the ability of the Project to meet its performance guarantees.

5.2 Review of major change orders or significant changes in Project execution or budget will be performed if required by the financing agreements at Client's authorization

5.3 Review of change orders over C$ 500,000 will be performed; we have assumed 8 reviews are required

MWH's review does not include any review of claims that may occur during the course of the work. However, if these services are required by the Client's and Owner, MWH would be able to assist in these reviews under separate arrangements.

ACTION ITEMS:

1. MWH will review all change orders over C$ 500,000 (8 assumed) as requested in writing by the Client and have assumed we will spend 20 hours each on the reviews.
2. MWH will hold several telephone calls with the Client and Owner to go over the findings and ask additional questions which might require the Contractor and EPCM engineer to furnish additional information for our review.
3. MWH will send a letter summarizing our findings and observations and will include a recommendation(s) for consideration by the Client.

Task 6: Prepare Independent Engineer's Periodic Report

MWH will prepare an Independent Engineer's Periodic Report which will include the following topics:

6.1 General status of construction versus the milestone schedule

6.2 Status of the budget versus actual expenditures

6.3 Status of planned contract expenditures versus actual

6.4 Status of change orders or claims

6.5 Areas of concern and actions being taken of which the IE is aware.

6.6 Submittal of the report to the Client and the Owner

ACTION ITEMS:

1. MWH will every three months issue an Independent Engineer's Periodic Report which will contain the topics given in Tasks 6.1-6.5
2. MWH will issue the Report to the Client and Owner as required in Task 6.6
3. Issues that may be of critical interest will be relayed to the Client and Owner via telephone and email, as necessary to alert each of our clients to these matters prior to receiving the reports. Since these are summary reports, we would expect that all parties will be knowledgeable of critical issues pending.

Task 7: Prepare Independent Engineer's Draw Certification

MWH will prepare IE draw certificates considering the following items:

7.1 Review the Client's monthly loan requisition certificate and supporting documentation
7.2 Compare the actual budget and schedule against the contract budget and schedule
7.3 Request changes or supplemental information as required to approve drawdown requests
7.4 Prepare the monthly IE's draw certification that will make a recommendation to the Client regarding the payment due
7.5 Submit the draw certificate to the Client and the Owner

ACTION ITEMS:

1. MWH will perform the services required in Tasks 7.1-7.4 as required by the Owner and Client
2. MWH will send to both the Client and Owner the monthly draw certificate as required in Task 7.5

Task 8: Verify Project Completion

MWH will confirm Project completion as required by the financing agreements which will include the following reviews and considerations:

8.1 Review of construction contracts' completion certificates
8.2 Monitor successful completion of each punch list item by telephone
8.3 Make final visit to the Project site to verify punch list items have been completed
8.4 Sign the appropriate document and submit it to the Client and the Owner
8.5 Provide certification to the Client certifying that the engineering, design, construction, testing and commissioning of the Project conforms to the applicable contracts, codes, standards, good industry practice and prudent utility practice.

ACTION ITEMS:

1. MWH will make a final visit to the Project site to verify punch list items have been completed, as required in Task 8.3. We have assumed that the project manager, lead structural/civil engineer, lead hydro-mechanical engineer, hydro-electrical engineer, lead transmission and switchyard electrical engineer, and lead submarine cable and high voltage DC engineers will be in attendance.
2. MWH will perform the Tasks listed in Tasks 81.and 8.2.
3. MWH will sign the appropriate documents for Project completion required by the Client and Owner and provide the Independent Engineer's Certificate for Project Completion as indicated in Tasks 8.4 and 8.5.

1.3 Specific Requirements

The Technical Proposal shall specifically address:

a) Project organization and execution strategy;

Response:

MWH Canada has dedicated a team of experienced engineers with many years of experience in the design and operation of hydroelectric plants, and who have performed numerous Independent Engineering reviews for other projects during their careers. The IE organization charts included with the Execution Plan indicates the specialized fields of expertise required to process the work and include specialists to allow the work to be processes relatively more quickly by providing several specialists in each of the main categories of Work. Also included with the Execution Plan is the MWH Global Organization Chart as required by the RFP. Our proposed project organization charts are attached as Appendix 1 at the end of this section.

b) Bidder's organization; (further detail regarding organization and Key Personnel shall be provided in response to question 3.0 herein);

Response:

Our corporate organization chart is attached as Appendix 2 at the end of this section.

c) Overall roles and responsibilities

Response:

Detail roles and responsibilities are listed in our Personnel Matrix Table which is attached as Appendix 3 at the end of the section.

d) Planning and scheduling methodology;

Response:

Typically for the review and preparation of the IE report, the work flow is dictated by the Owner's schedule of providing the data needed in a timely manner to be reviewed by the Independent Engineer. As such, the MWH team would be reviewing data as it becomes available which would dictate to a great extent the technical specialist's schedule. To avoid this typical issue, which causes delays to the planned schedule, we are requesting that 90 percent of the data be available by the beginning of Week 4 that will allow a more logical schedule to be promulgated in this case.

We also require that 100 percent (99% would be achievable) of the data be available by the end of week 10. Reviewing the project agreements and how they are successfully intertwined to allow a smooth prosecution of the work with no apparent gaps or conflicting statements is paramount to having a successful project. By this time (Week 10), MWH's specialists will be very familiar with the schedules being used by the various primary contractors and will be able to ascertain if one or more contracts does not fit-in with the overall Project schedule and work plan. This usually

requires adjusting the schedule and could lead to change orders. Another reason to have about 90 percent of the data available at the end of the third-week is the need to have at least a week to review the information prior to visiting the site. To ensure that the site visit is meaningful, our key technical experts must know what the Contractor (and major suppliers are proposing) to allow us to listen to their presentations and ask meaningful questions.

We intend to prepare lists of questions for these 'office meetings' and the field visit, based on our knowledge of the project. This will allow the MWH team to gain a better appreciation of how the different contracts work together and the limits of supply for each of the principal vendors/equipment suppliers. If we find that information is not available or apparently conflicting, our opinions will be conveyed to the Owner (and the Client) as our review progresses. We believe that if we can alert the Owner (and Clients) to issues or areas of concern, they can take action that should eliminate as much as possible, delays in our work as well as possibly delays to financing the project. It is also important that our Key personnel finish their work as generally scheduled to avoid schedule conflicts with other assignments. We have placed several individuals in each of the technical categories that are critical to this project with the intent of keeping to schedule. By doing so, we have provided some flexibility as to how the work for a particular task is performed since most of our staff has many years of experience in reviewing project documents and in the direct preparation of deigns and project construction documents (drawings and specifications). Throughout our Execution Plan, we have indicated how we approach work, listed outlines of data needed, provided a listing or outline of the sections in the IE report, and noted additional items where we will be carefully screening and reviewing the data provided. We have every reason to believe that we will be able to keep to our proposed schedule and budget for this assignment if our propose schedule is generally accepted by the Owner (and the Clients).

e) Reporting;

Response:

MWH's Global Project Delivery Framework requires the development and inclusion of a project specific Communication Plan as a key component of the overall Project Execution Plan. Our Communication Plan will detail all aspects of coordination and reporting between project team members internally and externally. The plan will include regular telephone and email communications, weekly or monthly MWH team conference call updates and Monthly Progress Reports to NALCOR. The Project Manager's Monthly Progress Report will demonstrate meeting budget, schedule and milestones, will record the overall progress during the month and will highlight key decisions and upcoming activities. The report will also address the specified in the RFP monthly invoicing requirements.

1.4 Schedule

Bidder shall provide, in its Technical Proposal, a summary schedule for the implementation of the work.

Response:
Our summary schedule is attached as Appendix 4 at the end of this section.

2.0 SUBCONTRACTORS

If applicable, Bidder shall provide a complete listing and details of all proposed Subcontractors, including the details of the Services proposed to be subcontracted.

Response:
Please see attached subcontractor list at the end of this section.

3.0 ORGANIZATION AND KEY PERSONNEL

3.1 General

Bidder shall provide sufficient detail with respect to Bidder's corporate structure and proposed Project organization and Key Personnel to demonstrate a thorough understanding of the requirements for the provision of the Services and the satisfaction of all obligations of Contractor under the Agreement.

Response:
MWH Canada has dedicated a team of experienced engineers with many years of experience in the design and operation of hydroelectric plants, and who have performed numerous Independent Engineering reviews for other projects during their careers. The IE organization charts indicates the specialized fields of expertise required to process the work and include specialists to allow the work to be processes relatively more quickly by providing several specialists in each of the main categories of Work. Also included is the MWH Global Organization Chart as required by the RFP.

3.2 Project Organization

Bidder shall provide, as an appendix to its response to this question, details of the Project-specific organization that Bidder proposes for the provision of the Services. The organizational structure shall be presented as an organization chart that clearly identifies the lines of authority, reporting structure, and relationships for all Agreement management functions.

The organization chart shall be arranged to present the proposed organization.

The respective organization chart shall clearly identify:

- Bidder's proposed Key Personnel;
- Any Subcontractor personnel that are proposed to be integrated into Bidder's project management organization;
- The organization of any nominated Subcontractor, including any Key Personnel of the Subcontractor;
- Identification of specialist personnel.

As part of its submission, provide resumes of all personnel identified as Key Personnel positions as identified in Attachment 1 and all other key positions as identified by the Bidder.

Response:
Our proposed project organization charts are attached as Appendix 1; resumes as Appendix 3 at end of this section.

3.3 Key Personnel

Bidder shall provide the following with respect to its list of proposed Key Personnel:

- Roles and responsibilities, including detailed role descriptions.
- Resumes for all Key Personnel candidate nominations.
- For each Key Personnel, confirmation of his/her availability and anticipated duration of assignment to the Services. This requirement also applies to Key Personnel to be provided from Subcontractors.
- Relevant experience of Key Personnel (redacted copies of work) which is applicable/related to the Scope of Work requested.

Contractor's Key Personnel, as agreed with Company, shall form Appendix A of the Agreement.

Response:
The requested information is listed in the Personnel Matrix Table, attached as Appendix 3 at the end of this section.

In direct response to record the "anticipated duration of assignment to the Services for each key personnel", we have excluded information for each individual and instead, guarantee all identified key personnel to perform the requested scope of services as outlined in the Detailed Scope of Work Section.
MWH believes that we have assembled a very highly experienced group of engineers and specialists to perform the work to address the tasks of the RFP. We believe that unless senior engineers are

predominately used for the Lower Churchill Project assignment, issues that most engineering firms would not likely be aware of would be overlooked in their reviews of the Project in performing Independent Engineering services. Since our staff has been involved in the preliminary phases of projects, from performing planning studies, preliminary design at feasibility level, final design, preparation of construction bid documents (drawings and specifications), Level 1 through Level 4 construction cost estimating, CPM scheduling, equipment testing and commissioning of large hydro-generating equipment, serving as resident engineers and lead site engineers, and in the preparation of numerous IE Reports for lenders and investors, we are confident that our review and assistance will be superior to others. We have included, because of the Project's importance and cost, additional senior support for most of the categories of work required to process the tasks. In reviewing the resumes that MWH presents for the reader's perusal, consideration should be given to many members of our staff have worked with MWH for a number of years, attesting to the desirability of working for the world-recognized, primer firm in the design of dams, spillways, and power stations. Our staff has and is working on other large power stations and dams in Canada and Alaska, as well as Iceland where attention to weather is also a major consideration in the design and construction of a hydroelectric project. We have also recognized in the staffing of the Project that there are several areas where additional expertise is required to ensure that we are providing specialists to support our team and have engaged them as sub consultants. We are also adept at expeditiously working with many parties to resolve problems and issues that are uncovered by our independent review to allow all parties to keep to the Project schedule and reduce potential risks.

4.0 PACKAGE SPECIFIC

4.1 Bidder shall provide a listing of hydroelectric generation projects for which it has served in a capacity similar to the role of independent engineer (IE) as described in this RFP package. Bidder shall identify such of those projects that were completed on an EPCM basis rather than EPC basis. For at least one of those projects, Bidder shall provide a full description of its participation including the roles it performed.

Response:

New Bong Escape Hydropower Project, Pakistan

MWH was retained by the developer of this 45 MW hydropower project located downstream of the Mangla Project tailrace to undertake a technical and financial due diligence assessment. In this connection, MWH reviewed: (1) the hydrologic data and energy estimates prepared by others; (2) the design of all major structures including the diversion, intake structure, penstock and powerhouse; and (3) project cost estimate including all major electrical and mechanical equipment. Applying the MWH financial model, the financial viability of the project was assessed including expected return on equity.

Maheshwar Hydroelectric Project, India

Client: Shree Maheshwar Hydel power Corporation Ltd., Entergy power Group

An Indian private power developer - Shree Maheshwar Hydel Power Corporation Ltd. (SMHPCL) - retained MWH to provide engineering services for the review of designs, construction drawings, and technical specifications prepared by an Indian consulting engineer for the 400-MW Maheshwar Hydroelectric Project

located on the Narmada River in Madhya Pradesh. Additional services in the future include assistance during tendering, assistance in evaluation of bids and recommendation of contractor(s) and suppliers. MWH also provided as-needed services during construction.

On the same project, Entergy contracted with MWH in 1997 to provide opinion on the technical feasibility of the Maheshwar Hydroelectric Project, and identify technical issues that may hinder its construction and operation. MWH services include a (1) review of previous hydrologic studies, (2) review energy generation computations previously prepared, (3) summary of MWH comments subsequent to bid document review, (4) summary of review of independent consultant's comments for Pacific Generation, (5) technical review of the Power Purchase Agreement, (6) cost estimate and construction previously prepared by MWH, and (7) report on the environmental investigations as to the effects of instantaneous water release at the Project on the area downstream during the dry season, and the requirements for minimum release.

4.2 Bidder shall provide a listing of major high voltage transmission line projects for which it has served in a capacity similar to the role of IE as described in this RFP package. Bidder shall identify such of those projects that were completed on an EPCM basis rather than EPC basis. For at least one of those projects, Bidder shall provide a full description of its participation including the roles it performed.

Response:

CBK Project, Philippines

Client: GE Capital/international Hydro/IMPSA Argentina

MWH performed condition assessments, system operation studies, and economic and financial analyses for the CBK Project in the Philippines, on behalf of an Engineering-Procurement-Construction (EPC) consortium, IMPSA Argentina, which is interested in acquiring the existing facilities - comprised of two small hydroelectric projects (Caliraya and Botocan) and the 300-MW Kalayaan I pumped-storage project - and expanding the pumped-storage project with an additional powerhouse and two new units totaling 300 MW (Kalayaan II).

MWH obtained engineering data for the National Power Corporation bulk power transmission system for the purpose of establishing plant performance requirements and electrical equipment characteristics. Projects are operated in an open access transmission system according to the requirements of the Philippine Power Grid Code.

MWH performed due diligence studies prior to submittal of build, rehabilitate, operate and transfer (BROT) bids. Duties included review of the physical, geologic and geotechnical conditions of the sites and an assessment of the anticipated conditions to be encountered during rehabilitation and construction. Also performed resident management services, including meetings with NPC and collection of data.

A team of senior civil, mechanical and electrical engineers recommended repairs to the existing facilities and prepared general arrangement drawings and a cost estimate for balance-of-plant equipment costs at Kalayaan II. A senior planning engineer has performed system operation studies, comprised primarily of hourly production cost analyses for future years and alternative expansion and load forecast scenarios. A basic financial analysis was prepared to determine whether the proposed acquisition was attractive given the likely cost of private funding of development, purchasing the pumping energy, and operating the projects, as compared to the rates that the National Power Corporation could be expected to pay for peaking power and energy.

Technical Advisory Services - Concession for 600-km Transmission Line, Peru

Client: Confidential

Transmission Line. MWH's services include review of the prior studies, confirm technical operating and reliability criteria, prepare estimates of O & M, and prepare technical sections in the offering memorandum and related concession documents.MWH provided technical services to an Financial Advisor/Investment Banking Company that has responsibility to undertake and manage the contracting of a concession to build and operate a 600 km

4.3 Bidder shall describe any prior experience it has working with project finance lenders and contractor consortiums in the role of IE or project monitor for lenders.

Response:

MWH has provided Independent Engineer services on numerous occasions to Lenders in respect of new or greenfield projects, for the sale or refinance of existing projects, and for operational projects. Selected examples of current and past projects are as follows:

Rio Las Vacas Hydroelectric Project

Client: Inter-American Investment Corporation

This is a 20 MW hydroelectric project located on the outskirts of Guatemala City in the Republic of Guatemala. The project includes a concrete gravity dam, intake, 4.5 km tunnel, surge chamber, penstock and powerhouse.

MWH's scope of work includes design review and construction and performance monitoring. Periodic visits are made to site and documentation is received including progress reports for review. MWH will witness the performance tests prior to commissioning of the station.

Taquesi Hydroelectric Project

Client: International Finance Corporation

This is an 84.2 MW hydroelectric project located along the Taquesi and Unduavi Rivers in the Republic of Bolivia. The project comprises two new run-of-river hydroelectric facilities with a total installed capacity of 83.5 MW, plus an existing refurbished 700 kW projects. The upstream plant will have a capacity of 34 MW and the downstream plant will have a capacity of 49.5 MW. The layout of both plants will include small diversion dams and re-regulation reservoirs, intakes, de-silting basins, tunnels (each 4.6 km), surge shafts, penstocks and powerhouses.

The major phases of the scope of work are:

- Phase I – Project Review and Assessment
- Phase II – Construction Monitoring
- Phase III – Performance Testing
- Phase IV – Initial and Annual Operations Review

At this time, Phase I is complete. Phase II will commence as soon as financial closure takes place.

Alto Cachapoal Hydroelectric Project

Client: Citibank

This is a new 195 MW hydroelectric plant located 100 kilometers southeast of Santiago, Chile. The scope of work for the Independent Engineer includes the following key aspects:

- Project evaluation and assessment, including review of plant design, project costs and schedule, engineering – procurement – construction contract documents, operation and maintenance arrangements, project pro forma, permits and licenses, and environmental impact assessments.
- Construction monitoring, including procurement and construction progress, review of applications for construction loan draws, review of change orders, and completion punch lists and verifications.
- Performance testing, including review of procedures and witnessing tests.
- Operation and maintenance arrangements, including review of manuals, spare parts inventory, training programs, and staffing.

Glen Park Hydroelectric Project

Client: Teachers Insurance and Annuity association

This is an existing 35 MW hydroelectric plant located on the Black River near Watertown, New York. The project is being refinanced.

As Independent Engineer, MWH's scope of work included:

- Condition assessment of the plant
- Evaluation of plant output
- Review operation and maintenance procedures and costs
- Review periodic larger expenses such as generator rewinds.
- Review capital expenditures including those for plant rehabilitation or upgrade and for regulatory compliance especially with respect to environmental matters and dam safety.
- Checking on regulatory and environmental compliance.

Sidney A. Murray Jr. Hydroelectric Project

Client: Philip Morris Capital Corporation, et al.

This is an operating 192 MW hydroelectric plant on the Mississippi River near Vidalia, Louisiana. The project is a sale/leaseback transaction and MWH is the Independent Engineer to the Owner Participants (Philip Morris Capital Corporation, Edison Capital, Bell Atlantic Credit Company, and Dominion Capital) and the Lenders (Prudential Capital, Teachers Insurance, John Hancock, Aetna, Cigna Investments et al).

Scope of work includes:

- Review of annual operation, maintenance and capital budgets
- Review calculation of coverage rates
- Periodic and annual plant and equipment inspection.
- Monitoring or operation and maintenance to ensure compliance with the special maintenance covenant for the project and with industry standards
- Review of project performance including energy output.
- Review of items requiring certificates prior to release of funds.
- Evaluation of major modifications if any to the project facilities and transmission line.

- Review of modifications to or matters arising from the power purchase agreements.
- Review of modifications to or matters arising from the memorandum of agreement with the Corps of Engineers regarding project operation, control of sediment, and maintenance or the Mississippi River navigation channel.

Previously MWH had provided, at financial closure, an independent assessment of the project to First Chicago Leasing Corporation.

Engineering Review and Services during Start-Up of the New Martinsville Hydroelectric Project, West Virginia

Client: Pru Capital, Inc.

MWH provided independent engineering services to Pru Capital to review the design and witness start-up of the 25-MW New Martinsville Hydroelectric Project. The project consists of two 19.5 MW bulb turbine/generator units on the left abutment of Hannibal Dam on the Ohio River.

MWH was contracted to provide the following services:

- Verify the Appurtenant Rights and Regulatory Approvals to Enable Construction
- Verify the River Hydrology at Hannibal Lock and Dam
- Verify the Energy Generation Estimates
- Review the Design and the Contract and Bid Documents of the Project
- Review of the Proposed Generating Equipment in Terms of Operation and Maintenance to Ensure High Availability
- Review of the General Construction Guarantees and Warranties
- Review of the Criteria for Acceptable Project Performance
- Witness Acceptance Testing of Generating Units and other Electrome-chanical Systems

4.4 Bidder shall describe any prior experience in due diligence sessions with banks, underwriters and potential investors, including participating in bank syndicate meeting(s) and conference calls with lenders. Bidder shall provide an estimate of the amount of time required for the due diligence sessions and any experience with means to expedite the review.

Response:

Bakun AC Hydroelectric Project, Luzon Island, Philippines

MWH performed a due diligence study for the 70-MW hydroelectric project located on the Bakun River on the island of Luzon in the Philippines. The project consists of a diversion weir, intake structure, desander, 6.5-km long headrace tunnel, 3.3-km long penstock, and a surface powerhouse housing two generating units each driven by two Pelton-type impulse hydraulic turbines. The Project was developed by the Luzon Hydro Corporation, a Philippine project company comprised of a consortium of three companies. The project was developed under Build-Operate-Transfer (BOT) terms. Luzon Hydro Corporation is responsible for operating and maintaining the project. Under the 25-year Power Purchase Agreement, electricity from the Project will be purchased by National Power Corporation (NPC). At the end of the PPA, the Project will be transferred to NPC at no cost.

MWH provided the following services to the client:

- Review EPC contract for completeness and any clauses that may adversely affect the owners liability;
- Review capital costs for completeness and identify any potential high risk areas;
- Review the project schedule for completeness, accuracy, and appropriateness to the project;
- Review and comment on the hydrology report;
- Comment generally on the risks and mitigation concerning a tunneling project of this nature;
- Comment on the evolving technology of the desanding inflatable bladder and its expected effectiveness and reliability and the ability of the desanding bladder and settling pond to remove silt adequately to meet the turbine manufacturer's requirements to minimize erosion;
- Review and assess the relative geologic risk and industry standards concerning this type of construction in an area known to have several faults;
- Review the adequacy of the geologic studies and their ability to predict the geology expected during the tunneling;
- Assess whether the geological information provides adequate information to make a reasonable assumption concerning the need for lining;
- Identify and assess the risks identified in the Stone and Webster report concerning the fault located directly beneath the penstock foundation; and
- Perform a site visit by an engineering geologist.
-

Pugu, Asiga and Siguil Projects, Philippines

Client: Consolidated Hydro, Incorporated/Basic Diversified

Twelve projects were determined to be economically attractive in the National Power Corporations (NPC) hydroelectric feasibility study program in Luzon Island A and B, Visayas, and Mindanao regions (the selected projects are equally distributed across the regions) and NPC released bid documents for BOT development. A consortium consisting of MWH, Consolidated Hydro, and ABB Susa are preparing bids for BOT development of hydroelectric potential in the Mindanao region of the Philippines.

MWH performed due diligence studies for a prospective development bidder and construction contractor prior to BOT bidding. Duties included review of existing reports, field reconnaissance, assessment of geologic conditions and report preparation for six small-hydro (10 to 25-MW) sites. Pugu, Asiga and Siguil were the three project sites that were visited in the field.

MWH's consortium responsibilities include performing engineering, scientific, and construction cost studies and participation in bid preparation and structuring of international project financing.

Harza Hydropower, Inc., India (MWH)

Client: Himachel Pradesh State Government in India

Harza Hydropower, Inc. (HHI), a subsidiary of MWH, signed a Memorandum of Understanding (MOU) with the Himachal Pradesh State Government in India for the private development of the 230-MW Hibra and 70-MW Dhamwari-Sunda Hydroelectric Projects. HHI completed due diligence studies on both and proceeded

with detailed technical, economic and environmental studies, arranging for project finance, and entering into negotiations for a power purchase agreement with the State Electricity Board after a favorable feasibility study recommendation. HHI evaluated previous investigations, and reviewed and modified designs that call for power tunnels of 10 to 16 km in length through complex Himalayan geology. Responsible for design and implementation of additional site investigations, reconnaissance mapping, seismic review, and inspection of exploratory tunnels. HHI provided geotechnical sections of detailed project report, developed criteria for tunnel design and rock support, dam foundation treatment, landslide mitigation measures, liquefaction assessment, assisted in construction cost estimate, and client liaison.

Met with representatives of the federal and state governments to discuss the terms and conditions of a Memorandum of Understanding to obtain the rights to develop the 70-MW Dhamwari Sunda and 230-MW Hibra projects. Discussed the terms and conditions of draft Power Purchase Agreements to sell the energy output to the State Electricity Boards of the states of Himachal Pradesh and Punjab. Negotiated the sale of 80% of the development rights to the Goyal Group, an Indian conglomerate. Advising on the implementation of the project.

Dhamwari Sunda Project (Pabbar River): The 70-MW run-of-river Dhamwari Sunda project is located about 150 km from Shimla in Himachal Pradesh. This hydroelectric scheme was developed by private sector companies and comprises a diversion weir about 15-m-high, a side bank intake, an underground desanding chamber, a 10.4-km-long headrace tunnel, a surge shaft and underground penstock, and a surface powerstation housing two 35-MW Pelton units. The gross head of the project is 460 m. The project will link with the national power grid via a short transmission line to a nearby power project.

Hibra Hydroelectric (Ravi River): The Hibra Hydroelectric Project is a run-of-river project located in northern Himachal Pradesh near the town of Chamba. The project has a gross head of 225 m and an installed capacity of 231 MW. Project development was undertaken by private sector companies. This hydroelectric scheme comprises a 68-m-high gravity dam, a side bank intake, a series of underground desanding chambers, a 14.7-km-long headrace tunnel, a surge shaft and underground penstock, and a surface powerstation housing three Francis units each of 77 MW capacity.

San Francisco Hydroelectric Project

Client: Scudder Latin America Fund

Provision of due diligence support services for the concession bid for the 230 MW San Francisco Hydroelectric Project in Ecuador.

Due-Diligence Review of the River Mountain Pumped Storage Project, Arkansas

Client: Entergy Power Development Corporation

MWH performed a due diligence review for the proposed 725-MW River Mountain Pumped-Storage project on behalf of Entergy Power Development Corporation. The project involves the proposed construction of an embankment dam forming the upper reservoir, concrete lined shafts and tunnels, and three-unit underground power station. The review investigation included a site reconnaissance by MWH civil and geotechnical engineers, visual inspection of rock cores recovered during the feasibility-level subsurface

exploration program, and a review of the licensing documents, layout of major civil features, performance characteristics and estimated construction cost. The review resulted in verification of the cost estimate and suitability of the developer's proposed layout. Recommendations included monitoring of fisheries related aspect in the proposed lower reservoir, and existing lake, to avoid the possibility of future major fisheries related operational restrictions.

Banks and Financial Clients

MWH has provided due diligence and independent engineering services to a number of financial institutions. A representative list is as follows:

- ABN Amro Bank
- ADB
- Aetna
- Arthur Anderson
- Bell Atlantic Credit
- CIGNA Investments
- Citibank
- Dominion Capital
- Edison Capital
- Fleming Bank Peru
- GE Capital
- Great West Life
- IDB
- International Finance Corporation
- John Hancock
- New York Life
- Ohio National
- OPIC
- Philip Morris Capital Corporation
- Prudential Capital
- Scudder, Stevens & Clark
- Stein, Roe and Farnham
- Teacher's Insurance and Annuity Association
- Wisconsin Investment Board
- West LB
- Wilmington Trust
- World Bank

4.5 Bidder shall describe its experience with EPCM execution of major projects where safety, schedule, budget and performance are paramount, whether as contractor, IE, or otherwise. Bidder's response shall address relevant aspects of EPCM execution including project risks, budget, and schedule.

Response:

Finchaa–Amerti–Neshe (FAN) Multipurpose Project, Ethiopia

Client:Ethiopian Electric Power Corporation (EEPCO)

The Finchaa-Amerti-Neshe (FAN) Multipurpose Project is located about 250 km west of Addis Ababa, in the Blue Nile river basin. The project comprises a development of the hydropower potential of the Neshe River and a potential irrigation of some 6,000 Ha, located in the vicinity of the existing Finchaa Sugar Estate.

Principal features of the project include:

- Neshe Dam, a zoned earthfill embankment dam (2,235-m crest length; 38-m height above lowest foundation level; 1,900,000 m3 of fill; 230,000 m3 of excavation), with an upstream shell, and a 15-m deep grout curtain.
- A water conveyance system consisting of a gated intake constructed integrally with the spillway and bottom outlet; a 1,100-m-long low-pressure steel or reinforced concrete conduit at 1% and 0.1% slopes; a 170-m-deep 2.5-m (I.D.) concrete-lined shaft; a 1,300-m-long 2.6-m horseshoe-shaped lined tunnel at 8% slope; a 360-m-long 2.1-m (I.D.) steel-lined tunnel at 8% and 2% slopes; and an above-ground 1,500-m-long 2.1-m-dia. surface high-pressure steel conduit changing to 2x1.45-m in size at a bifurcation prior to entering the powerhouse.
- A fully-equipped powerhouse, consisting of two 5-jet Pelton units, an erection bay and miscellaneous rooms, with a raft foundation resting on alluvium/boulders. Each unit has the following characteristics: 48.5-MW maximum output; 9.65- m3/s maximum unit discharge; 614.5-m gross head; 500-rpm rotational speed, 0.95-m-dia. inlet valve, and generators having 50-Hz frequency, 98% efficiency, 0.9 power factor and 53-MVA rating. Annual power generation is anticipated to be 215.5 GWh.
- A new switchyard adjacent to the powerhouse.
- Internal service roads between the dam and powerhouse, valve house and other features constructed as a part of this Project.

The MWH-ISL Consortium, supported by Tropics Consulting and Concert Engineering, performed pre-feasibility and feasibility studies of the FAN hydropower and irrigation developments in light of optimum allocation of water resources. MWH's planning services included: identification of project alternatives, hydrological analyses, geological assessment, preparation of site investigation programs, supervision and interpretation of results, operation studies and benefit analyses of 3 interconnected reservoirs, pre-feasibility and feasibility design, environmental, socio-economic and resettlement assessment of the project, supervision and coordination of soil, agronomy and irrigation studies, cost estimate and schedule, economic and financial analyses, ranking of alternatives, recommendation, and reporting. In addition, technical training and transfer of knowledge was provided to the EEPCO staff.

To assist in resolution of a severe power shortage in the country, the FAN Project was selected by the Government of Ethiopia for accelerated Fast Track implementation. MWH was requested to expand its services to include preparation of tender documents for EPC development of the works and to assist the Owner in administration of tendering and selection of suppliers and contractors.

Following completion of EPC contract tendering and financial close, MWH was again requested to expand services to include on-site technical oversight and contract administration of the EPC contract. Principal services provided by MWH include: review and provision of "no objection" to civil, electro-mechanical and hydro-mechanical designs; technical oversight of the construction, erection, and commissioning works of the Project; oversight of environmental activities during the construction, finalization as well as demobilization stages of the Project; checking, evaluating, and verifying of payment invoices issued by the Contractor; administration of claims arising from the Contractor; preparation and provision of acceptance certificates for works completed in accordance with the Contract, and coordination of project activities in respect to achieving the planned implementation schedule.

Jinnah Hydropower Project, Pakistan

Client: Pakistan Water and Power Development Authority (WAPDA)

The Jinnah Hydropower Project is being built to help meet Pakistan's increasing requirements for energy and reduce dependence on thermal power. The project is located in the Punjab Province of Pakistan, 234 km from Islamabad. The powerhouse is at the right side of the Jinnah Barrage on the Indus River approximately 5 km downstream of the Town of Kalabagh. The project is being implemented under an EPC contract awarded by WAPDA to Dong Fang Electric Corporation, a Chinese contractor, for a total project cost of $128 million. Construction started in February 2006 and is expected to last 60 months.

The main components of the project include a headrace channel, a powerhouse housing eight low head pit horizontal Kaplan turbines each producing 12 MW for a total of 96 MW, a tailrace channel, a 132 kV double circuit transmission line and a 132 kV switchyard. The project will produce 688 GWh of energy annually. Designed for a discharge of 2800 m3/s, the headrace channel will comprise a curved alignment of 500 meters and an 800-meter-long straight segment upstream of the powerhouse. The powerhouse will be a cast-in-place reinforced concrete structure and will house eight 6.5-meter, diameter, pit turbines each rated at 12.8 MW with rated head of 4.8 meters and rated speed of 72.7 RPM. The generators will be coupled to the turbines through a speed increaser and the output of each generator will be 12 MW at 750 RPM. The EPC contractor has subcontracted with European firms for the design of the pit turbines, and supply of runner blades and gearboxes. A 132 kV switchyard will be constructed on the right side of the powerhouse and will be connected to the 132 kV Daud Khel Substation with a 5 km transmission line.

As part of a joint venture with three Pakistani engineering firms, MWH is providing a variety of design review and resident engineering services for the project. These services include review of the updating and verification of the base design; monitoring and inspecting construction activities; engineering review of documents submitted by the Contractor (drawings, specifications, O&M manuals); witnessing commissioning and reliability tests, and procurement support.

MWH is also responsible for reviewing compliance with design specifications and standards, reviewing the Contractor's quality assurance plan, and monitoring compliance with the Contractor's construction and environmental management plans. MWH will also be responsible for providing a close-out report, as-built documentation, and O&E manuals before commissioning

Mirani Dam Project, Pakistan

Client: Water and Power Development Authority (WAPDA)

The goal of the Mirani Dam Project is to provide dependable irrigation supplies for the development of irrigated agriculture on the two banks of the Dasht River. This project includes the CFRD embankment dam, spillways, irrigation tunnel and approach channel, an inlet structure and an outlet control structure for the irrigation tunnel, left and right bank irrigation main canals and distribution system, bridges and associated structures. An access road, temporary works, laboratory buildings, living accommodations and recreational facilities are also included within the scope of the project. The project has a catchment area of 7964 square miles with a 302,000 acre-ft reservoir, of which 152,000 acre-ft is live. The dam is 127 ft, with a crest length of 3350 ft and a top width of 20 ft. The spillway is ungated with a stilling basin. The outlet is 1490 ft in length. While the main goal of the project is to store water for developing agriculture through irrigation of over 33,000 acres of land, other benefits of the project include flood mitigation, fisheries development, recreational facilities, and improved supply of electricity to local villages.

MWH was the Owner's Engineer for the project. In this role, MWH provided coordination and engineering review services, beginning with the selection of the EPC Contractor through to Final Commissioning of the project.

Phase I services included review, evaluation and preparation of a shortlist of contractors for approval by the employer, as well as the preparation of the EPC Tender documents.

Activities in Phase II included responding to technical questions and clarifications, completing the initial technical evaluation of EPC proposed project designs and obtaining clarifications as required. Evaluations of cost proposals financing arrangements were performed for bidders with qualifying designs. MWH assisted WAPDA in negotiations with the selected bidder to finalize and draft the EPC contract. During Phase III, MWH monitored, reviewed and provided oversight of the EPC contractor's engineering, procurement, contract administration and construction activities.

Major tasks undertaken by MWH included review of the EPC contractor's major design documents and data and verifying basis of design; monitoring submission of documents against the Engineering Review Documents Schedule; and reviewing the EPC contractor's drawings, specifications, and O&M manuals for compliance with the EPC specification. Additionally, MWH monitored the procurement process and responded to change requests by the EPC contractor. During construction, MWH maintained presence at the site until it was cleared by the EPC contractor. During this time, MWH had an effective working relationship with the EPC contractor so that clear and appropriate lines of communication were established and maintained throughout the on-site construction, commissioning and testing phases of the project.

4.6 Bidder shall acknowledge that the IE's Report may be published in prospectus or offering memorandum.

Response:

MWH hereby acknowledges that our final IE Report may be published in a prospectus or other similar offering memorandum.

4.7 Bidder shall acknowledge that banks and other financial institutions will rely on the IE's Report in making their lending decisions, and on the reports submitted by the IE during construction.

Response:
MWH hereby acknowledges that banks and other financial institutions will rely on our final IE Report in making their lending decisions, and on the reports submitted by MWH as the Lenders' IE during construction.

4.8 Bidder shall provide a sample of each of the following based on its experience with previous projects:

a) IE's Report.
b) Certificates issued by the IE at financial close.
c) Certificates issued by the IE during construction, including for drawdowns under the financing agreements.
d) Certificates issued by the IE to the lenders at completion of the Project

Response:
Please see attached documents at the end of this section.

5.0 COST ESTIMATE

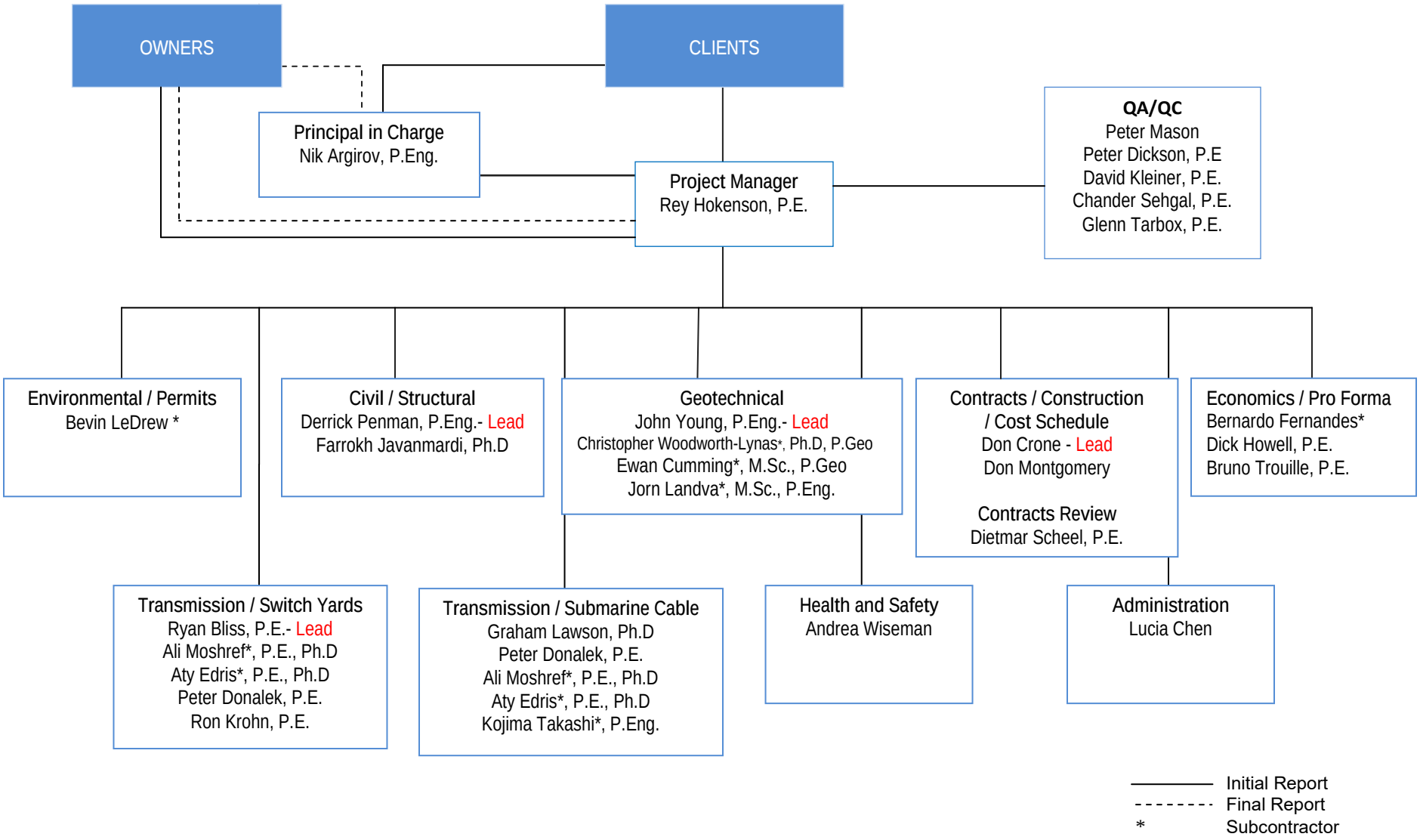
5.1 Bidder shall provide estimated person hours and estimated costs using the Cost Time Resources (CTR) form attached to this Attachment 6.

Response:
Due to the nature that this section includes pricing, MWH is submitting it in our priced original Commercial Form of Proposal per the instruction in Part I, page 8 of the RFP, requesting the Commercial section to be submitted as a separate volume. In addition, the instructions request only one priced original is to be submitted.

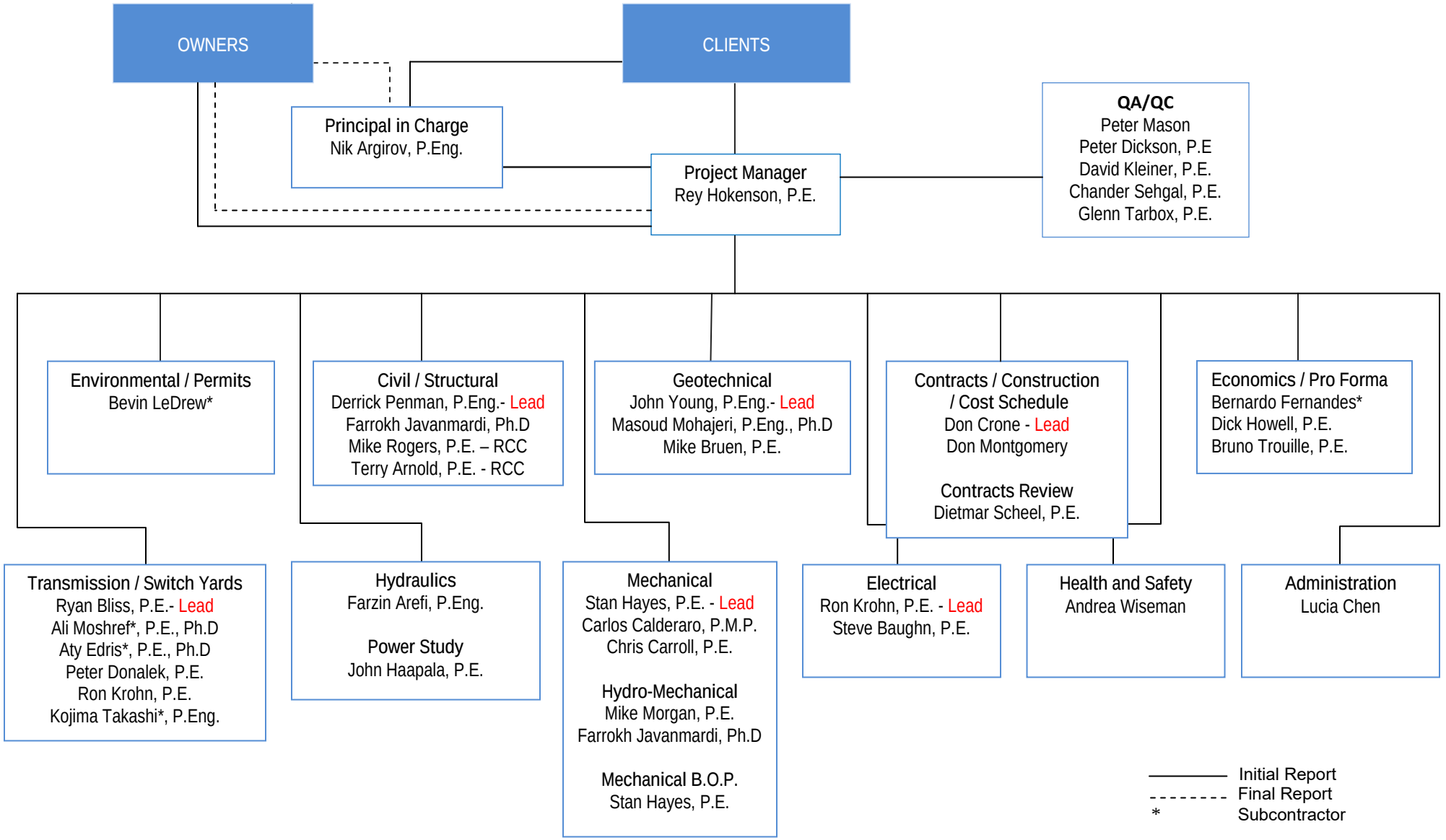
Please see MWH Proposal, Priced Original Commercial volume, for response to 5.1.

Organization Charts

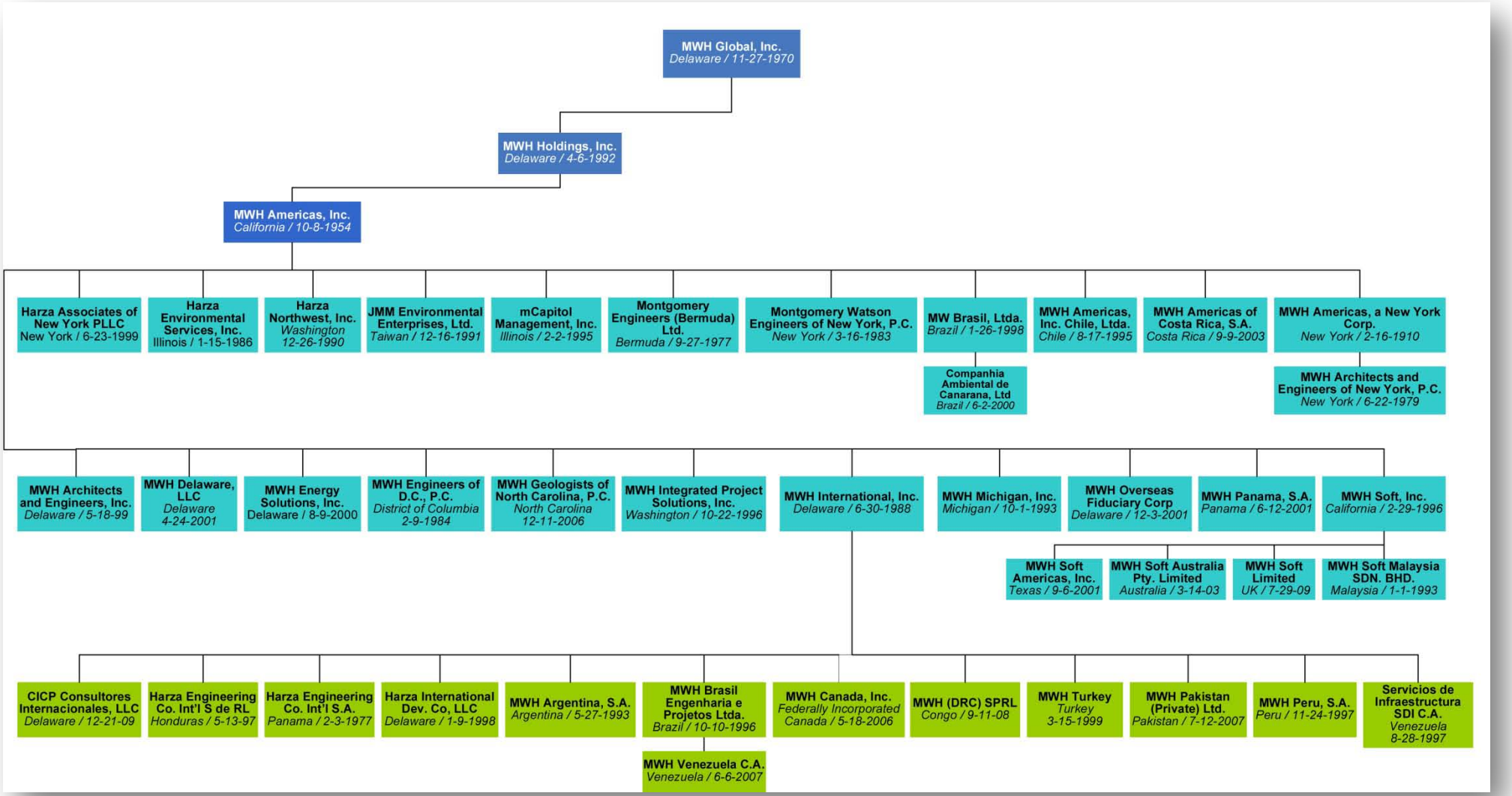
LABRADOR ISLAND LINK AND MARITIME LINK



MUSKRAT FALLS GENERATING PLANT



MWH Corporate Organizational Chart



Personnel Matrix and Resumes

Section 3-4 - Appendix 3 - Key Personnel Matrix Table

	ROLE	RESPONSIBILITIES	CONFIRMATION OF AVAILABILITY
Rey Hokenson	PM	Will be the project manager and principal author of the IE report and serve as the principal liason for the Client, Owner, and MWH.	YES
Nik Argirov	PRINCIPAL IN CHARGE	Will be the principal-in-chargea and support Rey in his efforts as PM. He will also be available to the Client and Owner to discuss all aspects of the work and represent MWH's Senior Management in contractual matters.	YES
Peter Mason	QA / QC - Hydraulic	Review hydraulic opinions associated with the water passageways, spillway enery disipation, sediment issues , and diversion facilities used during construction	YES
Peter Dickson	QA / QC - Geotechnical	Review opinions associated with the foundations of all structures, seepage control, diversion tunnels, and	YES
Chander Sehgal	QA / QC - Mechanical	Chander will review opinions pertaining to hydraulic steel structures (penstocks, gates, large valves) and mechnaical aspects of the power station	YES
David Kleiner	QA / QC - Dam and Powerstation	David will review geotechnical issues associated with the dams and powerstation	YES
Glen Tarbox	QA / QC	Review opinions pertaining to the concrete dams, RCC dam, and constructability of these structures	YES
CIVIL / STRUCTURAL			
Derrick Penman	Civil/Structural Lead	**Derrick will review all aspects of the civil/structural engineering assoicated with project structures. He will also be the Principal author of the report aspects associated with his speciality.**	YES
Mike Rogers	Project Engineer	Responsible for reviewing the RCC dam design, powerplant design	YES
Terry Arnold	Project Engineer	Responsible for reviewing the RCC mix design	YES
Farrokh Javanmardi	Project Engineer	Will assist Derrick in the review of the civil/structural engineering of project features	YES
GEOTECHNICAL			
John Young	**Geotechnical Lead**	**Responsible for reviewing the geotechnical and geological issues assoicaed with the Project. He will be the principal author of this work.**	YES
Masoud Mohajeri	Project Engineer	Assist John in reviewing geotechncial and geologic aspects of the project	YES
Michael Bruen	Project Engineer	Assist John and review the issues associated with project foundations, with a focus on the Muskrat Falls dam's left abutment stability, and suitable burrow?? materials for the dams and powerstation	YES
Ewan Cumming ***(Fugro)***	Project Engineer	Submarine Geotechnical Support	YES
Christopher Woodwroth-Lynas ***(Fugro)***	Project Engineer	Submarine Geotechnical Support	YES

	ROLE	RESPONSIBILITIES	CONFIRMATION OF AVAILABILITY
Rey Hokenson	PM	Will be the project manager and principal author of the IE report and serve as the principal liason for the Client, Owner, and MWH.	YES
John Landva ***(Fugro)***	Project Engineer	Submarine Geotechnical Support	YES
MECHANICAL / HYDRO MECHANICAL / MECHANICAL B.O.P.			
Stan Hayes	**Mechanical Lead**	**Stan will be responsible for leading the reviews of all mechanical equipment and systems for the powerhouse and will be the principal author of the report sections dealing with this topic**	YES
Christopher Carroll	Project Engineer	Chris will support Stan in the review of the BOP and other mechanical systems	YES
Carlos Calderaro	Project Engineer	Carlos will support Stan in reviewing of turbins and auxiliary mechanical systems.	YES
Mike Morgan	Project Engineer	Mike will be responsible for reviewing gates, large valves, cranes, trashracks and heavy steel structures for the powerhouse and spillway	YES
HYDRAULICS / POWER STUDY			
Farzin Arefi	Hydraulics Lead	Farzin will review the hydraulic aspects of the Project including the diversion facilities, the spillway, the water conveyance system, the headwater and tailwater curves. She will be responsible for writing the subsections of the report on these Project features.	YES
John Haapala	Power Study Lead	Responsible for review of the power study and will assist Bruno, Bernardo, and Dick in reviewing aspects of the pro forma involving power output (energy and capacity)	YES
ELECTRICAL / TRANSMISSION / SWITCH YARDS / SUBMARINE CABLE			
Ron Krohn	**Electrical Lead**	**Ron will review and support Ryan on matters concerning the switchyards and transmission system, and be the lead for all powerhouse electrial reviews**	YES
Ryan Bliss	**Switch Yard Lead**	**Review transmission system and switchyards and will be the principal author of the report sections pertaining to these features**	YES
Graham Lawson ***(Energy Cable Consultants Inc.)***	**Submarine Cable Lead**	**Responsible for all aspects of the HVDC cables engineering and will be the author of the sections of the report pertaining to these aspects.**	YES
Peter Donalek	Project Engineer	Reviewing opinions pertaining to the transmission lines and switchyards	YES
Steve Baughn	Project Engineer	Reviewing of electrical generation equipments, control and protection systems and electrical B.O.P.	YES
Kojima Takashi ***(Independent Consultant)***	Project Engineer	Will review all mechanical aspects related to transmission, submarine cables, and converter stations	YES
Ali Moshref ***(Quanta Technology)***	Project Engineer	HVDC transmission lines, system study	YES
Aty Edris ***(Quanta Technology)***	Project Engineer	Reviewing all aspects of HVDC transmission lines and converter station	YES
ENVIRONMENTAL / PERMITS			

	ROLE	RESPONSIBILITIES	CONFIRMATION OF AVAILABILITY
Rey Hokenson	PM	Will be the project manager and principal author of the IE report and serve as the principal liason for the Client, Owner, and MWH.	YES
Bevin LeDrew (***Sikumit Environmental Mgt. Co. NFLD)***	Project Specialist	Bevin will review all aspects of the permits and licenses, discuss current status with agency personnel, and be the principal author of report sections dealing with these topics.	YES
CONTRACT, CONSTRUCTION COST AND SCHEUDLING		CONSTRUCTION COST & SCHEUDLING	
Don Crone	**Lead**	**Don will review the contracts, the cost estimates, construction schedules, constructability issues for the Project. He will be the principal author of the report sections dealing with construction and cost.**	YES
Don Montgomery	Project Specialist	Don Montgomery will assist Don Crone in the review of the contracts, cost estimates, schedules, associated with construction including the camp	YES
Dietmar Scheel	Project Specialist	Contract Review	YES
ECONOMICS PRO FORMA			
Bernardo Fernandes ***(EnVenture)***	Project Specialist	Review contracts and project agreements, permits, the pro forma,and be available for meetings with lenders	YES
Dick Howell	Project Specialist	Support Bernardo and Dick in the review of the agreements and the proforma	YES
Bruno Trouille	Project Specialist	Review contracts and project agreements, permits, the pro forma, and will be available for meetings with the lenders	YES
HEALTH & SAFETY			
Andrera Wiseman	Project Specialist	Andrea will be responsible for all issues associates with the health and safety matters of the project as well as the resource for MWH staff when they visit the site. Andrea will be the principal author of report sections dealing with Health & Safety.	YES
ADMINISTRATION			
MWH VANCOUVER OFFICE	Project Support	Administrative employees from Vancouver office will be responsible for all administration support to Rey, Nik and the staff on Phase 1 and 2	YES

FARZIN AREFI, P.Eng.

PRINCIPAL HYDRAULICS ENGINEER

KEY QUALIFICATIONS

Ms. Arefi has a solid background in hydraulic engineering developed through 26 years of progressive experience within the hydraulic structures sector. She has experience in all aspects of study and design for both hydropower facilities and other water control projects, such as hydraulic structure design, intakes, outlets, spillways, energy dissipators, channel design, headrace tunnels, surge tanks, penstocks, tailrace structures, flood frequency analysis , power and operation studies of reservoirs and hydro power plant. Her experience in dam safety analysis includes dam break analysis and inundation mapping preparation. Ms. Arefi's capabilities also include analyzing transient flow conditions in hydropower waterways, open channel and pipe hydraulics, high velocity flows, air entrainment, flood protection issues in rivers, general layout design of hydropower and dam projects, and value engineering for hydropower projects. Prior to joining MWH, she supervised and performed hydraulic modeling of hydraulic structures of various hydropower and large dam projects, as well as managed a hydraulic department with 25+ engineers and 20+ parallel projects in a large hydropower company, applying ISO procedures.

EDUCATION

M.Sc. Civil Engineering, University of Tehran, Iran

Licenses and Professional Memberships

Professional Engineer – BC, license #: 32356 Association of Professional Engineers and Geoscientists of British Columbia

Associate Value Specialist (AVS), SAVE International (The Value Society)

EXPERIENCE RECORD

White River Project
Regional Power Inc.
Lead Civil/Hydraulic Engineer for design/analysis of preliminary level layout and design of Power Intake and power canal, by-pass facilities, spillways and diversion canal for two cascade dams; Upper white River and Lower white River.

Marlin Mine TSF Closure Spillway
Montana Exploradora De Guatemala, S.A.
Lead Civil/Hydraulic Engineer for detailed design of Labyrinth spillway, chute and stilling basin.

Susitna-Watana Hydroelectric Project
Alaska Energy Authority
Hydraulic Engineer for review the preliminary design of conveyance structures.

Taltson Expansion Project
Northwest Territory
Lead Civil/Hydraulic Engineer for design/analysis of feasibility level layout and design of Power Intake and power canal, by-pass and minimum release facilities and transient analysis in penstock.
Reviewed hydrology report and flood frequency analysis and energy studies.

MWH

Screening Studies
Responsible for screening and pre-feasibility design of hydroelectric power projects. Work includes reservoir operation simulation model and energy studies, layout development and preliminary design of storage dams, diversion works, spillways, intakes, power tunnels and powerhouses.

Bear Hydro Project, British Columbia
Regional Power Inc.
Owner's engineer project manager/coordinator for an EPC project consisting of two hydropower; Upper Bear and Lower Bear. Responsible for preparation of Owner's Performance Requirements for Bear Hydro project, design and Build contract. Prepared preliminary power house layout and hydraulic loss calculations for the Lower Bear and Upper Bear penstocks, flood frequency analysis, estimation of Clowhom Lake reservoir flood water levels for considering as tail water level for Lower Bear tail race channel and ramping study based on DFO requirements.
Manage the MWH team for reviewing and providing comments on Contactor's transmittals including design reports, notes, drawings and specifications.

San Joaquin river Basin storage Investigation Project, California
USBR
Lead engineer for design of feasibility level layout and design of Selective Level intake Structure for the Upper San Joaquin River Basin Storage Investigation Project. The intake structure is inclined concrete structure founded in the dam abutments. The Intake Structure consists of four intakes in four different levels. The lowest one serves as bottom outlet intake as well. Perform transient analysis to estimate the hydrodynamic load for design of pipe and penstock. Review powerhouse layout and drawings.

Waneta Expansion Project, British Columbia
Responsible Hydraulic engineer for optimization of tunnel diameter, hydraulic calculation of guaranteed loss in power intake, tunnel and tail race channel, and transient analysis in power tunnel of Waneta Expansion Project. Waneta Expansion Project is a design build project, in British Colombia, planned to be constructed on the right bank of the existing Waneta Dam. The project consists of an intake, power tunnels, a powerhouse and tailrace.

L.L. Anderson Dam spillway Modification Project, Placer Country, California
Civil/Hydraulic Engineer for detailed design of spillway and stilling basin of L.L.Anderson Dam, Spillway Modification Project. The new spillway structures consists of two radial gates located approximately 45 feet d/s of the existing control structure.

John Hart Redevelopment Project, BC Hydro
Lead Hydraulic engineer, review and validate the hydraulic design of intake, water conveyance system and transient analysis of 126MW John Hart hydro project. Developed alternative solution for the water conveyance system

Hydraulics Engineer, Alberta
Responsible for pre-feasibility design and layout of four hydroelectric power projects for Atco Power, with installed capacities ranging from 140 to 160 MW. Work includes layout and preliminary design of storage dams, diversion works, spillways, intakes, power tunnels and powerhouses.

Hydraulics Engineer, Vancouver, BC
Responsible for sedimentation analysis for Kokish river morphology assessment, for Brookfield. The Kokish River Hydroelectric Project is a run-of-river project situated on north eastern Vancouver Island.

Hydraulics Engineer, Vancouver, BC
BC Hydro Spillway Gate Reliability Program. Hydraulic analysis of spillway and low level outlet gates of four BC Hydro dams including, Seton, Cheakamus, Duncan, Keenleyside.

Special Technical Committee of Ministry of Energy of Iran
Hydraulic Expert – Review and approve general layout of hydraulic structures of nationally important dam projects in Iran, such as: Ekbatan concrete dam, Chenareh earth fill dam, Barandooz earth fill dam, Jamishan earth fill dam, Zagroos earth fill dam, Kavar earth fill dam, Gabric earth fill dam, Daroongar earth fill dam, Kalan Malayer earth

fill dam, Lylan chay and kharagoo chay earth fill dam, Marvak earth fill dam ,Salman Farsi arch concrete dam, Safa earthfill dam, Nohob earth fill dam, Shur-e-Jiroft, Zanganlo, Sylveh, Sabz kuh earth fill dam, Kuhrang arch concrete dam, Aghbelagh earth fill dam, Cheragh vaise earth fill dam, Bar earth fill dam, Kaka sharaf earth fill dam, Mangol earth fill dam, Garmrud eart fill dam, Patagh earth fill dam, Azadi earth fill dam, Sikan earth fill dam, Kamandan earth fill dam, Absardeh earth fill, Firoozan earth fill dam, Ain khosh and Fakeh water supply project, Shanjoor, Emam zadeh Naser earth fill dam, Baghan earth fill dam and Sirvan project.

Siah Bisheh Pump Storage Project
Design manager and lead hydraulic Engineer – two rock fill concrete-face dams, each about 100 m height and two 2 km long concrete lined headrace tunnel of 5.75 m diameter, a surge shaft of 18 m diameter and an underground power house with 2 x 250 MW pump turbines for a discharge of 107m³/s with a 500 m head. Review of tender documents, design modification, detailed design and construction supervision of the two dams, appurtenance structures (two spillways and bottom outlets), power intake, and 3000 m of the pressure tunnels.

Gotvand hydropower plant
Project Manager for conceptual design and lead hydraulic Engineer for detailed design– review of general layout of a 180 m high clay core rock fill dam, down stream of Karun III and Karun I dams, which was under construction stages. The surface powerhouse consisted of 4 x 250 MW Francis turbines (total discharges 800 m³/s). The work included the redesign of general layout mainly the power house location, pressure tunnels alignments, spillway location and type of dissipation energy and evaluation of different alternatives to ensure proper performance of spillway and energy dissipation system and bottom outlet. The objective of these studies was to solve the problems raised during the construction period. Supervised the hydraulic model study of different alternatives of spillways. Detailed design of gated chute spillway with 4 gates each 15*17m with a max. Capacity of 16000 m3/s, flip buckets, plunge pool, aeration systems to prevent cavitations. Detailed design of power intakes, 2*1500 m long headrace tunnel of 11m diameter each connecting to two penstocks of 7.5 m diameter each, and two surge tanks. Detailed design of bottom outlet with a 3m wide by 4 m high service gate of 150 m head.

Lead Hydraulic Engineer, Iran
Designed general layout of KarunIV, a 220 m high concrete arch dam, 2 diversion tunnels each 600 m long and 9.5 m diameter, 2 spillways, one gated spillway on the right abutment and one free over fall spillway on the crest of the dam with the total capacity of 10000 m3/s, two bottom outlets in the dam body and two power tunnels each 9 m diameter and 400 m length connecting to 4 units each 250 MWcapacity. Detailed design of diversion system including the risk analysis for the optimization of diversion system. Lead the detailed design of hydraulic structures including spillways, bottom outlet, Power intake and tunnels. Supervised hydraulic model testing of spillways and plunge pool and scour hole of Karun IV in Water Research Center
Lead Hydraulic Engineer, Iran.

KarunIII project consisted of a 200 m high arch dam, 3 types of spillway with total capacity of 17000 m3/s, a long lined plunge pool, power intake and tunnels. Designed an alternative solution for spillway and aerator system of the chute spillway. Designed plunge pool, river protection system in Doshablary Valley, and anti- vortex devices for the power intake. Supervised hydraulic model study for crest spillway, aeration system of the chute spillway, hydrodynamic pressure measurements in the fixed bed plunge pool, and scouring depth measurements in moveable bed plunge pool with two types of cohesive and non-cohesive material. Supervised hydraulic model of power intake for vortex study.

Ms. Arefi's substantial project experience also includes:

- Keeyask Generation Station, Stephens Lake, Northern Manitoba – sedimentation analysis during Construction.
- Keeyask Hydroelectric, Nelson River, Northern Manitoba – sedimentation monitoring studies for a 675 MW run-of-river hydroelectric project.
- Europa, Northern British Columbia – diversion channel design of a run-of-river hydroelectric project.
- Forrest Kerr Hydroelectric Project – assisted in design of tailrace tunnel of a 120MW run-of-river project.
- Karuvn IV Hydropower Project, Poyry Energy (formerly Electrowatt-Ekono), Iran Branch Office – principal engineer supervising design of overflow cofferdam; previous cofferdams failed on two separate occasions because of high flood events.

- Atbara Water Supply Project, Sudan – project manager and hydraulic engineer for a water treatment plant with the capacity of 50000m3/day, a movable intake structure in the Nile River, four km of pipeline and two pump stations for Atbara and Eldemar city.
- Narmab Dam – supervised design of hydraulic structures including diversion tunnels, bottom outlet, irrigation and water supply system and spillways; controlled hydraulic calculation and preparation of review report.
- Siahbisheh pump storage project – supervised the hydraulic model study of power intake for studying vortex problem in intake structure.
- Monj Mini-Hydropower Plant – analysis of the transient flow conditions and dimensioning the surge tank, 2030m long steel penstock with 2.00 m diameter.
- Shahr-E- Bijar Dam – hydraulic specialist in value engineering workshop of earth fill dam with stepped spillway.

Publications:

- A.Bauman, F.Arefi, A.J.Schleiss, Design of two stepped spillways for a pumped storage scheme in Iran, Proceedings of International Hydropower Conference, September 2006.
- J.Attari, F.Arefi, Andaroodi, Using cohesive material for scour modeling in plunge pool of Karun III Project, Proceedings of the XXXIAHR Congress, Greece, September 2003.
- J.Attari, F.Arefi, F.Golzari, A review on physical models of scour holes below large dams in Iran, Proceedings of the International Workshop on Rock Scour due to High-Velocity Jets, Lausanne, September 2002.
- M.Mahzri, F.Arefi, A.J.Schleiss, Dynamic response of the drainage system of a cracked plunge pool liner due to free falling jet impact., Proceedings of the International Workshop on Rock Scour due to High-Velocity Jets, Lausanne, September 2002.

NIK ARGIROV, P.Eng

PRINCIPAL IN CHARGE / STRUCTURAL ENGINEER

KEY QUALIFICATIONS

Mr. Argirov is a Principal Engineer with over 30 years of experience in the management and design of hydroelectric projects, offshore/marine structures related work, and building construction. He is a Vice President of MWH Canada Inc. and MWH's British Columbia Regional Manager, overseeing administrative operations, professional and technical staff, client relations, and business development within the Province. Mr. Argirov is a P. Eng and a certified Project Management Professional. He has served as Project Manager, Engineering Manager, and Civil/Structural Design Engineer for numerous new construction, as well as repair/replacement projects related to dams, powerhouses and water conveyance facilities throughout Canada and internationally. His experience encompasses all phases of engineering and construction, including feasibility and conceptual studies, facility inspection, economic evaluation, specification, contract document preparation, and design.

EDUCATION

Master Certificate of Project Management, University of Victoria/York University,
MEng, Civil and Structural Engineering, Higher Institute of Architecture and Civil Engineering, Sofia, Bulgaria

Licenses and Professional Memberships

Professional Engineer – APEGBC, license #: 29031; APEGGA, license # 50801
American Society of Civil Engineers
Canadian Dam Safety Association
Project Management Institute

EXPERIENCE RECORD

Taltson Expansion Project

NWT Energy Corporation (03) Ltd

Principal-in-Charge for the Taltson Hydroelectric Expansion Project that will add a new power plant of approximately 50MW install capacity and 700km transmission lines to supply power to as many as three operating and one proposed diamond mines north of Great Slave Lake. Responsible for contract negotiations and overall project performance overview.

Chakachamna Hydroelectric Project

TDX Power

Project Manager for the preliminary engineering studies to refined feature design concepts and reservoir operations modeling for this underground hydroelectric development with estimated install capacity of 330 (MW)

PMSP

BC Hydro

Project Management Services Partnership (PMSP) provides an umbrella / program management solution for portfolio of projects with estimated total capital cost of $3,000 M CAD. The portfolio includes John Hart Replacement Project, Ruskin Project and Upper Columbia Project. As the MWH regional manager and member of the program steering committee involved in various strategic activities, meetings and presentations as well as in key technical roles during the planning/validation phase of the program. Responsibilities also include consultation and execution of contracts as well as provision of resources for the needs of the involvement.

LL Anderson Dam
Placer County Water Agency
Local team Project Manager for the modification of LL Anderson Dam spillway and radial gates. The project includes provision of engineering services and final design for complete spillway modification and replacement of radial spillway control gates. Three dimensional Finite Element Model was developed for the static and dynamic analysis and design of the radial gates and spillway piers. Project deliverables include design basis report for client and FERC review as well as final design / construction drawings and documents.

Global Gate Survey
BC Hydro
Project Manager for the study / research on the global state of the art and practice in the seismic design and analysis of radial gates.

Soda Spring Arch Dam Seismic Updates
PacificCorp Energy
Local team Project Manager for the seismic evaluation of the 130 ft high single curvature arch dam. Static, thermal, and seismic analyses were conducted utilizing 3D finite element model of dam components and foundation. The results of the 3D analyses were evaluated with respect to the acceptance criteria contained in Chapters 3 and 11 of the FERC Guidelines.

El Tablón Hydroelectric Power Project
Empresa Nacional de Energía Eléctrica
Project Manager for the preparation of general contract tender documents for this project that consists of an 80 meter high roller-compacted concrete (RCC) dam with 2x10MW vertical Francis units powerhouse. The dam/reservoir provides irrigation, flood control, and power generation.

Brilliant Expansion Project
Columbia Power Corporation and Columbia Basin Trust
Engineering Manager responsible for all engineering on this 120MW project, executed under an Engineer-Procure-Construct (EPC) contract. Responsibilities include complete detail design, value added engineering ,disciplines coordination as well as coordination of multiple contracts, reporting, review and approval of shop drawings and vendor documents including all turbine ,generator and BOP equipment drawings, installation ,commissioning and OM manuals, completion of as-built documentation, etc. The project is situated on the left reservoir/river bank at the Brilliant Dam location and consists of power intake, power tunnel, access tunnel and above ground powerhouse with single 120MW generating unit. The concrete spiral case of this vertical Kaplan turbine is considered to be one of the largest in the World.

Karebbe Hydroelectric Project
PT Inco – Indonesia
Engineering Manager and/or Lead Civil Engineer involved periodically in the design phase of the project with responsibilities ranging from civil to the overall project design. The project is located in a high seismic area and consists of a 74-meter-high roller-compacted concrete (RCC) dam, self--standing double intake tower and 132MW hydro-combine powerhouse (powerhouse located under the dam shut spillway) arrangement complete with two vertical Francis turbine generating units.

POSO 2 Hydroelectric Project
PT Antam Tbk
Lead Civil Engineer responsible for the civil part of the study and report preparation with contribution to the mechanical /electrical disciplines in terms of powerhouse equipment arrangement and evaluation of the units' rotational inertia required for stable generation and voltage and frequency control. This generation facility is proposed to supply power for the smelter operations of local mining company. The study was undertaken to evaluate current design, construction activities, project schedule and risks associated with the client's potential participation in the project. One of the major concerns is the capability of the project design to deliver quality of power satisfying the highly fluctuating load demand of smelter furnaces.

Granite Canal Hydro Electric Development
Newfoundland and Labrador Hydro
Engineering Manager responsible for project contracts strategy, development and control of project schedule, engineering management, preparation of tender documents, contractor design and drawings/documents review, contractor coordination, commissioning supervision and coordination, development of operations and maintenance manuals, and contractor claims settlement for this 42 MW Kaplan turbine development project. In addition, as a Commissioning Manager, responsible for the complete commissioning of the plant.

Penstock #1 Replacement
Deer Lake Power Company
Project Manager for replacement of the 70-year-old, 2.9-meter-ID wood stave penstock with the same size steel pipe penstock utilizing expansion joint design and on ring girder supports founded on wood piles.

Engineering Services
Tennessee Valley Authority
Project Manager responsible for preparation and submission of proposal for the provision of engineering services to be executed under a blanket agreement for a term of 5 years. Engineering support services will include the following operational areas: fossil power generation, transmission and power supply, hydro electric generation (including dams and pump-storage facilities), and nuclear power generation.

Wind Velocities and Air Pressure Differentials Study
Churchill Falls Corporation
Project Manager for the study of air velocity in the tailrace surge chamber during full or partial load rejection of the 5,000 MW capacity Churchill Falls underground powerhouse.

Feasibility Study
The Provincial Government of Newfoundland and Labrador
Project Manager for a de-inking facility feasibility study.

Project Manager , Proposal for Wind Generation Facility
Northland Contracting Inc.
Preparation of proposals for pilot project development of 25 MW wind generating facility.

Technical Advisor/Reviewer and Quality Control Specialist, Gull Island and Muskrat Falls Feasibility Studies
Churchill Falls Corporation
Technical Advisor/Reviewer and Quality Control Specialist for the final feasibility studies for 2,200 MW Gull Island and 840 MW Muskrat Falls Hydroelectric Developments. Responsible for implementing engineering solutions for significant reduction of the project capital cost and overall budget control of the joint venture. Reported directly to the Chairman of the Project Management Committee.

Avalon East School Restructuring Program
Avalon East School District
Project Engineer responsible for coordination with AESB, DWS&T and DE and managing engineering, scheduling, budget estimates, and tenders for the execution of the project.

Sheet Harbour Hydro Generating Facility Rehabilitation Feasibility Study
Nova Scotia Power
Project Manager of the feasibility study for rehabilitation of this generating facility. The cascade system includes seven reservoirs and two powerhouses with a total installed capacity of 10.5 MW. Each powerhouse consists of three-generation units. The scope of work included water management, evaluation of a third generating station, increasing capacity of water conveyance system, dam safety improvements, and improvement of the total system efficiency and output.

Project Engineer, Rose Blanche Hydroelectric Development
Newfoundland Light and Power Co. (Fortis Inc.)
Project Engineer responsibilities for final design of this 6 MW development, which included engineering management, design supervision, coordination of disciplines, design scheduling and tender preparation. The scope of work entailed design and construction support of a concrete-faced rockfill dam, concrete intake, and an excavated overflow spillway and above-ground powerhouse.

Project Engineer, Great Falls Hydro Generating Station Assessment and Alternatives Development
Noranda Inc.
Project Engineer for the assessment of existing conditions and development of rehabilitation alternatives. Responsibilities included engineering management, design supervision, and coordination of disciplines. To increase flood-handling capacity of the controlled spillway, different options were evaluated and the most feasible were selected for final tendering. The alternatives include combinations of rubber dam(s), vertical roller gates, radial or flap crest gates, and a submerged gate.

Project Engineer, Millertown Dam Rehabilitation Feasibility Study
Abitiby Consolidated, Newfoundland
Project Engineer responsible for management of engineering, development of alternatives, coordination, scheduling, estimates and report preparation. The 15-meter-high concrete dam rehabilitation feasibility study included developing the optimum alternative for handling probable maximum flood (PMF), construction schedule and final cost estimate.

Lead Inspector / Reviewer, Dam Safety Inspection and Review
Deer Lake Power Company
Lead Inspector / Reviewer responsible for inspecting several aging wood stave and steel pipe penstocks including field conditions evaluation and onsite testing and preparation of final inspection report. Also responsible for review of the main 23.5-meter-high diversion/spillway dam for the generation facility. The dam is a hollow buttressed reinforced concrete design constructed with buttresses at 5.5 m span. The review included general inspection, condition evaluation, finite elements stress analysis, preparation of final report with recommendations for monitoring and rehabilitation requirements.

Project Engineer, Fraser Dam Inspection and Rehabilitation Report
Fraser Paper Inc
Responsible for development of alternatives and coordination of disciplines. Work included evaluation of existing concrete dam conditions, recommendations for remedial work, cost estimate, and development of construction schedule.

Project Manager, Bishops Falls 14.5 MW Hydro Generating Facility Rehabilitation and Upgrade Pre-Feasibility Study
Abitibi Consolidated Inc.
Project Manager responsible for development and evaluation of alternatives, coordination of disciplines, etc. The scope of work included consideration for new installed capacity of 8- to 16-MW plus screening of alternatives for upgrading existing eight horizontal units with improved performance and conversion from 50 to 60 Hz.

Project Manager, 30 MW Turbine/Generator Unit Installation
Abitibi-Price Inc.
Project Manager for the preparation of tender documents and execution of the tender for WWES for a 30 MW turbine/generator unit supply and installation. Also managed preliminary design and feasibility study for the turbine/generator installation as a refurbishment and addition to the hydrogeneration facility.

Project Engineer, Rehabilitation of Power generation facility
Abitibi-Price Inc.
Project Engineer for the design of a power canal to replace aging forebay gravity dam/intake and more than 60 years old steel penstocks. Responsible for the engineering management, design supervision and support, design of some

major components, coordination of disciplines, etc. The project included a 10,900 m3 roller-compacted concrete (RCC) spillway, three new intakes, 15-foot and 20.5-foot ID penstock sections to existing powerhouse, gravity concrete dam and earthfill dams. The project involved complicated designs, particularly for penstock section between intake and powerhouse, and in general for the design of structures which had to be constructed in close proximity to operating systems.

Project Engineer, Star Lake 15 MW Hydroelectric Development
Abitibi-Consolidated Inc. and CHI Hydroelectric Company Inc.
Project Engineer responsible for engineering management, design supervision and development of design criteria, coordination of disciplines, coordination with the general contractor and subcontractors, construction support, and tender documents and specifications. The final project scope included 30 m high earthfill dam, 85 m long concrete overflow spillway, intake structure, 2 km buried steel penstock and powerhouse complex with vertical Francis turbine installation.

Project Engineer, No.7 penstock Replacement
Deer Lake Power Company Limited
Project Engineer responsible for complete detailed civil, structural, geotechnical, and mechanical design; erection procedures; coordination with contractors and fabricators; and construction support. Existing 2.9-meter-diameter wood stave penstock was replaced with steel pipe supported on ring girders and steel saddles over a distance of 700 meters.

Design Engineer, Victoria Lake Spillway Gate Modifications
Newfoundland and Labrador Hydro
Design and supervision of spillway gate modifications and design of spray wall during reservoir improvement construction program.

Structural Engineer, Holyrood Thermal Electric Generating Station
Newfoundland and Labrador Hydro
Feasibility design of 180 MW thermal cogeneration facilities as an extension of the existing thermal generating station. Design of new self-supporting breeching y-section spanning over 27 m for stack at the station.

TERRY ARNOLD, P.E.

CIVIL ENGINEER

KEY QUALIFICATIONS

Mr. Arnold has more than 23 years of experience as a civil and geotechnical engineer. He has been responsible for, and conducted, field and laboratory investigations, analyses, design plans and specifications for earth dams, rock fill dams, roller-compacted concrete (RCC) dams, tailing dams, landfills, and foundations for industrial buildings. Mr. Arnold's experience includes siting studies and project layout; development of design criteria; settlement, seepage, stability and hydraulic analysis; preparation of plans, specifications, and construction cost estimates; construction engineering; and project management. His experience ranges from initial site investigation through project construction. Mr. Arnold has also provided analyses and consultation for construction contractors.

EDUCATION

BS/BSc, Civil Engineering, Kansas State University
MS/MSc, Civil Engineering, Kansas State University

Licenses and Professional Memberships

Professional Engineer, CO, KS, WY, WA, NM, SD, FL, MT

EXPERIENCE RECORD

Broomfield Reservoir
City of Broomfield
Responsibilities include optimization of reservoir storage capacity; development of the water supply pipeline, inlet/outlet works, spillway, pump station and pipeline to deliver reservoir storage to the existing water treatment plant. Developed the work breakdown structure quantity estimates and the Engineer's Opinion of Probable Construction Cost with the MWH certified cost estimating staff.

Everglades Restoration Project
South Florida Water Management District
Principal Engineer. Responsible for development of program design criteria for multiple facilities (including water storage impoundments covering more than 17,000 acres and stormwater treatment areas for treatment of runoff from agricultural areas prior to downstream release to the Everglades). Development of design criteria included assessment of environmental restoration objective and technical requirements for dam safety in coordination with the US Army Corps of Engineers and the Florida Department of Environmental Protection. Other specific assignments included:

Principal Engineer. Responsible for alternatives analysis of embankment heights, dam type and cross-section, seepage and drainage analysis, and cost evaluation for the planned A-1 Reservoir. Reservoir A-1 generally consists of a 17,000 acre site with a perimeter embankment length of approximately 23 miles. The reservoir will impound between about 150,000 and 200,000 acre-feet of water when completed. Two new pump stations, with a combined capacity of 4,000 cfs, will be used to fill the reservoir, more than 23 miles of new canals as well as modifications to existing canals, and a two - 3,000 cfs spillways will be incorporated to provide storm water releases.

Principal Engineer. Responsible for development of design flood and freeboard requirements, and evaluation of alternative reservoir and canal configurations for the C-44 reservoir, with storage ranging from 44,000 acre-feet to 75,000 acre-feet. Value engineering of conceptual designs by others resulted in savings of more than $50 million dollars (more than 15 %) of the construction cost.

Principal Engineer. Responsibilities include evaluation of borrow sources for construction of 4 miles of earthfill levees, geologic and geotechnical assessment of the borrow sites, construction cost estimates and analysis and ranking for selection of the borrow site for enhancement of the STA-2 stormwater treatment area.

Technical Reviewer and Senior Civil/geotechnical reviewer for the development of the 30 percent design for the new C-43 (Berry Groves) Storage Reservoir, in Hendry County Florida.

Principal Engineer. Preliminary design of a flood control levee around a 160 acre parcel in the Southern Golden Gates Restoration Area. Preliminary design analysis included seepage and stability analysis, wind and wave analysis for the 100 year design flood condition, and an evaluation of pumping requirements to maintain acceptable water levels within the 160 acre parcel.

Cannelton Hydroelectric Project
American Municipal Power-Ohio, Inc
Senior Technical Lead for the analysis and design of appurtenant structures to new hydroelectric facility along the Ohio River. Responsibilities include stability analysis and design of hardfill closure section and stability analysis of the powerhouse.

Peace River Reservoir Expansion
Peace River Manasota Regional Water Supply Authority (PRMRWSA)
Responsibilities included optimizing project configuration, developing design criteria, analyzing stability, seepage and settlement, geologic assessment of the site, and designing the four-mile long earthfill dam, water inlet/outlet works, spillway, wetlands mitigation, and appurtenant facilities. A unique aspect of this project included development of spillway design criteria and design flood requirements where the state did not have established criteria in place for above ground water storage reservoirs. His optimization efforts included evaluating alternative embankment cross-sections, minimizing the embankment height including freeboard requirements and balancing the spillway size, seepage reduction measures, and slope protection alternatives. He performed preliminary design and permitting for the selected reservoir size and configuration, followed by final design, preparation of plans and specifications, and development of an Emergency Action Plan (EAP). Flood inundation mapping and coordination of the EAP with emergency management agencies provided a special challenge due to the flat terrain surrounding the reservoir and a fully encircling embankment. Dam break analysis with an essentially 360 degree embankment and no defined downstream channels where breach flows would concentrate required development of new methodologies to be developed. The first application of a two-dimensional dam break program, and combining the output of breach flows from various selected breach locations around the perimeter of the dam, were combined in a breach inundation map that emergency managers could use in their planning and response to a potential emergency. His services during construction included design review, site visits, and observation during key construction phases, followed by data review and inspections of the dam during initial filling and operation, and annual inspections of the dam.

Priest Rapids Dam Liquefaction and Post Earthquake Stability Evaluation
Public Utility District No. 2 of Grant County, Washington
Serving as Senior Technical Reviewer for liquefaction analysis of the foundation of earthen portions of the Priest Rapids Dam on the Columbia River near Ephrata, Washington. Responsible for reviewing the investigation, evaluation, report preparation and conceptual mitigation design.

Wanapum Turbine Uprating and Dam Safety Improvements
Public Utility District (PUD) No. 2 of Grant County, Washington
Terry was responsible for review of the Phase III liquefaction potential and post-earthquake deformation analyses for the Priest Rapids and Wanapum Dams on the Columbia River in central Washington. Phase III of the project consists of developing a field investigation program to define the extent of liquefiable foundation soils beneath the earthen embankment portions of the dams. The project is being conducted under the jurisdiction of FERC, and consists of field exploration, a laboratory testing program, engineering analyses of foundation soils, and development of conceptual liquefaction mitigation design alternatives. The District decided to replace all 10 turbine runners, selected appurtenant parts, and refurbish the remainder of the turbine parts and contracted MWH to provide engineering services in support of this initiative.

Cannelton, Smithland, Willow Island, and Meldahl Hydroelectric Projects
American Municipal Power-Ohio, Inc
Senior Technical Lead for the Cannelton Hydroelectric Project. Led design of the closure embankment section between the dam and powerhouse and between the powerhouse and the bank. His responsibilities included analyzing and designing the unique application of hardfill as the closure embankment section, and design integration of the foundation, under-seepage control and water bearing tie-in from the powerhouse to the dam and spillway on the Ohio River.

San Vicente Dam Raise
San Diego County Water Authority
Led the concrete construction evaluation of the existing dam, material investigation, and identification of construction materials to be used in construction of the raise to the original 220-foot high concrete gravity dam by 117 feet. The increased water storage addresses the need for both emergency and carry-over storage, which stores water during periods of normal and above-normal water availability for use during extended periods of drought. Responsibilities included development of borrow requirements, RCC mixture design and testing for design of the dam, development of RCC properties for design, and RCC test section placement in advance of the start of RCC construction.

STEPHEN BAUGHN, PE

SENIOR ELECTRICAL ENGINEER

KEY QUALIFICATIONS

Mr. Baughn has over 38 years experience in the design and rehabilitation of power generation, distribution, and automation systems. He is experienced in all phases of project engineering from conceptual planning through development of construction plans and specifications. Mr. Baughn is also experienced in electrical power and automation construction and commissioning tasks including inspection and turbine-generator commissioning/testing. His design, rehabilitation, and construction experience covers a diverse range of power plant and industrial plant projects. Power generation systems including generators, exciters, switchgear, transformers and their associated automation and protection equipment; Automation systems including SCADA systems utilizing PLC processors and fiber optic and wireless communication; Electrical distribution substations including transformers, circuit breakers, bus work, switchgear, motor control, grounding, etc.; Plant commissioning activities including performance testing of hydroelectric generators, and SCADA systems; Fault studies, protective device coordination and other system calculations.

EDUCATION

BS/BSc, Electrical Engineering University of Washington, 1969

Professional Registration: Professional Engineer, WA; AK; CA; OR.

EXPERIENCE RECORD

Big Tujunga Dam

Client: Los Angeles County Dept of Public Works

Provided construction drawings, specifications, and cost estimate for the $88M, 251-ft high Big Tujunga Dam. Supervised a 2-person electrical design team. Conducted total rehabilitation of the existing power, lighting, control, and communication systems. Designed new valve control system, including a PLC-based control and monitoring system with PC-based remote control and monitoring station. Constructed a new control house, including a new communication system, and a new diesel standby generator system. Integrated new dam monitoring instrumentation system into existing systems. Electrical and automation construction is on schedule. MWH provided valuable input on automation and SCADA system design and completed factory testing of the local SCADA control and dam monitoring system. CONTRACT - Seismic Assessment Study for Gene Wash Dam/Reservoir and Copper Basin Dam/Reservoir - Metropolitan Water District of Southern California

Lenihan Dam Outlet Modifications Project

Client: Santa Clara Valley Water District

Lead instrument and controls engineer for the design of the project automation systems Responsible for the design and specification of the automation system for controlling and monitoring the gates and valves associated with the new dam inlet and outlet structures. System design used PLC based monitoring and controls with fiber optic communication between the inlet and outlet structures. Also provided submittal review and construction oversight during manufacture and installation of the instrumentation and control systems.

Tulloch 3rd Unit Addition

Client: Tri Dam

Lead electrical engineer for the design of an additional 7 MW hydro generator for the existing Tulloch Powerhouse. Tasks included developing procurement documents for the generator, exciter, circuit breaker, and automation system. Also responsible for providing detail design for construction of the powerhouse extension for housing the new turbin-generator equipment. Designs included a PLC based automation system, lighting system, plant power

MWH

distribution, and interface with the owner's existing SCADA system. Tasks will also include services duriing construction including submittal review, factory inspections, testing, and commisioning assistance.

Ruskin Powerhouse Refurbishment
Client: BC Hydro
Lead electrical and automation engineer for the refurbishment of the existing Ruskin Powerhouse. The Ruskin Powerhouse has a total generation capacity of 135 MVA using 3-45MVA turbine generators. The refurbishement project includes the refurbishment of the existing three 45 MVA generators, new excitation systems, new generator circuit breakers, and new generator step-up transformers. The project also includes the total replacement of the existing station power distribution system. A new automatioin system will be provided for control and monitoring of the refurbished turbine-generators along with interfacing with BC Hydro's existing SCADA system. Electrical and automation tasks include developing purchase documents for the generation and automation equipment equipment, and detailed construction documents for installation of the new and refurbishment equipment.

Chelan Falls Powerhouse Rehabilitation
Client: Chelan County PUD
Lead electrical engineer for the rehabiliatation of the Chelan Falls Powerhouse. The Chelan Falls Powerhouse has two 30 MVA hydro turbine-generators installed in the 1930's. The turbine-generators are being refurbished and a new automation system installed. The project also includes the refurbishment of the existing 117-ton bridge crane. Electrical tasks include generator and bridge crane refurbishment documents, and prepration of documents for furnishing and installing a new automation system for controlling and monitoring the refurbished turbine-generator system. Construction management tasks will include submittal review, factory inspection/testing, and construction inspection assistance.

Los Vaqueros Expansion Investigation & Feasibility Study Report
Client: Bureau of Reclamation, Mid-Pacific Region
Provided electrical and automation system input for investigation into addition of an energy recovery turbine generator. Provided specifications and drawings for use in procuring a design/construct contract for providing a 1-MW turbine-generator energy recovery system at an existing pumping facility. Contract documents were completed on schedule and ready for contractor bidding. CONTRACT - IDIQ for Water Resources Planning and Engineering - Bureau of Reclamation, Mid-Pacific Region (01CS20210B and BRPS/06CS204097B)

McCook Reservoir
Client: USACE, Nashville District
Provided electrical and instrumentation assistance during installation of valve control system and supporting electrical and control equipment for the McCook Reservoir distribution tunnel system. Several system changes needed to be implemented during the construction process that required design input. Provided circuit protection settings for equipment based on the contractor submittal information. Expedited installation information and provided quick turnaround time on submittal reviews to keep on schedule. MWH provided other critical information needed to keep construction on schedule. CONTRACT - IDIQ Contract for A-E Services for New Lock Design & Major Rehab Projects for Existing Locks & Dams, Grand Rivers, KY / Chattanooga, TN - USACE, Nashville District (DACW-62-02-D-0006)

Chief Joseph Dam DC and Essential AC System Design
Client: USACE - Portland District
Developed contract documents for a $3M upgrade to the existing powerhouse DC system and preferred AC System. Supervised a design staff of 3 engineers and 1 CAD operator. Work included replacement of two 125VDC and one 250VDC battery systems and new DC and preferred AC switchgear and distribution panels. Design improved existing DC and AC system reliability for a 27-unit hydroelectric powerhouse and included redundant distribution system for all critical DC and AC systems while minimizing down time. CONTRACT - IDIQ for Hydroelectric Power and Pumping Plant Engineering Design and Analysis Services - Hydroelectric Design Center, USACE, Portland District

Craig Brook Hydroelectric Plant
Client: US Fish & Wildlife
Lead electrical engineer for the detail electrical and instumentation design for a 22kW small hydroelectric plant. Design included drawings and specifictaions for a 22kW, 480V, induction generator system including control and

monitoing for the two nozzel pelton turbine. The system included a PLC based local control and monitoring system with provisions for remote monitoring. The control, protection and monitoring systems were based on unmanned type operation.

Philpott Powerhouse Planning Study
Client: US Army Corps of Engineers
Lead electrical engineer for the Planning Study for the 13.5MW Philpott Hydroelectric Plant. Work included the inspection and evaluation of the existing two 7.5 MVA generators, and their associated switchgear and bus systems. The electrical equipment evaluations were included in the plant planning report for optimizing future plant system upgrades.

Albeni Falls Dam DC and Essential AC System Design
Client: USACE - Portland District
Developed contract documents for a $1M upgrade to the existing powerhouse DC system and preferred AC System. Supervised a design staff of 1 engineer and 1 CAD operator. Work included replacement of one 125VDC battery system and one inverter system. Design improved existing DC and AC system reliability for a 3-unit hydroelectric powerhouse. The existing single point distribution system design was replaced with a dual redundant distribution system. Design will minimize plant down time. CONTRACT - IDIQ for Hydroelectric Power and Pumping Plant Engineering Design and Analysis Services - Hydroelectric Design Center, USACE, Portland District (W9127N-08-D-0003)

Palmdale Water District
Client: Palmdale Water District
Lead electrical engineer responsible for providing electrical and automation system construction documents for the rehabilitation of a 250 kW small hydroelectric installation, and integration with a 200 kW natural gas engine generator set. Electrical rehabilitation included new 250 kW induction generator, new 480 volt switchgear, new PLC based automation system, new 5 kV underground distribution system, and new ac and dc distribution systems. Provisions were also included for future remote monitoring and control via the client's SCADA system.

Cowlitz Salmon Hatchery Upgrade
Client: Tacoma Public Utilities
Lead electrical engineer for the rehabilitation of the existing Cowlitz Salmon Hatchery. The project included the design of a new Adult Handling Building, rehabilitation of the existing Adult Separation Facility, and remodel of the Early Rearing Building. Tasks included preparing electrical construction drawings and specifications for all of the power distribution, lighting systems, communication systems, and fire alarm systems. Also designed automation control panel for valve system. Provided interface engineering for hatchery SCADA system. Provided purchase and installation documentation for a new 2000 kVA Unit Substation, and 500 kW standby generator.

Castaic Pumped Storage Power plant Rehabilitation
Client: Los Angeles Department of Water & Power
Lead electrical engineer responsible for reviewing the Contractor's electrical and automation system design and installation documents for the rehabilitation of a 1247 MW pumped storage hydroelectric plant. The electrical rehabilitation includes refurbishing 6-240 MW generators, including new stator core and stator windings, along with new static exciters. A complete automation system is included, using PLC based plant controls and a PC based SCADA interface. New microprocessor based protective relaying panels are also included.

San Francisquito PP2 Power plant Rehabilitation
Client: Los Angeles Department of Water & Power
Lead electrical engineer responsible for providing the electrical and automation system refurbishment bidding documents for the rehabilitation of a 52 MW hydroelectric plant. The electrical rehabilitation includes furnishing one new 20 MW generator, along with a new static exciter, generator circuit breaker, and generator step-up transformer. A complete automation system is included, using PLC based plant controls and a PC based SCADA interface. New microprocessor based protective relaying panels are also included.

Rancho Penasquitos BU: 60259
Client: RBKA
Assist the Owner during construction of 5,000 kW hydroelectric plant construction. Review Contractor electrical submittal information, and perform factory inspection and witness equipment testing.

Leaburg and Walterville Hydroelectric Plant Rehabilitation
Client: Eugene Water and Electric Board
Project electrical engineer for developing contract specifications for automation and generator rewinding for the Leaburg and Walterville hydroelectric plants. Automation included new PLC based controls for automating the powerhouse turbine-generators; canal headgate structures and the Leaburg Dam roll gate controls. A SCADA system was also specified for remote monitoring and control of both plants. The SCADA system was based on a PC interface system communicating between plants with Ethernet radio modems. The generator rewind specifications included new stator cores, stator windings and field windings, along with associated testing, for two 9 MVA and one 7.5 MVA vertical generators.

Bull Run Dam Tower Improvements
Client: City of Portland
Lead electrical engineer for electrical power and automation upgrades to two existing outlet towers located at the Bull Run Dam 2. Tasks included a new 480-volt power distribution system with a shore-side distribution center with submarine cable connection to two reservoir outlet towers. A new automation system was designed for transferring control and monitoring information from the two reservoir towers to the clients shore-side SCADA system. Communication between the two towers and the shore-side SCADA system was via fiber optic cable and UHF radio link. A unique feature of the project was the incorporation of the fiber optic communication cables within the power submarine cable. The submarine cable routing included underground direct buried sections and sections anchored along the reservoir bottom.

Rock Island Power Plant Generator & T-Line Protective Relay Upgrade
Client: Chelan County PUD
Lead electrical engineer responsible for providing detailed elementary and wiring diagrams for new generator and transmission line protective relaying systems. Project included protective relaying systems for ten 25 MW generators, and associated step-up transformers, and four 115 kV transmission lines. New microprocessor based multifunction protective relaying systems were used. Responsible for furnishing the necessary drawings and documents for integrating the new relying components into the existing protective and control systems.

Olivenhain Dam
Client: San Diego County Water Authority
Project electrical engineer for the design of the 320-foot high Olivenhain Dam. Design includes power distribution and control for the inlet/outlet valves at the dam and the down stream valve house. Other system design includes; dam gallery power and lighting systems, outdoor lighting, standby generator system and interface with the Counties SCADA system.

El Dorado Irrigation District Generator Rehabilitation
Client: El Dorado Irrigation District
Project electrical engineer for developing contract documents for the rehabilitation of two 12.5 MVA, 6,600 volt, horizontal shaft generators. Rehabilitation of the two generators included new stator windings and core, new frame, and reinsulation of the rotor field windings. The project also included the installation of owner furnished turbine and generator control and protective equipment. Start-up and commissioning of the two generators was also included in the contract documents. In addition to developing prequalification and bidding documents Mr. Baughn will assist the owner during the prequalification, bidding process, and construction process.

RYAN BLISS, P.E.

ELECTRICAL ENGINEER

KEY QUALIFICATIONS

Mr. Bliss is an accomplished Transmission Line Engineer, Engineering Project Manager and Engineering Team Manager. Mr. Bliss is an experienced and accomplished user of the PowerLine Systems, PLS suite of software programs.

EDUCATION

BS/BSc, Civil Engineering University of Utah
ME/MEng, Civil Engineering University of Utah, 2005

Licenses and Professional Memberships

Professional Engineer, Structural, 2797329, Utah, 2008; Professional Engineer, 38968, Wisconsin, 2007; Professional Engineer, 19764, New Mexico, 2009; Professional Engineer - Civil, 50707, Arizona, 2010; Professional Engineer, 43715, Colorado, 2009
American Society of Civil Engineers (ASCE)

EXPERIENCE RECORD

Double Circuit 34.5 kV Fox River Crossing
Kaukauna Utilities
Engineering Project Manager for the Double Circuit 34.5 kV Fox River Crossing Project, responsibilities included the design of a double-circuit steel monopole and accompanying reinforced concrete foundations. The project utilized unique structure framing and high-temperature, high-strength conductor in order to meet long span, 1500 feet and future load requirement needs of the project. Responsibilities also included oversight and assistance of the construction bid process as well managing the procurement of all project material and construction support. (2009 – 2011)

Iron Horse to Salvador 230/138 kV Transmission Line
La Plata Electric Association
Engineering Project Manager for the design of the 138 kV transmission line loop to feed the new Iron Horse substation and a new double circuit 230/138 kV transmission line to feed the new Salvador substation. The line incorporated the design of steel tangent, angle and dead-end structures. All steel structures also had accompanying reinforced foundations designed. (2009 – 2011)

Pre-Certification - Monroe County to Council Creek 161/69 kV Double Circuit TSP
American Transmission Company
Engineering Project Manager for the development and preliminary design of a 17 mile 161/69 kV double-circuit transmission line. The preliminary design for this project consisted of structure design configuration for use in areas of limited ROW width, T2 conductor, multiple switch and substation interconnections which included the analysis of difficult routing and structure spotting. Many unique and specialized structure designs were also developed in-order to accommodate existing obstacles of the selected line route. Preliminary activities also included the development of project cost estimates, EMF analysis, FAA analysis, and satisfying the design requirement of four distinct entities. (2009 – 2011)

TRTP - Segment 6 - 500 kV LST & TSP
Southern California Edison
Responsibilities as Segment Design Lead / Project Manager for this 500 kV rebuild project included steel monopole, multi-pole and lattice tower analysis and evaluation, leg extension selection and design of reinforced concrete

foundations for all structure types. This line posed many challenges for structure and leg extensions selection as it traversed through the mountains of the Angeles National Forest for its entire 32 mile length. Design of long spans, many in excess of 2500 feet, was necessary for the majority of the project as spotted structure locations were limited due to terrain and environmental constraints. (2008 – 2011)

TRTP Segment 7 - 500 kV LST & TSP
Southern California Edison
Responsibilities included supporting the design teams during design and Engineering. Lead for the detailed design of all foundation systems for both segments, which included both Lattice and steel pole construction. Design?s included incorporating specialty foundations (Micro-Pile) for the most difficult locations. (2008 – 2011)

TRTP Segment 11 - 500 kV LST & TSP
Southern California Edison
Responsibilities included supporting the design teams during design and Engineering. Lead for the detailed design of all foundation systems for both segments, which included both Lattice and steel pole construction. Design?s included incorporating specialty foundations (Micro-Pile) for the most difficult locations. (2008 – 2011)

LiDar Post Processing, PLS Modeling & Rating Analysis
American Transmission Company
Numerous projects over several years involving Post Processing of LiDar Survey data, PLS modeling of processed LiDar Data and Line Rating Analysis for more than 2500 miles of transmission lines. Responsibilities included managing a team environment focused on transmission line rating services and value added engineering solutions for line uprating recommendations. Rating reports include capacity analysis, methodology, thermal rating results, clearance diagrams and recommended upgrading solutions. (2001 – 2011)

Arden Substation Buildout - 230 kV Quad Circuit TSP
Nevada Power Company
Engineering Project Manager for the transmission structures associated with a major substation expansion. Project consisted of twelve double and quad circuit 230 kV and 138 kV dead-ends on self-supporting steel reinforced concrete foundations along with two tangent structures. Responsibilities included managing a team environment focusing on electrical transmission line design, PLS-CADD Modeling & QC, Developing & checking loads, clearances, drawings and designs. Responsible for the Scoping, Estimating, Budget Adherence, Schedule Adherence, and Quality Control of the construction documents, specifications and drawing packages. (2006 – 2007)

LiDar Post Processing, PLS Modeling & Rating Analysis
Nevada Power Company
Numerous projects over several years involving Post Processing of LiDar Survey data, PLS modeling of processed LiDar Data and Line Rating Analysis for more than 2000 miles of transmission lines. Responsibilities included managing a team environment focused on transmission line rating services and value added engineering solutions for line uprating recommendations. Rating reports include capacity analysis, methodology, thermal rating results, clearance diagrams, span violation descriptions and recommended upgrading solutions. (2001 – 2004)

MICHAEL BRUEN, P.E.

GEOTECHNICAL ENGINEER

KEY QUALIFICATIONS

Michael Bruen is responsible for design and construction management of underground structures, tunnels, and shafts. His experience also includes dam rehabilitation studies, dam inspections and remedial construction assignments, post-tensioned anchorage, grouting, and planning and implementation of geotechnical exploration programs for feasibility and design studies. He has considerable geologic, geotechnical and construction experience as Project Manager, Project/Lead Geologist and as Resident Project Representative/Geologist on numerous tunnels and underground structures; hydroelectric and water supply dams; hydroelectric pumped-storage, dam rehabilitation, combined sewage overflow, flood control and shoreline reconstruction projects. His duties include supervision of staff engineers and geologists for design and construction assignments.

EDUCATION

BS/BSc, Geology, University of New Hampshire
MA, Geology, State University of New York (Buffalo)

Licenses and Professional Memberships

Professional Geologist, Alaska
Professional Geologist, Virginia, 2801000300
Professional Geologist, Illinois, 196-000006
Professional Geologist, Pennsylvania, 001360-G
Professional Geologist, Washington, 2406
Professional Engineering Geologist, Washington, 2406

EXPERIENCE RECORD

Austin Water Treatment Plant CMAR

Lead development of project risk register for raw water intake, tunnel, and pumping station. Lead and facilitate risk workshop, identification of risks, perform risk analysis and identify appropriate risk mitigation measures. Prepare constructability risk register.

Upper Bhote Koshi Hydroelectric Project

Lead Tunnel Engineer/Geologist during inspection of run of the river Upper Bhote Koshi Hydroelectric Project during dewatering of power tunnel system. Project consists of a 45m high gravity dam and gates spillway structure, desanding basin, a 3.4 km long headrace tunnel in rock, 4m-5m wide horseshoe shaped shotcrete lined tunnel, surge shaft and 430m long above ground penstock, and a two unit, 36 MW surface powerhouse. Services provided included review of tunnel dewatering and filling plan, confined space plan, and spillway repair program, and geotechnical instrumentation; inspection of headrace tunnel and above ground structures, and preparation of inspection report. In particular, inspection focus was the tunnel condition, rock cut slope stability, powerhouse back slope, and right abutment slope movement upstream of dam.

Morse Lake Pump Plant Project

Lead Geologist and Tunnel Engineer for conceptual design and final design of the Morse Lake Pump Plant Project for Seattle Public Utilities (SPU). The proposed 240-MGD permanent land-based pump plant is intended to replace SPU's existing floating barge pump station in Morse Lake. The project consists of a deep water intake, microtunnel,

underground pump plant, and large diameter buried pipeline that will access deep storage in Morse Lake and deliver it to Masonry Pool, where it flows into the Cedar River via Masonry Dam. During the conceptual development phase, responsibilities included: the evaluation of various pump plant configurations, pump types, pump motor types, and operational strategies; performing detailed hydraulic calculations for the pumps and discharge transmission pipeline; development of other mechanical systems required for the facility, including an air burst cleaning system for the intake fish screens; preparation of a Construction Sequencing Plan for the project; preparing detailed pump plant technical memoranda; and assisting with the preparation of project permit applications. The selected alternative was a 7-pump system using vertical turbine, constant speed pumps capable of delivering 34.3 MGD. The pump plant is buried beneath an existing forest road adjacent to Morse Lake and includes one large 20-ft diameter access shaft and five individual drilled pump shafts down to a forebay cavern. From the forebay cavern, a 350-ft long microtunnel extends out to a lake tap in Morse Lake, and the lake tap is fitted with intake fish screens. The project has been suspended in November 2009 prior to completion of the 60% design submittal.

Lower Baker Floating Surface Collector
Principle in Charge and Senior Project Manager for conceptual and final design and engineering support during construction of a 500-cfs capacity (1000-cfs pumping capacity) floating surface collector (FSC) and ancillary facilities to be installed on Lake Shannon upstream of the Lower Baker Dam that will collect fish for transport below the dam. The FSC will consist of guide nets, net transition structure, fish collection system, FSC structure, and moorages and shore-side support facilities. Responsible for client interface, project execution guidance and provide review of certain project deliverables.

Thornton Composite Reservoir Tunnel and Gates
QC reviewer of design GDR, design memoranda, and contract documents at the 60% and 98% levels. Project consists of 30-ft ID rock tunnel connecting the TARP Calumet System to Thornton Quarry/Reservoir and a 63-ft diameter, 350-ft deep gate shaft in rock. Tunnel excavation to be by conventional drill and blast.

Red Hill Fuel Storage Facility Structural Assessment
QC reviewer of two reports prepared following inspection and limited coring and testing; Condition / Alternative Repair Evaluation and Repair and the Alternative Rehabilitation Reports. The Red Hill Underground Fule Storage Facility consists of 4.6 miles of rock tunnels, varies from 12-ft wide and 18-ft high to 14-ft wide and 24-ft high, a modified horseshoe shape excavation that has been supported with timbers or steel sets and covered with gunite and also includes twenty 100-ft diameter and 250-ft high steel lined shafts / caverns for fuel storage. This condition assessment did not include the shafts, fuel storage tanks. Investigation included visual inspection, coring,

Alaska Way Viaduct Electrical Relocation Study
Project Manager for viaduct electrical relocation study for Seattle City Light and Seattle Public Utilities. The Phase 2 electrical relocation included development of various alternatives for relocating two 115kV transmission lines and 5-mass distribution lines from the Massachusetts to Union Substations. Over much of this length, the electrical lines are affixed to the underside of the elevated section of the Alaska Way Viaduct. Review of HDD and small bored tunnel construction alternatives developed by WSDOT and development of additional construction alternatives utilizing multiple construction methods including HDD, open cut trenching, overhead aerial, , submarine cable and bored tunnels. Tasks included development of alignments, key criteria, and concepts, risk analysis, triple bottom line analysis, construction cost estimating, third-party review, and report writing.

Systems Conveyance Operation Program (SCOP)Boulder Islands Outfall
Project Manager for final design of the approximately $140 million pipeline project to convey treated effluent out into Lake Mead. The project consists of five 63-inch diameter diffuser pipelines ranging in length from 14,400-ft to 20,550-ft in length extending to various discharge locations in lake with air capture chambers, and a re-regulation reservoir, downstream of a powerhouse. The HDPE pipeline will be constructed using cut and cover methods, dredging, and laying on the surface of the lakebed. Tasks include optimization of preliminary design; physical and numerical modeling, preparation of technical memoranda, technical specifications, drawings, and GBRs for three contract packages. Optimization of preliminary design resulted in $100million reduction of construction cost.

SCOP Reach 3 Tunnel
QC reviewer for a 10-ft diameter, 5280-ft long mixed-face and rock tunnel and two large diameter shafts. Tunnel to be excavated with EPBM and secondary 8-ft diameter steel lining will be installed for conveying treated effluent to Lake Mead. Independent review of technical memoranda, specification (TBM), and GBR.

Lake Mead Intake No. 3
QC reviewer for three design/contract packages associated with the $600M Lake Mead Intake No. 3for 17,000-foot-long, 20-foot-diameter intake tunnel to be excavated using EPBM and four large diameter shafts and a 182-foot-long, 62-foot-wide, 65-foot-high underground pump station being excavated using conventional drill and blast beneath and adjacent to Lake Mead. The intake will provide new raw water to the Las Vegas Valley. Review of GDRs, GBRs, design reports, technical specifications, and contract drawings for the D-B (intake) and D-B-B (connection tunnel, underground pump station) contracts. Key issues include high groundwater pressures (up to 17 bar), tunnel excavation through variable rock conditions, one pass lining, pump station chamber excavation support systems, gate shaft design and live tunnel connection to IPS-2.

Hidden Lakes Pump Station and Sewer Improvement Project
Project Manager for construction management support services to King County for the $24-million wastewater pump station, 500,000 gallon underground storage facility (12-ft dia concrete pipe, 600-ft long), four 48-inch diameter MTBM segments, 310 to 610-ft long, using EPBM, and 12,000-ft of trunk sewer for the City of Shoreline.

Barton Creek Lift Station Relief Tunnel
Chairman of the Disputes Resolution Board (DRB) for this $10M underground project. The project includes three shafts (25 and 40-ft diameter) and soft ground (1650-ft) and rock tunnels (1600-ft) which were excavated beneath Barton Creek in a terrace deposit, clay shale and limestone. Tunnel excavated completed with 90-inch diameter digger shield and 96-inch diameter American Auger TBM. Initial support steel ribs and wood lagging, carrier pipes installed and grouted in place. Each tunnel included primary and secondary linings. Two significant claims filed: water inflow at shaft and rock hardness in tunnel.

Lower Baker Powerhouse Expansion Siting Study
Project Manager for third-party review of new powerhouse alternative designed by others and development of two additional viable powerhouse alternatives for a $50 million expansion of the power generating capabilities of the Lower Baker site. Assessed the viability of two alternate sites previously investigated by others, a surface and underground powerhouse option utilizing the existing 16-ft-diameter concrete power tunnel. Develop conceptual layouts for powerhouse, tunnel bifurcation, 12-ft diameter steel lined penstock and bypass valve; assess hydraulic efficiency of expansion on power tunnels; prepare construction cost estimates; and participate in constructability review.

Brightwater Conveyance Final Design
Quality Program Manager for final design of the approximately $480 million wastewater conveyance system consisting of approximately 12.6 miles of influent and effluent tunnels, ranging in depths from 40-ft to 440-ft in depth. Six contract packages were prepared. The soft ground tunnels are being mined using pressurized face TBM (3-EPBM, 1-Slurry), as pressures up to 7 bar may be encountered. A single pass bolted and gasketed, precast segmental linings with inside diameters of 10 to 17.5 feet are being constructed, with two contracts having multiple secondary linings for influent and effluent flows. Five portals (shafts) are being constructed with the largest being 150 foot wide rectangular excavation. As the Quality Manager responsible for the planning and implementation of the quality program for MWH-Jacobs Associates JV which included 17 subconsultants. This included identifying independent QC staff and setting up and coordinating technical advisory committee meetings, preparing a Quality Plan, scheduling and implementing quality control reviews of all design deliverables (TMs, BDR, 60%, 90% and interdisciplinary reviews of each contract package), and quality assurance audits. Also participated in development of risk register and construction contract packaging approach.

Denny Way CSO Control Facilities
Project Manager for construction management services in support of this CSO project that consisted of a 14-ft diameter segmental lined tunnel excavated using an EPBM, five shafts, and four microtunnels, one 72-inch diameter bore and jack and three 72-inch diameter MTBM, 716-ft to 964-ft, flow diversion structures on the existing sewer, interceptors, and a tunnel. Participated in review and resolution of change orders and claims with the contractor. Team tasks included inspection, review of submittals and RFIs, scheduling, document control utilizing Primavera Expedition, claim management and preparation of a construction report.

CARLOS CALDERARO, P.M.P.

PRINCIPAL MECHANICAL ENGINEER

KEY QUALIFICATIONS

Carlos Calderaro is an Electro-Mechanical engineer with more than 25 years of experience in the hydraulic turbine and power generation equipment manufacturing field. He has been involved in various aspects of turbine and generator design as well as management shop and site and supervision of equipment installation and commissioning. He is a certified Project Management Professional and has authored several publications in internationally recognized magazines on hydropower generation projects.

EDUCATION

Electromechanical Engineer (BSEME) National Tech University, Argentina
MBA International, Lleida University, Barcelona. Spain
PMP Certification, Professional Project Manager

Additional

Project Management (PMI based)
Harvard model on Negotiation techniques
Management Course. Francisco de Vittoria University (Spain)
Project Management Certificate (PMI) Penn State University. York. Pa
Purchasing Management Certificate. Penn State University. York. Pa

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EXPERIENCE RECORD

Hydropower Projects

Review and coordination of design of mechanical equipment for new and rehabilitation projects in the Pacific North West Region and South America.
Equipment assessment, shop inspection and manufacturing follow up.
Balance of plant coordination.
Due diligence.

- **Huanza Hydroelectric Project (Peru)**
  FEA analysis for embedded section of hyperstatic penstock .
  FEA analysis of bifurcation and penstock 800 m design head.
  Manufacturing coordination
- **Confluencia Hydroelectric Project (Chile)**
  FEA analysis and fracture mechanical studies for penstock bifurcation . 400 m design head-
- **Ana Cua (Argentina-Paraguay)**
  Studies on hydro-mechanical equipment. Specification for tender of power generation equipment. (Bulb turbines and generators)
- **Ruskin Project (BC Hydro)**
  Technical responsible for the turbine and generator design specifications.
- **Bear Hydro (Regional Power)**
  Project Manager
- **Transalta (Canada)**
  Evaluation assessment of existing hydro fleet for future investment opportunities.
- **Transalta (Canada)**
  Pre-feasibility study of a green-field project

- **Wells Dam (USA)**
  Repair program of wicket gates
- **San Joaquin (USA)**
  Project pre- feasibility design.

Voith Siemens Hydro (Austria)
Project Manager
Hydraulic turbine manufacturing –oversee new & rehabilitation projects in Eastern Europe and Russia , supervise project design teams . Liaise with clients and provide outsourcing negotiation and management of sub-contractors.

- **Ulluabat Hydroelectric Project (Turkey)**
  Technical responsible for the design, manufacturing, shop inspection and site installation support for turbines and spherical valves

- **Uglich Hydroelectric Project (Russia)**
  Rehabilitation of a large Kaplan Unit (9 m diameter) in the Volga river. Coordination of design team Interfaces with generator, civil construction and balance of plant equipment

Voith Siemens Hydro (York, Pa-USA)
Project Leader Engineer
Project coordinator for South American projects. Design integration and basic engineering development. Supply coordination of key components of long lead time.

- **Cana Brava Hydroelectric project (Brazil)**
  Project leader coordinator. Project liaison between US engineering office and South American manufacturing (3 Francis units, 135 MW each, 6 m in diameter)

- **Lajeado Hydroelectric project (Brazil)**
  Project leader coordinator. Liason between US engineering office and South American manufacturing. 5 Kaplan units 180 MW each 8.6 m diameter. .

- **Calderwood Hydropower Project (USA, Tn)**
  Project leader. Major turbine rehabilitation.

IMPSA Hydro (Argentina)
Project Coordinator Engineer
Hydraulic turbine manufacturing
Coordination of multidisciplinary teams involved in the design, manufacturing and installation of the equipment for hydropower projects. Balance of plant and field erection support.

- **Tocoma Hydroelectric Project (Venezuela)**
  Lead mechanical proposal engineer
  Coordination and successful completion of proposal design for the largest output Kaplan units in the Americas. 10K x 220 MW.

- **Bakun Hydropower Project (Malaysia)**
  Lead mechanical engineer
  Design, manufacturing inspection and installation coordination of four Francis units 4 x 350 MW in Borneo Island. South East Asia.

- **Dahua Hydropower Project (China)**
  Lead mechanical engineer
  Design, coordination, shop manufacturing inspection and installation for the rehabilitation of four Kaplan units 4K x 120 MW (8, 6 m) diameter
  Oversee assignment in South East Asia and China.

- **Santa Clara / Fundao (Brazil)**
  Lead mechanical engineer
  Design coordination, manufacturing follow up and site installation for mechanical equipment of two new powerhouses, housing 2 units each of 60 MW. Turbine, generator and auxiliaries design coordination

- **Potrerillos (Argentina)**
  Lead mechanical engineer
  Design coordination and installation for the mechanical equipment for new units and rehabilitation of existing powerhouse.
  4 x 35 MW units (180 m head) and 3 x 25 MW (80 m head)

- **Yacyreta (Argentina)**
  Lead mechanical engineer
  Manufacturing inspection and installation for turbines and their auxiliary mechanical and electrical equipment 20K x 160 MW

CHRISTOPHER CARROLL, P.E.

LEAD SUPERVISOR MECHANICAL ENGINEER

KEY QUALIFICATIONS

Mr. Carroll has 24 years of mechanical, civil and construction management experience successfully leading and participating in multidisciplinary teams on a variety of municipal public works projects. His diverse experience includes projects for water, wastewater, solid waste, electrical, and surface water utilities and hydro electric facilities. He has served as both project manager and engineer. His background includes preliminary engineering studies, conceptual and final design activities, project scheduling, construction cost estimating, permit acquisitions, agency coordination, independent engineering review, and construction management services.

EDUCATION

BS, Mechanical Engineering, University of Washington

Licenses and Professional Memberships

Professional Engineer, Washington No. 29001, California

EXPERIENCE RECORD

Sunset and Heathfield Pump Stations and Force Main Upgrade Project
King County, Washington
Prepared alternative pump station configurations including pump size and layouts. Evaluated alternatives and prepared final report.

Crookes Falls Hydroelectric Evaluation
Upper Gunnison River Water Conservancy District
Prepared feasibility level design for increasing the capacity of a small hydroelectric facility. Wrote letter report to support an evaluation of water right for the project.

Hydroelectric Sites FERC Licensing
Grand Coulee Project Hydroelectric Authority
Wrote preliminary permit applications for three potential hydroelectric sites. Managed preparation of applications.

Grand Coulee Dam Third Powerhouse Turbine Runner Upgrade Study
USBR
Prepared evaluation of 700 MW turbine runner replacement alternatives. Researched means, methods, and materials for use in larger runner replacements. Performed site inspection of runner and documented wear ring clearances and cavitation damage.

Ruskin Generating Station Powerhouse Improvements Project
BC Hydro
Designed balance of plant systems for complete replacement. Systems included compressed air, scroll case dewatering, and draft tube dewatering.

Alderwood Water and Wasterwater District
Lynwood, Washington
Project Engineer. Designed and performed the daily management of construction for a booster pump station and two chlorination system replacements. Performed the mechanical design for water pumps, piping, valves, heating and ventilation systems for the new pump station building.

Alderwood Water and Wasterwater District
Lynwood, Washington
Project Manager. Designed and managed construction of and seismic upgrades to reservoir piping connections. He was responsible for the design, coordination permitting, and bid review. Responsible for construction management and inspection of this project.

Seattle Public Utilities
Seattle, Washington
Engineer. Prepared plans and specification for 30 and 36 inch butterfly valve replacement on two water supply pipes for the City.

Omaha District Corps of Engineers
Fort Peck, Montana
Mechanical Engineer. Responsible for the 25- and 14-foot-diameter penstock layout and design, trifurcation layout, temporary HVAC system design, drafting, assembly of design submittals, project management assistance, and client and sub-consultant correspondence. Performed shop drawing reviews and provided technical support during construction.

Blue Lake Hydroelectric Project
City and Borough of Sitka, Alaska
Project Engineer. Responsible for the design of 35-foot-long, 36-inch-diameter steel pipe penstocks and bifurcations for the Fish Valve Powerhouse and the Pulp Mill Powerhouse at Blue Lake. Designed the 60-foot-long, 18-inch-diameter steel pipe bypass system and performed shop drawing reviews.

Massachusetts Water Resources Authority
Boston, Massachusetts
Mechanical Engineer. Involved in the development and design of the 70-MW on-site power plant, which consists of two 26-MW simple-cycle combustion turbines and a cogeneration plant with two 600-psig boilers and an 18-MW topping steam-turbine generator. The plant is capable of producing 300 MMBH of high-temperature hot water for process and space heating. Responsible for the design of a 3,300-foot-long, 30-inch diameter cooling water pipeline and for hydraulic analysis, water-hammer analysis, drawing production, and cost estimate. In addition, designed the conversion of a steam heating system to a hot-water heating system.

Boston Harbor Wastewater Treatment Plant
Thurston County, Washington
Mechanical Engineer. Prepared contract drawings of civil features and mechanical piping for a new waterwater treatment plant.

Redmond Town Center Sanitary Sewer Lift Station
The Winmar Company/Redmond, Washington
Mechanical Engineer. Prepared contract drawings and specifications for mechanical piping, valves, and equipment for a new wastewater pump station.

West Branch Union River Intake
City of Bremerton, Washington
Engineer. Prepared designs of a new water supply intake for the City of Bremerton. The intake included reinforced headwall and sidewalls, fish screens, fish bypass and measuring weir, biostabilized bank restoration, side channel overflow, and two four-foot by four-foot gates to sluice bedload during high flows.

DON CRONE, P.E.

LEAD CONSTRUCTION / COST SCHEDULER

KEY QUALIFICATIONS

Mr. Crone has over 35 years of experience in the engineering and construction industry. His extensive experience includes project planning, estimating, contracts, and allocation of labor and equipment resources, scheduling, budgeting and overall project execution. Mr. Crone's process for cost estimation includes site visits, reviewing local labor rates, developing equipment rates, and obtaining material prices and subcontractor quotes. The estimate is then developed by crew base estimating by performing quantity takeoffs and applying reasonable production rates for the crews. The estimates are prepared with direct cost and indirect cost with markup and appropriate contingencies added. These estimates are prepared to an AACE Class 2 estimate level. Mr. Crone's process for developing project schedules entails applying the correct predecessors and successors to work activities to accomplish the project. The work activities are assigned durations from the cost estimating process. During this process the plan and specification reviews are accomplished to Quality Control the final plans and specifications. Mr. Crone has progressed from surveyor, office engineer, field engineer, project engineer, estimator, project manager, operations manager to Vice President of Operations of a top 10 ENR construction company.

EDUCATION

BS Civil Engineering, Tri State University

Licenses and Professional Memberships

Professional Engineer – WY, MD, KY

EXPERIENCE RECORD

Ruskin Powerhouse Rehabilitation

BC Hydro

Cost Estimator. Identification Phase work (detailed feasibility studies) to develop a preferred alternative for comprehensive rehabilitation, modernization, and improvements to the Ruskin powerhouse, a 1930 vintage plant housing three vertical-shaft, 35 MW Francis-type turbines and generators. Overall scope is to support BC Hydro in developing a preferred alternative for comprehensive rehabilitation, modernization, and improvements to the Project intakes, generating unit water conveyances, generating units, plant auxiliary equipment and systems, and powerhouse structure.

Lower Baker Floating Surface Collector

Performed cost estimates for Puget Sound Energy's Lower Baker floating surface collector (FSC). Estimated costs for the FSC hull and floatation structure, on-board fisheries facilities, net transition structure, guide nets, mooring lines and winches, and the shoreside facilities including buried and submarine power feeds, piers, docks and fish handling facilities.

Blue Diamond Pump Storage Project

Las Vegas, Nevada

A joint venture with PKS (Peter Kewit & Sons. Performed cost estimates for the construction of a 300 Million Design Build Pump Storage project. The project consisted of an upper and lower reservoir, intake shaft, power tunnel, underground power house, and tailrace tunnel and outlet.

Bakun Hydropower Project

Ahmad Zaki Sdn Bhd, Malaysia

Senior estimator and construction specialist assisting the contractor with construction planning and preparation of cost estimates for construction of the spillway and power intake works for the Bakun Hydropower Project in Malaysia. Construction involves 500,000 cubic meters of concrete placement with a completion period of about two years

Karahnjukar Dam and Hydropower Project
Landsvirkjun, Iceland
As a Construction Specialist, assistance was provided to the Owner with cost analysis, change order negotiations, and schedule impacts with the contractor on site. Construction involved 8,500,000 cubic meters of rock fill dam that is 650 ft high with a concrete face slab. The project also has diversion tunnels, access tunnels and grouting tunnels. The concrete toe wall has approximately 60,000 cubic yards of concrete.

Al Wehdah Dam
Performed an AACE class 2 cost estimate and schedule for the construction of a 1,300,000 cubic yard, RCC dam that is 70 meters high, requiring the development of a quarry, intake towers, and steel conduits to a discharge structure.

Portugues Dam
U. S. Army Corps of Engineers
Principal Estimator. Performed an AACE class 2 construction estimates for construction of the spillway and power intake works. This dam is a double curvature arch dam with a height of 220 feet and a crest length of 1317 feet that contains 200,000 cubic yards of concrete, also performed an alternate class 2 estimate for the construction of a RCC dam.

Folsom Dam Spillway Project
Joint Federal Project: U. S. Army Corps of Engineers, Department of Interior Bureau of Reclamation
Performed scheduling and phasing tasks for the spillway construction and recommendations on construction work packages and staging considerations The project consists of civil work including mass excavation and construction of a new control structure and new spillway at Folsom Dam in Folsom, CA. The concrete spillway will be constructed to control flows associated with 100-200 year flood events. Six submerged Tainter gates will be installed at the control structure to accomplish this. The project is value at $875 M and will extend to the year 2016.

Broomfield Dam & Reservoir Project
City of Broomfield
Cost estimator and scheduler for this project, which the project consists of the construction of a 3,000,000 cubic yard earthen dam embankment with a height of 90 feet and a crest length of 4700 feet. A grout curtain will be constructed extending from the central core trench to the underlying impervious foundation zone. Water deliveries to a water treatment plant from the reservoir will be from new welded steel piping. Structures on the project are a pumping plant, outlet tower, spillway outfall structure, drainage structures and pipelines.

Iowa Hill Hydropower Project
Sacramento Municipal Utility District (SMUD)
Performed a feasibility estimate for a pump storage project consisting of a 2100 acre foot to a 6500 acre foot upper reservoir, intake shaft, power tunnel, under-ground powerhouse and tailrace tunnels. The power generation was comprised of combinations different size upper reservoirs and power generation from two 125MW Units to two 200MW Units.

Lake Mead Intake No. 3 Pumping Station
Southern Nevada Water Authority, Henderson
Cost estimator and scheduler for this project, which consisted of civil work including mass excavation and grading of the new pump station with 22,390-foot pumps, surge chamber and a 50-foot diameter surge tank, site and yard, site utilities, access road, and view beams. Underground civil work included a 26-foot inside diameter concrete lined shaft 390 feet deep, and construction of a fore bay cavern. Tunneling consisted of approximately 2,200 feet of modified horseshoe tunnel 14 feet wide by 16 feet high, including tunnels connecting to the fore bay and 300 feet of connector tunnel. Pumping station work consisted of vertical turbine pumps and motors, ancillary systems such a HVAC and plumbing, the pumping station building, and raw-water 84-inch discharge pipelines.

Lake Mead Intake No. 2 Connection and Modifications
Southern Nevada Water Authority, Henderson
Provided cost estimating and scheduling for the Lake Mead Intake No. 2 Connection and Modification. The project consisted of the construction of a 22-foot-diameter concrete-lined shaft, 377 vertical feet, with the installation of a gate and electrical driven gate hoist, electrical equipment, and controls. Tunneling consisted of 536 lineal feet of modified horseshoe tunnel 14 feet wide by 16 feet high. Chemical feed lines installed in IPS-2 existing tunnel and shaft and installation of electrical and control systems.

Calaveras Dam Replacement
San Francisco Public Utilities Commission
Responsible for providing cost estimating and scheduling. Project involves the replacement of the existing Calaveras Dam with a new earth fill dam consisting of 4,000,000 cubic yards of zoned embankment to be constructed from borrow sources and project excavations. Excavations involve dam foundation, 1,800,000 cubic yards and 2,300,000 cubic yards of spillway excavation. The project also will consist of the construction of a new outlet works and a concrete spillway with 49,000 cubic yards of concrete

San Joaquin Pipeline System
San Francisco Public Utilities Commission
Provided cost estimating and scheduling. The project consists of the installation of 55,000 feet of 92-inch welded steel pipeline and valve vaults. The project also included four trench-less crossings involving large-diameter micro-tunnels.

Crystal Springs/San Andreas Transmission System Upgrade
San Francisco Public Utilities Commission
Provided cost estimating and scheduling for the construction of a new pump station consisting of a building 165 feet by 55 feet with four 2500HP pumps. The modifications of four outlet towers, all towers require under water demolition and construction of multilevel outlets at each tower, while maintaining water service with the existing pump station and pipelines. The project also includes the rehab and new construction of a 60in steel pipeline, and reconstruction of inlets and outlets at Crystal Springs Dam.

Olivenhain–Hodges ESP/Pumped Storage Projects
San Diego County Water Authority
Prepared the project cost through feasibility to 65 percent planning phase. Major features of the pumped storage project consist of a 5,700-foot-long pressure tunnel in very hard rock that will connect to the existing inlet/outlet structure in the Olivenhain Reservoir; a two-unit 40-MW pump house with reversible Francis pump-turbines; and a tailrace tunnel and inlet/outlet structure in Lake Hodges.

Bakun Hydropower Project
Ahmad Zaki Sdn Bhd
Senior Estimator and Construction Specialist assisting the contractor with construction planning and preparation of cost estimates for construction of the spillway and power intake works for the Bakun Hydropower Project in Malaysia. Construction involves 500,000 cubic meters of concrete placement with a completion period of about two years.

RESUME

EWAN H. CUMMING, M.Sc., P.Geo.
MANAGER – GEOSCIENCE AND MARINE SURVEY

FUGRO GEOSURVEYS INC.

Last Update: March 2011

EDUCATION

Master's Degree (Earth Sciences; Marine Geology) 1990
Memorial University of Newfoundland, St. John's, NL

B.Sc (Honours) Degree (Earth Sciences) 1986
Memorial University of Newfoundland, St. John's, NL

SAFETY TRAINING

Lockout / Tagout 2008
Video based, Self Study Program

Due Diligence 2004
Atlantic Safety Centre, St. John's NL.

MED A1 1994
Fisheries & Marine Institute
Memeorial University of Newfoundland, St. John's, NL

EXPERIENCE

Mr. Cumming is a professionally registered marine geoscientist. He has acquired experience in geological/geophysical studies from a variety of marine environments. Ewan has conducted and supervised studies of coastal geology, in Canada, the United States and abroad, as well as drill site and regional investigations on the Grand Banks of Newfoundland, Scotian Shelf and North Sea. He has coordinated and managed pipeline and cable route investigations from within Eastern Canada, and well as corridors to the U.S. He has operated and supervised a variety of geophysical survey systems, as well as advanced processing and presentation tools, always with the goal of optimizing data quality from a geologist's point of view. Ewan has completed the Fugro Senior Management Training Program.

The following is a sample of Mr. Cumming's experience:

- Geophysical Project Management of Wellsite Surveys for Corridor Resources.
- Geophysical Project Management of Wellsite Surveys for Statoil Canada.
- Geophysical Project Management of Hebron and Hibernia South Geophysical Surveys.
- Management of High Voltage DC Cable Route Surveys, Nalcor.
- Geophysical Project Management of Wellsite Surveys at White Rose for Husky Energy.
- Geophysical Project Management, Wellsite Surveys for Suncor, Grand Banks.
- High Voltage DC Cable Route Surveys, Newfoundland and Labrador Hydro.
- Geophysical Project Management, Northeast Gateway LNG Surveys.

- Wellsite Surveys over South Whale Basin for Husky Energy.
- Multiple Wellsite and Site Investigations for Chevron Canada Resources.
- Wellsite and Surficial Surveys, Hibernia GBS area, HMDC/ExxonMobil.
- Multiple Wellsite Surveys, Terra Nova Development, Petro-Canada.
- Multiple Wellsite Surveys, White Rose Development, Husky Energy.
- Tailings Pond Geophysical Investigation, Wabush, Labrador.
- Client Representative, Lake Maracaibo Geophysical Survey, Venezuela.
- White Rose Repetitive Seabed Mapping.
- Pipeline Route Survey from Scotian Shelf to U.S. (Blue Atlantic).
- Offshore Pipeline Route Surveys: Sable Offshore Energy Project and EnCana, Scotian Shelf, Nova Scotia.
- Geophysical/Hydrographic Surveys: Voisey's Bay, Labrador.
- Geophysical/Hydrographic Surveys: Whiffen Head Transshipment Facility.
- Voisey's Bay Shipping Route Investigations (1996 to 2004).
- Drilling hazards identification and mapping, Atchafalaya Bay, Louisiana.
- Mapping of Shallow Stratigraphy, Hibernia to Terra Nova, Grand Banks.
- Extension of Shallow Seismostratigraphic Framework, Grand Banks.
- Grand Banks Wellsite Survey Review.
- Marine Geological Compilation, Northern Grand Bank.
- Iceberg Scour Database Update, Northern Grand Bank and Labrador Shelf.
- Cable route surveys, West Palm Beach, Florida.
- Multiple cable-route surveys for the CANTAT 3 project.

PROFESSIONAL ASSOCIATIONS

- Professional Member of the Association of Professional Engineers and Geoscientists of Newfoundland (PEGNL) since 1992.

PUBLICATIONS

- Cumming, E.H., Aksu, A.E. and Mudie, P., 1992. Late Quaternary glacial and sedimentary history of Bonavista Bay, northeast Newfoundland. Canadian Journal of Earth Sciences, 29; 222-235.

- Cumming, E.H., 1994. Extension of the shallow seismostratigraphic framework for northeastern Grand Bank, Newfoundland. Report submitted by Terraquest Associates to the Atlantic Geoscience Centre, Dartmouth, Nova Scotia.

- Sonnichsen, G.V., Cumming, E.H., Moran, K., Parrott, D.R. and Lewis, C.F.M., Shallow stratigraphy, sediment properties and foundation stability in the Jeanne D'Arc Basin Discovery Areas.

- Cumming, E.H., 1995. Structural contour maps of the shallow seismostratigraphy, northeast Grand Bank, Newfoundland. GSC Open File Rep. #3128, 31 p.

- Cumming, E.H. and Sonnichsen, G.H., 1997. White Rose repetitive seafloor mapping: a correlation of side scan sonar data and a swath bathymetry image from the grand banks, Newfoundland. GSC Open File Rep.

PETER DICKSON, Ph.D., P.G.

SENIOR TECHNICAL ADVISOR - GEOTECH

KEY QUALIFICATIONS

Dr. Peter Dickson has broad experience on a large variety of water resource projects in many parts of the world including dams for water supply and hydroelectric projects, power plants, penstocks, tunnels, caverns, pumping stations, and flood control structures. His experience includes project screening and ranking; design and supervision of geological, geotechnical, and hydro-geologic investigations; siting of project features and developing preliminary layouts and arrangements; dam type selection (Earth and Rock fill dams, CFRD, RCC, Gravity, Arch Dams), slope stability evaluations and slope design; landslide studies; technical training and technology transfer; and determining criteria for planning, design and construction of tunnels, caverns, and dams. His work includes assessment of risk, identification and evaluation of mitigation options and alternative project arrangements, development of project cost parameters, and constructability review. Recent work has included project development planning and has involved evaluations and assessments of existing and new projects being considered as investment opportunities. He is responsible for management of Quality Assurance and Quality Control and for risk management on high risk projects focusing on geological and geotechnical factors. He is also responsible for seismic hazard and risk evaluations and recommending seismic parameters for design of new projects and seismic safety evaluations of existing facilities.

He provides technical management of investigations, engineering, and construction work on dams and tunnels for major Water Resource Projects, Quality Management (including Quality Assurance and Quality Control), Risk Management, Technical Risk Identification/Analysis/Mitigation, and QA/QC.

As Quality Management Director he has been responsible for development and institution of quality management systems (including systems meeting ISO 9001 standards) for use in a broad range of company operations extending over many countries and five continents. His activities include implementation of continuous improvement approaches, training, conducting quality audits, as well as technical review roles. Dr. Dickson works with other MWH managers in development and training of consistent project management practices that are applied globally in all our operations. As Manager of the MWH Geotechnical Risk Management Program, he is also integrally involved in company risk management, with a special focus on high-risk projects.

As the MWH Americas leader for Technical Risk Review and Analysis, he is responsible for implementing and managing technical risk review of project pursuits that entail geotechnical risk components including dams, tunnels, geotechnical investigations, foundations and excavation design and high seismic hazard areas. Dr. Dickson has broad experience on a large variety of water resource projects; his 38-year professional history includes large civil geotechnical services provided on more than 125 projects in 33 countries.

EDUCATION

PhD, Geology University of Pittsburgh
MS/MSc, Geology University of Manchester (England)
BS/BSc, Geology University of Leeds (England

Licenses and Professional Memberships

Professional Geologist: Georgia; Virginia; Wyoming; Indiana
USSD (U.S. Committee on Large Dams), Associate Member; Geological Society of America (GSA), Associate Member; American Rock Mechanics Association (ARMA), Member; International Association of Engineering Geologists (IAEG), Associate Member; International Society of Rock Mechanics (ISRM), Member

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MWH

EXPERIENCE RECORD

Panama Canal Locks Expansion Project
Panama Canal Authority
Member of Independent Technical Review Board on development of design for design-build bid for construction of new Panama Canal locks expansion project. Lead reviewer for foundations and seismic aspects. In addition to high-level technical reviews, he was also responsible for developing and maintaining quality management system for the project. At the request of Canal Authority (Client) and prior to bidding period, he participated in peer review of seismic hazard and geologic data acquisition and interpretation, and advised client in approach to selection of seismic design criteria.

Neelum-Jhelum Hydroelectric Project
WAPDA, Pakistan
Member of senior technical review team during detailed design and construction of 950-MW hydroelectric project scheme in Himalaya foothills, Jammu-Kashmir northern Pakistan. Responsible for site visits, value engineering and technical advice to design team, technical review of underground works (28-km-long headrace and tail tunnels, underground power station complex, 300-m-high surge shaft, access tunnels), and concrete gravity dam, de-sanding chambers. Severe project challenges include major earthquake hazard (within zone of catastrophic 2005 earthquake, M=7.6), weak foundation materials, active fault crossings for tunnels, highly deformed and complex tunnel geology. Served as technical lead in evaluation of earthquake hazard using DSHA and PSHA methods for project region in northern Pakistan. Results were used for development of seismic design parameters for final design including ground motion estimates, response spectra and time histories.

Tekeze Dam
Ethiopian Electric Power Corporation
Responsible for technical review and field inspection of project works and seismic hazard on 190-high thin-arch concrete dam under construction, special focus on foundation and rock slope stability assessment, rock mechanics evaluations (including 3-D rigid block and kinematic analyses, block theory, 2-D and 3-D FEM stress and deformation analysis), rock reinforcement and anchor design, including participation in thrust-block design and left abutment remedial works (abutment replacement), review of underground works (power tunnel system and powerhouse cavern); QA of site engineering.

Cerro Corona
Goldfields
Member of independent technical review panel responsible for review of design, plans and specifications for construction of 225-m-high tailings dam and related works located in high seismic hazard region in Andes. Visited project site to conduct field inspections, participated in technical review meetings with client and design team, participated in Failure Modes and Effects Analysis of project.

Proyectos HidroAysen
HidroAysen
Served on Board of Consultants as technical expert on foundations and underground structures. Assignment involved review of five hydroelectric projects under various stages of development with total installed capacity of 2750 MW. Projects are being developed within framework of Sustainability Protocol of IHA. Review activities included site visits and detailed inspection of investigations and design with Owner and its design team.

Dasu Hydroelectric Project
WAPDA
Lead geological engineer in feasibility study and design of major hydroelectric project on Indus River (4000-MW installed capacity powerhouse, 200-m-high dam). Responsible for geotechnical investigations, development of design criteria for dam, and design of underground facilities. Also responsible for direction and review of seismic hazard and neotectonics investigations and determination of seismic parameters for design.

Al Wehdah Multipurpose Project
Jordan Valley Authority
Reviewed and evaluated foundations during construction, conducted special stability assessments (including 3-D block analyses), rock mechanics analyses, proposed design and construction modifications, reviewed foundation treatment and grouting works, attended Panel of Experts Meetings.

Pinalito Hydroelectric Project
Corporacion Delacueducto y Alcantarilla
During project development and planning, responsible for seismic hazard assessment, geological investigations, assisted in preparation and evaluation of alternative arrangements including preliminary tunnel design aspects for dam and 13-km-long headrace tunnel. During construction, responsible for senior review of contractor and engineering submittals on foundations, excavations, earthquake, construction materials, tunnel design and construction (10-km x 3.6 m dia TBM tunnel, 3-km drill/blast); conducted detailed review of contractor's tunnel progress and basis for claims; QA review and audits of site engineering during construction.

International Panel of Experts, Iraq
Ministry of Water and Energy Resources
Expert in geological engineering and seismicity serving on International Panel of Experts (POE) for Ministry of Water, provided technical review, advice, and oversight of all dam projects in operation, under design, or investigation for planning and future development.

ITR McCook Tunnel Connecting Tunnels
Client: US Army Corps of Engineers
Member of Independent Technical Review (ITR) - team responsible for design review of USACE concepts, designs, drawings, and specifications for large diameter (33 ft) connecting tunnel system and gate shaft/chamber.

El Cajon Hydrolectric Project
CFE and CIISA
Principal engineering geologist serving as Member of Dispute Resolution Board retained by Owner (CFE) and contractor consortium (CIISA) to provide expert opinion and resolve financial disputes upon completion of construction of major hydroelectric project with high concrete-faced dam, underground power station complex. Responsibilities included visit to project site, participation in meetings with Owner and Contractor, review of technical and contract information, and development of opinion on validity of claims involving changed/unanticipated geologic conditions, scheduling interferences, cost impacts. Responsibilities primarily focused on claims associated with construction of tunnels, and underground power house cavern.

Rosia Montana
S.C. Rosia Montana Gold Corporation SA
Member of independent technical review panel responsible for review of designs, plans, and specifications for construction of tailings dam and related works located in central Romania.

Spavinaw Dam Modifications
Craig & Keithline, Inc.
Project manager for structural improvement of 80-year old concrete gravity dam with overflow spillway. Work involved field visits for condition assessment, reservoir sediment survey, geotechnical investigations, stability assessments, preparation of designs, plans and specifications for repair and re-facing of concrete structures.

Karahnjukar Hydroelectric Project
Landsvirkjun
Lead geological engineer in review and finalization of seismic design for 200-m-high concrete-faced rockfill dam in Iceland, QA review of geology, foundations, and grouting. Presented findings and recommendations to independent technical review Panel of Experts.

Shandong Taian Pumped-Storage Project
Shandong Taian Pumped-Storage Power Station Co. Ltd
Consultant responsible for review and technical advice on design and construction of underground features, including power house cavern, transformer hall, water conveyance tunnels, power shafts, and surge chambers. Responsible for review of geology, tunnel design, assessment of stability of caverns and tunnels, and shafts; numerical analysis, excavation and support design of caverns, overall review of cavern design and construction methods; review and advise construction design of underground works, including review of construction procedures and specifications; check of project construction schedule, implementation plan, and construction cost estimates. Also was responsible for review and advice on geo-membrane lining system for upper reservoir.

Kotli Hydropower Project
Mira Pakistan Limited
Lead geological engineer in identification and selection of preferred scheme for run-of-river hydropower project in Himalaya foothills, Jammu-Kashmir. Responsible for seismic hazard evaluation and development of earthquake design criteria in high-hazard region (recommended parameters that forecast affects of devastating earthquake that afflicted the region in 2005). Carried out field visits, development of geological investigation program, assessment of project geotechnical risks, dam foundation evaluation, design of 7-km-long tunnel system (5.5-m-dia) through weak, highly deformed Himalayan strata; tunnel construction cost estimation, and development of preliminary project layouts.

Seneca Pumped Storage Project
First Energy
Lead geologist and quality control engineer during emergency investigations, development of repair program, drawings and specifications, and implementation of repairs at lined upper reservoir of pumped storage project. Responsible for supervision and review of design components (geo-membrane system), Health and Safety Plan, Quality Control Implementation Plan, and field supervision.

Alpaslan II Project
Devlet Su Isleri
Lead geologist and geotechnical engineer for turnkey design-build team on project on the Murat River in eastern Turkey. The project involves a fill dam about 106 m high, a gated chute spillway, and a hydroelectric powerstation with an installed capacity of 200 MW. The project geology presents some important considerations including low strengths of clay shales in the foundations, swelling clays, widespread landsliding, and high earthquake hazard. Responsible for site visits and review of feasibility studies and investigations, development of additional investigations (drilling, geophysics, mapping, testing), seismic hazard analysis, and design recommendations. Supervised team of engineering geologists and geotechnical engineers during the following processes - design, seismic analysis, preparation of specifications and drawings, and the QA/QC process.

Missouri Pumped Storage Project
Confidential
Supervised team of engineers and scientists in conceptual study of proposed new pumped-storage project with a view to mitigation of environmental and visual impacts. Tasks included optimization of previously developed project configuration to establish a base scheme; modification of base scheme to account for different generation capacities (200 MW-800 MW installed capacities) as well as to mitigate environmental, real estate and aesthetics constraints; prepare cost estimates for the various schemes; identify alternative locations for the pumped storage project.

Rio Indio Water Supply Project
Panama Canal Authority
Lead geologist on a project to supply water to the Panama Canal. Responsible for site visits, development and supervision of investigation programs (including geophysical studies) for a 75-m high dam, dam type selection RCC versus CFRD dam types), appurtenant works, two small hydro plants, and a 8.5-km long inter-basin transfer tunnel; seismic hazard evaluation. Investigations carried out in remote areas requiring helicopter mobilization and support. Responsible for developing criteria for preliminary design of dam and tunnel, basic design of tunnel system, construction cost parameters and schedule. Also was responsible for geotechnical Quality Assurance on evaluation of new Lock and Canal Alignments.

PETER DONALEK, P.E.

ELECTRICAL ENGINEER, LEAD POWER SYSTEM PLANNER

KEY QUALIFICATIONS

Mr. Donalek has significant recent experience with electric utilities that are reorganizing and adopting a market approach to their services. Mr. Donalek has been involved with the organization of Open Access transmission systems that are a fundamental part of the deregulated electric utility system. He has provided engineering input to the preparation of concession bidding documents for a major transmission line in Peru, and technical engineering assistance in the privatization of two government owned bulk power transmission systems in South America. He has drafted a Technical Grid Code for the power system of Pakistan. On projects in the United States, he is involved in the analysis of power transmission requirements for Non Utility Generators and the evaluation of distribution system planning and reliability. He has submitted comments to the Federal Energy Regulatory Commission (FERC) on the early draft of FERC rule 888 regarding the definition of Available Transmission Capacity. Mr. Donalek has significant recent experience with electric utilities that are reorganizing and adopting a market approach to their services. Mr. Donalek has been involved with the organization of Open Access transmission systems that are a fundamental part of the deregulated electric utility system. He has provided engineering input to the preparation of concession bidding documents for a major transmission line in Peru, and technical engineering assistance in the privatization of two government owned bulk power transmission systems in South America. He has drafted a Technical Grid Code for the power system of Pakistan. On projects in the United States, he is involved in the analysis of power transmission requirements for Non Utility Generators and the evaluation of distribution system planning and reliability. He has submitted comments to the Federal Energy Regulatory Commission (FERC) on the early draft of FERC rule 888 regarding the definition of Available Transmission Capacity. For several nationwide and regional utilities carried out an assessment of the condition of bulk power transmission system and substation facilities as part of program to privatize the system. These efforts included the formulation of due diligence, field inspections, review of design criteria, evaluation of maintenance programs, control centers and system operating practices. Prepared several region-wide and national transmission planning studies, including load-flow, short-circuit and transient stability analysis. Provided transmission expansion plan schedules and cost estimates. Carried out assessments of combined generation expansion plans with associated transmission expansion plans. Developed transmission connection studies, developed connection alternatives, evaluated costs, evaluated reliability issues, provided input to applications for public need and necessity for new generation facilities. Assignments were carried out for hydro, pumped storage and thermal generation plants. Mr. Donalek contentiously continues to expand his knowledge base by engaging in numerous professional development activities. Since 1975 he has attended either the winter or summer meeting, and some years both meetings, of the Institute of Electrical and Electronics Engineers - Power Engineering Society (IEEE-PES). At these meetings he attends paper sessions, presides as chairman of technical sessions, participates in meetings of Task Forces, Working Groups, Subcommittees and Main Committees. Mr. Donalek is an electrical engineer with specific and relevant experience related to evaluation and modernization of pumped storage projects. His experience includes nine pumped storage projects. He has carried out plant electrical equipment design as well as more recent experience with the application of adjustable speed machines to pumped storage projects. He has conducted a research assignment for the Electric Power Research Institute on the application of adjustable speed machines in conventional and pumped storage hydro plants. He has published several technical articles related to pumped storage projects and adjustable speed pumped storage projects. In addition to his experience with pumped storage plants he also has experience with the transmission system connection requirements for generating plants under the FERC rule 888. He has formulated system study plans and directed the preparation of system studies for new and upgraded generating plants.

EDUCATION

MA, Mathematics University of Toledo

MS/MSc, Electrical Engineering University of Pennsylvania

BS/BSc, Electrical Engineering University of Illinois (Urbana-Champaign), 1961

Professional Registration: Professional Engineer, 062-025529, Illinois, 1966

Professional Organizations: Seminar Chairman, Chicago Section, Chairman, 1981 expires 1982; IEEE-PES System Dynamic Performance Committee, Member, 1985; Mathematical Association of America, Member, 1972; Institute of Electrical and Electronics Engineers (IEEE), Senior Member, 1981; International Conference on Large High Voltage Electric Systems (CIGRE), Member, 1997; Task Force on Discrete Supplemental Controls for Stability, Chairman, 1975 expires 1981; American Power Conference , Program Committee, 1984 expires 1992; IEEE-PES Working Group on Renewable Technologies, Member, 1998

EXPERIENCE RECORD

Taltson Hydroelectric Expansion Project
NWT Energy Corporation (03) Ltd.
Prepared scope of services for power system studies for the 161 kV transmission system and reviewed transmission line designs prepared by sub consultant.

JRSP Jordan River Pipeline Project
Jordan
Prepared preliminary transmssion plan for the connection of pumping stations and energy recovery hydro generators to the 400/132 kV bulk power transmssion system of Jordan.

Lake Powell Pipeline Project
State of Utah; natural resources Division of Water Resources
Prepared plans for the interconnection of booster pump stations, in-line hydro generators and pumped storage hydro plant to electric power transmisison grid in southern Utah. Worked with local transmisson owners to identify interconnnection points. Prepared costs estimates for transmission lines and substations. Worked with transmission owners to prepare power system studies.

AMP Hydroelectric Projects (Ohio River Run-of-river Hydroelectric Projects)/Cannelton, Smithland, Willow Island, and Meldahl Hydroelectric Projects
Client: American Municipal Power (AMP Ohio)
Prepared transmisison interconnection applications to Mid West ISO for Smithland and Cannelton Projects. Prepared transmisison interconnection application to PJM for Willow Island Project. Plants will have bulb turbine driven generators. Prepared preliminary transmission line designs for Smithland (161 kV), Cannelton (138 kV) and Willow Island (138 kV). Peter has participated in the Cannelton Hydroelectric Project, which will be located on the left descending bank at Cannelton locks and dam, near Cannelton, IN. Gross head at the Cannelton site is about 25 ft. The new facilities will include a three-unit powerhouse with an estimated capacity of 84 MW. The project is expected to generate an average of 390,000 MWh annually. (Ongoing) (2007 – Present)

SDCWA-Lake Hodges Pumped Storage -61004
San Diego County Water Authority
Developed transmission connection options for proposed pumped storage hydro project. Prepared plant and machine data required by Cal ISO for Transmission Connection and System Impact Study. Reviewed and advised client on the Electric System Impact Study Agreement. Prepared substation planning report.

Mangla Dam Raising, Water and Power Development Authority
Indus Basin, Pakistan
Peter participated in this project, where the main objective of the Mangla Dam Raising was to regain the storage capacity lost due to sedimentation in the reservoir. The project involved raising the main and ancillary dams by 30 feet; modification of the headwork and orifices of the main spillway; and construction of a control weir upstream of the emergency spillway. The Mangla reservoir is primarily operated to meet irrigation requirements, with power generation as a secondary objective. The main benefits of the project included additional average annual water availability and additional average annual generation of 644 GWh.

San Francisco Transmission Project (HVDC Cable)
San Francisco Public Utility Commission
Prepared electric power system section of pre-feasibility study and report. Prepared description of power system configuration for a base plan and three variants. Described relevant HVDC converter/inverter technology as well as conventional alternating current power system facilities. Established voltages, major equipment ratings and representative costs. Project is based on 30 mile HVDC undersea cable to transmit approximatly 400 MW of hydro generation from the Newark substation to load centers in the city of San Franscisco and Alameda.

Technical Analysis of Pump Storage and Integration with Wind Power in the Pacific Northwest
U.S. Army Corps of Engineer NW Dividsion HDC and Bonneville Power Administation
Prepared engineering description of conventional pump storage and adjustable speed pump storage. Described benerfits and explained how adjustable speed pump storage can be used to integrate wind powered and solar generation into interconnected system operation. Suggested how pump storage wtih adjustable speed machines can participate in Wide Angle Measurement System and Wide Area stability and voltage Control System.

Beltzville Hydroelectric project
Borough of Lehighton
Prepared application to PJM for interconnection of the 2.8 MW Beltzville hydro electric power project to the Allegheny Power Services Corp. Provided electrical characteristics and models for use in Generation Interconnection Feasibility Study.

NERC/WECC Compliance Monitoring and Reporting
California Departmetn of Water Resources
For CalDWR assisted in the preparation of software to monitor and accumulate information needed for reliability audits by WECC as part of the NERC Compliance Monitoring Project.

Supplementary Feasibility Study of the Proposed Steelpoort Pumped Storage Scheme
ESKOM Holdings Ltd
Prepared study and report of the applicability of 380 MVA adjustable speed machines in the Steelpoort Pumped Storage project. Evaluated technology, identified benefits, described operating condtions and recommended adjustable speed machines.

Characteristics of Pumped Storage Hydro Units with Adjustable Speed Capabilities - Hawaii
Hawaiian Electric company, Inc
Conducted study and prepared report on the capability of adjustable speed machines in pumped storage plants. Study was based on two pumped storage sites each with 2 x 25 MVA machines. Study evaluated the operating benefits and recommended that pumped storage machines with adjustable speed capability can proide power and frequency regulation in systems with high penitration of wind powered generation.

Bujagali Falls Hydro
Sithe Global
Reviewed existing transmission plan and specification for 220 kV and 132 kV transmission lines and substations. Reviewed Uganda Grid code. Recommended changes to the specifications reflecting changes in line of ownership between plant facilities and national transmission system.

Dana Point Desalination Facility Power Delivery Study
Municipal Water District of Orange County, CA
Conducted a study and prepared a report recommending a 138 kV transmission connection along with a preliminary design of the 13.8 kV plant distribution system. Study included evaluation of overhead vs. underground 138 kV transmission and the use of a SF6 gas insulated substation. The plant would contain twelve 2.2 MGD reverse osmosis trains and includes a energy recovery turbine.

New Zealand 400 kV Transmission System
Transpower
Provided technical input and review of site selection reports for the nation wide 400 kV grid development.

USAID Central Asia Water-Energy Nexus
United States Agency for International Development
Visited the four countries interviewed more than 60 government officials, utility managers and international donors. Prepared an evaluation of the technical programs in the energy sector and recommended programs in the transmission and energy sector to be funded by USAID for the next five years.

Kajakai & Darunta Assistance
Advanced Engineering Associates, Intl.
Reconstruction of bulk power transmission system of Afghanistan. As a subconsultant to Advanced Engineering Associates International (AEAI) reviewed various transmission planning and design reports and provided recommendations for follow-on projects and connection to Central Asia grid.

Generation Investment Study
MWH sa/nv (Belgium)
Reviewed volume on transmission system issues for the Southeast Europe Generation Investment Study. The study determined the optimal timing, size and location of future generating capacity and associated bulk power transmission in the region over the next 15 years (2005 to 2020). GTMax and PSS/E were used to perform detailed models of the interconnected transmission grid for the Southeast Europe Regional Electricity Market.

Hill Air Force Base Relay Coordination Study
US Air Force
Senior Electrical Engineer for the relay coordination study of the Hill Air Force base 44 kV and 12.47 kV distribution systems. Selected relay coordination software. Developed data collection and establishment of an electronic database, established case study list, recommend fuse ratings, revised relay settings and reviewed draft and final reports.

SDCWA-LH Pump Stn & I/O -61006
San Diego County Water Authority
Designed 69 kV transmission connection and switchyard for a two-unit pumped storage plant in San Diego California. Plant is connected to the San Diego Gas & Electric bulk power system according to standards of the California Independent System Operator. Prepared equipment, material and construction specifications for two 69 kV circuits, 69kV switchyard and connection to SDG&E bulk power transmission system.

Oroville Sp-E3-04/Oroville Thermalito Power
Harza/Edaw Joint Venture
Department of Water Resources State of California. FERC Re Licensing Study for the Oroville-Thermalito Power Complex. Evaluated the application of adjustable speed generator/motor turbine/pump units on 40 MW Units 2, 3 and 4 in the Thermalito plant. Study examined technical aspects and included preliminary layout design, cost estimates and evaluation of cost/benefit analysis.

Mendota Hills Wind Farm
Navitas Energy
Organized study program, devleoped study case list, coordinated data collection, evaluated study results, recomended type and capacity rating for reactive power controller, contacted equipment manufacturers, prepared cost estimate and drafted report.

Upper Indus Transmission Plan for Basha Dam
Water and Power Development Authority
Developed several transmission expansion plans for study. Plans were based on the use of HVDC, 765 kV and 500 kV transmission technologies.

USAID Role of Hydro in Southeast Europe Regional Electricity Market
USAID
Project Manager for the USAID funded technical assistance program to the countries of South East Europe. Purpose of the plan is to provide necessary analysis and technical assistance to define the role of hydro generation in a regional electricity market.

Aty Edris

Profession: Power Systems

Nationality: U.S. Citizen

Years of Experience: 35 years

Education: Ph.D. Electrical Engineering, Chalmers University of Technology, Sweden
M.S. Electrical Engineering, Ain-Shams University, Egypt
B.S. Electrical Engineering, Cairo University, Egypt

Position: Sr. Director and Executive Advisor, Quanta Technology

Summary: Summary of career.

Experience:

10/10 – present **Quanta Technology, Raleigh, NC**
Sr. Director and Executive Advisor
Adjunct Professor at Santa Clara University, Santa Clara, CA
Teaching a Graduate Course on Power Systems

10/08 – 10/10 **Siemens Energy, Mountain View, CA, US**
Principal Consultant—
- Developing innovative solutions to overcome low voltage ride through for the interconnection of renewable energy sources
- Invented Smart Grid "Automatic Self-Adjusting Voltage Controller" (patent filed)
- Managed the stability and electromagnetic transient studies for large static var compensator (SVC)

08/92 – 09/08 **Electric Power Research Institute, Palo Alto, CA, US**
Sr. Technology Manager — Directing R&D program for development, installation, and field demonstration of large scale power electronics-based transmission Controllers. Managed R&D program on better managed and controlled transmission grids

Research/Teaching

08/92 – 08/08 **Electric Power Research Institute (EPRI), Palo Alto, CA**
Development Engineer—
- Specified, organized, and directed R&D efforts to develop and demonstrate in full-scale field applications of FACTS technology in power transmission systems. Overseen and managed the development and deployment of the world's largest static synchronous compensator at the Tennessee Valley Authority's Sullivan Substation, the world's first Unified Power Flow Controller at the Inez Substation of American Electric Power, the

first Convertible Static Compensator at the New York Power Authority's Marcy Substation, and the world's first voltage source converter-based back-to-back tie connecting the asynchronous US and Mexican power grids at American Electric Power's Eagle Pass Substation.

- Developed DTCR technology, which offers utilities a way to significantly increase loading on existing transmission circuits and substation equipment.
- Initiated an R&D program for interregional reactive power management of large interconnected transmission grids. The program has resulted in developing highly automated methodology identifying areas in power systems that are prone to voltage instability under particular operating conditions and contingencies, and the reactive power reserves requirement to ensure secure system operation under the considered operating conditions and transmission contingencies.
- Introduced the concept of Grid Shock Absorber, a concept ensuring robustness of transmission grid and eliminating cascading failures.
- Managed an R&D program for the development of an application guide for the conversion of AC power transmission lines into bipole and tripole DC transmission lines. The tripole is a new DC transmission concept based on the use of bidirectional valves in at least one of the three pole converter stations.

11/80 – 08/92 **ABB Power Systems in Sweden and in the US**
Development Engineer—

- Involved in the development and application of reactive power compensating systems and high voltage DC transmissions (HVDC)
- Performed power system analysis and developed powerful digital and analog power systems simulation tools
- Teaching a course on Power System Stability at ABB's Advanced System Technology

04/74 – 11/80 **Chalmers University Of Technology, Sweden**
Senior Research Fellow —

- Developed a research program for the integration of wind power plants into power grids.
- Taught undergraduate and graduate courses in power electronics, power systems, and electrical machinery
- Conducted research and development on renewable energy

Professional Affiliations: **IEEE Power & Energy Society**
Actively involved in IEEE subcommittees work and membership and chairing Working Groups
CIGRE
Convener and member of a number of Working Group under SC B4

Publications: Over 100 published articles in IEEE, CIGRE, technical journals, conferences, and industry magazines.

Selected Publications:

FACTS Controllers, Technology Development and Field Demonstrations (selected publications)

1. "Softening the Blow of Disturbances-Segmentation with Grid Shock Absorbers for Reliability of Large Transmission Interconnections," *IEEE Power & Energy Magazine*, vol. 6, pp. 30-41, January-February, 2008.

2. "Composite System Reliability Assessment Incorporating an Interline Power Flow Controller," *IEEE Transactions on Power Delivery*, vol. 23, no. 2, pp. 1191-1199, April 2008.

3. "Addressing Transmission Grid Complexity using Advanced Technological Concepts," Panel paper presented at the IEEE PES General Meeting, Tampa, FL, June 2007.

4. "Grid Shock Absorber Shows Promise," Innovation: Emerging Technologies and Cutting Edge Engineering," *EPRI Journal*, Electric Power Research Institute, Palo Alto, CA, Spring 2007.

5. "Emerging HVDC Technologies, Controls, and Application Concepts," presented at PowerGrid Europe, Madrid, Spain, June 2007.

6. "A Novel Operator Training Simulator for System Dispatch of Multi-Functional FACTS Controllers," Paper B4-210, presented at the CIGRE 2006 Session in Paris, France.

7. "Emitter Turn-Off (ETO) Thyristor: An Emerging Power Semiconductor Switch with Lower Cost, Improved Reliability and Scalability for Next Generation FACTS Controllers," Paper B4-107, presented at the CIGRE 2006 Session in Paris, France.

8. "Operating Characteristics of the Convertible Static Compensator on the 345 kV Network," in *Proc. of IEEE PES 2004 Power Systems Conference & Exposition*, New York, NY, vol. 2, pp. 732-738.

9. "Power Electronics-Based T&D Controllers Technology Development," in *Proc. of 2003 IEEE PES T&D Conference*, Dallas, Texas, vol. 3, pp. 1180-1186, Paper #0-7803-8110-6/03.

10. "Squeezing More MWs from the Grid," *IEEE Power Engineering Review*, vol. 22, no. 6, pp. 4-6, June 2002 .

11. "NYPA Convertible Static Compensator, Validation of Controls and Steady State Characteristics," CIGRE Session 2002, Paris, France, Paper #14-104.

12. "Reinforcing the T&D Infrastructure," *T&D World Magazine*, pp. 23-25, April 2002.

13. "Eagle Pass Back-to-Back Tie: Dual Purpose Applications of Voltage Source Converter Technology," IEEE 2001 Winter Meeting, Paper #0-7803.

14. "Dynamic Performance of the Eagle Pass Back-to-Back HVDC Tie," in *Proc. of Seventh International Conference on AC-DC Power Transmissio*n, 2001, Conf. Publ. No. 485, pp. 220-225.

15. "Emerging Application of Voltage Source Converter Technology in Back-to-Back Asynchronous Tie," VII SEPOPE, Curitiba, Brazil, May 2000.

16. "FACTS Technology Development: an Update," *IEEE Power Engineering Review*, vol. 20, issue 3, pp. 4-9, March 2000.

17. "Convertible Static Compensator Project - Hardware Overview," in *Proc. of 2000 IEEE Winter Meeting*, pp. 2511-2517.

18. "AEP Unified Power Flow Controller Performance," *IEEE Transactions on Power Delivery*, vol. 14, no. 4, pp. 1374-1381, October 1999.

19. "Thyristor Controlled Series Compensation," CIGRE Working Group final document, 1999.

20. "Unified Power Flow Controller (UPFC): Modeling and Analysis," *IEEE Transactions on Power Delivery*, vol. 14, no. 2, pp. 648-654, April 1999.

21. "Operation of the Unified Power Flow Controller (UPFC) Under Practical Constraints," *IEEE Transactions on Power Delivery*, vol. 13, pp. 630-639, April 1998.

22. "World's First Unified Power Flow Controller on the AEP System," CIGRE Session 1998, Paris, France, Paper #14-107.

23. "Convertible Static Compensator Application to the New York Transmission System," CIGRE Session 1998, Paris, France, Paper #14-103.

24. "Controlling the Flow of Real and Reactive Power," *IEEE Computer Applications in Power*, pp. 20-25, January 1998.

25. "AEP UPFC Project: Installation, Commissioning, and Operation of the + 160 MVA STATCOM (Phase I)," *IEEE Transactions on Power Delivery*, vol. 13, no. 4, pp. 1530-1535, October 1998.

26. "Operation of + 100 MVAr TVA STATCON," *IEEE Transactions on Power Delivery*, vol. 12, no. 4, pp. 1805-1811, October 1997.

27. "A Study of Equipment Sizes and Constraints for Unified Power Flow Controller," *IEEE Transactions on Power Delivery*, vol. 12, no. 3, pp. 1385-1391, July 1997.

28. "Proposed Terms and Definitions for Flexible AC Transmission System (FACTS)," *IEEE Transactions on Power Delivery*, vol. 12, issue 4, pp. 1848-1853, October 1997.

29. "TVA STATCOM: Design, Installation, and Commissioning," CIGRE Session 1996, Paris, France, Paper #14-106.

30. "The Unified Power Flow Controller: a New Approach to Power Transmission Control Power Delivery," *IEEE Transactions on Power Delivery*, vol. 10, no. 2, pp. 1085-1097, April 1995.

31. "Development of a + 100 MVAr Static Condenser for Voltage Control of Transmission Systems," *IEEE Transactions on Power Delivery*, vol. 10, no. 3, pp. 1486-1496, July 1995.

Power System Planning and Operation (selected publications)

1. "Integration of Novel Permanent Magnet Synchronous Generators to Utility Grids Using Voltage Sourced Converter Technology," *CIGRE paper A1-10, to be presented at the CIGRE Session August 2010.*

2. "ComEd's Elmhurst SVCs: Challenges and Opportunities," *IEEE Paper to be presented at the IEEE T&D Conference, New Orleans, LA, April 2010* .

3. "Identification of Voltage Control Areas and Reactive Power Reserves; An Advancement in On-Line Voltage Security Assessment," in *Proc. of IEEE PES General Meeting*, Pittsburgh, PA, 2008, pp. 1-7.

4. "FirstEnergy Uses EPRI Interregional Reactive Power Management Framework to Help Improve Transmission Voltage Stability," *Innovators*, Electric Power Research Institute, Palo Alto, CA, August 2008.

5. "Emerging Grid Reliability Improvement Technologies and Their Control Requirements," presented at the PowerGrid Conference, Milano, Italy, June 2008.

6. "Upgrading AC Transmission to DC for Maximum Power Transfer Capacity," presented at the MEPCON'08, Aswan, Egypt, March 2008.

7. "The Application of Segmentation and Grid Shock Absorber Concept for Reliable Power Grids," presented at the MEPCON'08, Aswan, Egypt, March 2008.

8. "Sensitivity Formulation in a Multi-Functional FACTS Controller Training Simulator," in *Proc. of DRPT 2008*, Nanjing, China, pp. 122-129 .

9. "Dynamic Control Modes of Unified Power Flow Controllers for Transmission Reinforcement," in *Proc. of IEEE T&D Conference*, April 2008, pp. 1-8.

10. "Systematic Approach for Identification of Voltage Collapse Areas and the Reactive Power Reserve Requirements in Large Interconnected Transmission Grids," CIGRE Session 2008, Paris, France, Paper #C1-201.

11. "The New York Power Authority (NYPA) Installs Multi-functional FACTS Controller Operator Training Simulator," *Innovators*, Electric Power Research Institute, Palo Alto, CA, February 2006.

12. "A Dispatch Strategy for a Unified Power Flow Controller to Maximize Voltage Stability-Limited Power Transfer," *IEEE Transactions on Power Delivery*, vol. 20, pp. 2022-2029, July 2005.

13. "A Dispatch Strategy for Interline Power Flow Controller," in *Proc. of IEEE 2004 Power Systems Conference & Exposition*, New York, NY, pp. 732-738.

14. "High Frequency Impacts in a Converter-Based Back-to-Back Tie: The Eagle Pass Installation," *IEEE Transactions on Power Delivery*, vol. 18, no. 4, pp. 1410-1415, October 2003.

15. "Common Modeling Framework of Voltage-Sourced Converters for Load Flow, Sensitivity, and Dispatch Analysis," in *Proc. of IEEE PES General Meeting*, 2003, Toronto, ON, Canada, pp. 934-941.

16. "Potential Use of Voltage Sourced Converter-Based Back-to-Back Tie in Load Restoration," *IEEE Transactions on Power Delivery*, vol. 18, no. 4, pp. 1416-1421, October 2003.

17. "Shunt Capacitor Bank Series Group Shorting (CAPS): Design and Application," *IEEE Transactions on Power Delivery*, vol. 16, no. 1, pp. 24-32, January 2001 (with co-authors).

18. "Basic Mechanisms of Control Interactions among Power Electronics-Based Controllers in Power Systems," in *Proc. of 2001 EEE/PES Transmission and Distribution Conference and Exposition*, pp. 397-402.

19. "Determination of needed FACTS Controllers that Increase Asset Utilization of Power Systems," *IEEE Transactions on Power Delivery*, vol. 12, issue 1, pp. 364-371, January 1997.

20. "An Adaptive Out-of-Step Relay for Power System Protection," *IEEE Transactions on Power Delivery*, vol. 2, issue 1, pp. 61-71, January 1997.

21. "Design Issues for a Single Core Transformer Thyristor Controlled Phase Angle Regulator," *IEEE Transactions on Power Delivery*, vol. 10, issue 4, pp. 2013-2019, October 1995.

22. "Hybrid-Active Filtering of Harmonic Currents in Power Systems," *IEEE Transactions on Power Delivery*, vol. 10, no. 4, pp. 1994-2000, October 1995 (with co-authors).

23. "Filtering of Harmonic Currents and Damping of Resonance in Power Systems with Hybrid-Active Filter," in *Proc. of Applied Electronics Conference and Exposition*, Chicago, IL, 1995, vol. 2, pp. 607-612.

24. "Effectiveness of Thyristor Controlled Series Capacitor in Enhancing Power System Dynamics: an Analog Simulator Study," *IEEE Transactions on Power Delivery*, vol. 9, issue 2, pp. 1018-1027, April 1994 (with co-authors).

25. "Enhancement of First-Swing Stability Using High-Speed Phase Shifter," *IEEE Transactions on Power Delivery*, vol. 6, no. 3, pp. 1113-1118, August 1991.

26. "Advanced Simulation Techniques for Analysis of Power System Dynamics," *IEEE Computation Applications in Power*, vol. 4, no. 4, pp. 31-36, October 1990.

27. "Controllable VAr Compensator: a Potential Solution to Loadability Problem of Low Capacity Power Systems," *IEEE Transactions on Power Systems*, vol. 2, issue 3, pp. 561-567, August 1987.

28. Method and Device for Preventing an Electric Alternating Current Generator from Falling out of Step, Swedish Patent No. 85013076, July 1986.

29. Dynamic Characteristics of a Wind Driven Induction Generator Equipped with Thyristor Controlled Inductances on the Stator Side, BHRA Fluid Engineering, Cranfield, Bedford MK43 OAJ, England, August 1980, pp. 279-295.

Subsynchronous Resonance

1. "Enhancement of Power System Dynamics using Phase Imbalanced Series Compensation," PESGM2010-000022, a Transaction Paper presented at the 2010 IEEE GM in Minneapolis, MN

2. "A Hybrid Series Compensation Scheme Capable of Damping Subsynchronous Resonance," to be published on IET Generation Transmission and Distribution, UK.

3. "Supplemental Control of Voltage Sourced Converter for Damping Subsynchronous Resonance," IEEE Paper 09GM1119, presented at the IEEE PES, Calgary, Alberta, Canada, July 2009

4. "Damping Subsynchronous Resonance using STATCOM Operated in Phase Imbalance Mode," IEEE Paper 09GM0749, presented at the IEEE PES, Calgary, Alberta, Canada, July 2009

5. "Impact of TCSC Control Methodologies on Subsynchronous Oscillations," *IEEE Transactions on Power Delivery*, vol. 18, no. 1, pp. 243-252, January 2003.

6. "Eigen Analysis of Series Compensation Schemes Reducing the Potential of Subsynchronous Resonance," *IEEE Transactions on Power Systems*, vol. 10, no. 2, pp. 876-883, May 1995.

7. "Subsynchronous Resonance Countermeasure Using Phase Imbalance," *IEEE Transactions on Power Systems*, vol. 8, no. 4, pp.1438-1447, November 1993.

8. "Series Compensation Schemes Reducing the Potential of Subsynchronous Resonance," *IEEE Transactions on Power Systems*, vol. 5, issue 1, pp. 219-226, February 1990.

9. "Method and Arrangement for Protecting Turbine Generators against Subsynchronous Resonances Occurring in Power Transmission Systems," US Patent No. 4,843,513, June 1989.

Dynamic Thermal Circuit Ratings Technology

1. "Dynamic Thermal Loading of Transmission Circuits-Lessons Learned," CIGRE Session 2002, Paris, France

2. "Dynamic Thermal Ratings Realize Circuit Load Limit," *IEEE Computer Applications in Power*, vol. 13, no.1, pp. 38-44, January 2000.

3. "Field Application of a Dynamic Thermal Circuit Rating Method," *IEEE Transactions on Power Delivery*, vol. 12, no. 2, pp. 823-831, April 1997.

4. "Real-Time Monitoring and Dynamic Thermal Circuit Rating of Power Transmission Circuits," *IEEE Transactions on Power Delivery*, vol. 11, no. 3, pp. 1407-1418, July 1996.

Substation Automation

1. "Automated Analysis Systems for Monitoring, Maintenance and Control of Power Systems," presented at the MEPCON'08

Conference, Aswan, Egypt, 2008.

2. "Data Integration/Exchange - Part 1: Existing Technical and Business Opportunities," *IEEE Power & Energy Magazine*, vol. 2, no. 2, pp. 14-19, March-April 2004

3. "Data Integration/Exchange - Part 2: Future Technical and Business Opportunities," *IEEE Power & Energy Magazine*, vol. 2, no. 2, pp. 24-29, May-June 2004

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PROFILE

Bernardo Fernandes, founding and managing partner of **ENVENTURE LLC** and **ENVENTURE BRASIL**, is a specialist in the electrical power industry, with over 38 years of practice in various regions of the world. In both companies, Mr. Fernandes is responsible for business and project development activities.

His strong credentials and qualifications in the non-utility (IPP) power field were gathered during the last two decades, following the development, in 1985, of his first private cogeneration project in the United States, at the Massachusetts Institute of Technology (M.I.T.), and through creative ventures in several privatized electrical sectors of Europe and Latin America. In the process, he has become well versed in project financing, and served often in the past as an advisor to major commercial and investment banks, discharging on their behalf a wide range of duties, including contract negotiations, risk assessment, economic analyses and financial structuring. The portfolio on financial closings where he has taken a lead role is in excess of US$8,000 million dollars.

Previously, he worked for major engineering firms, as a senior director, and as a consultant, building and demonstrating sound technical design and planning expertise on most generation technologies. His contributions include global business development and marketing activities, and extensive involvement in legal, regulatory and contractual matters. Another important facet of his distinguished career involves the training of other professionals accomplished through assignments as a university lecturer, seminar instructor and speaker at business conferences.

EDUCATION

Instituto Superior Técnico (Universidade de Lisboa, Portugal)
Mechanical Engineering (B.Sc) (1970)
Imperial College University of London, England
Thermal Power (M.Sc.) (1973)
Diploma in Thermal Power Engineering (1973)

CULTURAL AND LANGUAGE

Mr. Fernandes has translated numerous technical publications in the Portuguese, English, Spanish and French languages and, while a student, he was a part-time technical translator for Derwent Publications (London). Excellent command of, and fluency on, these languages,
allied to his working and living experience in several countries, affords him a rare broad cultural perspective and serves him well in promoting and expanding **ENVENTURE**'s international energy ventures.

GLOBAL PRACTICE

Mr. Fernandes has worked in the energy sector and projects in over 25 countries, where he has developed generation projects, advised equity investors and financial institutions, performed engineering and been responsible for construction.

- **EUROPE**

PORTUGAL	ENGLAND	NORTHERN IRELAND	
HOLLAND	SWITZERLAND	SPAIN	

- **AFRICA & MIDDLE EAST**

GHANA	JORDAN	KUWAIT	IVORY COAST
SAUDI ARABIA	MOZAMBIQUE	TANZANIA	TUNISIA

- **AMERICAS**

BOLIVIA	CANADA	ARGENTINA	GUAYANA
BRAZIL	COLOMBIA	GUATEMALA	HONDURAS
UNITED STATES	VENZUELA	MEXICO	CHILE

EXPERIENCE

Mr. Fernandes' professional record is comprehensive and diversified. He has worked with all commercial generation technologies, from nuclear to solar; performed conceptual and detailed engineering; undertaken planning studies; led complex studies and analyses; developed software applications; participated in turbo-machinery research and lectured on thermodynamics; contributed to the privatization of electrical sectors in several countries; played leading roles in project finance; and, developed many projects.

The following is a partial list that exemplifies the breadth of his work.

IPP PROJECT FINANCING (Attachment 1)

Since the late 80's, Mr. Fernandes has focused his professional activities in Project Financing of independent power and other infrastructure facilities, rendering advisory services to a wide range of international financial institutions, from commercial banks to multilateral agencies, from investment funds to private developers.

He has contributed, mostly as the lead technical advisor towards numerous financial closings, in excess of US$8 billion, of both domestic and international projects.

Mr. Fernandes works closely with owners and financial advisors in structuring private power projects, and has reviewed, negotiated and drafted power purchase (PPA), construction (EPC), energy sales and operation and maintenance (O&M) contracts.

The vast array of responsibilities he has discharged in financing many energy projects has gained Mr. Fernandes considerable and diversified experience and made him a well known expert in both the U.S. and international energy business. In recognition, various industry participants call upon him to opine on diverse matters and train bankers, engineers and other professionals.

COMBINED-CYCLE GAS FIRED PROJECT EXPERIENCE (Attachment 2)

In the last twenty-five years, Mr. Fernandes has participated in, and contributed to, the development and financing of combined-cycle plants, with and without co-generation, in the U.S., Europe, Africa and Latin America. He has played an instrumental role in the growth of the gas-fired, combined-cycle, and co-generation business

His role as lead developer or advisor to the multilateral agencies and major international financial institutions encompasses more than 10,000 MW on close to fifty plants using combustion turbine technology.

ENGINEERING

In his role as a consulting engineer, Mr. Fernandes worked in a wide variety of projects, including power generation in off-shore oil exploration platforms, three different nuclear facilities, and several very large thermal utility plants, including large coal-fired plants.

LECTURES, PRESENTATIONS, SPEAKING ENGAGEMENTS

Mr. Fernandes has lectured, instructed, and trained in the fields of power engineering and energy economics at college and professional levels, people with backgrounds as diverse as Chinese (People's Republic of China), South American (Brazil) and African (Mozambique).

Mr. Fernandes has been a guest speaker at industry conferences and business seminars in Europe, North and South America, and Africa. He has also sponsored and organized the first Project Finance conferences in Portugal and Brazil.

RESEARCH AND REPORTS

Author - Mr. Fernandes prepared a White Paper on the technical, commercial, and environmental aspects of burning oil for private power projects. The document was used by a major natural gas supplier in its executive planning decisions.

During his tenure as university lecturer and in subsequent years, Mr. Fernandes conducted research in fluid mechanics and turbine/compressor design and performance. His published thesis is entitled "Centrifugal Compressor Performance Prediction."

PRIVATIZATIONS

Mr. Fernandes has contributed directly to the privatization of the electrical sector in Colombia, Northern Ireland, Portugal, England, Guatemala and Brazil, by advising local government agencies, assisting with the development of legislation and participating in sales of assets. He also worked as a consultant in the preparation and evaluation of several bidding processes in various regions of the world.

NORTHERN IRELAND ELECTRICITY EXPANSION/PLANNING STUDIES

Northern Ireland Electricity (NIE)

Generation expansion and corporate planning studies were conducted for this European utility in anticipation of its privatization. Mr. Fernandes' contribution included a technical assessment of existing power plants, identification of the type and size of future units, and their integration into the system. Mr. Fernandes was responsible for studying and advising NIE on the various contracting methods for future projects.

AFRICAN DEVELOPMENT BANK

Mr. Fernandes was a consultant and advisor to this international agency on the financing of the rehabilitation of the Zanzibar (Tanzania) Electrical Power System. Amongst other responsibilities, Mr. Fernandes was charged with the preparation of the Terms of Reference, bid analyses and selection of contractors.

IPP PROJECT DEVELOPMENT (Attachment 3)

Mr. Fernandes has developed several power and cogeneration projects. In this capacity he has been involved with most technical, financial, legal and regulatory aspects of an independent venture and performed feasibility studies, developed pro forma models, completed economic analysis, negotiated contracts (PPA's, fuel supply, O&M, etc.) and negotiated debt and equity participations. Some of the projects include:

- El Cerrejon 40 Mw simple-cycle generator (Colombia)
- Acquisition of a 17 Mw gas turbine cogeneration; conversion to natural gas and refurbishment and re-powering to 35 Mw - Brazil
- Combined-cycle cogeneration (80 Mw, with GE Frame 6FA) - Brazil
- MIT campus cogeneration facility (20 Mw), Cambridge, MA
- S. Paulo 6 Mw diesel fired IPP in Portugal
- Heavy-oil fired 85 MW in Manaus, Brazil
- 150 MW hydro project in Guyana
- Windfarm of 25 MW installed capacity, Ceará, Brazil

CONTRACT NEGOTIATIONS

Mr. Fernandes has reviewed and negotiated a very large number of contracts supporting project finance (EPC, PPA's, O&M, Fuel Supply, etc.) and has been responsible for the negotiation and draft of many others in several countries, including, as examples:

- Power Purchase Agreements (in Spanish) of CORELCA (Colombia)
- Contracts (in French) for a wood-fire, 20 Mw power plant in Quebec, Canada
- EPC Contract (in Portuguese) for Campos Novos, 880MW hydro in Brazil
- Negotiated the EPC contract for the 250 Mw Alto Cachapoal (Chile) project
- Responsible for all contract negotiations on the 80Mw c.c. plant at Tibras , Brazil
- Transmission line and sub-station contracts in Mexico

- O&M negotiations for a 150 MW oil-fired plant (La Laguna, Guatemala)
- Acquisition of a 60 Mw oil-fired plant, and responsible for operating contracts
- In charge of all contracts for 85 MW Manaus oil/gas project

FEASIBILITY STUDIES AND PLANNING (International)

KUWAIT THERMAL RECIRCULATION STUDY

For this Thermal Recirculation Study for a site in Kuwait combining 4,800 MW of power generating units with 200 MIGPD of desalination capability, Mr. Fernandes was responsible for comparing twelve different site layouts, and developing a cost/benefit analysis used to select plant final configuration

KUWAIT AZ ZOUR NORTH PROJECT

For the 2,400 MW Az Zour North power station in Kuwait, with a 100 MIGPD MSF desalination plant, Mr. Fernandes was in charge and responsible for all feasibility studies involving:

Economic criteria System planning/unit sizing Cogeneration cycle optimization
Selection of number and type of desalination units Selection of major equipment

A similar scope of work was performed for the twin plant at Az Zour South.

TRANSFER OF TECHNOLOGY/TRAINING PROGRAM

People's Republic of China

Mr. Fernandes participated in the organization, layout, and scheduling of the program, and was responsible for conducting lectures covering all feasibility studies, heat balances, and economics, including theory, cost-benefit, and financial analysis.

SYSTEM PLANING STUDIES

Saudi Arabia

Mr. Fernandes engaged in Systems Planning Studies for the development of several alternative sites in Saudi Arabia; he conceived a generic method, including a graphic solution, to assess and price fuel delivery schemes. He created a monogram, integrating capital and operating costs versus distances and mode of transportation for quick reference.

JORDAN ELECTRICITY AUTHORITY PROJECT

Jordan - Electricity Authority

For the 2-unit, 130 MW power station for the Jordan Electricity Authority, Mr. Fernandes was in charge of all feasibility studies, including:

System planning and unit size selection Condenser selection Power cycle optimization
Fuel selection, transportation future conversion to coal Desalination plant type and size

Tender Documentation / Bid evaluation on Turbine, Boiler, Switchyard, and Civil Works

Verification of guarantees Operating (Performance) cost evaluation
Financial analysis - developed micro-computer program to handle source of financing (governmental loans and World Bank Credits) Participated in loan negotiations

SABIYA STATION STUDY
Kuwait Ministry of Electricity and Water

Mr. Fernandes was responsible for the unit size/design selection, thermal cycle, and condenser studies of the proposed Sabiya 2,400 MW oil-fired power station for the Kuwait Ministry of Electricity and Water. He developed the economic criteria and respective evaluators for the Project, and prepared a comparative analysis of desalination plant sizes and types (MSF versus Reverse Osmosis).

RABIGH POWER STATION ANALYSIS/DESIGN
Saudi Arabia

For the 1,000 MW Rabigh oil-fired electric generating station, Mr. Fernandes was responsible for the economical analysis, cycle configuration and parameter selection, and circulating water system design. He also wrote part of its specification, guarantee terms, and performance criteria. In addition, Mr. Fernandes studied the supply of fuel oil and investigated the feasibility of burning natural gas as an alternative energy source. An in-depth pipeline study was performed to optimize number and size of lines, pumping stations, and pipe location. A report covering technical and economic aspects was prepared to substantiate recommendations.

Domestic IPP Projects (Partial List – Attachment 4)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY (M.I.T.)
Cambridge, Massachusetts

Developed the M.I.T. campus 20 MW gas-fired cogeneration plant, and was responsible for all the feasibility studies, financial analyses, power sales contract negotiations, and equipment selection.

POLAROID
New Bedford, Massachusetts

Technical and economic feasibility of installing a coal-fired power station at this site.

TAUNTON MUNICIPAL LIGHTING PLANT
Taunton, Massachusetts

Project review and bid evaluation of a 100 MW coal-fired power plant using a single circulating fluidized bed (CFB) boiler and one condensing steam turbine.

UNIVERSITY OF MASSACHUSETTS
Amherst, Massachusetts

Conducted a comprehensive feasibility study of a cogeneration project for this academic institution. Various project options and alternative approaches to ownership, design, construction and operation of the facility were studied.

SALT CITY COGENERATION
Syracuse, New York

Responsible for a coal-fired cogeneration plant rated at 80 MW net and maximum steam extraction of 200,000 lb/hr. The project, developed by HYDRA-Co, consisted of the rehabilitation of an existing plant fitted with eight boilers.

MULTITRADE - HURT SMALL POWER PROJECT
Hurt, Virginia

Evaluation of a dispatchable, 80 MW wood/coal facility. Fuel procurement reliability, costs, and unit ability to cycle under utility dispatch were among the major issues addressed.

FORT ORANGE COGENERATION
Castleton-on-Hudson, New York

Due diligence on a topping-cycle cogeneration facility consisting of a steam-injected, natural-gas-fired GE Frame 6 gas turbine. This combined-cycle plant produces 62 MW (net) of electrical power while supplying an average of 35,000 lb/hr.

EMPIRE ENERGY - Niagara
Lockport, New York

Technical and economic assessment of a proposed 170 MW net cogeneration plant with a combined-cycle configuration based on three GE Frame 6 gas turbines coupled with three heat recovery steam generators. Steam is used for NO_x control and for export to an adjacent General Motors plant to maintain QF status.

AETNA COGENERATION
Windsor, Connecticut

Evaluated the project feasibility for a 3 MW cogeneration plant. Alternative use of gas turbines or reciprocating engines was investigated and agreements with purchasing utility reviewed.

RICHMOND POWER ENTERPRISE LP
Richmond, Virginia

Independent Engineering Review for a 250 MW dual-fired combined-cycle plant using two ABB Type II combustion turbines, selling power to VEPCO under a long-term contract and steam to a paper processing facility. At a later date, assisted in the negotiations for facility re-sale.

MORGANTOWN ENERGY ASSOCIATES
Morgantown, West Virginia

Mr. Fernandes provided contract review for a cogeneration plant consisting of a coal and coal waste-fired atmospheric circulating fluidized bed boiler with a gross design capacity of 69 MW.

CPC LOWELL AND ARROWEAD PROJECTS
Lowell, Massachusetts and Georgia, Vermont

Consolidated Power Company of Connecticut developed the Lowell combined-cycle plant around a GE LM 2500 gas turbine and a HRSG with a total output of 27 MW of electrical power and 50,000 lb/hr process steam. Mr. Fernandes conducted a preliminary assessment of the proposed replication of this concept at the Georgia site, with special focus on environmental and contractual aspects.

MID-CONTINENT POWER COMPANY
Pryor, Oklahoma

This gas-fired 150 MW cogeneration facility was developed through an extensive renovation and expansion of an existing utility-grade power plant. Incorporation of three used Pratt & Whitney GG 4-A7 gas turbines, three used Deltak HRSG's and a new GE Frame 6 GT required comprehensive inspection of the equipment and, in the absence of a turnkey construction contract, creative structuring of performance guarantees and liquidated damage provisions. Mr. Fernandes managed the project review and implementation on behalf of the Lenders.

LONE STAR NATURAL GAS STORAGE FACILITY
North Dayton, Texas

The project facility stores 4.8 BCF of natural gas in a salt dome, and can deliver up to 500 MM SCFD to Houston Light & Power. Mr. Fernandes directed the due diligence review of the design, construction and operation of this storage complex.

SUNNYSIDE COGENERATION
Sunnyside, Utah

Mine-mouth cogeneration facility using coal waste to fuel a circulating fluidized bed boiler. The steam turbine plant generates 45 MW (net) and supplies thermal energy to an adjacent tomato greenhouse. Mr. Fernandes conducted a technical and contractual project evaluation, as an advisor to a potential equity participant.

FIRESTONE COGENERATION
Salinas, California

For a 48-MW, simple-cycle plant based on a GE LM 5000 gas turbine, conducted an Independent Engineering Review and contract negotiations.

SPRECKLES COGENERATION
Salinas, California

Mr. Fernandes was also responsible for work done for a replica of the Firestone project, located within the same Industrial Business Park, involving a similar scope of work.

COGENERATION BRIEFING REPORT

In charge of a comprehensive study of the U.S. Independent Power Production (IPP) industry, which was prepared to assist a financial institution in its executive decision to participate in the IPP market. Technical, regulatory, and risk assessment issues were among those addressed.

STERLING POWER PARTNERS, L.P.
Oneida, New York

Mr. Fernandes managed the independent review required prior to the financial closing of a 52 MW net combined-cycle cogeneration plant. The consistency of all documentation and the technical, contractual, financial, and legal structure of the deal were assessed. After the closing, Mr. Fernandes was also called upon to advise the project's new gas supplier on the project's merits and risks.

SELKIRK COGEN PARTNERS, L.P.

Along with his duties as project manager for the Lender's due diligence activities, Mr. Fernandes actively participated in the construction contract negotiations of this 79.9 MW gas-fired combined-cycle plant, and was responsible for all aspects of the review.

LOCKPORT ENERGY ASSOCIATES, L.P.
Lockport, New York

Manged all technical evaluations, contract reviews and financial analyses that constituted the scope of services rendered to the Lenders for the third-party financing of this combined-cycle cogeneration project.

COGENTRIX OF RICHMOND
Richmond, Virginia

Mr. Fernandes was requested by one of the Lending Banks to review the construction contract on this 210 MW coal-fired station. The risks associated with the lack of a turnkey contract were assessed, the project financial structure analyzed, and risk-mitigating strategies proposed.

NEVADA SUN-PEAK
Clark County, Nevada

Reviewed the Power Sales and Operating and Maintenance Contracts for this 210 MW gas-turbine peaking plant, one of the first IPP projects in the U.S., for Nevada Sun-Peak, a project lender.

OTHER REPRESENTATIVE DOMESTIC PROJECTS

COAL-FIRED POWER PLANT INVESTIGATION
Mr. Fernandes participated in the investigation of a continuous malfunction of two 560 MW coal-fired units. He assessed, to support legal action, all cost damages through review of design and contractual documentation, and by simulating several system dispatching scenarios. He also evaluated the impact of major design deficiencies on the utility's financing and planning activities.

MASSACHUSETTS DEPARTMENT OF PUBLIC UTILITIES

Mr. Fernandes defined the scope of services provided to utilities for power plant performance and energy audit programs to be implemented in compliance with the Department of Public Utility's requirements. He integrated hardware/software resources and technical expertise into a comprehensive "Performance Enhancement Program" to achieve the desired higher availability, capacity and overall efficiency objectives.

POWER STATION ASSESSMENT

Mr. Fernandes performed a technical and economic assessment of air handling/chilled water coils vs. small air handling/local fan coils air-conditioned systems for an eight-unit, 2,400 MW power station complex. Both alternatives were sized and priced based on meteorological conditions, cooling loads, power consumptions and various indoor ambient conditions.

LIGNITE-FIRED POWER STATION

Mr. Fernandes sized the evaporative cooling pond for the heat rejection system for a three-unit, 1,500 MW lignite-fired power station.

FUEL CELL DEMONSTRATOR PLANT

Mr. Fernandes conducted an investigation on ways to recover the waste heat from the glycol water coolant system of the DC module on a 4.8 MW Fuel Cell Demonstrator Plant. He recommended plant and site modifications to improve overall plant efficiency.

SEAWATER DESALINATION PLANT STUDY

Mr. Fernandes was responsible for the feasibility study of a seawater desalination plant comprising 16 distillation units of 6 million Imperial GPD; the effort included technical and economical assessment of alternative processes and sites.

JOHN HAAPALA, P.E.

HYDRAULICS / POWER STUDY

KEY QUALIFICATIONS

Mr. Haapala has 35 years of specialized experience in hydrology, hydraulics, reservoir operation and power studies, engineering economics and fisheries issues with an emphasis on computer applications. He is adept at the usage and adaptation of many existing standard hydrologic and hydraulic computer programs, and has developed a number of new application programs. He has been lead hydrologist on numerous hydrology and hydraulics studies for hydroelectric power developments worldwide.

He has performed power and operation studies of more than 100 reservoirs and powerplants including complex multi-reservoir, multi-use systems. The studies were performed to determine firm water supply yield, hydroelectric generation, benefits of component sizing and the effects of alternative instream flow requirements.
His hydrologic experience has included stochastic hydrology, the development of long-term monthly and daily flow records at many sites using correlation, and watershed simulation techniques. He has derived flood hydrographs from storms for various flood frequencies up to the Probable Maximum Flood (PMF) in several states, and prepared statistical analyses of flood data. His hydrologic and hydraulic analysis experience also includes reservoir and channel flood routing, spillway sizing, gated spillway flood operations, freeboard analysis and riprap sizing for shore protection.

EDUCATION

MS/MSc, Civil Engineering University of Washington
BS/BSc, Civil Engineering University of Washington

Licenses and Memberships
Professional Engineer, 27907, California, 1977; Professional Engineer, 19661, Washington
American Society of Civil Engineers (ASCE)
United States Society on Dams (USSD)
Association of State Dam Safety Officials (ASDSO)

EXPERIENCE RECORD

Portugues Dam
U.S. Army COE - Jacksonville
Portugues Dam is a new dam in the design phase that will provide flood control and water supply for Ponce, Puerto Rico. As a member of the Board of Consultants for the dam, Mr. Haapala reviewed the spillway and stilling basin design and the hydraulics of the low-level outlet.

Eweb Carmen-Smith Eng. Support
Eugene Water & Electric Board
A power study and reservoir operation model was developed in support of FERC relicensing of the 120-MW Carmen-Smith project. The model included development of 42-years of daily natural inflows to three reservoirs, the diversion of water between reservoirs, the hourly peaking operation, the reregulation reservoir operation, and all project operating constraints and objectives. Economics were included in the model to account for the production of energy, capacity, and ancillary benefits.

Chugach-CooperLake Relicensing
Chugach Electric Association, Inc.
An operation study model was developed to simulate the effects of a hydroelectric peaking operation on the receiving lake. Reverse routing of the recorded lake outflows was used to develop the natural inflows to the lake. The operation model was used to compare the fluctuation in lake levels both with and without the hydroelectric project.

Santa Anita Dam
Los Angeles Department of Public Works
Santa Anita Dam is a 225-foot high concrete arch dam near Los Angeles built in the 1920's for flood control. Investigations were conducted to determine the adequacy of the existing spillways. Rating curves were developed for the existing spillways and routing of flood hydrographs through the reservoir was performed. The trajectory of spill and the downstream impact points were determined.

Big Tujunga Dam Seismic Rehabilitation and Spillway Modification Project
Los Angeles Department of Public Works
John investigated several alternative spillway types and configurations for Big Tujunga Dam, a 251-foot-high concrete arch dam near Los Angeles built in the 1930s for flood control. Performed flood routings with HEC-1 modeling to determine the maximum reservoir level during PMF passage for this $88M project. Performed detailed hydraulic analysis of the proposed emergency spillway including both stepped spillway and flip bucket alternatives. Estimated erosion potential below the spillway for the spillway alternatives. The final design met client needs, was accepted by the California Division of Safety of Dams and is under construction.

Bart Lake FERC License Application
Alaska Electric Light and Power
Bart Lake is a new 14 MW hydroelectric project that would supply the City of Juneau. Alternative power study runs were performed to determine the effects of component sizing on the available energy generation. Appropriate tables and figures on the hydrology and energy output of the project were developed for inclusion in the FERC license application.

Bart Lake Hydroelectric Project
Alaska Electric Light and Power
An operation study model was developed to determine the generation available from a range of turbine installed capacities and conduit hydraulic capacities. Simulation of the upstream storage reservoir operations was included in the model. Firm and average generation results were presented for a matrix of turbine and conduit sizes.

Gillespie Dam Litigation
Mesch, Clark & Rothschild, P.C.
Expert witness support was provided for the defendant in a lawsuit resulting from a dam breach. Technical support included mathematical modeling of the dam-break to determine the downstream effects of breach formation. To assist in determining the cause of the dam failure, a detailed 2-dimensional mathematical hydraulic model was developed for about one mile of river upstream from the dam.

Lake Dorothy Hydroelectric Project
Alaska Electric Light and Power
The available hydrologic data was reviewed and extended by correlation after an evaluation of alternative methods of data extension. A reservoir operation model was developed to simulate operation of the storage reservoir, the tunnel and conduit system, and the powerhouse for a period of 65 years. A series of operation model runs were performed to determine the effects of alternative installed capacities and alternative reservoir operation modes.

Upper San Joaquin River Basin Storage Investigation Feasibility Study and Environmental Impact Study/Report
USBR - Mid-Pacific Region
Reviewed model development and provided alternative ideas for model development based on extensive modeling experience. Additional improved methods were incorporated into the model.IDIQ for Water Resources Planning and Engineering - Bureau of Reclamation, Mid-Pacific Region (01CS20210B and BRPS/06CS204097B).John also

participated in a hydropower workshop to develop a daily hydropower model for use in the feasibility phase of the USJRBSI to assess water storage increase alternatives. He assisted in creating model concepts that would best address the unique hydropower challenges of the project, while maintaining flexibility to adapt to potential changes in project alternatives. He advised the MWH Team during model development, and performed a quality assurance/ quality control review of the daily hydropower model. He is currently assisting the integration of daily reservoir operations and hydropower models to better maximize benefits of the USJRBSI.

L L Anderson Dam Raise and Spillway Modification
Placer County Water Agency
The rock channel spillway with gated ogee crest needed to be modified to pass the revised and increased Probable Maximum Flood (PMF). Served as lead hydraulic/hydrologic engineer for spillway expansion at this 230-foot-high dam that impounds 136,000 acre-feet of storage. Evaluated alternatives for increasing the spillway capacity including increasing the spillway channel and gated crest width, raising the allowable maximum pool level, and changing the slope and energy dissipation characteristics of the channel. Provided gated spillway sizing and rating curve development, approach and downstream channel hydraulic analysis, and oversight of a physical hydraulic model of the spillway. Determined best solution was a widened channel and gate structure with a long stilling basin cut into the rock channel for increased spillway capacity, energy dissipation and acceptable channel velocities. Supervised two engineers on hydraulic design. A physical hydraulic model study confirmed the validity of the spillway design. The increased capacity spillway design and crest structure was approved by the California Division of Safety of Dams and the Federal Energy Regulatory Commission

Site-Specific Waste Water Treatment Plant Design and Standard Design for Water Plants in Iraq
AFCEE (4PAE)
Reviewed 100-year flood flow and water-level determination. Assembled information from multiple sources to compensate for scarce information in Iraq. Information obtained from alternative sources served as check on the limited study information that was initially provided. The client was given a better basis to evaluate flood risks.

Comprehensive Everglades Restoration Plan (CERP)/Acceler8
South Florida Water Management District
Reviewer of 15 environmental restoration projects to be constructed within an 8-year expedited schedule period. Projects consist of large storage reservoirs, natural stormwater treatment areas, spreader canals to rehydrate wetlands, major pump stations and water control structures, and other water impoundments. Original author of the Design Criteria Memorandums to be applied to all new dams for dam hazard potential classification, wind and precipitation design criteria for freeboard, and spillway capacity design criteria. Hydrology and Hydraulics Reviewer for several of the new reservoir basis of design reports.

Peace River Reservoir Expansion
Southwest Florida Water Management District
Developed extensive hydrologic computer model (AdICPR) for the above ground, water supply reservoir which required compensatory mitigation for wetland impacts. He was also responsible for a continuous simulation model, which used site specific rainfall data to predict runoff and ponding characteristics once ditch blocks were in place. Preliminary designs and model results were provided to the Southwest Florida Water Management District and Florida Department of Environmental Protection engineers for review early in the project design. The models included over 140 wetland basins and the design of 40 hardened control structures. Mr. Haapala demonstrated through modeling that historic wetland hydrology could be restored to the existing wetlands

Broadwater Power Project ? Dam Break Study
Montana Department of Natural Resources and Conservation
Dam-break studies were performed for wet and dry weather breaches of the main dam gravity blocks, for the embankment section near the abutments, and for a rapid deflation of the spillway rubber dam. Dam-break flows were routed downstream to the point where they would no longer pose a hazard. The BOSS DAMBRK model was calibrated using available downstream rating curves. Sufficient dam break model runs were performed to determine a hazard potential classification for the dam. A dam break study report complete with inundation mapping was prepared.

Cowlitz River Hydroelectric Project Dam-Break Studies
Tacoma Power
Dam-break studies were performed for a breach of the 606-foot high Mossyrock Dam. The study was a revision of a dam breach study previously performed by Tacoma Power. The use of more accurate topography at critical cross-sections and different hydraulic routing methods resulted in a substantially inundation map.

Peace River Reservoir Expansion - Dambreak
Peace River/Manasota Regional Water Supply Authority
A new off-stream water supply reservoir was being constructed on nearly flat ground in Florida. The reservoir would be formed by an encircling embankment dam. Dambreak studies were performed using the 2-dimensional hydraulics program FLO-2D. Inundation maps were performed for assumed breaches in different parts of the dam.

Depression Lake Dike Dam-Break Study/Engineering Services for Baker River Projects
Puget Sound Energy
A dam-break study was performed for Depression Lake Dike, which impounds seepage water from Baker Lake for later pump-back to Baker Reservoir. Depression Lake has an area of about 50 acres and a storage volume of about 700 acre-feet. Sinkholes in the vicinity of the dike have raised some concerns about the potential impacts of a dam-break flood on a campground area that is downstream from the dike. Dam-break floods were routed from Depression Lake Dike to Baker River and an inundation map was prepared.John developed a spillway rating curve for the multi-gated spillway. Because of dam overtopping potential during the PMF, he determined the over-topping spill trajectory and impact areas. He also performed a dam-break study for Depression Lake Dike, which impounds seepage water from Baker Lake for later pump-back to Baker Reservoir. John routed dam-break floods from Depression Lake Dike to Baker River and prepared an inundation map. MWH is performing this project to provide dam seismic rehabilitation and spillway modification.

Santa Clara Reservoir Dam-Break Study
City of Eugene, Oregon
Santa Clara Reservoir was a drinking water supply reservoir located to the northwest of the Eugene city limits. The reservoir had an area of 5.5 acres and a maximum depth of 14.75 feet. Since construction of the reservoir, surrounding housing developments were constructed, with the closest house being about 80 feet from the reservoir embankment. A dam-break study was performed to support a determination of hazard potential. The BOSS dam-break model was used to route potential dam-break floods through the residential areas. Dam-break flow rates and maximum velocities and depths were determined at a number of cross-sections. Results were summarized in a letter report.

San Vicente Dam Raise
San Diego County Water Authority
Mr. Haapala was the Lead Hydraulic Engineer for the San Vicente Dam Raise project. He performed the spillway hydraulic design for a 280-foot-high stepped spillway with an ogee crest and a flip bucket at the spillway terminus. Mr. Haapala also developed a HEC-RAS river backwater profile and scour analysis downstream from the spillway.

Report on Pacific Northwest Pumped Storage and Wind Energy Integration
USACE Portland District
Supervised 11 staff and wrote report sections for a $106,000 pumped storage and wind integration study. Rapid recent and planned installation of several thousand MW of wind power in a limited area near the Columbia River posed a number of challenges for intermittent power integration into the existing transmission system. Evaluated several benefits and the approximate costs of developing pumped storage hydroelectric plants to facilitate the integration. Study was completed on time on a very aggressive, 4-week start-to-finish schedule with full client satisfaction. USACE formal performance evaluation was very good or exceptional in all categories. ?MWH did an impressive job on a formidable task in a very short time frame. Exceptional Service!?IDIQ for Hydroelectric Power and Pumping Plant Engineering Design and Analysis Services - Hydroelectric Design Center, USACE, Portland District

STAN HAYES, P.E.

MECHANICAL B.O.P ENGINEER

KEY QUALIFICATIONS

A mechanical engineer with more than 30 years of professional experience, Mr. Hayes is skilled in the management and design and/or refurbishment of water resources projects, including all mechanical elements. He has been responsible for the study, selection, design coordination, installation and testing of a wide range of new and rehabilitated equipment for hydroelectric facilities and hydraulic structures. His expertise includes project management, cost estimating, preparation of design memoranda and contract documents, analysis of bids, review of suppliers' drawings, shop inspection, and start-up and testing of equipment. He routinely investigates and resolves technical problems during the selection, design, manufacture, installation, testing and operation of equipment and projects. Mr. Hayes has also conducted planning studies and prepared cost estimates related to water resources projects, including specifically hydraulic machinery and/or mechanical equipment for more than 50 projects.

EDUCATION

BS/BSC, Mechanical Engineering, University of Illinois (Urbana-Champaign), 1976

Professional Registration: Professional Engineer, 062-040776, Illinois, 1982

EXPERIENCE RECORD

Ruskin Powerhouse Improvements Project

BC Hydro

Project manager and lead mechanical engineer for Identification Phase work (detailed feasibility studies) to develop a preferred alternative for comprehensive rehabilitation, modernization, and improvements to the Ruskin powerhouse, a 1930 vintage plant housing three vertical-shaft, 35 MW Francis-type turbines and generators. Overall scope is to support BC Hydro in developing a preferred alternative for comprehensive rehabilitation, modernization, and improvements to the Project intakes, generating unit water conveyances, generating units, plant auxiliary equipment and systems, and powerhouse structure. Work includes review of operation and maintenance records and previous studies and reports; detailed physical examination of features, structures, equipment, and systems, in-depth interviews with plant, project, and management staff; development of User Requirements and Working Design Bases; development and evaluation of alternatives, selection/development of a preferred alternative, and development of plans for Definition and Implementation Phase work. All work will incorporate Safety by Design principles and practices.

Boundary Hydroelectric Project

Seattle City Light

Mr. Hayes was the project manager for design services for rehabilitation and improvements of the Project Access Roads for the 1,051-MW Boundary Hydroelectric Project in Pend Oreille County, Washington.

Alice Falls Project

Long Lake Energy Corporation

In charge of preparing specifications and bidding documents for a 2.5 MW s-type unit. He also analyzed the bids for the equipment.

MWH

Cowlitz Falls Project
Lewis County Public Utilities District
Mr. Hayes was project manager of a multi-disciplinary team of MWH engineers acting as the Independent Engineer providing a triennial review of Lewis County PUD's Cowlitz Falls Project on the Cowlitz River in eastern Lewis County, Washington.

Humpback Creek
Cordova Electric Cooperative
Lead Mechanical Engineer responsible for preparation of specifications and bidding documents for hydraulic machinery including a 1MW Francis unit. Responsible for reviewing the manufacturer's submittals, providing technical support and coordination, and preparing designs, specifications, drawings, and bidding documents for the general mechanical systems, including piping, pumps, HVAC and cranes.

Due Diligence Review Services
Various Clients Nationwide
Responsible for the mechanical engineering aspects of due diligence reviews and analyses for a number of hydroelectric projects. His responsibilities included review of contract documents and bids, review of shop drawings, site inspections, review of quality control plans and documentation, review of staffing, review of project budgets and/or witnessing of plant start-up and testing. Performed work for the financing agencies involved with the projects. The projects include: (1986-Present)Upper Sterling Dam, IL (two 1MW pit units)Hannibal Lock and Dam, WV (two 18MW bulb units)Guilman Amorim Project, Brazil (four 35-MW Francis units)Pichi Picun Leufu Project, Argentina (three 80-MW Kaplan units)Chivor Project, Columbia (eight 125-MW Pelton units)Betania Project, Columbia (three 180-MW Francis units)Sidney S. Murray Hydroelectric Project, LA (eight 24MW pit units.)

Leaburg and Walterville Hydroelectric Plant Rehabilitation
Eugene Water and Electric Board
Project manager for plant upgrades and unit overhauls, including runner replacements and upgrades, generator rewinding, and plant automation. The turbine overhaul work includes two 9,500 Hp Francis turbines and a single 11,000 Hp Kaplan turbine. The turbine work primarily related to runner and seal ring replacements, governor replacements/modifications, wicket gate and guide bearing upgrades/refurbishments, and overall reconditioning of the units. Plant automation included PLC based controls for automating the turbine-generators, canal headgates, dam roller gates, and other control points.

Facilities Condition Assessment
Seattle City Light
Mr. Hayes was responsible for mechanical engineering aspects of this independent review of Seattle City Light's (SCL) Capital Improvement Program. Mr. Hayes performed independent assessments of the condition of selected water resource development, generation, transmission and distribution facilities, including five dams and associated hydroelectric generating facilities: Cedar Falls, Boundary, Ross, Diablo, and Gorge. The assessment included physical observations and inspection of each project's dam and spillways, water intakes and conveyance structures, generating equipment, auxiliary equipment and systems, powerhouse structure, and switchyard as well as interviews with each plant's operating and maintenance personnel, and review of inspection, maintenance, and availability/reliability data. The resulting report provided SCL with an independent opinion as to the state of its water resources infrastructure, including water control equipment and hydroelectric facilities.

Lower Saranac Project
Long Lake Energy Corporation
Responsible for preparing specifications and bidding documents for the hydraulic machinery at this facility. Equipment included two 3.5 MW s-type units.

East Canyon Dam,
City of Bountiful
Responsibilities as Lead Mechanical Engineer included the preparation of specifications and bidding documents for one 2.1MW Francis-type unit. Prepared designs, specifications, drawings, and bidding documents for associated mechanical systems, including large valves, piping, pumps, cranes and HVAC.

Abiquiu Dam Outlet Works Gates
U.S. Bureau of Reclamation
Mr. Hayes served as Project manager, responsible for the design of two high-pressure bonnetted slide gates, hydraulic operating cylinders, and hydraulic power operating system, to be installed in an existing underground gate chamber at the Abiquiu Dam in New Mexico.

Cordova Tidal Power Study
Tidal Electric
power applications using a unique development scheme developed by Tidal Electric, the use of a ring dike in a tidal pool area to impound water for hydroelectric generation. Mr. Hayes is the lead mechanical engineer, providing support in the areas of overall project layout, generating equipment selection and sizing, energy production estimates, and project cost estimates.

High Falls Project
Long Lake Energy Corporation
Prepared the necessary specifications and bidding documents for a 250-kW Francis-type unit.

Olivenhain Dam Design
San Diego County Water Authority
Provided guidance and technical review and oversight of a multi-port Inlet/Outlet Tower, downstream control facilities to provide maximum flexibility in routing water into and out of the reservoir from/to multiple locations, and equipment to provide emergency drawdown of the reservoir. Provided design and procurement support for piping, valves, operating systems, instrumentation and controls, and miscellaneous mechanical systems (HVAC, piping, and drainage). Overall design included three major iterations/revisions to arrive at final design. Provided overall oversight of mechanical and electrical design team of 5 engineers of an important off-source 24,000 acre-foot water storage dam. The final design reduced costs over 25% compared with the initial final design concept. Project has operated successfully since 2003, providing flexible storage and water routing to multiple end users.

Bonneville Dam Emergency Relief Gate
Portland District, Corps of Engineers
Project Manager/Lead Mechanical Engineer, Bonneville Project Fish Passage Gate. Site constraints limited room and resulted in high bearing loads. Researched and applied state-of-the-art self lubricating materials specifically designed for high bearing pressures. Managed design of a flap-type gate that provides emergency flow relief to fish passage facilities at the Bonneville Dam on the Columbia River. Supervised structural engineer, mechanical engineer, and CAD operator. The gate was fabricated and installed and operates well and reliably.Project Manager/Lead Mechanical Engineer, Bonneville Project Spillway Gate Automation Study. Evaluated site constraints, developed and sketched alternative physical operators and gate control technologies, performed an evaluation and rating of each alternative, and detailed the recommended alternative. Managed feasibility study evaluating ways to automate exiting vertical-lift spillway gate to meet demanding and highly varying spillway flow requirements. The final recommendations included new, semi-fixed wire type hoists and a PLC-based control system to automate operation of a total of 16 of the 18 spillway gates. The installed systems allow the project to meet varying spillway flow requirements under normal operation and flood events. IDIQ for Hydroelectric Power and Pumping Plant Engineering Design and Analysis Services - Hydroelectric Design Center, USACE, Portland District.

Kangneung Project,
Korea Electric Power Corporation
As Senior Mechanical Engineer Mr. Hayes was responsible for the preparation of specifications and bidding documents for two 43.5MW Pelton turbines and the associated spherical inlet valves and governing systems.

Green River Headworks Modifications
City of Tacoma
Provided technical review and oversight of all mechanical design work for modifications to the City of Tacoma's primary water source on the Green River, which involved raising an existing diversion dam eight feet, providing fish screens, and reorienting the intake structure. Mechanical elements included the design of the intake structure, new slide gates and stop logs for service closure and maintenance of gates and other structures.

Serra da Mesa Project
Nacional Energetica
Assisted Nacional Energetica (NE) with evaluation of equipment vendor qualifications and evaluation and ranking of proposals for supply and installation of hydraulic turbines, generators, and all major mechanical and electrical equipment and systems for this 1,200 MW hydroelectric project. Reviewed the Terms and Conditions for the subsequent Contract.

Cerron Grande Project
Comision Ejecutiva del Rio Lempa
Mr. Hayes reviewed manufacturers' submittals and witnessed index and load-rejection tests for two 69.3MW Francis turbines for the Cerron Grande Project.

Big Tujunga Dam Seismic Rehabilitation and Spillway Modification Project
Los Angeles County Department of Public Works
Guided and approved design concepts developed during alternatives analysis; functioned as technical resource during design; performed formal review at designated design points. Provided technical guidance during design development and performed QA review at established review points. Project produced an integrated and optimal design to store flood flows and manage releases over a wide range of reservoir levels and inflow conditions.

San Vicente Dam Raise
San Diego County Water Authority
Led initial design development (to 15%), and then oversaw design development through final design. Provided guidance and technical review and oversight of a multi-port Inlet/Outlet Tower, downstream piping and valves to provide for routing of water into the reservoir and out of the reservoir from/to several sources/end locations. Also included piping and valves to provide emergency drawdown of the reservoir. Provided design support for piping, valves, operating systems, instrumentation and controls. Final design, which is just being completed, meets all project objectives at minimum cost.

Castaic Powerplant Condition Assessment and Modernization Project
Client: Los Angeles Department of Water and Power
Mr. Hayes, as project manager, is providing Owner's Engineering services for refurbishment of this 1,200 MW pumped storage project. Work at the project will include turbine refurbishment including runner replacement, inlet valve rehabilitation, motor/generator rewinds, updating of automation and controls to a state-of the art distributed control system, and refurbishment of balance of plant systems. Montgomery Watson Harza (MWH) services will include contract development, independent review of Contractor's condition assessment and optimization studies, review of final designs, witness inspections including physical model testing and major components, and support throughout filed work, including commissioning and field performance testing.

REYNOLD HOKENSON, P.E.

PROJECT MANAGER

KEY QUALIFICATIONS

Mr. Hokenson has completed several FERC licensing and numerous FERC Part 12D safety inspections. He has prepared safety inspections for more than 500 water-retaining facilities and flood control projects, giving him extensive knowledge of gate types, hoists, outlet works, spillways, appurtenant gate machinery, dams, and auxiliary power systems. Rey has over 35 years of experience in hydroelectric and water resources related projects. For four years he was the Department of Energy's (DOE) designated engineer for reviewing over 40 small (less than 2,500-kW) hydroelectric projects at a pre-feasibility level. In addition to DOE projects, he has completed over 20 feasibility projects for small hydroelectric projects less than 25 MW, many of which were constructed and are now online. He has been involved in several dam removal projects, including those at Port Arthur, Elwha, Glines Canyon, Condit, and Edwards. Internationally recognized, his projects include pre-feasibility and feasibility-level studies and final designs for facilities in Panama, Columbia, Brazil, Laos, Thailand, Canada, Mexico, Peru, Nigeria, Liberia, Cameroon, Costa Rica, Nicaragua, Guyana, and the Philippines. Rey's water resources experience includes renovation design, resurfacing, post tensioning, buttressing, draining, dewatering, and placement of stabilizing beams for concrete, steel, and embankment-type structures. He has worked on several dam rehabilitation and replacement projects, new dam projects, and authored several technical papers.

EDUCATION

MS, Civil Engineering, University of Minnesota
BS, Civil Engineering, University of Minnesota

Licenses and Professional Registrations

Professional Engineer, Civil, AZ, AR, CO, CT, ID, KY, MA, MN, NH, NJ, NY, OR, PA, VT, WA, WI, WY

EXPERIENCE RECORD

Furnas Technical Evaluation

Brazil

Rey was the Project Manager and Principal Investigator/Independent Engineer to enable the Inter-American Bank to support the funding of the Furnas Investment Program, at the request of the Government of Brazil, which entails the modernization of three large hydroelectric projects (2742 MW) on the Grande River, Brazil. The modernization program involved the following upgrades: generator re-winds and exciter and voltage regulation upgrades; turbine repairs including bearings, wicket gates and runners; bearing and oil cooling systems; replacement of water and oil filtration systems; scroll case and speed ring repairs; turbine governor replacements and oil cleaning systems and containment replacement; high voltage switchgear upgrades using SF6 breakers; installation of new power transformers for the Peixoto project; upgrades to the oil containment systems for all of the plants; replacement of HVAC systems in two of the plants; reconstruction of switchyards; improvement of access to one power station; and improvements to the intakes of two projects.

Ruskin Power Plant Condition Assessment

BC Hydro

Project manager for assessing the current condition of the hydrogenerating equipment and the water conveyance system; and reviewed and confirmed the risks to better ascertain the need for component reconditioning, refurbishment, or replacement for this 105 MW station with equipment dating to 1930. Included in the evaluation

were the following components under study: intake structure; penstocks and power tunnels; powerhouse structure; switchyard; access bridge; turbines; generators; governors; exciters and excitation systems; control and protection systems; main power transformers; AC and DC station service systems; turbine inlet valves; powerhouse cranes; air, oil and water piping; draft tube and stop logs; and draft tube gate hoists. Probability of failure within 1, 5 and 10 years were assessed using mortality curve and Crow AMSAA analyses performed by BC Hydro.

John Hart Powerhouse Condition Assessment and Rehabilitation Options;
British Columbia, Canada
Project Manager responsible for assessing the current condition of the hydrogenerating equipment and the water conveyance system; and reviewed and confirmed the risks to better ascertain the need for component reconditioning, refurbishment, or replacement for this 126 MW station with equipment dating to 1945. Included in the evaluation were the following components under study: intake structure; pipelines of steel and woodstave; differential surge tanks; powerhouse structure; switchyard; access timber bridge; turbines; generators; governors; exciters and excitation systems; control and protection systems; main power transformers; AC and DC station service systems; turbine inlet valves; powerhouse cranes; air, oil and water piping; draft tube and stop logs; hoist; and service elevator. Life extensions of 15; 25; and 50+ years were reviewed and rated using mortality curve and Crow AMSAA analyses. Sustainability was of considerable importance since the station is located on a world-class salmon fishing river, and abuts the Campbell River Recreation area, requiring strict adherence to these principals and conditions.

Catawba-Wateree Project;
Duke Power Company; North and South Carolina
Project Engineer. Performed the FERC safety inspection, prepared stability analyses for water-retaining structures, and submitted a final report for the 11 separate power stations that comprised the Catawba-Wateree Project.

Upriver Dam Hydroelectric Project;
City of Spokane, WA
Prepared the FERC Part 12D safety inspection report and was involved in preparing designs to replace and stabilize piping beneath the radial-gated spillway. Mr. Hokenson was the Project Manager responsible for the design and construction management of the restoration of the Upriver Dam Hydroelectric Project and for the preparation of the FERC failure investigation report. Fast-track design efforts for five contracts, including the unique contract involving the jacking and leveling of the 11,000-ton No. 1 Powerhouse, allowed both powerhouses to be placed on-line according to schedule.

Green Lake Hydroelectric Project FERC Safety Inspection;
City and Borough of Sitka, AK
Project Manager and Principal Investigator. Performed the FERC safety inspection for this 210-foot-high concrete arch dam; 1,900-foot-long, 9-foot-diameter tunnel and penstock; and 16.5-MW powerhouse. Subsequent studies have involved special investigations concerning leaching of the grout curtain and increases in piezometric pressure in the left abutment.

Swan Lake Hydroelectric Project, FERC Safety Inspection;
Alaska Energy Authority, AK
Project Manager/Principal Investigator for the FERC safety inspection for this 174-foot-high concrete, elliptical, double-curvature arch dam; tunnel and penstock; and 22-MW powerhouse. Subsequent studies involved pseudostatic stability analysis of the abutments to evaluate their safety factor.

FERC Safety Inspections

York Haven
Hennepin Island Hydro
Buzzards Roost
Oswegatchie River Projects
Weston
Gulf Island
Brunswick-Topsham
Holcombe Hydro
Big Falls Hydro
Catawba-Wateree Project (11 stations)
Wymann
Williams
Shawmut
Deer Rips-Androscoggin

Lewiston Falls	Rock Island
Rocky Reach	Lake Chelan
Swan Lake	Green Lake
Upriver Dam	Blue Lake
Jackson Bluff	Tower and Kleber Dam
Potholes East Canal Headworks	Grand Coulee Main Canal Headworks
North Fork Stanislaus River Project	Loup River Project

John Day Fishway Auxiliary Pump P&S
USACE, Portland District
Reviewed drawings at 65 and 95 percent levels; recommended changes to the pump layout configuration to conform to industry standards.

Holyoke Hydroelectric Project
City of Holyoke Gas and Electric Department, MA
Managed the competitive re-licensing process of the Hadley Falls Hydroelectric Project. Services included management of the engineering and environmental studies; consultation with the required resource agencies under FERC's three-stage consultation process; and preparation of the draft and final license applications. The City of Holyoke Gas and Electric Department (HG&E) and the Massachusetts Municipal Wholesale Electric Company (MMWEC), a public corporation of the Commonwealth of Massachusetts, jointly filed this competing license application for FERC Project No. 2004, located on the Connecticut River in Holyoke, Massachusetts. Their joint proposal incorporates the existing Project 2004 generation, amounting to 43,156 kW of installed generating capacity, as well as an additional 15,000 kW from a new unit to be installed at the Dam. Equally important, the Joint Proposal is intended to integrate the project, a prominent feature in the City of Holyoke, with the community's other activities and to share with the City and the surrounding community the potential multi-purpose benefits the project is capable of providing. The project generally consists of the Hadley Falls Dam, a tri-level canal system and six hydroelectric generating plants -the Hadley Falls Station, the Beebe-Holbrook Station, the Skinner Station, the Boatlock Station, the Riverside Station and the Chemical Station. The largest of the six power plants is the Hadley Falls Station, which consists of two (2) vertical generating units with a plant capacity of 30,800 kW (one 15,000 kW fixed-blade propeller and one 15,800 kW adjustable Kaplan-type turbine) utilizing a gross head of 52 feet. The Hadley Falls power plant was constructed in 1950 with an initial installed capacity of 21,500 horsepower (15,800 kW adjustable Kaplan-type turbine). The second 15 MW unit was commissioned in 1984. Special environmental studies included fish and IFIM, recreation, socio-economic, water quality, and cultural resources.

Western Panama Power Supply Study
Institute of Hydraulic Resources and Electricity, Panama
Civil Engineer. Identified potential hydroelectric sites and prepared detailed layouts for more than 20 projects involving large embankment and concrete dams (100- to 150-meter-high concrete, thin-arch dams), tunnels, spillways, intake structures, diversion works, penstocks, and powerhouses, each capable of withstanding high seismic loadings (5/10 to 7/10g). Prepared cost estimates for several dam heights and tunnel and penstock diameters and installed capacities for each of the projects to allow for economic and financial evaluation and comparison. Three different plant capacity factors were assumed to allow the plant to be economically sized.

St. Paul River Regulation Study
World Bank, Liberia
Project Manager for the development of conceptual layouts for the step-pool (dam/reservoir) utilization of St. Paul River's hydraulic head. His responsibilities included mapping, site inspections, selection of design criteria, and project layouts relating to the construction of nine 50- to 70-meter-high concrete, earthfill, and rockfill dams. Responsible for feasibility reports and cost estimating for this 1,000-MW project. This study helped define the development of another project, the Mano-Lofa River Transbasin Diversion Project, which involved 23 miles of tunnel and penstock, and a 200-MW underground power station.

Nine Mile Hydroelectric Project
Washington Water Power Company
Project Manager responsible for the preparation of six contracts to restore this existing project and to increase its capacity from 19 to 29 MW. Value engineering exercises examined the feasibility of having six contracts for this project, which included several types of contracts, as well as near optimizing the construction schedule. The project involved upgrading two bridge cranes and intake gate hoists; upgrading two Francis quad units and installing two uprated Francis quad units; upgrading switchgear; installing new draft-tube gates; installing a new intake structure including wheeled gates, trash racks, trash rake, and piers; and refurbishing the powerhouse building. The installation of the intake structure was innovative in that caisson-type steel piers were bolted to the powerhouse, dewatered, filled with concrete, and then post-tensioned to the existing powerhouse. This construction technique saved the owner over $1 million.

Columbus and Monroe Hydroelectric Plant Rehabilitation
Loup Power District, NE
Lead Civil Engineer/QC Reviewer responsible for the civil engineering aspects of the upgrade of the Columbus and Monroe plants and review of the EPC contract documents for the unit upgrades. For each of the plants, the turbines and generators were upgraded to accommodate FERC criteria limiting the amount of installed capacity possible under the existing license and to meet economic and financial criteria established by the Owner. The Columbus plant houses three 14,000 kVA generators at 95 percent Power Factor and the Monroe plant housed three 2,750 kVA generators at 95 percent Power Factor. Of particular civil engineering interest is the apparent movement of the Columbus power station since it was commissioned in 1937. The power station is founded on firm river sands that have apparently allowed the powerhouse to displace vertically, which was accommodated in the unit upgrade designs. Responsible for preparation of the FERC license amendment, the EPC contract documents for the upgrades to the turbines, generators, and associated switchgear, the economic feasibility study to justify the capacity addition bidding assistance, and construction management services.

Elwha River Restoration Project (Removal of Glines Canyon and Elwha Dams)
Summit Technology, WA
Project Manager responsible for developing potential dam removal techniques and for addressing water quality issues and water supply restoration. Prepared the construction cost estimates for the complete dam removal and restoration program with the exception of the sediment removal program, which was performed by Summit Technology. For the first time in American history two dams are being considered expendable solely for the restoration of a fishery habitat. The two dams on the Elwha River are 100-foot-high concrete gravity dam and 210-foot-high concrete arch dam. The restoration of the Elwha River would require not only the demolition and removal of the two dams, but more importantly, the removal of an estimated 16 million cubic yards of silt, sand, gravel, and other debris accumulated in the two reservoirs. River channel restoration is paramount because if the reservoir sediments are not secured, the river could become completely uninhabitable for any salmon species. The restoration program performed by Rey included developing alternatives for new water supply sources to the nearby community of Port Angeles and two pulp mills, which rely on water diverted from the Elwha immediately downstream of the dams. The reservoirs provide effective settling ponds in which much of the fines settle out yielding water with low turbidity.

Watertown Hydroelectric Project
City of Watertown, NY
Project Manager. In obtaining a new FERC license, was responsible for preparing the initial information packet, directing a number of critical environmental and technical studies related to the project, conducting first stage and second stage consultation, and preparing and submitting a new license application to FERC. The team provided services involving IFIM studies, sizing of fish passage structures, requirements associated with low-flow releases and trash rack requirements, and whitewater kayaking provisions in the project bypass reach. Helped negotiate settlement agreements between the FERC, the client, resource agencies, and community groups concerning these issues. He wrote one of the first applicant-prepared FERC Environmental Assessments of the project for the City.

RICHARD (DICK) HOWELL, P.E.

ECONOMICS / PRO FORMA

KEY QUALIFICATIONS

Mr. Howell has participated in over 100 system master planning projects, including economic analysis of project alternatives and structuring of capital improvement plans. He has developed in-depth financial planning models for many long term financial plans including sources of funds analysis, reserves utilization and rate, fee and tax payer impact analysis. He currently serves as financial and economic consultant to the King County, Washington, Department of Natural Resources Wastewater Division for implementation of the $1.3 billion Regional Wastewater Services Plan. He recently completed a financial planning effort for City of Cincinnati to determine whether future water supply for Northern Kentucky should be provided on a wholesale basis by Cincinnati, with a new Ohio River crossing, or by a regional water district in Kentucky.

Mr. Howell's financial and institutional management experience derives from a strong foundation as a water and wastewater engineer. As a sanitary engineer he was responsible for many water and sewage pipeline and pumping projects, water and wastewater treatment plant design projects, ocean engineering and master planning. Mr. Howell has construction experience including resident engineering/inspection, underwater construction management, construction planning, administration and claims negotiation.

Mr. Howell participates in public works bond financings by preparing due diligence reports and feasibility studies for official statements, including pro forma results of operations, net revenue coverage analysis, additional bonds tests and other analyses required by bond covenants, bond counsel and financing teams. He recently completed the engineer's feasibility report for the $551-million wastewater system revenue bond sale for the Sacramento Regional County Sanitation District in California.

EDUCATION

MBA, Economics and Finance, Claremont Graduate School
MS/MSc, Environmental Engineering, Stanford University
BS/BSc, Civil Engineering, Stanford University
BA, Management Engineering, Claremont Men's College

Licenses and Professional Memberships

Professional Engineer - Civil, Washington, 17709
Professional Engineer, Nevada, 628
Professional Engineer - Civil, California, 2795
Professional Engineer - Civil, Arizona, 1513
Professional Engineer, Montana, 9494PE

EXPERIENCE RECORD

Lake Powell Pipeline

Currently engaged in economic evaluations and financial planning including rate impacts for the Lake Powell Pipeline project. The pipeline project includes dam connection, 140 miles of pipeline, pumping stations, energy recovery and pumped storage facilities, and terminal storage to accommodate communities along the southern border of Utah. Cost will exceed $1.2M. Mr. Howell is involved with cost sharing and local financing as well as state participation.

San Diego Wastewater Program
Provided financial and rate consulting and modeling, and completed the engineers' feasibility report for the $551M wastewater system revenue bond sale for construction of a wastewater treatment plant expansion for the San Diego Metropolitan Wastewater Department. The purpose of the project was to achieve compliance with federal and state regulatory mandates that required the City to reclaim 45-mgd of water by 2010 by constructing two new treatment plants and 60 miles of large-diameter pipeline. The San Diego program was similar in nature but smaller in scope ($2B) as the Los Angeles program. Mr. Howells participation in San Diego was as feasibility consultant for a large bond sale to support the local share of the capital requirement.

King County Regional Wastewater Services Program
Similar scope and duration as the Los Angeles program for the Seattle regional program. Regional cost sharing equity and growth/cost flexibility are common features of regional programs.

Combined Sewer Overflow (CSO) Program
NEORSD is the regional wastewater service provider for the 2M people in 62 cities in the metropolitan Cleveland region. NEORSD's combined sewer overflow program has a price tag of about $2B. Mr. Howell prepared the Financial Capability Assessment for the program, in conformance with EPA regulation and guidance documents. While the region has the wherewithal to financially support the program, and although NEORSD has committed and shown diligence in moving forward with the program, the EPA and U.S. Department of Justice lawyers seem equally committed in their part of consent decree negotiations to hold up progress.The USEPA required the District to prepare a long-term CSO control plan and implement improvements for the entire district to conform with CSO guidelines. MWH helped the District win acceptance of the 20-year CSO plan from the US and Ohio EPA and secure low-interest state revolving loan fund money. The plan saved the District $302M and served as the blueprint for detailed study, design and construction of four major projects.

Contra Costa Water District Los Vaqueros Program
Project manager/principal consultant for capital programming and financing of the Los Vaqueros Project, a dam and pipeline water quality improvement project for the Contra Costa Water District east of the San Francisco Bay in California. ($450 million) He also recently completed system development/connection fee economic assessment studies for the district (250,000 service area population).

City of Los Angeles Clean Water Program
Served as liaison for financial matters between the City of Los Angeles and twenty-nine wastewater agencies in the development of new wastewater CIP service contracts to comply with state and federal grant/loan regulations. Project duties included an economic evaluation of institutional arrangements and utility management structures and procedures.

Water Works Project Financing
Completed capital programming feasibility reports to support bond financings for the construction of water works projects for the City and County of San Francisco. Mr. Howell participates in public works bond financings by preparing due diligence reports, economic assessments, and feasibility studies for official statements, including pro forma results of operations, net revenue coverage analysis, additional bonds tests and other analyses required by bond covenants, bond counsel and financing teams.

FARROKH JAVANMARDI, Ph.D.

CIVIL / STRUCTURAL ENGINEER

KEY QUALIFICATIONS

Dr. Javanmardi is a Civil/Structural Engineer with 21 years of experience in design of hydraulic structures and building construction. He is an expert in seismic design of new dams, and seismic evaluation of existing dams. He is proficient in advanced finite element analyses of hydraulic structures and seismic water-structure and soil-structure interaction analysis. His hydro power experience includes analysis and design of concrete gravity and arch dams, thermal stress analysis of RCC dams, seismic evaluation and strengthening of concrete dams, design of powerhouse substructure and super structure, design of tainter gates, and design of components utilized in hydroelectric project. He is also experienced in preparation of design criteria as well as proposal for hydroelectric projects. He is proficient in finite element and finite difference software including ANSYS, SAP2000, FLAC, and UDEC.

EDUCATION

Ph.D. Structural Engineering Ecole Polytechnique Montreal
M.Sc. Structural Engineering Shiraz University
B.Sc. Civil Engineering Shiraz University

EXPERIENCE RECORD

White River Project
Regional Power Inc.
Lead Civil/Structural Engineer for structural design/analysis of preliminary level layout and design of Power Intake and power canal, by-pass facilities, spillways and diversion canal for two cascade dams; Upper white River and Lower white River located in Ontario, Canada.

BC Hydro Spillway gate System Improvement, Stave Falls Project, British Columbia, Canada
HMI Construction Inc.
Mr Javanmardi worked as lead structural engineer for detailed design of four new orifice type spillway radial gates and their hydraulic hoists for Stave falls spillway improvement project in British Columbia. He has also been responsible for managing the project and coordination of the works between contractor/fabricator and design disciplines.

Ruskin Dam Spillway Gate Project, British Columbia, Canada
BC Hydro
The main scope of the work was to make an independent review of Ruskin spillway radial gate. BC Hydro design team introduced an innovative design concept by incorporating some yielding beams into gate structural frame.
Mr Javanmardi was responsible to conduct an independent set of calculations verifying that the BC Hydro structural design of the Ruskin spillway gates meets the requirements of the design basis.

Bear Hydro Project, British Columbia
Regional Power Inc.
Mr. Javanmardi worked as owner engineer for Bear Hydro project, a design and Build project. He conducted and supervised all the activities for structural review and approval of contractor submitted drawings and calculations for all hydraulic structures.

Upper San Joaquin River Storage Project,
U.S. Bureau of Reclamation
The main scope of the work was a feasibility study evaluation alternate to develop water supplied from San Joaquin River. As structural engineer he was responsible for structural design of Selective Level intake Structure for the Upper San Joaquin River Basin Storage Investigation Project. The Intake Structure consists of four intakes in four different levels. The lowest one serves as bottom outlet intake as well.
He was also responsible to assess the stability of the Kerckhoff Arch Dam after construction of a proposed RCC dam downstream of Kerckoff dam. Finite Element model of the arch dam was developed to determine whether modification or upgrades were needed to withstand water on the downstream face.

Susitna-Watana Hydroelectric Project
Alaska Energy Authority
Provision of preliminary structural analyses and stability design of hydraulic structures

Taltson Expansion Project
NWT Energy Corporation (03) Ltd.
The main scope of work was preliminary design for Twin Gorges Facilities and Nonacho Lake Facilities. He was responsible for preparation of Design Basis Memorandum, structural design, and quantity estimate for two alternatives with capacities of 40 MW and 60 MW.

Wanapum trunnion and trunnion anchorage assessment,
Grant County Public Utility District, Washington
The main scope of work was to conduct a structural evaluation of the Wanapum spillway gates trunnion and trunnion anchorage assemblies to determine their adequacy for a proposed operating reservoir level increase. As lead structural engineer, he was responsible to develop finite element model and conduct seismic analysis of radial gate and trunnion anchorage and to extend the remediation measures necessary to achieve a workable system.

Ruskin Power House Improvement Project,
BC Hydro
The main scope of work was to develop a comprehensive rehabilitation/upgrade plan for the powerhouse including powerhouse structure, water conveyance system, and generating units. As structural engineer of the team he was responsible for conducting seismic stress/stability evaluation of intake structure and power tunnel, recommendation for the rehabilitation/strengthening alternatives, and preparation of a structural report. Work performed also included review of the report for seismic upgrade alternatives of the powerhouse superstructure.

Soda Spring Dam seismic updates
PacificCorp Energy
Soda Spring Dam consists of the main 35 m high arch dam, thrust block on the right abutment, and spillway section on the left abutment. The scope of this work included performing a seismic stability analysis update as required by the Federal Energy Regulatory Commission (FERC). As lead structural engineer, he developed 3D finite element model of dam components and foundations with 3D solid elements, conducted static, thermal, and linear time history analyses, and assessed the performance of the dam based on the acceptance criteria contained in Chapters III and XI of the FERC (Federal Energy Regulatory Commission) Guidelines. Linear link elements were used to model the contraction joints in the dam body and staged construction analysis was conducted to simulate the effect of grouting and construction sequences on stress distribution in the dam.

John Hart Redevelopment Project, BC Hydro
Lead Structural engineer, evaluation of the existing penstock and powerhouse structure for value engineering study and report.

Global gate survey
BC Hydro
The project comprises research services to determine the state of the art and state of the practice in the design and analysis of spillway gates subjected to high seismic loading in the North America and globally. As structural engineer of research team he performed a global survey on magnitude of the hydrodynamic pressure during the

earthquake and prepared a comprehensive report explaining the existing analytical and numerical methods for analysis of tainter gates subjected to high seismic loads. The detailed discussion about the existing methods for evaluating the hydrodynamic pressure on radial gates during the earthquake was also presented in the report.

LLAnderson
Placer County water Agency
L.L. Anderson dam is 820-meter-long embankment with a maximum structural height of 70.5 m. The main scope was design of a new wider spillway to replace the existing spillway of L.L. Anderson dam. Responsibilities as lead structural engineer included preparation of structural design criteria, Three dimensional finite element modeling of the piers and steel gates, conducting static and seismic response spectra analyses, and detailed design of radial gate and piers. The gate steel structure was designed using the SAP2000 design capabilities based on the AISC-LRFD design method. Detailed structural drawings were also prepared.

Jordan River Dam
BC Hydro
The project comprises dynamic analysis, seismic assessment and definition of remediation for the concrete Ambursen-type Buttress Dam at Jordan River, which is located on Vancouver Island. The Peer review of the draft report entitled “Seismic assessment of the concrete Ambursen-type dam at Jordan River- 3D dynamic analysis” was conducted. The original report presented the results of seismic evaluation of the dam using linear response spectra, linear and nonlinear time history analyses. The major concerns of BC-Hydro including modeling accuracy, analysis method, fluid structure interaction modeling method, and credibility of identified deficiencies were addressed in the review.

EL Tablon
Emprsa Nacional de Energia Eleectrica
This project consist of a 80 m high roller compacted concrete (RCC) dam with 2x10MW vertical Francis units powerhouse. As project engineer, he was responsible for preparation of design criteria, design of RCC dam, design of diversion works, quantity estimate, and supervision of the drafting staff for preparation of drawings.

Karebbe Hydroelectric
PT-INCO
The project is located in a high seismic area and consists of a 74-m high Roller Compacted Concrete (RCC) dam, self standing double intake tower and 132MW hydro-combine powerhouse with two vertical Francis Turbine generation units. As structural engineer, he was responsible for analysis and design of intake tower and powerhouse structure and preparation of detailed construction drawings. He also reviewed the stability analysis of the RCC dam and prepared an addendum to address the Karrebe advisory board concerns about the post seismic sliding stability of the dam.

Huoi-Quang Hydroelectric
Electricity of Vietnam
He was responsible for structural analysis and design of a 104 m high RCC dam in Phase 2. This included:

- Stability analysis and design of RCC dam. The CADAM software was used to conduct sliding stability and tensile stresses analyses and optimize the downstream slope of the RCC dam.
- Thermal and thermal stress analysis of RCC dam. The temperature field in dam body during the construction of the dam and its lifetime was simulated using the finite element modeling with ANSYS. Nonlinear analysis, considering the creep characteristics of the RCC, was conducted to compute the developed thermal stresses due to temperature variations. Also, the contraction joint spacing was determined based on the results of this analysis.
- Static and dynamic stress analysis of RCC dam. 3D-Soild elements of ANSYS, were used to model the dam-foundation system. Static and linear time history analyses based on three base acceleration time histories were conducted. The performance curves were developed to asses the performance of dam during the earthquake event.

DAVID KLEINER, P.E.

QA/QC – GEOTECHNICAL – DAM/POWERSTATION

KEY QUALIFICATIONS

During Mr. Kleiner's many years with MWH, he has participated in a broad mix of assignments, including site investigations; field and laboratory testing; design, analysis, and construction of earth and rock dams, tunnels and underground caverns, tailings dams, industrial waste disposal projects, and foundations for structures; and monitoring of construction and project start-up. He has served as project manager on a variety of studies and design assignments and made numerous presentations to boards of consultants and at technical meetings. Mr. Kleiner currently serves as a member of several boards of consultants. In his capacity as a Senior Advisor, Mr. Kleiner provides senior review of geotechnical reports, design of dams and foundations, drawings, and construction specifications.

EDUCATION

MS/MSc, Civil Engineering Northwestern University
BS/BSc, Civil Engineering Valparaiso University

Professional Registration: Professional Engineer, AK; AR; CO; GA; IL; TX

Professional Organizations: United States Society on Dams (USSD), Chairman, Committee on Materials for Embankment Dams; International Society of Soil Mechanics and Foundations, Member; Earthquake Engineering Research Institute, Member; United States Society on Dams (USSD), Vice President; International Commission on Large Dams , Member, Committee on Materials for Fill Dams; American Society of Civil Engineers (ASCE), Member; United States Society on Dams (USSD), Secretary/Treasurer; United States Society on Dams (USSD), Member, Board of Directors; National Society of Professional Engineers (NSPE), Member; American Society of Civil Engineers, 2001 Philip R. Hoffman Award for contributions in the planning, design and construction of hydroelectric pumped-storage projects.

EXPERIENCE RECORD

Rocky Mountain Pumped-Storage Project
Client: Oglethorpe Power Corporation
Project Geotechnical Engineer for upper and lower reservoirs, auxiliary reservoirs, power tunnel, and penstocks. Assignments included layout studies; site exploration; evaluation of construction materials; detail design of the upper reservoir dam, including lining systems, dams forming the lower reservoir and auxiliary reservoirs, foundations for spillways and powerhouse, excavated slopes, and drainage features; and numerous presentations to owner and Board of Consultants. Designed test filling of the power tunnel and penstocks; specified instrumentation program; provided oversight during the tunnel filling test; and evaluated tunnel performance subsequent to test. In addition, Mr. Kleiner regularly visited the construction site to observe progress and evaluate construction quality with respect to design (1989-1996). Independent Consultant for the preparation of the Initial FERC 5-year Inspection (1997). Provide consulting assistance and advice to Oglethorpe operating personnel entrusted with monitoring and evaluating the performance of the dams, reservoirs, and foundations

San Roque Multi-purpose Project
Client: San Roque Power Corporation
Member of the Consulting Panel charged with the review of all technical aspects of design and construction of the 650-ft-high (200-m) central core rockfill dam, including the dam, diversion tunnels, cofferdams, foundation excavation and treatment, spillway, power tunnels, and powerhouse.

MWH

Peace River Reservoir Expani
Client: MWH Americas, Inc. (Interco use only)
Geotechnical Reviewer for the design and construction of a water supply reservoir for west central Florida. The reservoir consists of a ring dam, 13,000 feet long, with geomembrane water barrier and slurry trench cutoff

Ridges Basin Dam
Client: United States Bureau of Reclamation
Member of the Consulting Board for the review of design, analysis, construction contract documents, and construction of the 275-ft-high (84-m) central core embankment dam, foundation treatment, and the low-level outlet works. Suspect, potentially liquefiable material will be excavated from the foundation of the dam

Toulnustouc Dam
Client: Hydro-Quebec
Member of the Consulting Board for the review of dam-type selection studies, design, analysis, construction contract documents, and construction of the 250-ft-high (75-m) concrete face rockfill dam and the 9 km long power tunnel. Foundations consist of hard, competent granite

Eastmain 1 Hydro
Client: Hydro-Quebec
Member of the Consulting Board for the review of the design and construction of the 70-m high central core rockfill dam, 15 dikes ranging in height from 5 to 39 m, the intake, power tunnel, power station excavation, and tailrace. Foundations consist of granite, glacial till and

Chicago Freight Tunnel
Client: City of Chicago
Consultant/Reviewer of the design and construction of remedial treatment of the freight tunnel at locations of deterioration.

Eastmain 1A Hydro Project and Rupert River Diversion
Client: Hydro-Quebec
Member of the Consulting Board for the review of the design and construction of 74 rockfill and earthfill dams and dikes, ranging in height from 2 to 32 m, the 3-km-long 16 m by 16 m transfer tunnel, spillway, low-level outlets, power intake, penstock, tunnel, powerhouse, and foundation excavation and treatment. Foundations consist of granite, glacial till and moraine.

Panama Canal Planning and Studies and Program Management Advisory Services
Client: Unknown
Mr. Kleiner is responsible for feasibility level studies to determine locations of new water supply reservoirs and supply tunnels for the Panama Canal Expansion Project. Responsibilities also include field investigations of the dam and reservoir sites to determine site conditions and construction materials availability and feasibility level design of fill dams, spillways, and water transfer tunnels

Sogamoso Hydro Project
Client: Isagen, Generacion y Comercializacion de Energia
Member of a Special Board of Consultants to assist in the selection of the most appropriate dam type, roller-compacted concrete gravity hard fill (RCC) or concrete-face rockfill dam (CFRD), for the Sogamoso Hydroelectric Project (height of dam, 190 m). The selection depended on an engineering evaluation of foundation conditions for each dam type. Because of the prevalence of deep weathering and high-angle stress relief joints in the steep canyon walls, the CFRD was recommended to the client as the most appropriate dam type

Peribonka Hydro Project
Client: Hydro-Quebec
Member of the Consulting Board for the review of the design and construction of the 80-m high central core rockfill dam and two dikes, ranging in height from 21 to 30 m, the intake, power tunnel, underground power station, and tailrace. Foundations consist of granite, glacial till and moraine. A unique feature of the project is the 115-m deep cutoff wall through coarse alluvium, and outwash sand and gravel at the main dam.

Concrete-Face Rockfill Dam Workshop
Client: Nippon Koei and Department of Public Works
A two-day workshop on the analysis, design, and construction of the concrete-face rockfill dam. The workshop was based on the final draft of the ICOLD report on the Concrete-Face Rockfill Dam. Mr. Kleiner is the lead author of the soon-to-be-published report on the CFRD.

Olivenhain Emergency Storage Project
Client: San Diego County Water Authority
Lead Engineer for foundation evaluation and treatment for the 300-ft-high roller-compacted concrete (RCC) dam. Responsibilities include the design of excavation for the dam, foundation grouting and drainage plans, underseepage and foundation stability analyses, and an evaluation of offsite seepage from the reservoir

Project Aqua
Client: Meridian Energy, Wellington
Member of a four-person Board of Review to review the design of a 560 MW hydroelectric power scheme on the lower Waitaki River, South Island. The scheme consisted of a series of six power stations fed by 80-m wide headrace canals. Foundation conditions and use of materials were major considerations along the 60-km long alignment

Ulu Tutong Dam and Reservoir
Client: Negara Brunei Darussalam, National Water Resources Development Project
Provided detailed geotechnical review of the design of the 40-m-high earthfill dam, the plastic-concrete cutoff wall, and foundation excavation and treatment. The review included the evaluation of foundation conditions, use of materials, and detailed review of construction drawings and specifications.

Al Wehdah Dam
Client: Jordan Valley Authority
Consultant/Senior Reviewer of the 100-m-high roller compacted concrete dam. Reviewed the design of the dam and foundation treatment (2001-2002). Visited the site during construction to participate in decisions concerning foundation evaluation, excavation and treatment.

Al Wehdah Dam
Client: Jordan Valley Authority
As Department Head, guided and supervised the design and preparation of construction drawings, specifications, and design reports for the dam, foundations and abutment treatment. Main features are the 390-ft -high (120-m) concrete-face rockfill dam, and 130-ft-high (40-m), 980-ft-long (300-m) cutoff wall in the left abutment (1989-1991).The dam was re-designed as a roller-compacted concrete dam in the 2002. Provided senior level review of design of the dam and foundation treatment

Mohale Dam
Client: Lesotho Highlands Development Authority
Member of the Technical Review Panel for the site investigations, design, analysis, and preparation of construction contract documents, and construction of the 475-ft-high (145-m) concrete face rockfill dam, cofferdams, spillway, tunnels, and outlet works. Foundations consist of interbedded basalt flows

Porce III
Client: Empresas Publicas de Medillin
Member of a Special Board of Consultants to assist in the selection of the most appropriate dam type, roller-compacted concrete gravity (RCC) or concrete-face rockfill dam (CFRD), for the Porce III hydroelectric project (height of dam, 150 m). The selection depended on an evaluation of foundation conditions and the cost to treat the foundation for each dam type. Because of the prevalence of sub-horizontal shear zones within the abutments of the dam, the CFRD was recommended and selected by the client.

Parsa Pumped-Storage Project
Client: Israel Electric Corporation, Ltd.
Project Geotechnical Engineer for feasibility study and evaluation of site conditions, construction materials and project layout studies; and development of design concepts for the upper and lower reservoirs, the embankment dams,

lining and drainage systems, and the underground caverns and tunnels (1992-2002). Prepared study and report on the seismic stability of project structures using empirical methods. Structures included dams, reservoirs, water conveyance tunnels, access tunnels, and the underground powerhouse complex. Chief Geotechnical Engineer for the evaluation of the seismic stability of the embankment dams during and subsequent to the Maximum Design Earthquake using the program GEFDYN

Chivor Dam
Client: Chivor Hydroelectric Powerplant
Member of a two-person Consulting Board to inspect and evaluate the performance of the 27-year-old, 238-meter high, central-core rock and earthfill dam and its foundation, the spillway, tunnels and drainage and instrumentation galleries.

Trinidad Dam
Client: Panama Canal Authority
Designated Reviewer of studies to support the technical feasibility of a 100-ft-high (33-m) embankment dam across the Trinidad Arm of Gatun Lake. Existing lake depths reach a maximum of about 80-ft along the alignment of the dam. Foundations consist of the very soft weak Atlantic Muck

Al Wehdah Dam
Client: Jordan Valley Authority
Consultant/Senior Reviewer of the 100-m-high roller compacted concrete dam. Reviewed the design of the dam and foundation treatment (2001-2002). Visited the site during construction to participate in decisions concerning foundation evaluation, excavation and treatment.

Seneca Pumped-Storage Project
Client: First Energy
Consultant/reviewer for the design and construction of the new asphalt concrete lining of the side slopes of the upper reservoir. Assisted in the review of data during reservoir re-filling and in evaluating the performance of the reservoir.Lead Geotechnical Engineer for the design of the upper reservoir. Presented site investigation data and design concepts to the Owner and to their Board of Consultants at several meetings. Made numerous inspection visits to the site during construction. Lead Geotechnical in the design of repairs to the upper reservoir and participated in site inspection during construction of the repairs.

Wanapum Dam
Client: Public Utility District of Grant County
Member of the Consulting Board to review the nature and occurrence of unusual settlement of the earth and gravel fill embankment dam. Evaluations include review of site investigations, measurements of instruments, and analyses of settlement causes and effects

Keenleyside Power Project
Client: Peter Kiewit Sons, Inc.
Consultant/Reviewer, for civil and geotechnical design and construction of the concrete-lined approach channel, the concrete-face rockfill dam, (CFRD) foundations, overburden and rock slopes and powerhouse. Analyses include evaluation of soil and rock investigations, stability of the CFRD foundation and underseepage and stability of the approach channel

RON KROHN, P.E.

PRINCIPAL ELECTRICAL ENGINEER

KEY QUALIFICATIONS

Experienced in preparation of specifications, design review, field supervision of erection, field monitoring of quality control, preparation of plans for Engineer quality assurance program, participation in and/or direction of field commissioning activities, direction and/or performing of generator performance tests, and analysis test results. For new units, plan powerhouse development to include the requirements of potential generator vendors. Work with field teams to establish roundness and centering control to achieve specification and/or CEA tolerances for field stacked cores and field constructed rotors. Work with turbine designers to develop overall unit schedule when generator and turbine rehabilitation are combined. Maintain Project schedule and quality control through review of Contractor design drawings and procedures submitted in addition to monitoring work in progress. Utilize electronic drawings (CAD) and electronic documents (text) submittal, review and commenting to expedite the submittal process. Experienced in both conventional hydroelectric plant and pumped storage applications for design of units and peripherals. Experienced in design of variable speed units to take advantage of efficiency gains in pumped storage applications or conventional turbines applications with extreme head ranges.

EDUCATION

BS/BSc, Electrical Engineering University of Missouri

Professional Registration:

Professional Engineer: Nebraska, Alaska

EXPERIENCE RECORD

Rocky Mountain

Oglethorpe Power Corporation

Preparation of specifications for rehabilitation of generator/motors, specifically upgrading the field winding insulation system to allow the units to be operated continuously at 80 degrees C.

Basha Diamer Dam, Feasibility Report

WAPDA

Prepared feasibility level study for 4500 MW development of 12 x 375MW or 10 x 450MW in two underground powerhouses. Design details provided to establish underground excavation requirements and functional arrangement. System required use of 18 kV generators, SF6 generator circuit breakers, underground transformer yard, underground gas insulated substation (planned as 765 kV, but later determined impossible). Price estimates obtained for all major features, and concepts and layouts all provided as CAD files. Due to a high range of head fluctuation (~2:1), consideration to variable speed generators is given. Details on price, design and how to fit into powerhouse also provided

Basha Daimer Dam, Transmission Study

WAPDA

The planning had left the option of 765 kV and 550 kV because no vendors had provided data on 765 kV GIS. The study works were expanded to clearly show that there are some 16 GW of generation to connect to Pakistan, and that to do so with 550 kV along is not possible, due to the narrow transmission corridor. Either 765 kV or HVDC is needed to accomplish the job. To attract GIS vendors to the 765 kV portion of the work, details of the 2025 vision of the Government of Pakistan were released to prospective suppliers. Unfortunately, the response was not in the affirmative for supply of 765 kV GIS. Issue is still not resolved.

MWH

Lake Chelan Powerhouse Rehab Feasibility Study
Chelan County PUD
Worked with lead turbine engineer and clients team to produce a feasibility study concerning how to proceed with rehabilitation of the 75+ year old Lake Chelan Powerhouse. The original study was conceived as a turbine study, that evolved to include CFD analysis of the turbines, showing economic benefit to runner replacement, the economic need to replace the generator stators and field poles, upgrade the governors, and provided a list of items to the client for consideration in modernization of the balance of the station. Recommendations were to provide combined unit replacements to take advantage of a single disassembly of the unit, to avoid allowing the generator to fail in service for economic reasons, and a list of other suggested improvements for the balance of plant.

Bear Hydro Project, British Columbia
Regional Power Inc.
QA/QC for Hydrotechnical aspects. MWH is the Owner's engineer for this project which consisting of two hydropower facilities; Upper Bear and Lower Bear.

Malakand III Project, Package I & II review and Contract Negotiations
Shydo
81 MW hydroelectric project, 3 units, 500 rpm. Provided review comments to Packages I and II before issue of tenders in summer of 2002. In July 2003, traveled to Lahore for evaluation of tenders. Preliminary evaluation listings completed by local partners at Pakistan Engineering Services (PES). Final evaluation report compiled and issued while in Pakistan. Traveled to Peshawar to present report to Shydo and answer any questions they might pose. Successful tenderers for both packages are Chinese. Requested to return to Pakistan in January 2004 for contract negotiations. Led negotiation team and prepared Memorandum of Understanding for Package I and II. Principal negotiation issues for both packages were for contractor financing. Technical terms were successfully negotiated

Rocky Reach Generators Units C1-7
Chelan County PUD
Provide technical review of electronic design drawings and other technical documents for rehabilitation of generators. Information transmitted via an FTP site. Comments were coordinated between site team members, and documents issued to Contractor. Assisted in maintaining record of document reviews. Generator rehab included new stator frames, cores, stator windings, new rotor, new field poles, radially keyed soleplates, control of "large" hydroelectric generator air gap to +/-5% of the air gap, factory and lab visits to witness fabrication and design tests on stator bars, and all site testing associated with the new unit.

Rock Island Dam, Major Electrical Works Replacement Study
Chelan County PUD
Scope of work was to study transformer T1 and T2 replacement, and determine best method and size for replacement. Also study medium voltage cables and circuit breakers for generator voltage system and assess condition and need for upgrading and replacement. Study was started by subcontractor, and rejected by client. Study reviewed and redrafted into logical sections to create document that can be understood by readers. Short circuit study data and load flow data updated and presented in form that can be read by knowledgeable readers, identifying by highlight all conditions not within ratings. Study analyzed system between generator terminals and 115 kV McKenzie Switchyard. Revised study accepted by client.

Lake Chelan Static Excitation Systems
Chelan County PUD
Project was to replace the existing rotating exciters with new static excitation. As a preventative measure, a motor generator set was made active as a standby excitation system should a rotating exciter fail. Specifications were prepared for the system, reviewed by the PUD and issued. Bids were received and evaluated by the PUD. When the job was returned to my control, e-mail record file was established, drawing procedures were established to do drawing approvals electronically. All information was stored on a PUD server. Installation contractor was simultaneously working to supply its data for approval. Site location, erection, single lines, three lines, control drawings, and wiring drawings were all prepared in multi-color format. On site testing was directed to enable initial start. Liased with manufacturers commissioning engineer to ensure proper equipment calibration and operation. Worked with supplier to establish PUD training sessions and to obtain WEC models for the excitation and power system stabilizer

Kali Gandaki Project, Transmission Lines
Nepal Electricity Authority
Work consisted of one single circuit and one double circuit transmission line across some of the most undulating mountainside terrain imaginable. Led evaluation team for transmission line contract consisting of myself, IVO/Finland, and local seconded staff. In the interim between evaluation and award, rerouted the northern end to a different substation location than originally planned. Award to Tata Projects, India. In supervising the work, out the discovered a 40 degree surveying error that could have resulted in many bad real estate transactions. Negotiated a Variation Order with the Contractor to provide more of the largest tower sizes. Scope of work to contractor included determination of real estate requirements, permitting for right-of-way clearing, tree cutting and recovery of the timber, hand excavation or foundations, manual hauling of materials, manual concrete mixing and placement, manual erection of towers, controlled tension stringing, variation order for OPGW (fiber optic earth wire) and its installation.

Kali Gandaki Project, Resident Electrical Engineer
Nepal Electricity Authority
Negotiated for and obtained satellite communications system for project, and supervised installation of system, along with local telecommunication engineers. Installed PABX from Kathmandu office at jobsite to make a functional system that served for 3 years with minimal problem. Supervised seconded staff from client at jobsite for electrical works. Trained entire project site staff (>70 people) in AutoCAD over a course lasting approximately 6 weeks. Designed station earthing systems from field office using seconded Engineering staff and AutoCAD based drawings. Monitored construction of permanent electrical equipment and systems. Dealt with daily problems of construction activities on site. Analyzed and prepared variation orders for electrical works. Issued field orders as required for minor works resolution. Coordinated Electrical construction efforts with contracts for headworks structures, powerhouse civil works, headworks hydraulic steelworks, powerhouse turbines and mechanical equipment, and transmission lines and remote substations. Assumed additional responsibilities of resident civil engineer for last 8 months after departure of resident civil engineer, preparing civil field orders as needed for construction, preparing necessary civil designs, and handling unit price pay statement unit approvals

Line Relaying Upgrade, Wenatchee Substation
Chelan County PUD
Prepared design drawings for upgrade of line relaying for two 115 kV transmission lines from electro/mechanical type to digital relays with fiber optic interface for telecommunications. One of the two lines is a three terminal line. Schemes revised and updated to agree with master scheme later devised for the PUD McKenzie Switchyard.

McKenzie Switchyard, Line Relaying conversion to rack mounting
Chelan County PUD
MWH design previously prepared and approved was requested to be revised to utilize rack mounted equipment to facilitate a revised plan for field installation. Worked side by side with PUD wiremen to develop revised design. Design for all rack mounts was standardized to utilize a standard set of I/O so that digital relay programming could also be standardized. Engineering for the first line was completed within one week. New drawings issued for entire substation within 6 weeks. No delays were added to scheduled outages. Information from the design revision was fed back into ongoing designs for other line relaying packages to make all use a similar formatted design and standardization of I/O from the relays.

Kali Gandaki Project, Electrical Works
Nepal Electricity Authority
Scope of contract work was supply of powerhouse and other site required electrical equipment including 1) 132 kV gas insulated substation (Hyundai), 132/13.8 kV main transformers (Koncar), 13.8 kV generator to transformer bus (Indian), hydro generators (Toshiba), excitation (Alstom), 400 volt switchboards and motor control centers (Siemens-India), station computer system (Alstom), communications equipment (Alstom), station dc system (French), and an 11 kV power line from powerhouse to headworks. I handled final technical negotiations leading to award of Contract for electrical works. Performed submittal review for electrical works equipment, including vendor approvals, equipment approvals, equipment arrangement and incorporation into powerhouse design, control diagram approvals, lighting, cabling, raceways, and wiring and connection diagram approvals. Supervised seconded staff from client for electrical works. Major variations to the contract work included: 1) change from power line carrier to fiber optic based communications via OPGW, 2) non-metallic (teflon coated) thrust bearing shoes for the generators, 3) changing on-site

communications to be via fiber optics. Significant accomplishments included: 1) site stacked stators controlled to +/- 3% of air gap. Assumed responsibilities of resident civil engineer for last 8 months after departure of resident civil engineer, preparing field orders as needed for construction, preparing necessary civil designs, and handling unit price pay statement unit approvals. Participated in mechanical and electrical commissioning activities.

Illinois Creek Gold Mine
USMX
Served as electrical field engineer at the Illinois Creek Gold mine, enabling fast track construction to proceed. Assisted client out of trouble issues backlog. Ordered materials as required for continuing the work. Troubleshot design problems with gold elution process equipment and made systems functional. Worked with and simplified the process control and provided cad documentation of the same. Provided load calculations for total site diesel generation. Provided professional engineer sealed drawings to meet state law for electrical work.

115 kV Line Replacement
City of Seward, Alaska
Construction Manager for replacement of 115kV powerline on the same corridor. Inspected foundation preparation, wood pole line materials erection, helicopter setting of transmission poles, stringing and sagging of conductors, and coordination of switching for clearances for client. Assisted client at end of project in defense of a large claim by the Contractor against the foundations and anchors.

Diesel Generator Plant
City of Seward, Alaska
During transmission line outages, the City of Seward's diesel generating plant proved to be unstable when two units were paralleled. After researching the problem on the drawings, then searching for deviations from the drawings, located current transformers that were short circuited in a normally inaccessible bus location. Removal of the short circuits, probably left over from shipment to the site 25 years before, allowed the units to be operated in parallel as required.

Macagua II, Generator Erection
EDELCA
Review of Macagua Unit 8 erection revealed that the erection tolerances were not met. Further research showed that comments to design submittals on the erection manuals were neither responded to nor action taken by the contractor to remedy the situation. The summation of the erection tolerances for the parts exceeded the tolerance of the final product. The tolerance issue was remedied for future units, and unit 8 was studied further and determined that the tolerance excedance was on a very small area, and therefore of little impact to the generators. Working language was Spanish.

Macagua II, Construction Drawings
EDELCA
Worked with local engineers and sub-consultants to produce construction drawings that incorporated design data from suppliers, purchased materials, and engineering data from the National Electrical Code to produce functional installation drawings based on the latest available information. Various drawing sets were produced during my tenure. All drawings were in Spanish language, and Spanish was the working language of the offices.

Caruachi, Main Equipment Contract
EDELCA
Reviewed and approved generator design submittals. All drawings were dual language, Spanish and English. Consolidated comments from local engineers and included on returned documents. Working office language was Spanish.

115 kV Static VAR Systems
Alaska Energy Authority
Construction Manager and Client's Commissioning Engineer for two static VAR systems (70 MVAR and 30 MVAR). Managed site for approximately one year. Troubleshot problems encountered during construction and commissioning and obtained necessary solutions to allow for a smooth transition to operation.

RESUME

JØRN LANDVA, M.Sc.A., P.Eng.
Manager - Geotechnical

FUGRO GEOSURVEYS INC.

Last Update: September 2010

EDUCATION

M.Sc.A. (Géotechnique) École Polytechnique, Université de Montréal	1986
B.Sc.E. (Civil) University of New Brunswick, Fredericton, NB	1982

SAFETY TRAINING

	Expiry
Marine Basic First Aid, incl. CPR (meets STCW 1995 regulations) St. John Ambulance	2013
H_2S Alive ENFORM, Calgary Training Centre, Clagary, AB	2011
Basic Survival Training, incl. DONUT Familiarization and Skyscape (incl. Helicopter Underwater Egress Training, DONUT Familiarization and Skyscape) Survival Systems Training Limited, Dartmouth, NS	2011
HUEBA (Helicopter Underwater Egress Breathing Appartus) training Survival Systems Training Limited, Dartmouth, NS	2013
CAPP Offshore Medical Fitness Certificate	2011
Marine Emergency Duties (MED-A1) Survival Systems Limited, Dartmouth, NS (1998)	No expiry
WHMIS	
Training courses for JOHSC/Safety Rep;Hazard Assessments & Workplace Inspections; Due Diligence & the OHS Act	No expiry

EXPERIENCE

Jørn Landva joined Fugro in July 2000 as Manager of the Geotechnical Group. Jørn is a professional engineer with twenty-two years experience on offshore engineering projects, twelve of which were with the Marine Geotechnical Division of Jacques Whitford. Jørn has taken part as field engineer, project engineer, party chief, and project manager for marine geotechnical investigations for offshore developments off Nova Scotia and Newfoundland, and regularly provides assistance to other offices of the Fugro Group in Europe and North America.

The following is a sample of Jørn's work experience:

Offshore Engineering and Reporting

- Pokak 2010 Field Data Collection Program, Beaufort Sea (BP): Project Manager
- Ajurak 2009 Field Data Collection Program, Beaufort Sea (Imperial Oil): Project Manager
- West Chirag Field, 2008 Platform Site Investigation, Caspian Sea (BP): Party Chief
- Aubrey, Gyda, and Yme Beta Fields, 2007 Site Investigations, North Sea (Talisman Energy): Party Chief
- Gulf of Suez, Egypt, Exploration Well Sites, 2007 Jack-Up Rig Moves (Egyptian Drilling Co. and Transocean/Devon): Party Chief
- Ettrick Field Development, North Sea, 2006 Site Investigation (Nexen Energy): Party Chief
- West Bonne Bay Exploration Well Site, 2006 Jack-Up Rig Move (Norsk Hydro and Husky Energy): Project Manager and Party Chief
- White Rose Development and Lewis Hill Exploration Sites, 2005 Site Investigation (Husky Energy): Project Manager and Party Chief
- Hebron Development, 2005 Detailed Site Investigation (Chevron Canada Resources): Project Manager and Party Chief
- White Rose Development, 2003 and 2007 Dredging Programs (Husky Energy): Client Representative
- Sable Offshore Energy Project, Tier 2 South Venture, Thebaud Compression, and Glenelg Development, 2002 Site Investigation (ExxonMobil Canada): Project Manager and Party Chief
- Deep Panuke Development Platforms, 2002 Site Investigation (EnCana): Project Manager and Party Chief
- Marquis Exploration, 2002 Site Investigation (Canadian Superior Energy Inc): Project Manager
- Deep Panuke – Country Harbour Pipeline Survey 2001 (PanCanadian Energy): Project Manager (Geotechnical) and Party Chief
- White Rose Development, 2001 Site Investigation (Husky Energy): Project Manager and Party Chief
- Hebron Development, 2001 Site Investigation (Chevron Canada Resources): Project Manager and Party Chief
- Sable Offshore Energy Project, Tier 2 Alma Development, 2001 Site Investigation (SOEI): Project Manager
- Sable Bank Exploration Sites 2001 Site Investigation (PanCanadian Energy): Project Manager
- Sable Offshore Energy Project Site Investigation 1997 (SOEI): Party Chief and Project Engineer
- Hibernia GBS Site Investigations (Mobil 1988 and HMDC 1991 and 1992): Project Engineer
- Cohasset/Panuke Development Site Investigation, 1990 (LASMO): Project Engineer

  Jack-Up Rig Foundation Investigations (PanCanadian Petroleum):
  -Cohasset/Panuke Development, Grand Pre Field 1998: Project Engineer
  -Deep Panuke Development (3 sites) 2000: Project Manager

Desk Studies

- Hibernia South Glory Hole Design Study 2009 (HMDC)
- Pipeline Route Study 2007 (Husky Energy)
- White Rose Development, 2004 Pile Installation Analyses (Husky Energy)

- Hebron Development 2001 (Chevron Canada Resources)
- South Venture Pipeline Installation 2003 (Technip): Sediment Transport
- Cohasset/Panuke Development Scour Protection Study: Project Engineer
- Pile Drivability Studies: Project Engineer

Laboratory Studies

- Triaxial Testing Programs in Support of Offshore Site Investigations (Hibernia Field, Sable Offshore Field, Cohasset/Panuke Development): Project Supervisor
- Consolidation Tests, Sable Island Deep Borehole Samples: Project Manager

PROFESSIONAL ASSOCIATIONS

- Association of Professional Engineers of Nova Scotia
- Professional Engineers and Geoscientists of Newfoundland and Labrador
- Association of Professional Engineers, Geologists, and Geoscientists of Alberta
- Canadian Geotechnical Society and Engineering Institute of Canada
- International Society for Soil Mechanics and Foundation Engineering
- Member, Foundations Working Group, Canadian Advisory Committee to ISO Technical Committee 67 SC7

Energy Cable Consultants, Inc.

EXPERIENCE SUMMARY OF Dr. W. GRAHAM LAWSON

B.Sc., Ph.D., C.Eng., Fellow I.E.T., Sen. Mem. I.E.E.E.

Energy Cables Consulting Engineer with:

- **20 Years RD&E Experience in the Energy Cable Industry**

Plus:

- **15 Years International Experience as a Consulting Engineer in the Field of Underground and Submarine Cables**

Date: January, 2012

KEY QUALIFICATIONS:

Dr. Lawson's career in Research, Development and Engineering (RD&E) with Pirelli (now Prysmian) involved extended periods in Italy, Brazil, U.K. and in North America where he held the position of Vice President RD&E. In 1992 he joined Power Technologies, Inc. (now Siemens PTI, Inc.) of Schenectady, New York as Manager of the Underground/Submarine Cables Group. In 1997 he founded Energy Cable Consultants, Inc. a small business corporation registered in New York State. Since 1992 Dr. Lawson has provided consulting services in the field of underground and submarine cables to a worldwide client base. Among his most recent U.S. activities Dr. Lawson has provided consulting services for the Neptune^{RTS} Project, the 500 kVDC, 660 MW submarine cable link between New Jersey and Long Island, NY and the 3-core 138 kV, 300 MVA Connecticut to Long Island submarine cable link which replaced the 1969 SCFF submarine cable circuits.

EDUCATION:

Dr. Lawson graduated with a B.Sc. (Hons. Physics) from Edinburgh University and a Ph.D. (Electrical Engineering) from the University of Southampton ,(UK).

EXPERIENCE RECORD:

Since founding Energy Cable Consultants, Inc. Dr. Lawson has provided consulting services for the following clients:

ABB High Voltage Cables AB - Karlskrona, Sweden.
Advanced Power Solutions, Sdn. Bhd. Shah Alam, Selangor, Malaysia.
Atlantic Energy Partners LLC, Pittsfield, Maine, United States
Baltimore Gas & Electric Company - Baltimore Maryland.
Black & Veatch Corporation, Overland Park, KS.
Consolidated Edison Company of New York - New York City NY.
Electric Power Research Institute (EPRI) - Palo Alto CA.
Energy Initiatives Group, LLC, Sutton, MA.
Fichtner Consulting Engineers International - Stuttgart, Germany.
Harza Engineering Co., Bellevue, WA.
Lahmayer International, Bad Videl (Frankfurt), Germany.
Nexant, Inc., Second Street, San Francisco CA 94105.
Northern Ireland Electricity plc - Belfast, Northern Ireland.
Northeastern Utilities Service Company (NUSCO), Berlin, CT.
Siemens-PTI, Schenectady, NY.
Southern California Edison - Oakland CA.
Stantec Consulting Ltd. 10160-112 St. Edmonton AB T5K 2L6
Tasmania Hydro, Australia.
Teshmont Consultants LP, Winnipeg, Manitoba R3T 0P4.
Underground Systems, Inc. USA.
Vector Electricity, Newmarket, Auckland, New Zealand.

Brief details of Dr. Lawson's more recent submarine and underground cable consulting activities are summarized in the following Sections A and B, respectively:

A: SUBMARINE CABLE ACTIVITIES

- **San Francisco Bay Project (2011):** is currently working with Black & Veatch on planning of a short 230 kV, 400 MVA submarine cable link between PG&E's Potrero and Embarcadero Substations. Dr. Lawson has carried has prepared (at the time of writing) a draft Design Report and provisional Technical Specifications for the Project.

- **PREPA- VIWAPA Project (2010 – 2011):** Dr. Lawson is currently working with Siemens PTI on the Feasibility of Interconnecting the Caribbean Islands of Puerto Rico and the USVI / BVI by means of HVDC Light/Plus and HVAC submarine power cable types.

- **NORGER Project (2009 – 2011):** Dr. Lawson worked as a Subcontractor to Fichtner (Stuttgart) on this ± 500 kVDC, 1400 MW Interconnection between Norway and Germany, a distance of ~ 600 km, which is due to be commissioned in 2014. Consulting activities included HVDC submarine cable technology review, selection of cable type, detailed cable design and budgetary pricing, and review of marine survey data.

- **SEATRAC Project (2009-2010):** Dr. Lawson carried out studies and prepared budgetary costs and technical specifications for the supply and installation of a 500 kVdc, 1600 MW submarine cable link between East and West Malaysia, a distance on 670 km across the South China Sea (the new Bakun project now called SEATRAC). The submarine cable component of the project will cost on the region of EURO 2 billion (2.8 billion USD). The lead consultant for the Project is Fichtner (Stuttgart, Germany). The Project is currently on-hold.

- **CRESS Project - Caribbean Regional Energy Strategy Study (2009- 2010):** Dr. Lawson worked as a subcontractor to Nexant of San Francisco in this World Bank financed study, being responsible for furnishing advice on submarine transmission cable technologies and assessing viable interconnections among the islands to minimize generation and transmission investments to meet future power demand.

- **San Francisco Bay Submarine Cable Feasibility Study (2009):** Dr. Lawson worked as a subcontractor to Power Delivery Consultants, Inc. and was responsible for developing technically feasible and economic HVAC and HVDC submarine cable designs for the proposed 400 MW submarine power cable link between Newark Substation at the southern end of San Francisco Bay and San Francisco City at the northern end, a distance of some 30 miles (50 km). The lead consultant was MHW (San Francisco) and the client was San Francisco Public Utilities Commission.

- **British Columbia / California Renewable Power Transmission Study (2007):** Dr. Lawson was retained by EIG, LLC to participate as the submarine cable expert in a feasibility study concerned with all aspects of a proposed HVDC submarine cable interconnection between British Columbia (Canada) and Northern California (USA).

- **West Bay Project: Doha Qatar (2007- 2009):** Dr. Lawson worked with Lahmeyer International (Frankfurt, Germany) on KahraMaa's 220 kV, 1030 MW XLPE submarine

cable connection across the West Bay, Doha. Consulting services include provisional assessment of the cable route, provisional cable design, power transmission capacity, developing budgetary costs and the preparation of Technical Specifications and Bid Evaluation.

- **Bakun HVDC Project: (2007).** Dr. Lawson teamed with Advanced Power Solutions and Syme Darby on the proposed 700 km long 500 kVdc, 1000 MW submarine cable interconnection across the South China Sea between East and West Malaysia. Consulting services included technical and commercial evaluation of Submarine Cable Options.

- **The Neptune Project (2003-2007):** Dr. Lawson provided consulting services to the Neptune Team/Energy Initiatives Group for the 500 kVDC, 660 MW Neptune RTS™ HVDC submarine cable link between New Jersey and Long Island, New York. Involvement in design studies on HVdc and HVac cables and witnessing of Type Test in 2005 and Factory Acceptance Testing of the HVDC MI and MVDC-XLPE submarine and underground cables, and 345 kVAC and 230 kVAC XLPE insulated underground cables.

- **Long Island Cable Replacement Project (2003-2007):** Assistance to Northeast Utilities with provisional design studies, preparation of Technical Specifications and review of the Tenders received by NUSCO/LIPA for the supply and installation of a double circuit 138 kV, 300 MVA 3-core XLPE submarine cable link between Connecticut and Long Island, USA. Work also included the witnessing of Factory Acceptance Tests in Nexans submarine cable plant in Norway.

- **Java-Sumatra Interconnection Project (2005-2006):** Dr. Lawson performed a pre-feasibility study at the request of Black & Veatch, which concerned the proposed 2,000 MW submarine-cable interconnection between Sumatra and Java. The interconnection will form part of an approximately 500 km long transmission line which will bring electrical power from a large scale thermal power plant to be constructed near to the Sumatran coal mine region to the 500 kVAC grid in Java. The pre-feasibility study involved the development of optimum HVdc submarine cable designs and the preparation of budgetary costs.

B: UNDERGROUND CABLE ACTIVITIES

- **500 kV 600 MW HVDC Land Cable Interconnection: (2003)** Dr. Lawson carried out a feasibility study for a 60 km long Interconnection between Switzerland and Italy making use of a disused oil pipeline and existing tunnels in the Alps as a way leave. The Interconnection was never implemented due to permitting difficulties.

- **The Auckland Blackout: (1998)** Dr. Lawson was one of the cable experts selected by Mercury Energy Ltd. (now Vector Ltd.) to carry out investigations into the multiple failures of their 110 kV underground cable feeders which led to the 3 week blackout of Auckland's Central Business District in March 1998. Dr. Lawson worked as Power Technologies Inc. Associate in collaboration with the local consulting firm Worley International Ltd. of Auckland.

- **230 kV 1200 MVA XLPE Cable Project in Bangkok, Thailand**: A feasibility study was carried out on behalf of the Metropolitan Electricity Authority of Bangkok, Thailand. The study concerned the technical feasibility as well as the costs involved and the timeframe for implementation of a 230 kV, 1200 MVA link between two substations. The preferred solution was a deep cable tunnel installation with forced air cooling. Cable ratings studies were performed and cooling air velocity and fan power requirements were determined.

- **Pacific Gas & Electric, San Francisco, CA. 115 kV, 30 MVA XLPE Cable (2000):** Harza Engineering Co. prepared a conceptual study for PG&E involving two 115 kV, 30 MVA XLPE underground cable circuits between the Flynn and Pier Substations in San Francisco. These two circuits were to run parallel to a 12 kV distribution cable 6 x 3 horizontal duct bank for a distance of approximately 8,000 feet along 3rd Street, San Francisco. Harza carried out the sub-station work and retained Dr. Lawson as their power transmission cable expert. The Project Workscope was as follows:

  - Ampacity evaluation for the 12 kV cable duct bank installation- 18, 3/c cables in a 6 x 3 horizontal duct bank.
  - Development of a suitable 115 kV XLPE cable design based on AEIC CS7 - 93 Specifications.
  - Recommendations concerning suitable pulling lengths and splicing manhole dimensions for a 2 x 3 vertical duct bank installation.
  - Development of budgetary price for the supply of 48,000 ft. of the selected 115 kV XLPE cable size together with the required numbers of pre-molded splices and outdoor terminations.

- **Ceylon Electricity Board, Colombo, Sri Lanka 132 kV, 250 MVA XLPE Cable (2001):** Fichtner Consultants International carried out a design study for the Greater Colombo Grid Substation Project. This Project involved the system design of 30 circuit km of 132 kV, 250 MVA XLPE underground cable to loop in three new 33kV / 132kV substations to the existing grid. This part of the study was subcontracted to Dr. Lawson. The work involved Route Selection, System Design, Steady State and Emergency Load Carrying Capability, Magnetic Field Calculations, Development of Budgetary Costs and Project Scheduling.

- **Northeast Utilities, Berlin, CT. Bethel-Norwalk and Middletown-Norwalk 345 kV Projects (2002, 2005-2006).** Dr. Lawson provided consulting services to Northeast Utilities during the planning stages of these two projects. Among the activities carried out are the following:
  - Advice on the underground cable alternative solutions for a 345 kV, 70 mile long transmission line. Prequalification of potential vendors. Development of a Qualification Test Specification. (2002).
  - Bethel-Norwalk Project. This 21 mile long 345 kV, 600 MW double-circuit transmission line included 9.7 miles of HPFF cable plus 2.1 miles of XLPE cable – the longest and first installation of 345 kV XLPE cable to be installed in the USA with splices. Dr. Lawson participated in the development of Technical Specifications for this Project and in the review of Bidders Proposals. He also wrote a Position Paper on the technology,

testing and world-wide service experience of XLPE cables at 345 kV and above. (2005). Project completed 2006.

- Middletown – Norwalk Project. This 69 mile long double circuit transmission line included 24 miles of 345 kV, 600 MW XLPE cables and required the construction of 116 cable vaults and the installation of 372 splices. Dr. Lawson wrote white papers on various technical issues including, thermo-mechanical effects, thermal transients during emergency operation, and a review of worldwide long-length underground cable projects. He also participated in vendor pre-qualification and in the evaluation of Bidders Technical Proposals. (2006). Project completed 2008.

- **Abu Dhabi 400 kV XLPE Underground Cable Projects (2008).** Dr. Lawson supported Lahmeyer International with the design of a new 400 kV double circuit installation in Abu Dhabi by providing current rating analyses for 400 kV, 2500 mm^2 XLPE underground cables installed in a variety of configurations including direct burial in concrete troughs and deep burial in ducts installed by horizontal directional drilling in both flat and close triangular formations.

- **Hudson Transmission Project 345 kV XLPE Underground Cable Sections (2011).** During October Dr. Lawson visited Prysmian's new vertical continuous vulcanization plant in Abbeville, SC on behalf of Hudson Transmission Partners / Powerbridge, LLC., the developers on this Project. During the visit Dr. Lawson inspected the new line, witnessing cable manufacture in progress and witnessed factor inspection testing of ~ 10,000 ft. of finished cable. Electrical Testing was carried out to IEC 62067 / ICEA S-108-720 and material testing to ICEA S-108-720. This is the first 345 kV XLPE cable to be manufactured in the USA.

LANGUAGES:

	Speaking	Reading	Writing
English	Native	Native	Native
Italian	Good	Excellent	Good
Portuguese	Good	Excellent	Good

REFERENCES

Dipl. Ernst W. Kleine
Dept. Head Power Transmission and Distribution
Lahmeyer International GmbH
Friedberger Strasse 173, 61118 Bad Vilbel
Deutschland / Germany
Phone + 49 171 4486557
Email: Ernst.Kleine@lahmeyer.de
West Bay Submarine Cable Project (refer to CV)

Jay A. Williams, P.E.
Principal Engineer
Power Delivery Consultants, Inc.
28 Lundy Lane – Suite 102
Ballston Lake NY 12019
Phone 518-384-1300
Email: j.williams@pdc-cables.com
San Francisco Bay Submarine Cable Feasibility Study (refer to CV)
Long Island Cable Replacement Project (refer to CV)

Charles E. Wilson, P.E.
Principal
Energy Initiative Group
176 Worcester-Providence Turnpike – Suite 102
Sutton, MA 01590
Phone 508-865-8021
Email: chuckw@eig-llc.com
Neptune HVDC Submarine Cable Project (refer to CV)
British Columbia / California Renewable Power Transmission Study (refer to CV)

Dr. W. GRAHAM LAWSON. SCHEDULE OF COMPENSATION

Schedule of Rates (2012): US$ 1,280/day or US$ 160 / hour as applicable

Rates are applicable for all work performed and time charged, including travel time.

Invoicing:

Invoices will be transmitted at the end of each calendar month with payment due by the end of the following month.

Expenses:

Included in Rates:

- Routine local and US long distance calls.
- Computer, fax and Internet Service Provider (ISP) expenses
- US Mail, first class and below.
- Routine office supplies, routine copying (up to 11” x 17” size).

Billed at Cost plus 5%:

- International calls (voice, data and fax), international network services.
- Overnight delivery and courier services.
- Use of personal automobile (billed at rate per mile determined by IRS).
- Ground travel, rental car, taxi, other public conveyance.
- Travel within the Continental USA - coach class.
- International Air Travel - business class.
- Hotel accommodation and meals.
- Other expenses such as special equipment rental or reference material.
- Document publishing, copies of drawings/documents greater than 11” x 17” size.

Dr. W. Graham Lawson
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Clifton Park NY 12065
Tel/Fax: 1-518-373-8456
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Bevin R. LeDrew, M. Sc.
Partner
Resident of St. John's, NL

EDUCATION

1968 Bachelor of Science (Biology)
Memorial University of Newfoundland

1972 Masters of Science
Memorial University of Newfoundland

WORK EXPERIENCE

2002 – Present **Sikumiut Environmental Management Limited.**
President and Founding Partner

1998 – 2002 **AMEC Earth & Environmental Limited**
Principal
Responsible for management of major contracts, co-ordination of environmental monitoring and impact assessment disciplines.

1996 - 1998 **Environment Health and Safety, Voisey's Bay Nickel Company Limited.**
Manager, Environmental Assessment

1981 – 1996 **LeDrew Environmental Management Limited**
LeDrew, Fudge and Associates Ltd.
Jacques Whitford Environment Ltd.
Owner and manager

1984 - 1985 **Royal Commission on the Ocean Ranger Marine Disaster (on assignment)**
Director of Studies,

1978 – 1981 **Environmental Services, Newfoundland and Labrador Hydro**
Manager

1975 - 1978 **Centre for Cold Ocean Resources Engineering (C-CORE)**
Senior Researcher,

1969 – 1975 **Department of Fisheries and Oceans** Habitat Biologist

SKILLS AND ACCREDITATIONS

Mr. LeDrew. is an aquatic scientist and business leader who has extensive environmental assessment experience throughout Canada and internationally, starting in 1969 as a biologist working with Federal Fisheries in Newfoundland and Labrador, and most recently as the President, Sikumiut Environmental Management Ltd. Mr. LeDrew has been lead in the production of major environmental assessments, including the Lower Churchill Hydroelectric Project and the Voisey's Bay Mine/Mill Project environmental impact assessments. Mr. LeDrew has managed and conducted a variety of studies related to environmental, social and economic issues, including work for industry, Aboriginal organizations DND, D.F.O. and other government agencies, on baseline environmental surveys, monitoring, environmental management, emergency response planning/contingency planning, site closures, socio-economic impacts and public consultation, and economic development. Mr. LeDrew has managed a large number of environmental components for major undertakings, including oil and gas developments, mining, electric power generation and transmission. He has completed environmental assessments ranging in complexity from registrations and screenings, through to panel hearings in compliance with national processes. Some of the major environmental assessments managed include:

- Owner's Team – Marine – Baffinland Iron Mines Ltd. Mary River Project
- EIS Production Team Lead – Vale-Inco NL - Long Harbour Nickel Processing Facility
- Owner's Manager - Voisey's Bay Mine/Mill Project EIS.
- Owner's Manager – Voisey's Bay Smelter/Refinery
- Project Manager, Alaska Gas Producers Pipeline Project Environmental Impact Assessment
- Project Manager - Hibernia Production Operations Environmental Effects Monitoring Program Design and Implementation.
- Project Manager Hibernia Construction EPP
- EIS Manager, Coleson Cove Generating Station Refurbishment
- Project Manager, Long Harbour Phosphorus Plant Decommissioning
- Project Manager, Wabush Mines Fish Habitat Compensation Plan
- Project Manager – Granite Canal Fish Habitat Compensation Plan
- Project Manager - Offshore Labrador Oil Spill Scenario.
- Coordinator- Canadian Electricity Association Submission on the Five-Year Review of the Canadian Environmental Assessment Act.
- Project Manager - St. John's Outer Ring Road Environmental Impact Assessment.
- Project Manager, Lower Churchill Generation and Transmission Projects EIS
- Team Lead and Facilitator, Winter Shipping Studies for Voisey's Bay Mine/Mill
- Writer/Editor Keltic Gas – LNG Terminal Nova Scotia Environmental Impact Statement
- Team Lead and Facilitator, Winter Shipping Studies for Voisey's Bay Mine/Mill
- Research Team Leader - Labrador Sea Ship-In-the-Ice Project.
- Project Manager - Offshore Labrador Oil spill Scenario.
- Project Manager - Prosser's Rock Boat Basin Environmental Impact Assessment.
- Project Manager Long Harbour Phosphorus Plant Decommissioning Environmental Impact Assessment.
- Team Leader - Peru Offshore Oil and Gas Environmental Regulation Review and Development

Managed many marine and aquatic surveys, including

- ADCP Deployment and Recovery, Edward's Cove for the Voisey's Bay Mine and Mill Project
- Lake Melville Oceanography Baseline Survey of estuarine mixing in Goose Bay for the Lower Churchill Project

- Strait of Belle Isle Sediment Plume Modeling Submarine Cable Trenching for the Lower Churchill Project
- Sediment Contaminant Characterization, Long Harbour for the Vale Inco NL Long Harbour Nickel Processing Plant
- Marine Environmental Effects Monitoring Design and Implementation for various projects –
    - Bull Arm Construction Site Hibernia Project
    - Hibernia Offshore Production Site
    - Voisey/s Bay Mine and Mill EEM – marine, aquatic, terrestrial and atmospheric.
    - Edward's Cove Effluent Outfall

Has written over 25 scientific and technical papers, several of which have been published in academic journals, or presented at national conferences.

Selected Projects

Vale NL Long Harbour Nickel Processing Plant Environmental Impact Statement
The coordination of EIS completion was carried out so as to address the EIS Guidelines and develop technically accurate text that complied with accepted effects prediction methodology. A team of technical writers and editors worked under supervision and closely with the Owner to produce an acceptable EIS. The work scope included detailed participation in key technical issues, the greatest of which was the selection process disposal of wastes. Sandy Pond, a nearby natural water body was selected as the preferred option, based on the application of a Multiple Accounts Analysis completed as one ingredient of the overall environmental assessment.

Voisey's Bay Mine/Mill Project Environmental Impact Assessment.
The proposal for a major mining development on the coast of Labrador required an exhaustive environmental impact assessment of all aspects of the project, including the issue of marine transportation, with a focus on the proposal to ship during winter freeze-up period. The required studies included:

- Bathymetric surveys of candidate routes
- Contingency planning for oil spill prevention, including coastal zone mapping
- Marine ecosystem baseline surveys for fish, marine mammals, benthos, oceanography and ice conditions
- Modeling effluent dispersion,for emergency response planning
- Studies to document traditional and current resource use.

Bevin LeDrew was Manager responsible for all the studies conducted to support the EIS, for preparation of the Environmental Impact Statement, and for presentations to the EA Hearing Panel. The project also required the development and maintenance of a large environmental data base. A Geographic Information System was developed using Arc View software. The system was used as the basis for ongoing monitoring and compliance programs.

Hibernia Offshore Production Operations Environmental Effects Monitoring Program Design and Implementation
A condition of approval of the Hibernia Project required the development and implementation of an environmental effects monitoring program. The program was to address potential contaminant sources, and carry out a pattern of sampling to establish whether predicted levels were exceeded. The work required the development of testable hypotheses, identification of targets for sampling, development of a sampling methodology for benthos, sediment and fish, conduct of evaluation tests (metals and hydrocarbons in sediment and fish flesh/organs; bioassay of benthic

infauna, organoleptic testing of fish flesh). The proposed EEM Design was subjected to a public/stakeholder consultation review, and to negotiation with regulators. The contract included completion of the initial offshore sampling program. Bevin LeDrew was project manager.

Oceanography of Goose Bay, Lake Melville.
The physical oceanography of the mouth of the Churchill River was described through a year-long field survey program involving the deployment of arrays of monitoring equipment (surface wind and waves, water column temperature, conductivity, current speed and direction). A circulation model was developed to characterize temporal and spatial limits of estuarine mixing. Predictions were developed to reflect the anticipated changes in volume and pattern of freshwater input as a consequence of the development of the Lower Churchill Hydroelectric Project. The output of the modeling was used as input to the Project EIS.

Baseline Environment Characterization, Marine Shipping for Voisey's Bay Project
The required shipping schedule for the proposed Voisey's Bay Nickel Mine in northern Labrador entails year round transit of landfast ice and the extensive seasonal pack ice along the coast of Labrador, and is required to contend year round with icebergs and severe sea states. The study provided a characterization of atmospheric, sea-state and ice conditions along the route, extracted from available data sources, and inferred from indirect (remote sensing) methods.

Strait of Belle Isle Sediment Dispersion Model
The concept of placing an electric power cable across the Strait of Belle Isle has been a component of various plans to develop the hydroelectric power potential of Labrador, and import the electricity to the Island of Newfoundland. The cable crossing would have to contend with scouring icebergs, and would need to be protected by placing the cable in an excavated trench for at least part of its route. The environmental impact of this concept was examined as part of an extensive environmental assessment process in the late 1970s. B. LeDrew was responsible as project manager for this impact assessment. In addition, a recent examination of the proposed crossing required the development and application of a model to predict the distribution and settlement pattern of fines from the excavation process along the cable route. Agra Earth and Environmental carried out the required modeling work and produced a definition of the zone of influence associated with the trench excavation work.

Long Harbour Phosphorus Plant Decommissioning Environmental Impact Assessment
The Long Harbour plant operated for approximately twenty years before closure, at which time an extensive series of environmental studies were required by government in order to develop an acceptable plan for decommissioning which would provide assurance that contamination would not escape to the marine environment. The required studies included detailed assessment of contaminant presence within and pathways to the marine environment, and a human health and ecological risk assessment of marine contamination.

Voisey's Bay Mine/Mill Project Marine Environmental Effects Monitoring
Responsible for the design and implementation of a marine EEM study program intended to address the potential effects of planned (mill effluent) and unplanned (spill of oil or concentrate) discharges. Surveys under way include contaminant profiles (water, sediment, biota) and natural resource surveys.

Offshore Labrador Oil spill Scenario
The project entailed development of a hypothetical but realistic description of an oil spill resulting from a failure associated with exploratory drilling offshore Labrador. The purpose for developing this scenario was to identify gaps in capability to respond effectively to such an event, and thereby provide guidance with respect to research and development associated with oil spill

countermeasures. The study examined coastal geomorphology, logistics, behavior of oil in ice, pack ice dynamics, risk assessment, containment, recovery and disposal methods. The recommendations contributed to selection of research studies under the Arctic Marine Oil spill Program. Bevin LeDrew was project manager.

Labrador Sea Ship-In-the-Ice Project.
An icebreaker was chartered to conduct a program of research by freezing into the Labrador Pack and drifting south offshore Labrador during a one-month period. The sampling program focused on ice dynamics, ice microstructure, ice detection, remote sensing using imaging radar systems, and near surface wind and weather conditions, as well as sampling of water column and substrate. A team of over scientists and technicians conducted the work program using the vessel and its helicopter as a work station. Bevin LeDrew was research coordinator.

PETER MASON, Ph.D.

QA/QC - HYDRAULIC

KEY QUALIFICATIONS

Technical Director for international dams and hydropower with specific expertise on dams, hydropower, canals and tunnels and associated works from conceptual through to detailed design stages, including integrated Safety, Risk and Value Engineering Opportunity Analyses, also Safety and Due Diligence Inspections and Asset Evaluations. Specific expertise on; applied hydraulics, structural analyses, concrete technology, surface and underground power stations, RCC/Hardfill dams. Named by the USBR as the state-of-the-art author on plunge pool scour downstream of dam spillways and quoted by the ASCE as authoring a "key reference" in the hydraulic design of stilling basins.

Chairman of the Board of Management (BOM) for the US$ 3.3 billion, 969 MW, Neelum Jhelum Hydro Project in Pakistan, also BOM Member for other major hydropower and irrigation developments in Pakistan, including over 350 km of major canals. Chief Civil Engineer on the 75 MW Hydropower works of the Lesotho Highlands Water Project. Project Engineer for the 122 m high Victoria Arch Dam in Sri Lanka. Responsible for feasibility studies, contract documentation and design for major hydraulic works in Asia, Africa and South America, also advice, inspection visits and asset evaluations as a Named Expert in Africa, Asia, Australia and North and South America. Advice to Contractors, Owners, Funding Agencies and Prospective Purchasers with lectures and technology transfer to Client's Engineers. Periods of residence in Africa, South America and the Middle East.

Member of various National and International Committees and of the All-Reservoirs Panel of Engineers under the UK Reservoirs Act. Author of numerous publications on named specialities.

EDUCATION

PhD, Applied Hydraulics - Scour Downstream of Dams, City University, London,
MPhil, Applied Hydraulics - Scour Downstream of Dams, City University, London
BSc, Civil Engineering, Woolwich Polytechnic,

Professional Organizations:

Fellow, Institution of Civil Engineers, 1993 to date, (Member of ICE since 1973),
All Reservoirs Panel Engineer under the UK Reservoirs Act, 1994 to date,
Chairman of British Dam Society, 2009 -2011), (Vice Chairman 2007 – 2009),
Chairman of the joint Inst of Civil Engineers and UK Gov Reservoir Safety Advisory Group, 2007 to date,
Member of ICOLD Committee on Cost Savings at dams, 2006 to 2011and earlier committees since 1993,
Member of ICOLD Committee on Hydraulics for Dams, 2011 to date

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EXPERIENCE RECORD

Fasnakyle Power Station, Scotland

Condition asset inspection and review of the Fasnakyle power station. A review and assessment of remaining economic life in view of structural distress and age and condition of main Units.

Site C, Canada

Specialist advice to BC hydro of Canada on the hydraulic design of a 17,000 m^3/s capacity spillway for the proposed Site C dam on the Peace River.

Dam Safety Panel, Albania

Member of a Dam Safety Panel advising the government body KESH on remedial works to the Komeni dam

MWH

Dam Safety Inspections, Scotland and Wales
Safety Inspections and assessments of 6 major UK hydropower dams in Scotland and Wales under the UK Reservoirs Act

Damlapinar Hydropower Project, Turkey
Project Director for site inspections and review of structural, hydraulic and operational aspects of the project by others, following a major structural collapse on site.

Balmacaan and Coire Glas Pumped Storage Schemes, Scotland
Chairman of the Internal Review and Advisory Panel for feasibility studies into two major (circa 600 MW) pumped storage schemes in Scotland

New Bong Hydropower Project, Pakistan
Chairman of the Board of Management on this 84 MW hydropower development, taking irrigation flows form the existing Mangla dam and routing them through 4 No bulb turbines. The company role is as owner's engineer for design and site monitoring under an EPC design and construction.

Wimbleball dam, UK
Specialist Technical Advisor to the Client for major foundation remediation works to this major buttress dam, to address long-standing foundation seepage concerns.

Training Sessions, Uganda
Delivery of a series of training sessions in Uganda to staff of the Uganda Electricity Generating Company Limited into all aspects of dam design, construction and safety monitoring.

Panama Canal Parallel Locks
Specialist design liaison for the 55m wide by 32m high rolling lock gates and associated equipment for the new Panama Canal Locks, with particular focuses on hydraulics and aspects of seismic loading.

Vez Svoghe Hydropower Projects, Bulgaria
Specialist advice on all aspects of 9 run-of-river, small hydropower plants on the river Iskar, north of Sofia in Bulgaria and at various stages of design and construction. Typical installed capacities are around 3 MW, with heads of approx 10m and gated spillway design discharges up to 800 m^3/s

Climate Change Adaptation for Dams & Hydropower Project
Specialist inputs into two World Bank studies reviewing the possible effects of climate change on the design and operation of dams and hydropower projects

Risk Based Stability Assessments for Loyne Dam, Scotland
Carrying out USBR, event tree type risk assessments for certain stability aspects of the Loyne concrete gravity dam in Scotland as a development from a periodic inspection under the UK Reservoirs Act

Stepped Masonry Spillway Research
Leading a research project for the UK Environment Agency into the design and safe operation of stepped masonry spillways. It involves fluid dynamic testing and recommendations on the design, inspection and maintenance of such chutes

Neelum Jhelum Hydroelectric Project, Pakistan
Chairman of the Board of Management on this 970 MW hydropower development, including 32 km of 9m diameter tunnelling through the Himalayas in Northern Pakistan and a 40m high, gated, concrete gravity diversion dam with movement joint to accommodate a major foundation fault

Kafue Lower Project, Zambia
Technical advisor, dam designer and project layout specialist on the feasibility studies for this 750 MW hydropower development, as part of preparing RFQ and RFP documents for private developer selection. The probable dam will

be a 120m high RCC gravity dam with overflow spillway and downstream plunge pool. Specialist studies also carried out on seismic loading and into the effects of climate change on future project yield.

Ulley Dam, UK
One of two Engineers selected by the Environment Agency to carry out a post incident inspection and report on the failure of the stepped, masonry spillway at Ulley reservoir near Rotherham in the UK

Dasu Dam & Hydroelectic Project, Pakistan
Expert advice on the structural and seismic design, hydraulic structures, overall layout and construction programme aspects for the feasibility stage of the 220m high Dasu RCC dam and 4,500 MW underground power station on the upper reaches of the river Indus in Pakistan.

UK Dam Safety Inspections and Advice - various
Statutory inspections of various dams and reservoirs under the UK Reservoirs Act including hydropower works in Scotland, major dams in the UK Midlands and five major flood storage reservoirs in Leicester and Nottingham. Also various other non-statutory inspection related work and studies.

Al Wehdah Dam, Jordan
Temporary Resident Engineer on the 100m high Al Wehdah, RCC dam on the river Jordan between Jordan and Syria

Nam Theun 1 Hydropower Project, Laos
Peer reviewer and general advisor to the EPC designer on all aspects of a 175m high arch-gravity dam and hydropower project with particular reference to hydraulic and hydraulic-structure design aspects, including re-designing the 33,000 cumec, high-head, gated spillway.

Braamhoek Pumped Storage Scheme, South Africa
Independent estimates carried out for the Client of design inputs needed for the detailed design & construction phase of the 1,000 MW Braamhoek Pumped Storage Project in South Africa.

Lurio River Hydropower Project, Mozambique
Project Manager leading design work on feasibility studies into 120 to 200 MW hydropower options on the Lower Lurio river in northern Mozambique. Included conceptual designs for various dams ranging from small concrete diversion weirs to 40m high embankments with separate major spillways.

Wadi Dayqah Dam Project, Oman
Visiting dam expert and advisor for the tender and detailed designs of two dams to form the Wadi Dayqah water supply reservoir. The main dam is a 74m high gravity RCC structure and the secondary dam is a 43m high, central cored, zoned rockfill embankment. Inputs included leading the conceptual re-design of the main RCC dam and in particular re-designing the 18,000 cumec spillway works to improve reliability and reduce costs.

Kakariki RCC/Hardfill Dam, New Zealand
Undertook site visits and feasibility designs for alternative Kakariki RCC/Hardfill dams in New Zealand in an area of very high seismicity. This included producing structural analyses, overall layouts and construction sequencing for a range of alternative dams up to 50m high

Bujagali Hydroelectric Project, Uganda
Leading an assessment, for a private developer, of all aspects of the proposed Bujagali Project in Uganda.

Longtan Hydroelectric Project, China
Member of an international advisory and inspection team to the Client during the construction phase of the Longtan Hydro Project in China. This includes the highest roller compacted concrete (RCC) dam in the world, at 216.5 m and the largest hydro-electric underground cavern in the world, housing 9 machines with a total installed capacity of 6,300 MW.

Ghazi Barotha Hydroelectric Scheme, Pakistan
Board of Management member for the design and construction supervision of the $2.2 billion Ghazi Barotha hydropower scheme in Pakistan. The scheme includes a 3 km long gated barrage across the River Indus with a design capacity of 18,700 m3/sec and a 1,450 MW hydroelectric power station. The power canal is a particular feature. At 52 km long by 100 m wide, with a capacity of 1600 m3/s, it is one of the world's largest

Project Aqua, New Zealand
Value Engineering Manager for the feasibility study of a 540 MW hydropower project in New Zealand. The Project comprised 62 km of canal, a design flow of 340 m3/s and 6 power stations with installed capacities of 90 MW each. The works were designed for a design-and-construct "Alliance" basis, to a target price. Value Engineering and associated risk and opportunity evaluations were a key mechanism for achieving this safely.

Basha Diamer Dam & Hydropower Project, Pakistan
Expert hydropower advisor and board of management member on feasibility studies in Pakistan. This included review of 285m high rollcrete and concrete faced rockfill dams and layouts for underground hydropower caverns and associated works for an installed capacity of 4,300MW

Mangla Dam Raising, Pakistan
Expert hydropower advisor and board of management member on feasibility studies, detailed design and tender documentation stages for the raising of Mangla dam in Pakistan. This involves raising the existing 139m high earth embankment by 6.7m and all the associated intake and gated spillway works. The associated power station capacity will increase from 1,000 to 1,400MW

Kariba North Bank Power Station, Zambia
Detailed inspection in 2002 and analysis of the concrete foundations to the machines at Kariba North Bank Station, on behalf of KNBC. This was to clarify possible AAR induced present and future movements of the machine foundations in order to identify any associated refurbishment issues.

Swabi Scarp and Pehur Irrigation Schemes, Pakistan
Board of Management member for the construction supervision phases of the Swabi Scarp and Pehur Irrigation Projects in Pakistan. Together these feature over 300 km of main canal and siphons, 14 km of tunnel and all the secondary canals, control structures and drainage associated with approx. 115,000 ha of irrigated land. Much of the work involved upgrading and rehabilitation, but with a large portion of new tunnels and main canals.)

Cameroon Hydropower Asset Valuation, Cameroon
Team Leader. Pre-acquisition asset evaluation and audit of the 720 MW Cameroon Hydropower System on behalf of a prospective purchaser. Inspections, audits and liability assessments of 6 major dams and 3 hydropower complexes were carried out in country involving visits to all sites. Subsequent phases included preparing a strategic overview of future hydropower development in the country, advice on water resources and on insurance for the schemes. Subsequent phases also included the feasibility design and costing of a number of new hydropower schemes up to 200 MW and the refurbishment of existing small schemes from 0.35 to 2.54 MW. Advice was given on a separate visit on the future operation and maintenance requirements at a major hydropower station and large gated spillway, both affected by alkali aggregate reaction in the concrete

Can-Asujan Dam, Philippines
Preparation of feasibility designs and costs for a 40m high Rollcrete/Hardfill irrigation dam in the Philippines, with all work being carried out in the Clients offices in country. Subsequent advisory role during the detailed design and construction phase.

MASOUD MOHAJERI, Ph.D., P.Eng.

GEOTECHNICAL ENGINEER

KEY QUALIFICATIONS

Masoud Mohajeri is a geotechnical engineer with 20 years of experience in research and engineering projects. His experience includes geotechnical investigation, site characterization, soil sampling, laboratory testing, shake table and centrifuge testing, slope stability analysis, seepage analysis, site specific ground response analysis, liquefaction potential assessment and deformation analysis, geotechnical design of embankment dams, design of mechanically stabilized earth walls, temporary shoring design, foundation design, geotechnical risk assessment and preparation of geotechnical design specifications and baseline reports. Mr. Mohajeri's project management experience covers scope, schedule, cost, quality, communications, human resources, procurement, risk and integration management.

EDUCATION

Ph.D. Geotechnical Engineering (Civil), University of Tokyo, Japan
M.A.Sc. Geotechnical Engineering (Civil), Tehran University, Iran

Licenses and Professional Memberships
Professional Engineer – APEGBC

RELEVANT EXPERIENCE RECORD

John Hart Redevelopment Project
BC Hydro
Geotechnical engineer and workpackage manager leading conceptual and preliminary design studies for a replacement 138 MW hydroelectric powerhouse and water conveyance conduit(s). Responsibilities included planning and supervising several field and laboratory investigation programs, site characterization and preparation of investigation reports, slope stability analysis, liquefaction assessment and comparison of soil improvement techniques. Also supervised consultants to develop temporary excavation and groundwater control design, carry out geotechnical field mapping, prepare a tunnel feasibility design, prepare a performance base geotechnical specification for a tunnel and powerhouse, prepare geotechnical risk assessment matrix for preparation of a geotechnical baseline report, prepare a hydrogeological model and organize advisory board meeting. Responsibilities also included contract management, and attending meetings and workshops.

John Hart Seismic Upgrade Project
BC Hydro
Geotechnical engineer and workpackage manager leading a field and laboratory investigation program to explore foundation conditions to assess feasibility of a new proposed dam. Responsibilities included planning and supervising field and laboratory investigation program, site characterization and preparation of investigation report.

Ruskin Intake Seismic Upgrade Project
BC Hydro
Geotechnical engineer involved in planning a field and laboratory investigation program for seismic upgrade of an existing intake structure.

White River Hydro Project
Regional Power
Geotechnical engineer involved in preliminary and detail design of two new 20 m high embankment dams. Responsibilities include foundation and embankment dam design (including impervious core, filter, rockfill and riprap,) borrow material field and laboratory investigations to locate suitable construction material, preparation of design specifications, slope stability analysis, seepage analysis and preparation of design drawings.

Karun Watershed Project
Ministry of Energy, Iran
Geotechnical project engineer for site reconnaissance and conceptual design of five 153 to 180 m high earth and rockfill dams. Responsibilities included site selection, geotechnical studies on foundation conditions and availability of construction material, conceptual design and comparison of various embankment dam options, preparation of reports and design drawings. Preferred options are currently under construction or in operation.

Dez Watershed Project
Ministry of Energy, Iran
Geotechnical project engineer for site reconnaissance and conceptual design of four 165 to 180 m high earth and rockfill dams. Responsibilities included site selection, geotechnical studies on foundation conditions and availability of construction material, conceptual design and comparison of various embankment dam options, preparation of reports and design drawings. Preferred options are currently under construction or in operation.

Karkheh Hydroelectric Project
Ministry of Energy, Iran
Geotechnical project engineer involved in detail design of a 127 m high earthfill dam, a 78 m deep cut-off wall and a 400 MW underground powerhouse. Responsibilities included seepage and dynamic analysis of the dam and foundation, design of spillway foundation drainage system and design of groundwater control options for the underground powerhouse excavation. The dam is currently in operation.

Taham Hydroelectric Project
Zanjan Water Authority, Iran
Geotechnical project engineer involved in preliminary and detail design of a 124 m high earthfill dam. Responsibilities included slope stability analysis, seepage analysis, seismic deformation assessment of the dam body and foundation using FEM software, borrow material field and laboratory investigation and filter and riprap design. The dam is currently in operation.

Agchai Hydroelectric Project
West Azerbaijan Water Authority, Iran
Geotechnical project engineer and project manager involved in the preliminary and detail design of a 108 m high earthfill. Responsibilities included field and laboratory investigations on foundation and borrow material, liquefaction assessment of the foundation material, design of the dam body including filter and riprap. The dam is currently under construction.

Ramin Hydro Project
Zanjan Water Authority, Iran
Geotechnical project engineer for feasibility studies of a 46 m high earthfill dam. Responsibilities included borrow material field and laboratory investigation to explore suitable material to be used as impervious core and riprap. The studies suggested that a Roller Compacted Concrete dam is a preferred option.

Tabarak Abad Hydro Project
Korasan Water Authority, Iran
Geotechnical project engineer involved in preliminary and detail design of a 74 m high rockfill dam. Responsibilities included slope stability analysis, seepage analysis, seismic deformation assessment of the dam body using FEM software, borrow material field and laboratory investigation and filter and riprap design. The dam is currently in operation.

Ilam Hydro Project
Garb Water Authority, Iran
Geotechnical project engineer involved in preliminary and detail design of a 65 m high rockfill dam. Responsibilities included slope stability analysis, seepage analysis, seismic deformation assessment of the dam body using FEM software, borrow material field and laboratory investigation and filter and riprap design. The dam is currently in operation.

DON MONTGOMERY, P.E

CONSTRUCTION / COST SCHEDULE
PRINCIPAL ESTIMATOR

KEY QUALIFICATIONS

Mr. Montgomery has over 37 years experience in the civil, heavy/highway water/wastewater, and environmental remediation industries. Responsibilities have included program management, operations management, management of estimating, project management, and project cost control for both government and private entities. Over this period he has gained experience in concrete structures, hydroelectric facilities, petrochemical and oil field facilities, underground utilities, major earthwork, material handling, shoring systems, marine construction, environmental remediation including in-situ and ex-situ treatment, and highway construction.

EDUCATION

B.S., Civil Engineering/Construction Management, Oregon State University, Corvallis

EXPERIENCE RECORD

Senior Estimator / Senior Technical Advisor
BC Hydro
Assisted BC Hydro Estimating Group and BC Hydro Management in reviewing and updating Estimating Practice Documentation, Project Controls Practice, Construction Management Practice and the Supply Chain Practice. Supported Project Management and BC Hydro's Estimating Group for the Ruskin Dam Upgrade Project ($700 million), The John Hart Upgrade Project ($1 billion), the Upper Columbia Projects and the Site C Dam Project ($5 to $7 billion).

Senior Estimator and Project Controls Lead
British Petroleum (BP)
Anchorage Alaska
Responsible for the preparation of conceptual estimates and program schedules for Automation and Fire and Gas projects planned required for continued Prudhoe Bay field operations. Working with ConocoPhillips, he was responsible for preparing project estimates for planned 2009 and 2010 pipeline renewal projects. This culminated in the development of a predictive pipeline renewal model to estimate the construction costs of various options to be used during Alternative Analysis stage of project development. Division responsibilities included the setup and operation of a projects control group for monitoring project costs and schedules and the preparation of conceptual estimates.

IDIQ for Watershed and Ecosystem Planning Studies for Civil Works
USACE Sacramento District
Provided cost estimating services and assisted in Value Engineering Studies providing planning, engineering, reporting, cost estimating and scheduling support for Folsom Dam Modifications and Raise project. The mission was to assist USACE by evaluating alternatives to enhance flood protection and reduce hydrologic and seismic risks, including a concrete dam and earthen embankment dam/dike raises, modifications to existing dam gates and outlets, and addition of a new auxiliary spillway. Evaluated engineering feasibility and constructability, developed cost estimates, and assisted USACE and Reclamation to develop the Project Alternatives Solution Study II (PASS II) report.

Shell Oil Petrochemical Facility, Wastewater Treatment Plant, Dan Shui China.
As Area Construction Manager, responsible for completion and final inspection of the wastewater treatment portion of this petrochemical facility project. Components included Clarifiers, Dissolved Air Floatation (DAF) units, Aeration Basins, Sand Filters, Neutralization Basins and sludge handling.

Construction Manager
North East Water Purification System, Houston Texas
As Construction Manager for this project during transition from Design to Construction, Mr. Montgomery supervised the preparation of a detailed estimate of each component of the purification system. This effort led to modifying components to provide a more cost effective, constructable and operable system. He also directed the procurement effort for the project for over 30 subcontractor or vendor packages.

Water Reclamation Facility Expansion
Collier County South County
Claims Analyst for this project during final contract negotiations due to the large number of design changes 90% design (Bidding Stage) and the issued for construction design. These changes required a detailed estimate of the changes and negotiations with both the selected subcontractors and the client. These negotiations were concluded allowing work to proceed without affecting the overall project schedule.

Fish Protection and Enhancement Projects, Pacific Northwest
Bonneville Power Administration (BPA)
Supervised the design, procurement and construction of various fish protection and habitat enhancement projects funded by BPA throughout the Pacific Northwest. These projects include fish hatcheries, irrigation intake protection and streambed rehabilitation and enhancements.

Waste Vitrification Project ($57 Billion)
DOE Hanford
Provided constructability reviews, construction planning, and preparation of procurement packages for this nuclear waste to glass project. Construction Engineer assisting in the preparation of the Environmental Impact Statement for this Hanford Vitrification project.

Avila Beach Cleanup Project
Chevron
Prepared the estimate and budget for the $60 million Avila Beach Remediation Project. Mr. Montgomery, was assigned various responsibilities during the implementation including Construction Engineer, quality control inspection, constructablity reviews of drawings and specifications, procurement and scheduling. The project involved the excavation and backfill of approximately 500,000 cubic yards of affected soils under the beach town of Avila Beach. This required the design and installation of a tie-back sheetpile shoring system, construction planning and implementation of the excavation and backfill activities, and design and construction of the cities infrastructure removed during excavation. Infrastructure included utilities, streets, lighting and landscaping, a 1,500 lineal foot seawall, and concrete beach structures.

JE Merit
Installation of three groundwater extraction, treatment, and reinjection systems at the Massachusetts Air Nation Guard Station, Cape Cod Massachusetts. These systems valued at over $30 million included 5 – 2,000 gpm water treatment plants, 80,000 lineal feet of pipe and electrical and instrumentation to connect the system to a central monitoring station.

Closure of 7 Landfills at Castle Air Force Base, including the excavation, movement and placement of 200,000 cy of materials.

Laidlaw Environmental/U.S. Pollution Control, Inc.

Program Manager responsible for managing estimators, scheduling and cost engineers, and the proposal preparation group. Interfaced directly with the Vice President of Construction and Senior Vice President on estimates, proposals and project operations. Identified potential markets of growth, and established and implemented plans to enter and succeed in these markets.

Chief Estimator responsible for overseeing and performing cost estimates on all requests for proposals. This included; project conception, determination of approach, equipment and manpower selection, production rates, scheduling and costing. Mr. Montgomery was also responsible for contract negotiations, change order identification and submittal and claims management. Projects successfully estimated, negotiated, and awarded included:
- Army Corps of Engineers, Sacramento Army Depot, oxidation ponds. $13 million project to excavate and treat using soil washing approximately 50,000 cubic yards of metals-contaminated soils
- ARCO, Sand Springs, Oklahoma. $15 million cost plus fee contract for the solidification of acidic sludge, construction of a RCRA landfill, placement of treated sludge into the landfill and capping of the landfill.
- Laskin Poplar Superfund site, Jefferson, Ohio. $8 million firm fixed price contract for excavation, demolition, on-site incineration of PCB and dioxin contaminated materials, and on-site wastewater treatment. Developed estimate and negotiated the final contract award. Following award, coordinated with the Vice President of Construction and
- - Region Operations Manager on operational issues as project conditions warranted.
Compressor stations cleanup, Gas Pipeline Company. Coordinated the estimating, proposal efforts, and project start-up for the annually bid program.
- Kennecott Copper, flue dust removal, Utah. Responsible for estimating, scheduling, and initial project start-up on this firm fixed price contract that involved movement of approximately 160,000 tons of stockpiled flue dust containing lead and arsenic.

Riedel Environmental Services, Inc.
(Major northwest Marine and Heavy Construction contractor and construction material producer and supplier)

Operations Manager, San Francisco California
Directed the activities of multi-disciplinary work forces in the cleanup of toxic and hazardous chemical spills. Responsible for all work activities; health and safety of crewmembers; cost control; scheduling and profitability for the division.

Field Coordinator/Chief Estimator, Portland Oregon
Field Coordinator responsible for supervising and scheduling of Project Mangers at numerous project sites throughout the United States. Included consultation and solving of site specific field situations.

Corporate Estimator responsible for the development of cost estimates and contract negotiations for proposals prepared and submitted by the corporate office, including incineration, groundwater remediation, excavation, and disposal projects ranging from $1 million to $60 million. Estimates required the determination of alternate technologies, health and safety regulatory requirements, proposed equipment, manpower utilization, and proposed subcontractors. Clients include the private sector and the US EPA using firm fixed price, fixed-price/indefinite quantity, and cost-plus-fixed-fee type contracts

Operations Manager, St. Louis, Missouri
Directed the activities of multi-disciplinary work forces in the cleanup of toxic and hazardous chemical spills. Responsible for all work activities; health and safety of crewmembers; cost control; profitability; and scheduling of the divisions projects. Developed site mitigation and safety plans, and determined the necessary level of protective equipment required. Additionally, oversaw the estimating, proposal, and contract negotiation efforts of the operations.

Project/Response Manager responsible for management of the Quail Run Mobile Home Park cleanup, EPA Region VII, St. Louis, Missouri, the first Dioxin Cleanup in Missouri. Responsible for design and selection of excavation techniques to surgical remove and store 8,000 cubic yards of dioxin-contaminated soils from the Quail Run Mobile Home Park. This project also entailed decontamination of 27 mobile homes and three structures. During the course of the project refined cost tracking and invoicing systems used for the EPA

MICHAEL MORGAN, P.E.

HYDRO-MECHANICAL

KEY QUALIFICATIONS

As an experienced gate designer, Mr. Morgan has prepared numerous new gate designs for owners and fabricators as well as rehabilitation projects from the initial feasibility stages, to the detailed design stage and through construction. Mr. Morgan has performed inspections and structural analyses of existing gates to verify their acceptability with present day standards. Work performed typically includes preparation of design reports and design memoranda, structural analysis (including finite element analysis), preparation of conceptual and detailed plans, preparation of specifications, cost estimates and review of manufacture drawings.

Related to gate equipment inspection, Mr. Morgan has visited many project sites and performed condition assessments of existing equipment and shop and field inspections of new equipment. Currently, Mr. Morgan is a member of an ASCE committee preparing guidelines for inspection and evaluation of gates and previously authored three papers related to design of gate equipment.

EDUCATION

BS, Civil Engineering Colorado School of Mines
Finite Element Analysis Certification

Licenses and Professional Memberships
Professional Engineer, 062-049299 , Illinois
U.S. Committee on Large Dams
American Society of Civil Engineers (ASCE)
Consulting Engineers Council of Illinois,

EXPERIENCE RECORD

Radial Gate Inspection and Analyses
Avista, Eugene Water & Electric, Virginia Power, City of Ann Arbor
Performed several inspection and/or structural analyses of existing radial spillway gates at over 10 projects to verify conformance with FERC's requirements regarding trunnion friction as brought about by the failure of the Folson Dam Spillway gate. Analyses ranged from basic hand calculations to 3D finite element analysis. Designed and prepared drawings for gate arm strengthening at Avista's Noxon Dam, Grant County PUD's Wanapum Dam and Lewis County PUD's Cowlitz Dam.

Ruskin Dam Powerhouse Improvements
BC Hydro
Rehabilitation includes improvements to the project intakes, generating unit water conveyances, generating units, plant auxiliary equipment and systems, powerhouse structure, and auxiliary features. Develop the rehabilitation alternatives and prepare the final design for all mechanical and electrical equipment, seismic upgrade of the powerhouse structure, seismic upgrade to the dam intakes, intake emergency closure gate addition, draft tube gate system addition, slope stabilization and access bridge seismic upgrade. This is 5 year planned rehabilitation.

Cheeseman Dam Selective Withdrawal Intake Study
Denver Water Board
Investigations included inspection of the existing facilities and development of 3 alternatives to upgrade the existing low level system and add more extensive selective withdrawal facilities. Development of preliminary designs, all involve extensive underwater construction and cost estimates.

Gross Dam Inlet Gate Addition - Studies and Concept Design
Denver Water Board
Project Engineer for studies and preliminary design associated with the addition of a hydraulically operated upstream control gate to be added to the existing low level tunnel at the Gross Dam. Work included preparation of design alternatives for the installation of a gate in 350 ft. of water and rehabilitation and reinforcement of the inlet conduit at that location. Preliminary design calculations, drawings and cost estimates were prepared for the selected alternative which consisted of a self-contained, hydraulically operated slide gate with submerged hydraulic cylinder which will be affixed to a thimble formed into a tunnel extension.

French Meadows Upstream Sluice Gate Emergency Repair
Placer County Water Authority
Provided on-call assistance during emergency underwater repair of a hydraulically operated slide gate submerged in over 150-ft of water. Project consisted of replacement of the 40-yr old hydraulic cylinder and piping which had ruptured while in service. Work included review of replacement hydraulic cylinder, review and modifications to existing hydraulic operating system, structural design of miscellaneous components and design of a new packing gland arrangement to be installed by divers in over 150-ft of water.

Landsburg Flood Passage Improvements
Seattle Public Utilities
Investigated several alternative gate related improvements for flood passage and debris routing and collection through the diversion dam. Investigations included several different gate types, spillway widening and dam modifications to pass floods and debris. The study concluded with a cost analysis and recommendations for a preferred option. In the process of designing the spillway modifications including the new 44 ft wide by 8 ft high hydraulically operated gate, pier modifications and a new debris management system.

Cowlitz Falls Low Level Sluiceway Gate Evaluation
Lewis County PUD
Detailed investigation, evaluation and rehabilitation of two problematic low-level sluiceway regulating gates, 12ft wide by 16 ft high, 90 ft head. Project included inspection of the two inoperable gates, damaged by vibration and design of rehabilitation measures to reduce vibration in the short term and repair damaged components. Study also included long term recommendations to solve present vibration. Included in this work was design of new 12 ft wide by 19 ft high sluiceway to isolate problematic gates.

Pinopolis Lock Emergency Radial Gate
Oregon Ironworks
Project Manager and Senior Design Engineer for structural design of new 60 ft. wide by 31 ft. high radial type lock emergency gate for Santee Cooper's Pinopolis Lock. New gate had to be designed to be replace existing 60 year old gate and utilize existing embedded parts and counterweighted hoist system based on specifications prepared by the owner. Gate acts as maintenance gate for lock and emergency closure gate. Work included structural computations, design optimization/value engineering, preparation of fabrication details, and review of fabricator prepared shop drawings. Worked closely with fabricator and owners engineer to come up with cost effective design that met all owner requirements.

Bonneville Dam Surface Collector Project
USACE, Portland District
Performed studies related to modification of the Bonneville Dam Powerhouse No. 1 intakes to incorporate a surface collector system for routing fish around the dam. The study included conceptual design of alternative surface collector structures which included bulkheads, trashracks and trashraking systems. Investigated various bulkhead designs and trashrake systems and examined the feasibility of modifying and existing gantry crane to handle surface collector equipment. Prepared report describing various alternatives and associated advantages and disadvantages.

Wanapum Dam, Spillway Gate Trunnion Anchorage Analysis
PUD, Grant County
Design Lead for the detailed structural finite element analysis of the existing trunion anchorages which support the load from the 50-ft wide by 60 ft high spillway radial gates. Review of original model studies, calibration of finite element model to the model study and analysis of the trunnion anchorages to withstand 5 ft dam raise and newly developed seismic design criteria.

Wanapam Dam, Spillway Gate Trunion Friction Testing Program
PUD, Grant County
Developed and implemented a strain gage type trunnion friction testing program for the 50-ft wide by 69-ft high Wanapam Dam spillway radial gates. Work included development of a field testing program, oversight of date collection by testing company, field data reduction and detailed structural analysis to determine actual trunnion values.

McNary Dam Fishway Hydroelectric Project
Northern WASCO County Public Utility District
Performed studies and conceptual design, prepared technical specifications, and reviewed manufacturers design and drawings for two 6 ft wide by 8 ft high (70 ft head), hydraulically operated bonneted slide gates, and 21 ft wide by 13 ft high, (60 ft head), wire-rope hoist-operated draft tube gate. Performed detailed inspection and non-destructive testing of existing bonneted slide gate and performed structural analysis of the existing gate. Prepared report documenting results of the inspection and structural analysis.

Big Creek No. 7 and Vermillion Dam
Southern California Edison, California
Lead Engineer. Inspected four 40 ft wide by 30 ft high spillway radial gates and gate operating machinery at Big Creek No. 7 and one 15 ft wide by 8 ft high radial spillway gate and operating machinery at Vermillion Dam. Performed condition assessment of the equipment and structural analysis of each gate (including finite element analysis of the Big creek Gates) for expected loading conditions including a seismic condition to determine gates' structural integrity. Prepared a report documenting results of the inspection and structural analysis.

Kentucky Lock Sector Gear Replacement
Smith Seckman and Reid
Prepared detailed design and specifications for replacement 12 ft diameter sector gears for culvert valve operating equipment at USACE, Nashville District's, Kentucky Lock. Design included investigation of alternative materials and wearing surfaces and structural design.

Monongahela Project
USACE, Pittsburgh District
Performed drawing review and independent finite element structural analysis of a 110 ft wide by 21 ft high spillway radial gate as designed by the USACE. Suggested improvements and cost saving measures to the design, several of which were incorporated by the District into the final design.

Old Hickory Dam Spillway Hoist Chain Replacement Project
USACE, Nashville District
Prepared detailed design and specifications for replacement of roller chain for radial spillway gates at USACE, Nashville District's, Old Hickory Project. Design for two alternatives were prepared, one utilizing self-lubricating bushings and one included using grease fittings. Additional work included investigation of environmentally friendly greases, investigation of alternative materials, and comparative life cycle cost estimates.

Montgomery Point Lock and Dam Project
USACE, Little Rock District
Lead Gate Engineer for detailed design of ten 30 ft wide by 13 ft high hydraulically operated hinged crest gates for a 300 ft long, navigable pass spillway and a 180 ft long by 30 ft high dewatering structure for maintenance of the crest gates which are otherwise inaccessible. Responsibilities included structural design and design optimization of the hinged crest gate using finite element analysis considering numerous expected load cases using hydraulic pressure data interpreted from physical model studies, preparation of detailed design plans for the gate and gate drive system, and preparation of construction specifications. Performed structural analysis and prepared detailed design plans and specifications for thirty-three components of the dewatering structure. Work included design of the structural

framework which consisted of four 80 ft long support beams and four 28 ft high column supports for supporting eighteen, design of 20 ft wide by 30 ft high vertically framed bulkheads and one 50 ft wide by 30 ft high wheel gate. Designed temporary dewatering cofferdam 14 ft square by 23 ft high. Review of manufacturer submittals, shop inspections, and field startup and testing.

Folsom Dam Modifications and Raise Project
USACE - Sacramento District
Coordinated with the Bureau of Reclamation to incorporate additional dam safety components, including strengthening for seismic stability, addressing potential static seepage issues in earthen dikes, and passing the Probable Maximum Flood (PMF) through the new auxiliary spillway. Provided QA/QC on the existing dam gates modifications in support of the Folsom Dam Modifications and Raise project. CONTRACT - IDIQ for Watershed and Ecosystem Planning Studies for Civil Works - USACE, Sacramento District (DACW05-01-D-0018)

Water Resources Planning and Engineering
Bureau of Reclamation, Mid-Pacific Region
Replaced existing drum gates with six radial gates, approximately 52-foot (ft) wide x 38-ft high. Replaced four low elevation river outlets. Provided spillway radial gate and outlet works / tube valve replacement. CONTRACT - IDIQ for Water Resources Planning and Engineering - Bureau of Reclamation, Mid-Pacific Region

IDIQ Contract for A-E Services for New Lock Design & Major Rehab Projects for Existing Locks & Dams
USACE, Nashville District
Investigated alternative materials and wearing surfaces and structural design. Prepared detailed design and specifications for replacement of 12-ft diameter sector gears for culvert valve operating equipment in support of the $500M project. Member of MWH team that assisted the Nashville District in identifying over $83M in cost savings, and prepared a series of alternative design studies for the location and arrangement of the lock to reduce project cost while maintaining high performance levels. CONTRACT - IDIQ Contract for A-E Services for New Lock Design & Major Rehab Projects for Existing Locks & Dams, Grand Rivers, KY / Chattanooga, TN - USACE, Nashville District

Bonneville Dam Surface Collector Project
USACE, Portland District
Prepared alternative surface collector structures conceptual design which included bulkheads, trash racks and trash raking systems. Investigated various bulkhead designs and trash rake systems and examined the feasibility of modifying existing gantry crane to handle surface collector equipment. Prepared report describing various alternatives and associated advantages and disadvantages. Performed studies related to modification of the Bonneville Dam Powerhouse No. 1 intakes to incorporate a surface collector system for routing fish around the dam. CONTRACT - IDIQ for Hydroelectric Power and Pumping Plant Engineering Design and Analysis Services - Hydroelectric Design Center, USACE, Portland District.

Upper Falls Control Works Rolling Sector Gate Inspection & Evaluation
Avista Utilities
Detailed visual inspection of gates and open-gears chain hoists, non-destructive thickness testing, review and update of structural analysis and evaluation and rehabilitation recommendations. This evaluation was then used to design rehabilitation measures for the gates.

Lower Baker Dam -- Spillway Rehabilitation
Puget Sound Energy
Project Engineer for investigation and conceptual design of spillway rehabilitation program for the existing spillway gate system at Lower Baker Dam. Work included inspection of existing gate and hoist equipment, non-destructive testing, concrete inspection, development of multiple rehabilitation alternatives, preparation of cost estimates, structural pier stability analyses and preparation of Design Criteria.

Ali Moshref

Profession:	Over 30 years of experience in power system planning, system operation, asset management, alternate energy resources for power generation, and software development for the analysis of power system.
Nationality:	Canadian Citizen
Years of Experience:	32 years
Education:	Ph.D., Electrical Engineering, McGill University (1983) M.S., Electrical Engineering, The George Washington University (1979) B.S., Electrical Engineering, Iran University of Science and Technology(1977)
Position:	Senior Director, Transmission West Region, Quanta Technology

Summary:

With over 30 years of power system experience in the energy industry covering power system planning, system operation, asset management, alternate energy resources for power generation, and software development for the analysis of power system. A Senior member of IEEE with areas of expertise including:

- Development of Planning and Operational Policies
- Power System Stability and Control,
- WECC/NERC synchronous generator testing and model validation, PSS/AVR tuning
- Design of Under Frequency and Under Voltage Load Shedding (UFLS and UVLS) Schemes
- Power Quality and Harmonics
- Design of System Protection Schemes (SPS/RAS)
- Electromagnetic Transients
- Transmission Line Modeling, electric and magnetic fields, and grounding
- Software Development for Power System Analysis – Designed/developed CYMHARMO program at CYME International and IREQ
- Power System Training – designed/delivered courses in Power

System Analysis to a number of utilities in North America, Middle east and Asia

Experience:

Jan 2012 – Now	Quanta Technology, Raleigh, NC Senior Director, Transmission West Region
Nov 95 – Oct 2011	Powertech Labs Inc., Surrey, BC, Canada, Manager, Power System Studies reporting to the director Smart Utility Business unit, contributed to the development of the five-year strategy for Powertech, improved reliability and maximized grid utilization by managing analysis/studies and developing planning and power system operation strategies and policies for utilities and industrial organizations
Jan 86 – Dec 1995	CYME International Inc., Montreal, Quebec, Canada, Cofounder and Director, System Engineering, reporting to the president and CEO, responsible for product and business development, designed/developed more than 12 computer programs for power system analysis. Within three years of startup, the company revenue increased to $5M with clients in over 70 countries

Professional Affiliations: Senior Member, Institute of Electrical and Electronics Engineers (IEEE)

Publications: Over 40 published articles in industry magazines and conference proceedings and other publications.

Selected publications:

"Network Security Assessments for Integrating Large-Scale Tidal Current and Ocean Wave Resources into Future Electrical Grids", Proceedings of the IEEE, 2011

"A Scenario Analysis of Northwest Electrical System toward Determining the Level of Wave Power that Can be Integrated By 2019 in Oregon", www.oregonwave.org, 2010.

"Key Features and Identification of Needed Improvements to Existing Interconnection Guidelines for Facilitating Integration of Ocean Energy Pilot Projects", a report prepared by Powertech Labs for the IEA-OES Annex III, [Online], www.iea-oceans.org, 2009

"Systematic Approach for Identification of Voltage Collapse Areas and the Reactive Power Reserve Requirements in Large Interconnected Transmission Grids" CIGRE, Paris, France, 2008.

"Annex III: Integration of Ocean Energy Plants into Distribution and Transmission Electrical Grids", IEA-OES, Annual report 2007, pp 22-28.

"An Assessment of Variable Characteristics of the Pacific Northwest

Regions Wave and Tidal Current Power Resources, and their Interaction with Electricity Demand & Implications for Large Scale Development Scenarios for the Region: Phase-1 Report", Report No: 17485-21-00(REP#3); Powertech Labs Inc., Dec 2007.

"A PI Control of DFIG-Based Wind Farm for Voltage Regulation at Remote Location", Approved for publication in the IEEE Transactions on Power Delivery, November 2006.

"Oscillatory Stability Limit Prediction Using Stochastic Subspace Identification", approved for publication in the IEEE Transactions on Power Delivery, August 2005.

"Assessing and Limiting Impact of Transformer Inrush Current on Power Quality", approved for publication in the IEEE Transactions on Power Delivery, June 2005.

"Design of a Special Protection System to Maintain System Security at High Import", Presented to IEEE-PES conference, July 2003

"An Intelligent System for Advanced Dynamic Security Assessment" IEEE-PES/CSEE INTERNATIONAL CONFERENCE ON POWER SYSTEM TECHNOLOGY, October 13-17, 2002 Kunming, China

"Simulation of Start-Up of a Hydro Power Plant for the emergency Power Supply of a Nuclear Power Station", IEEE Transactions on Power System, Vol. 16, No. 1, 2001, pp.163-169

"Experience with Testing and Modeling of Gas Turbines", IEEE winter meeting at Columbus Ohio, USA, Jan. 2001

"A Framework for Power System Restoration", proceedings of the CCECE '00, May 2000, Halifax, Canada.

"Measures To Improve Power System Security In The New Competitive Market Environment", SEPOPE, Brazil, 2000

"Analysis and Control of Harmonic Overvoltages during Power System Restoration", International Conference on Power System Transients - IPST '99, June 20-24, 1999, Budapest, Hungary.

Selected Experience:

Project Leader for "Development of the North American Reliability Council (NERC) Dynamic Simulation Cases and Dynamic Database". Technical leader for ERAG/NERC dynamic database and case development. Designed and developed synchronous generator testing and model validation procedures in compliance with WECC and NERC standards.

Project Leader for "POSSIT - POwer System Security Using Intelligent Technologies", Precarn Incorporated, Intelligent Systems. Developed

and implemented data mining in conjunction with modal analysis for predicting power system security.

Project Leader for "Special Protection System" Saudi Electric Company Designed and analyzed a system protection scheme to defer capital investment. SPS is successfully in operation for the past several years.

Project Leader for UFLS program assessment for SERC, SPP, TNB, SEC.

Project Leader for "Capacitor Application" PowerGrid Singapore. Determined optimum location and size for the implementation in the Power Grid of Singapore, the first of such installation in PG power system.

Project Leader for "Generator Testing and Model Validation" for BC Hydro in compliance with WECC

Project Leader for "Review of Steady-State Operating Guidelines and Procedures", SEC, Saudi Arabia.

Project Leader for "Design of Automatic Load Shedding Schemes", American Electric Power (AEP). Designed scheme for the load shedding in the AEP to defer millions of dollars of capital investment for a 765 kV transmission line.

Co-supervised M.Sc. and Ph.D. students at UBC and Concordia University

Developed a Harmonic Analysis Program (CYMHARMO) the first of its kind in North America. Conducted Harmonic Study for HVDC filter design of NTPC India.

DERRICK PENMAN, P.Eng.

PRINCIPAL CIVIL / STRUCTURAL ENGINEER

KEY QUALIFICATIONS

Mr. Penman is a Hydropower Engineer with experience in the layout and design of hydroelectric plants at prefeasibility, feasibility and detailed design levels both in Canada and internationally. He has also been involved in dam safety assessments and due diligence assessments of hydroelectric projects for financial institutions. His most recent experience includes ranking and feasibility studies, tender design through to construction, review of design concepts, due diligence work, and construction supervision.

EDUCATION

BS/BSc, Civil Engineering, Heriot-Watt University,

Licenses and Professional Memberships

Professional Engineer, Ontario, Newfoundland and Labrador,- Canada
Institution of Civil Engineers, UK
Order of Engineers of Quebec, Canada

EXPERIENCE RECORD

White River Hydro Project

Regional Power Opco, Inc.

Project Manager for the White River Hydroelectric Project. White River project consists of two hydroelectric projects located approximately 30 km northwest of White River, Ontario, consisting of (i) Gitchi Animki Bezhig facility (the “Upper White River Project”) being located approximately 3.2 km downstream of the existing MNR-operated White Lake Dam, and (ii) Gitchi Animki Niizh facility (the “Lower White River Project”) being located approximately 1.6 km downstream of Chicagonce Falls. The two sites are situated approximately 12 km apart on the river. MWH is involving in Preliminary/Detail/Final design as well as Support during construction and commissioning.

Taltson Expansion Project

NWT Energy Corporation (03) Ltd

Project Manager for the Taltson Hydroelectric Expansion Project that will add a new power plant of approximately 50MW install capacity and 700km transmission lines to supply power to as many as three operating and one proposed diamond mines north of Great Slave Lake.

Waneta Expansion Project

Peter Kiewit & Sons, British Columbia

Responsible for the coordination between the various engineering disciplines in the preparation of the design of the 335MW expansion to the existing Waneta Hydroelectric Project on the Pend d’Oreille river in British Columbia for an EPC bid submitted by Peter Kiewit & Sons a major North American civil engineering contractor. The Waneta Expansion project is located on the right abutment of the existing facility. The layout comprised two separate power intakes, located adjacent to the existing north closure wall, two lined tunnels with a diameter of 10m for the concrete section and 8.3m for the steel lined portion upstream of the powerhouse and a powerhouse located some 80m downstream of the existing dam containing two vertical axis Francis units. Water is conveyed from the existing reservoir to the power intakes through a 185m long unlined channel excavated in rock and overburden. The inlet to the approach channel is located approximately 40m upstream of the existing intake.

Tekeze Hydropower Project
Ethiopian Electric Power Corporation
As Chief Design Engineer, responsible for supervision of the design activities at site including re-design of elements of the project where site conditions vary from those assumed during the initial design phase, review of contractor's shop drawings, review of method statements, temporary works designs, and other technical submissions from the Contractor. The project comprises a 185-m-high double curvature arch dam containing 4 orifice type outlets to handle a flood of 4500 m³/sec after routing through the reservoir. Power flows are conveyed to a 4 unit underground powerhouse with an installed capacity of 300 MW through a f 7.25 m 320-m-long concrete lined headrace tunnel, a f 6.75 m pressure shaft leading to a concrete lined manifold which branches to 4 steel lined tunnels f 4.0 m varying in length from 76 m to 52 m. Flows are discharged to the river through 55-m-long concrete lined D-shaped tunnels with an equivalent diameter of 5.0 m.

Karun III Hydroelectric Project, Iran
Iran Water and Power Development Corporation (IWPC))
Responsible for providing advisory services to the joint venture of Acres and their local Iranian partner Mahab Godss on the construction supervision of the Karun III Hydroelectric Project in a joint role as Design Manager and Area Engineer for the Plunge Pool and Underground Power Complex. The project comprises a 205 m high concrete arch dam, spillway facilities to handle flows of 21,440 m3/sec and underground works, which comprise an 8 unit underground powerhouse (installed capacity 2,000 MW), and an underground transformer gallery. Flows for power generation are conveyed through penstock tunnels approximately 700-m-long and varying in size from 12.6 m to 5 m in diameter. As Design Manager responsible for managing and coordinating the efforts of the design team, which reviewed design changes proposed by the contractors, temporary works designs, and other technical submissions. An area engineer for the plunge pool and underground works coordinating the construction supervision.

Supplementary Studies for the Upper Karnali Hydroelectric Project, Nepal
Acres International (funded by the World Bank)
Project Manager for the supplementary studies for the 300 MW Upper Karnali Hydroelectric Project in Nepal carried out in preparation for construction approval submissions. The feasibility study was initially carried out by Acres under the Medium Hydro Study Project funded by the World Bank. The supplementary studies involved the EIA and cadastral surveys for 100 km of 220 kV transmission line, EIA and cadastral survey for 22 km of access road between the intake and powerhouse, Glacial Lake Outburst Flood (GLOF) studies, investigation of new headworks layout and supplementary hydraulic studies for the lower reaches of the Karnali River to determine the effect on aquatic habitat. This work was suspended in the initial stages due to political problems in the country.

Misema Hydroelectric Project, Canada
Green Energy Developers, Toronto, Canada
Project manager for the 3 MW Misema Hydroelectric Project, near New Liskeard Ontario during the preparation of the final engineer's estimate, application documents for construction approval and the preparation of the bid documents for the procurement of the electromechanical equipment. The project layout comprised a low concrete weir to divert water into an intake and power waterway through a ridge to develop the available head at a series of rapids in the Misema River. The project was located in an area of deep unstable sands prevalent along the banks of the Misema river and after studying various options the f 0.9 steel penstock was located below the sand in a f 2.6 tunnel constructed through the underlying rock and the intake adapted to a dropshaft type. The surface powerhouse contained 2-horizontal Francis units.

High Falls Hydroelectric Project, Canada
Beaver Power Company
Project Manager for the studies carried out for the rehabilitation of the 3MW High Falls Hydroelectric Project, north of Thunder Bay, Ontario. The project comprised some 30m of woodstave penstock leading from a power intake at the head of a set of rapids in the High Falls River to a single horizontal axis Kaplan unit. The project had flooded during the spring freshet some years before. The remedial measures included: redesign of flood protection walls; design of access walkways inside; rehabilitation of the generator and controls damaged during the flood; and preparation of a budget cost estimate for the Client.

El Canada Hydroelectric Project, Costa Rica
Energía Global, USA Private Developer
Provided engineering support on the detailed design of the 60MW El Canada Hydroelectric Project in Costa Rica. The project comprised a small weir intake and desilting structure located immediately downstream from an existing concrete gravity dam, the storage for which had become depleted due to siltation.
The spill from the upstream dam was diverted into an 800-m-long f 1.2 m low-pressure buried steel pipeline, which led to a storage reservoir excavated in volcanic tuff and lined with a PVC liner. The storage tank was connected by another intake and surface penstock to a surface powerhouse, housing 3-Francis turbines.

Brilliant Dam Expansion Studies, British Columbia, Canada
Columbia Power Corporation
Project Engineer responsible for the conceptual studies for the 100 MW Brilliant Dam Expansion Studies on the Kootenay River in British Columbia. The conceptual studies formed the basic technical information to be included with EPC documents. The work involved preparation of layouts and cost estimates for surface and underground options for the addition of a new powerhouse, with a single Kaplan turbine to capture spill flows at an existing dam and power installation. The work included investigations of options for disposal of spoil from the excavations to satisfy strict environmental regulations on what was an important salmon river in British Columbia.

Ethiopia Long-Range Generation Plant
Ethiopian Electric Power Corporation (EEPCO)
Hydroelectric Specialist on the Ethiopia Long-Range Generation Plan for EEPCO funded by the African Development Bank. Responsible for bringing cost estimates for candidate projects at different levels of study to a common base for input into the planning model. Projects included the Chemoga Yeda, Beles and Halele Werabasa projects, which are currently in the design stage.

Dona Francisca Hydroelectric Project
Inter-American Development Bank
Project Manager for the Independent Engineer Review for the design and construction of the 125-MW Dona Francisca Project on the Jacui River in the state of Rio Grande do Sul in the South of Brazil. The project comprised a 58-m-high, 610-m-long gravity dam constructed of RCC, a free overflow spillway constructed of RCC and conventional concrete, and a surface powerhouse, housing two Francis units.

Alto Cachapoal Project
Bechtel, USA & Andrade Gutierez, Brazil (Project Developers)
Project Manager for a supplementary design phase of the 180-MW Alto Cachapoal Project in Chile, with the objective of reducing the capital cost of the project. The project comprised a number of small intakes and desilting structures diverting water from small catchments, adjoining the main Cachapoal catchment to a central reservoir and intake, which lead to a power tunnel and underground powerhouse. This phase of the work involved revisions to the project layouts to include basic low-cost, high-maintenance structures. This culminated in a three-day value engineering exercise by specialized consultants to identify the lowest cost alternative.

Screening and Ranking of Medium Hydropower Study Project
NEA (Nepal Electricity Authority)
Project Manager for the feasibility studies and Project Engineer for the screening and ranking phase of the Medium Hydropower Study project, Nepal. The first phase of the project involved the screening and ranking of 138 projects defined as medium-scale in the Nepal context to lie in the range from 10 MW to 300 MW. From the 138 projects seven projects were selected for full feasibility study and environmental impact assessment study, through a coarse and fine screening process, using both environmental and technical parameters. The MHSP team carried out three of the studies, namely 300-MW Upper Karnali, 300-MW Dudh Koshi and 100-MW Tamur-Mewa. Local consultants under the supervision of the MHSP team carried out the remaining four in the 10-MW to 50-MW range, namely Rahughat, Likhu, Budhi Ganga and Kabeli A. The Upper Karnali Project comprises a gated barrage type intake (3-12m high by 12m wide gates) and large desanding structure (190m3/sec flow), approximately 2km of power tunnels ranging in diameter from 11m for the unlined headrace tunnel to 8.0m and 6.0m for the concrete lined and steel lined respectively, an underground surge shaft and underground powerhouse with 4-Francis units. The Dudh Kosi Project features a 180m high zoned fill dam and approximately 11km of power tunnels with a range of

diameters of 11m to 6.0m depending on the lining condition and an underground powerhouse housing 4 -Francis units. The remaining projects have similar layouts comprising a free overflow concrete weir, desanding structures power tunnels and underground powerhouses.

Jebba Hydroelectric Project
NEA (Employer:Montreal Engineering Company Ltd.)
Provided engineering support to the field staff during construction, reviewing contractor's designs and diversion schemes, for the 560-MW Jebba Hydroelectric Project in Nigeria. Also responsible for the detailed design and preparation of construction drawings for a 15,000-m3/s underflow spillway and a 200-m-long, 12-m-wide, 30-m-tall lift navigation lock for the project.

Addalam Hydropower Project
ConWest Exploration Co. Ltd. of Canada
Modifications to the layouts and preliminary design of component structures for a build-operate-transfer (BOT) bid on the 46-MW Addalam hydropower project in the Philippines.

Rehabilitation of Big Eddy Dam
Inco Sudbury, Canada
Coordinator for the rehabilitation study of the 159-ft-high Big Eddy Dam, near Sudbury, Ontario. The work included evaluation of structural stability, review of construction methodology and preparation of a detailed cost estimate.

Birr and Koga Irrigation Project, Ethiopia
Ministry of Water Resources, Ethiopia
Preparation of layouts and preliminary design of hydraulic structures for the 320,000-ha Birr and Koga Irrigation project in Ethiopia. The project included two assignments of two and a half months between 1994 and 1995.

Trishuli Devighat Hydroelectric Complex
Nepal Electricity Authority (NEA)
Supervision of detailed design and preparation of construction drawings for the 31.5-MW Trishuli Devighat hydroelectric complex, Nepal. Four short-term assignments of two months and a four-month assignment on the construction site.

Aleltu Hydroelectric Project
Ethiopian Electric Power Corporation (EEPCO)
Civil design coordinator responsible for layout and design of civil works including the underground powerhouse and related works for the feasibility study of the 300-MW Aleltu hydroelectric project. Two 2-month assignments in Ethiopia and completion of design work in Canada.

MICHAEL ROGERS, P.E.

VICE PRESIDENT & PRINCIPAL CIVIL ENGINEER

KEY QUALIFICATIONS

Mr. Rogers is a Principal Civil Engineer and Senior Project Manager at MWH Americas, Inc. He is responsible for technical design, project and contract management, client coordination, client service manager, project scheduling, technical review and preparation of contract documents for dam projects. His experience includes management of multi-disciplinary teams and subcontractors for dam design and construction, including project cost monitoring and control, technical scope direction, and oversight review.

Mr. Rogers is a registered Professional Engineer in Illinois and California. He has worked on more than 100 different dam projects, including 25 dams under the jurisdiction of the State of California, Division of Safety of Dams (DSOD). Five of these California Projects have included roller-compacted concrete (RCC) design.

Mr. Rogers is a recognized technical expert in the field of dam engineering. He currently serves as President of the Board of Directors of the United States Society on Dams (USSD) and Chair of the Committee on Concrete Dams. As President, he is the head of the USSD delegation to the International Commission on Large Dams (ICOLD) and member of the ICOLD Committee on Concrete Dams. He is a past recipient of the ASCE Rickey Medal for his work on the Task Committee on Lessons Learned from the Design, Construction, and Operation of Hydroelectric Facilities. He is a past member of ASCE's Hydraulic Structures Committee, including a term as Chairman.

EDUCATION

Master of Science, Civil Engineering, St. Anthony Falls Hydraulic Laboratory, University of Minnesota
Bachelor of Science, Civil Engineering, Illinois Institute of Technology

Licenses and Professional Memberships

U.S. Society on Dams; International Commission on Large Dams, American Society of Civil Engineers; Association of State Dam Safety Officials
Professional Engineer, California, C56062 (1996); Illinois, 062-044368 (1988)

EXPERIENCE RECORD

South Fork II Dam Preliminary Engineering
City of Nanaimo
Project Manager supervising an MWH Design Team in the investigation of potential sites for a new dam to expand the City's water supply storage system. The scope of work includes geotechnical, environmental, hydrological and seismic feasibility studies to select a preferred site and develop a construction cost estimate.

John Hart Powerhouse Replacement
BC Hydro
Mr. Rogers is the Design Manager supervising a BC Hydro Design Team in the preparation of Design-Build specifications for a replacement $1.3 billion (Canadian $), 138 MW hydroelectric powerhouse, including 2.1 km hard rock tunnel, intake structure and appurtenant facilities. The project design is being prepared under Design-Build-Finance-Rehabilitate governance as part of a Public-Private-Partnership in the British Columbia Province.

San Vicente Dam Raise Project
San Diego County Water Authority
Project & Design Manager for a multidisciplinary team responsible for the preliminary and final design of the 117-ft raise on an existing 220-ft high concrete gravity dam. The raised portion of the dam will be constructed with roller-compacted concrete (RCC), which when completed will be the largest concrete dam raise in the United States and the largest RCC dam raise in the world. Project management responsibilities include Design Team coordination, client interface, coordination with other client designers and construction management teams, quality reviews, and public interactions. Design scope includes foundation excavation, structural assessment of interaction between existing and new dam, RCC materials, 5 acre marina, on-site quarry, access roads, inlet/outlet facilities and a geomembrane liner on the upstream portion of the raised dam. Project design is under the jurisdiction of the State of California dam safety office (DSOD).

Diemer Site Preparation Project
Metropolitan Water District of Southern California
As RCC Design Manager, was responsible for RCC value engineering, constructability review, RCC mix design program development, RCC mix design laboratory testing, final RCC design, and RCC design support services during construction. Project includes more than 185,000 cubic yards of RCC for foundation replacement and buttress support at the Diemer Filtration Plant in Yorba Linda, California. Project design was performed under the jurisdiction of the State of California dam safety office (DSOD).

Vail Dam Rehabilitation, Rancho
California Water District
As Project & Design Manager, was responsible for design oversight, quality control, and client coordination for replacement of entire inlet/outlet works at Vail Dam, including eight submerged intakes on the upstream side of the dam and piping/flow control valves on the downstream side of the dam. Prepared a Condition Assessment Report based on a diving inspection of the upstream equipment, including a recommendation to client for the overall project scope. Project design was performed under the jurisdiction of the State of California dam safety office (DSOD).

Bear Valley Dam Rehabilitation,
Big Bear Municipal Water District
As Project Manager, is responsible for design oversight, quality control, and client coordination for Bear Valley Dam rehabilitation, including strengthening of multi-barrel arch dam section, placement of erosion control riprap on the downstream side of the dam, and upgrading the operational features of the dam. Operational upgrades included adding remote control and monitoring of gates and valves, and addition of security video systems. Work included preparation of a Condition Assessment Report based on a site inspection and engineering assessment of the dam. Project design was performed under the jurisdiction of the State of California dam safety office (DSOD).

Big Creek Expansion Project Feasibility Assessment
Southern California Edison
As Project & Design Manager, was responsible for feasibility design oversight, quality control, and client coordination for study a $1 billion expansion of Edison's Big Creek Hydroelectric system. The project would add new facilities, including more than 5000 feet of new tunnels, reservoir intakes, penstock piping, and hydroelectric facilities. Our Team prepared a Feasibility Assessment Report, including project layout and cost estimates.

Olivenhain RCC Dam – Warranty Services
San Diego County Water Authority
As Project Manager, was responsible for coordination between the Water Authority and construction contract to resolve outstanding warranty issues. Work included a final walk-through inspection of all constructed facilities by the design engineering staff.

Olivenhain RCC Dam
San Diego County Water Authority
Resident Design Engineer during construction. He was responsible for on-site design support services during construction, including review of contractor submittals, contractor request for information, design changes, design control, RCC Mix Design, RCC Placement, and record drawings. He provided on-site support to the Owner, including interface to construction manager, environmental support, safety team, and public relations. He prepared

the project Operation and Maintenance Manual, including review of contractor-provided detailed O&M Manuals. Provided periodic field inspection supporting the construction manager, as necessary, to verify conformance to contract documents and design intent. He participated in monthly partnering sessions with the Owner, construction manager, contractor, and state dam safety regulator. Identified and documented "Lessons Learned" from the design team perspective for Owner.

Olivenhain RCC Dam – Design
San Diego County Water Authority
Deputy Project Manager and Design Manager responsible for oversight of design engineers, including preliminary design, final design, and preparation of contract documents. Mr. Rogers was the principle point of contact for the client and participated in several public meetings concerning the project design. The Olivenhain Dam is a 318-foot-high RCC - roller-compacted concrete - gravity dam with a multiport inlet/outlet tower on the upstream face and an elaborate flow control facility at the downstream toe. RCC design included mix design, RCC placement methods, integration of upstream geomembrane liner, and RCC test sections. Project design was performed under the jurisdiction of the State of California dam safety office (DSOD).

Pacoima Dam
Project Manager for the detailed design of automation of existing flow control valves for a new control house, including SCADA operation system. Project also includes design and preparation of contract documents for a new utility corridor, including potable water, electrical, and sewer. Project includes design approval from California dam safety office (DSOD) (1997-98).Project & Design Manager, Santa Ana River Hydroelectric Plant, Southern California Edison, San Dimas, California.
Responsible for design management, quality control, design/build team coordination, and client interface for a new 6.1 MW hydroelectric power station. The design/build assignment included a new 2-mile-long, 48-inch-diameter welded steel pipeline to be used as a penstock for the new hydropower development downstream of Seven Oaks Dam. Pipeline design considerations included anti-flotation treatment, fault crossing, tunnel jacking, tunnel sealing at dam abutment, and energy dissipation (up to 300 feet of water pressure) for implementation phasing (1996-98). Project design was performed under the jurisdiction of the State of California dam safety office (DSOD) and the Corps of Engineers.

Radial Gate Inspections
Project Manager and Principal Field Engineer for radial gate inspections at Big Creek No. 7 and Vermilion Dams to address State of California, Division of Safety of Dams (DSOD) requirements. Project included site inspection, finite element structural analysis, and condition assessment of four 30-foot high radial gates and one 8-foot high gate (1996).

Alta Mesa Pumped-Storage Hydroelectric Project
Project & Design Manager for the feasibility assessment of a new closed-loop pumped storage project utilizing wind energy for off-peak energy for pumping cycle. Primary responsibilities include preliminary engineering and concept development for permitting, including field surveying and geotechnical investigations (1997-98).

Big Tujunga Dam
Los Angeles County Department of Public Work
Project Manager for the seismic re-analysis of variable radius, 251-foot-high concrete arch dam. The project includes a finite element method analysis of the dam utilizing a dynamic joint opening and closing algorithm for relief of high tensile stresses developed during seismic conditions. Project includes development of site-specific seismic input and design approval from California dam safety office (DSOD).

Rattlesnake Canyon Dam
Project Manager for repair of side channel spillway after it was destroyed by a landslide. Work included preparation of plans and technical specifications for structural repair of the spillway and stabilization of the landslide mass. He was also the Field Engineer responsible for construction issues effecting design, including construction requests for information, design changes, and regulatory interface with state Division of Safety of Dams (DSOD).

Devil's Gate Dam
Los Angeles County Department of Public Work
Peer reviewer for design of roller-compacted concrete (RCC) buttress for seismic strengthening of the existing 120-ft high concrete gravity-arch dam near Pasadena. Responsibilities included general staff direction and peer review of engineering design and drafting for production of construction documents. Resident Construction Engineer for supervision and review of new RCC buttress on the downstream side of an existing dam, demolition and construction of a new upstream flow control structure and entrance to spillway, and regulatory interface with state Division of Safety of Dams (DSOD).

Big Dalton Dam
Los Angeles County Department of Public Works
Project engineer for design of roller-compacted concrete (RCC) filling between buttresses for seismic strengthening of an existing 160-ft high multiple arch dam near Glendora, CA. Responsibilities included structural design of mass concrete filling between arch buttresses, relocation of access galleries, hydraulic design of overtopping flows, and peer review of overall engineering design and drafting for production of construction documents. Project design was performed under the jurisdiction of the State of California dam safety office (DSOD).

Rogers Dam
Project manager and lead engineer for the spillway capacity expansion alternatives study, including feasibility-level studies to increase project discharge capacity by 10,000 cfs to meet FERC engineering guidelines.

He Dog, Parmelee, and Ponca RCC Dam Rehabilitation
Project Manager for the rehabilitation of He Dog, Parmelee, and Ponca Dams on the Rosebud Sioux Indian Reservation (SD). Responsibilities included inflow design flood studies, conceptual design, final design, and construction management at all three dams. Significant project features included large service/emergency RCC spillways, raising existing embankment dams, replacing low-level outlet gates, and lining of an existing low-level pipe conduit to allow pressurization. Construction engineering included periodic field inspection of construction activities. He was responsible for Office Engineering during construction, including budget & schedule tracking, review of contractor requests for information, submittals, and change order negotiations.

DIETMAR SCHEEL, PE

CONTRACT SPECIALIST

KEY QUALIFICATIONS

Mr. Scheel has extensive experience in construction planning and engineering, the preparation and administration of construction and equipment supply contracts, risk identification and mitigation, claims analysis and resolution, management of field offices, contractor-owner liaison, construction scheduling and cost control, technical and general procurement, constructability review of designs, inspection work, progress reporting, and review of progress payments and civil-works technical submittals. His contracting experience covers various project delivery systems, including design-build, engineer-procure-construct (EPC), target-estimate, cost-plus, conventional design-bid-build lump-sum / unit-price, and various unconventional hybrid contract forms. He is familiar with various standard contract forms, including those of the Engineer's Joint Contract Documents Committee (EJCDC), Federation Intenationale des Ingenieurs-Conseils (FIDIC), Design-Build Institute of America (DBIA), American Institute of Architects (AIA), Associated General Contractors (AGC), and those of various domestic and international clients and funding agencies.

EDUCATION

BS/BSc, Civil Engineering, University of Illinois
PGDip, Business Administration, DePaul University

Licenses and Professional Memberships

Professional Engineers: Civil: No. 20878 – Wisconsin; No. 20244 – Washington

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EXPERIENCE RECORD

Infrastructure Needs Program IQC, West Bank (Palestine), USAID-Gaza/West Bank

Contract Specialist: Under the USAID Engineering & CMC Services IQC to support the Infrastructure Needs Program, MWH Americas, Inc. was selected to act as the United States Agency for International Development (USAID) agent and advisor on contractual, administrative and technical issues of various multidiscipline construction projects. Construction projects include, but are not limited to, activities such as water, storm water and wastewater collection, treatment, and reuse systems; water treatment, transmission and distribution systems, roads rehabilitation and construction, buildings construction, border crossings, security installations, environmental assessments and any other infrastructure related work. Mr Scheel reviewed all contracts for suitability for international or local bidding.

AMP Hydroelectric Projects, Ohio River, American Municipal Power, Inc.

Contracts Engineer responsible for all contractual, commercial, and technical coordination issues relating to the project, consisting of four run-of-the-river hydroelectric plants added to four existing locks and dams along the Ohio River in Kentucky and West Virginia. Wrote or oversaw the production of its 31 contracts. Construction Value = $1,300 MM.

Water Sanitation Project, Due Diligence (Lesotho), Millennium Challenge Corporation

Institutional specialist advising local and national authorities in the water sector as to best contracting practices. The principal objective of this assignment was to provide technical analysis and assessments that would serve as critical inputs to MCC's due diligence on the technical, financial and institutional aspects of the proposed investments in (1) bulk water supply; (ii) water distribution system rehabilitation, improvement and extension; and (3) rural water supply and sanitation. The project relies on coordination of donors for the construction of the Metolong Dam and extensive environmental and social aspects involved in that effort. Using available information and the results of existing studies, MWH determined and made recommendations on (1) justification, (2) viability,

(3) sustainability, and (4) feasibility of the proposed projects. MWH was also required to identify critical gaps and additional preparatory work that required addressing prior to project implementation, as well as meaningful conditions necessary to mitigate risk.
Responsibilities included risk identification and mitigation, developing an overall contracting approach for implementation of the projects, reviewing existing practices, recommending improvements, and transfering knowledge of contracting techniques.

Lake Mead Intake No. 3, Las Vegas, Nevada, Southern Nevada Water Authority,
Contracts Expert – The Lake Mead Intake No. 3 Project involves the investigation of three intake options, pumping stations, and tunnels. The Lake Mead Intake No. 3 project consists of a deep-water intake, a pumping station, and a large-diameter water supply tunnel between the intake and pumping station. The project area is about 24 km east of the City of Las Vegas, in the Lake Mead National Recreation Area, and the tunnel and intake will be constructed beneath Saddle Island and the waters of Lake Mead, terminating 3.7 km to 5.5 km northeast of Saddle Island.
The intake will be located north of the Las Vegas Wash, in the Boulder Basin of Lake Mead, and will be designed for a capacity of 4,500 million liters per day at an intake elevation of 262 m mean sea level (msl). The intake will be a lake tap structure, similar to the existing SNWA intakes on Saddle Island, and will include provisions for a future extension to deeper waters northeast of the planned location. Responsible for revising the Southern Nevada Water Authority's standard contract documents, rendering them suitable for use in design-build projects.

Wells Hydroelectric Project, Washington St., Douglas County Public Utility District No. 1
Contracts Engineer responsible for all contractual, commercial, and construction planning issues relating to the fast-track rehabilitation of the Wells hydroelectric powerhouse on the Columbia River in Washington State. The project includes rehabilitation of ten hydroelectric units (Units 1 through 10) and emergency replacement of items of balance-of-plant equipment.

Brightwater Conveyance Design, Bothell, Washington, King County (Seattle Metro)
Senior reviewer/advisor on the East and Central Contracts for the Brightwater Conveyance System, near Bothell, Washington, for the King County Department of Natural Resources & Parks. The contracts include 46,000 ft (14,000 m) of 10-ft (3-m) dia. tunnels and 5600 ft (1700 m) of microtunnels.

Bujagali Hydroelectric Power Project (Uganda), Sithe Global Power, LLC
Contracts Engineer responsible for all contractual, commercial, administrative and construction planning issues relating to the Bujagali Hydroelectric Power Project on behalf of Sithe Global Power LLC who, together with Industrial Promotion Services, is the private build-operate-transfer (BOT) developer for the 250-MW run-of-the-river greenfield development on the Victoria Nile River for the Republic of Uganda, Ministry of Energy & Mineral Development. Prepared the RFQ and RFP for the engineer-procure-construct (EPC) contract, in accordance with the guidelines of the International Finance Corporation (IFC) and the European Investment Bank (EIB).
Kingdom of Lesotho - Institutional Improvements for Water Sector, Millenium Challenge Corporation
Institutional specialist advising local and national authorities in the water sector as to best contracting practices. Responsibilities included reviewing existing practices, recommending improvements, and transfering knowledge of contracting techniques.

SDCWA-LH/Olivenhain Ppln-61004, San Diego County Water Authority
Contracts Engineer responsible for all contractual, commercial, administrative and construction planning issues relating to the Lake Hodges Pumped-Storage Project for the San Diego County Water Authority, as part of their Emergency Storage Project. Developed all primary contracts, including: a design-build contract for the 5800-ft (1800-m) long pressure tunnel, 600-ft (180-m) deep shaft, roadwork, and miscellaneous site improvements; an EPC contract for the pumping / power-generation equipment (two 20-MW units); and a conventional design-bid-build contract for construction of the inlet/outlet, pump house build-out, transmission lines, and switchyard. Major challenges included coordinating multi-disciplinary engineering and construction tasks under multiple contracts, while maintaining a fast-track approach on a small site. The site was also ecologically sensitve.

CHANDER SEHGAL, P.E.

QUALITY ASSURANCE / QUALITY CONTROL

KEY QUALIFICIATIONS

Mr. Sehgal has over 35 years of international experience. He has won several awards and authored numerous papers related to gate design and operation. As Manager of the Hydro-Mechanical Design Group, he manages and supervises projects relative to gates, valves, trashracks, cranes, and hoists. His responsibilities include the preparation of design reports for new projects; inspection and rehabilitation design reports for existing projects; preparation of design memoranda; conceptual and detailed designs; plans; specifications; cost estimates; bid analyses; review of manufacturers submittals; and shop and field inspections and tests. Considered a specialist in the design of gates, valves, trashracks, cranes, and hoists, Mr. Sehgal has been requested to several project sites and workshops in the U.S. and abroad to inspect and test equipment and meet with clients and manufacturers for design consultation. He has served as project manager and/or engineer on a wide variety of MWH projects including coordination of complete civil, electrical and mechanical work.

EDUCATION

MS/MSc, Civil Engineering, University of Minnesota, 1970
BS/BSc, Mechanical Engineering, University of Delhi (India), 1961

Licenses

Professional Engineer, Alaska, PE/Alaska/1988/ME-7684
Professional Engineer, Illinois, PE/Illinois/1975/062-33627
Professional Engineer, New York, PE/New York/1990/066993 (currently inactive)
Professional Engineer, West Virginia, PE/West Virginia/1994/012289
Professional Engineer, British Columbia - Canada, PE/British Columbia, Canada/1998/127735

EXPERIENCE RECORD

Prairie du Sac Intake Head Gates and Maintenance Gates Rehab

Responsibility to study the condition of the existing head gates and maintenance gates and include calculations to

Yards Creek PSP, Power Intake Emergency Closure

Study of alternatives for installing emergency closure gate(s) at the existing two ungated openings, 10ft wide by 30 ft high, or a valve in the 20 ft dia. steel penstock.

1,200 MW Kalai II HEP DPR Preparation

Project management and coordination of the site investigations, dam and powerhouse location selection, project layout, and preparation of detailed project report.

Srisailam Penstock Bifurications Failure Review

Senior Reviewer. Coordinated review of penstock sickle plate failure, including review of the possibility of fatigue and resonance, and repair design.

Stave Falls Replacement Radial Gates Design

Reviewed Design Basis Memoranda and provided design direction for 5.8 m by 5.8 m, 14 m head new orifice radial gates (hydraulically operated) to be designed for new higher head and new seismic acceleration to replace

similar wire rope operated radial gates.

Kentucky Lock Addition Project
Mechanical Engineer**,** Supervised detailed design of 12-ft-diameter structural steel sector gear and accessories to replace existing cast steel sector gear on existing Kentucky Lock. Studied the characteristics of the existing sector gear, including its material properties, type of gear teeth, support arrangement, and assembly to its shaft. The corresponding requirements for the new structural steel sector gear were then finalized, followed by preparation of design calculations and drawings, which were checked, corrected, and reviewed by an independent reviewer before they were finalized and submitted to USACE. Supervised three staff. Developed new design for the sector gear, using structural steel to save hundreds of dollars in fabrication compared to a cast steel replacement. The work was completed on schedule and USACE was very pleased with the design. Supervised conceptual studies and preparation of design memoranda for layout and design of operating machinery for miter gate leaves (two alternative heights of leaves were studied; each 62-foot-wide leaf, inclined in mitered position, will cover half the 110-foot width of the lock), for 15-feet-wide by 15-feet-high reverse tainter type culvert valves, and for mooring bits for the new proposed 110-foot-wide by 1,200-foot-long lock.The Kentucky Lock addition used an innovative filling system intake that reduced the length of the lock; the lock chamber was relocated to reduce excavation and concrete volume; and costly cofferdams were eliminated by using float-in structures and a drilled shaft-supported structure. Resulted in savings of $83M. Project Cost: $500M.

Held coordination meetings with civil designers and USACE staff, reviewed references from similar locks before preparing the design memoranda, which were further refined during detailed design. Completed on schedule and within budget and USACE was very pleased with the design memoranda. CONTRACT - IDIQ Contract for A-E Services for New Lock Design & Major Rehab Projects for Existing Locks & Dams, Grand Rivers, KY / Chattanooga, TN - USACE, Nashville District (DACW-62-02-D-0006)

Warragamba Radial Gates and Drum Gates Modifications Review
Project Manager. Review of modification to existing 12.2 m wide by 13.3 m high crest type radial gates to withstand impingement by new PMF flow and to withstand re-defined seismic loading; also review of the latching arrangement to hold the radial gates in fully raised position; in addition, review of the modifications to the existing latching arrangement for existing 27.4 m wide by 7.4 m high drum gates to prevent hydrodynamic uplift on the gate.

Gates and Cranes Design: 35 MW Willow Island**,** 72 MW Smithland & 84 MW Cannelton Hydroelectic Projects
QA/QC Manager/Mechanical Engineer
Preparation of Design Memoranda and specifications for trashracks, intake bulkheads, emergency closure gates, draft tube gates, overhead cranes, trashrakes, and log grabbers; also review of bids and Contractors submittals.

As a mechanical engineer he was responsible for mechanical designs and supervising inspection of several malfunctioning screw stem hoists and preparation of plans and specifications for their replacement. MWH is serving as Owner's Engineer for these four hydroelectric projects.

Design of 100 MW Singoli Bhatwari Hydroelectric Project
Project Manager. Coordination of the review of existing detailed project report (DPR) and finalization (including optimization) of the basic design of the project with the client and MWH specialists in geology, geotechnical, planning, civil structural, hydrology, hydraulics, construction, turbine, generator, general mechanical, general electrical, and hydro-mechanical specialists.

Peace River

Supervisor. Preparation of conceptual drawings and specifications for gates and operators, including two 6.0 ft x 6.0 ft sluice gates with screw stem hoists; one 16.0 ft x 2.0 ft crest gate and screw stem hoist (twin-stem); one 4 T jib crane; and review of Contractor's submittals and shop inspection for the stated equipment.

Landsburg Flood Passage Improvement Project
Senior Reviewer. Review of arrangement for widening of existing bay to accommodate larger flood passage and selection of gate type for the new bay width (two 22m wide bays combined into one 44m wide bay)

Thornton Composite Reservoir - Tunnels and Gates Project
Lead Gates Engineer. Preparation of conceptual design and specifications for hydraulically operated 12.5 ft wide by 29 ft high wheel gates with built-in jet flow gates, 12.5 ft wide by 29 ft high plain wheel gates, and 12.5 ft wide by 29 ft high maintenance bulkheads with built-in filling valves, all for 375 ft design head and designed for sealing

against flow in either direction. Review of preliminary layout and report prepared by the Army Corps of Engineers; participation in discussions relating to various alternatives for routing of reservoir filling and emptying tunnels, including arrangement of gates (bonneted gates vs. wet well gates; wheel gates vs. slide gates) and cost consideration.

Lockport Powerhouse Sluice Gates Rehabilitation Project
Supervisor. Detailed design of a 36 ft wide by 36 ft. high dewatering bulkhead with wheels (upstream skinplate, downstream sealing), embedded parts, and lifting beam; also design of rehabilitation items for 9 ft wide by 15 ft high wheel type sluice gates and guides. Before the detailed design, performed a study of sluice gates dewatering structure alternatives including supervision of underwater inspection of existing piers by divers, and preparation of a study report

Ronoake Rapids Dam
QA/QC Manager. Supervision of the design of new trashracks, one upstream of one of the existing 38 ft wide by 30 ft high spillway radial gates, and one, operated by a wire rope hoist, upstream of the existing 17 ft wide by 17 ft high trash skimmer gate to provide for minimum flow requirements (300 to 500 cfs) and for control of fish passing downstream.

Mud Mountain Dam Fish Passage
Supervised preliminary study for the arrangement of 3 radial gates and operators, one submersible/overtopping radial gate, for the fish passage, replacing an existing barrier dam. Gate sizes are 35 ft by 8 ft, 16 ft by 8 ft, and 8 ft by 8 ft (submersible/overtopping).

Ross River Dam Spillway
Gates Design Manager. Detailed design and formulation of installation procedure for 17 ft wide by 14 ft high bulkhead (18 ft water pressure) for underwater installation to facilitate inspection of 14 ft by 14 ft sluice gate; review of bulkhead shop drawings and assistance during bulkhead installation; preparation of specifications for inspection of gate and design/procurement of replacement screw stem and actuator for gate operation; review of contractor's gate and actuator inspection report, replacement stem and actuator calculations, and rehabilitation procedure.

Studies for flood gate type selection (radial, hinged crest, Obermeyer), performance of conceptual design, and direction on detailed design of radial gates (two 11.75 m wide by 4.3 m high gates and one 13.06 m wide by 4.3 m high gate) and maintenance bulkheads operable with a mobile crane and a lifting beam.

Rising Pond Dam Bulkhead
Project Manager. Detailed design and formulation of installation procedure for 17 ft wide by 14 ft high bulkhead (18 ft water pressure) for underwater installation to facilitate inspection of 14 ft by 14 ft sluice gate; review of bulkhead shop drawings and assistance during bulkhead installation; preparation of specifications for inspection of gate and design/procurement of replacement screw stem and actuator for gate operation; review of contractor?s gate and actuator inspection report, replacement stem and actuator calculations, and rehabilitation procedure.

Senior Reviewer/Engineering Services, Upper Baker/Baker River Projects
Review of the scheme for removal of existing screen system and design of new trashracks (23 ft. wide by 36 ft. high, 10 ft. differential head).

Quality Control of the gates at Lower Baker and trashrack at Upper Baker. Puget Sound Energy, Baker River Hydroelectric Project Re-licensing Plan. This work involved the design of a juvenile fish guidance net, a net transitions structure, and a floating barge used to generate attraction flows for juvenile fish migrating from Upper Baker Lake. Additional design included improvements to the existing fish trap facility and adult barrier dam. MWH provided innovative structural, hydraulic, mechanical, civil, electrical, and dam safety engineering services for this unprecedented project. Design for this project involved implementation of criteria that was new and innovative, as a project of this type and magnitude had not previously been undertaken.

Technical Support, Mangla Dam Raising
General consultancy on various issues relating to modification of existing gates for raising of dam by 30 ft, including review and revision of specifications for gate equipment including chain hoist operated radial type spillway (flood) gates, 36 ft. wide by 40 ft. high, 169 ft. design head; and hydraulically operated intake wheel gates, 18 ft. wide by 36 ft. high, 229 ft. head; review of Contractor's scheme for isolating the radial gates for modifications; and various discussions during several site visits. MWH served as a consultant for this project. (Ongoing)

Rock Island Powerhouse No. 1 Rehabilitation
Review of intake wheel gate rehab specifications; review of new replacement draft tube gate specs. including sealing arrangement and study of existing intake trashracks and preparation of a report detailing pros and cons of their replacement/ rehab, hydraulic efficiency enhancement, trashraking possibility, and procedure for replacement/rehabilitation

Rocky Mountain Upgrade-Power Systems/Rocky Mountain Pumped Storage Uprate Project
Review of existing draft tube trashrack design to withstand higher new flow (2003); supervision of specifications and drawings for the replacement operating cylinder for the existing 10 ft 8 in spherical valve (2006).

As lead gates and cranes engineer, prepared design memoranda, selected equipment, and wrote specifications for the 760-MW project for several gates and hoists, including 22-ft x 23-ft radial type flood gates with hydraulic hoists; 17-ft x 17-ft draft tube gates with wire rope hoists; 21-ft x 21-ft draft tube trashracks (approx. 33 ft per second flow velocity); 40-in. and 10-in. jet-flow gates (for flood control) with hydraulic hoist, and 22-ft x 25-ft spillway bulkheads. Provided detailed design of draft tube trashracks, and several other trashracks and stoplogs. Work included bid reviews, review of manufacturers drawings; shop inspections; and field assistance during the installation of various gate equipment items. Supervised preparation of specifications and review of manufacturer's drawings for 600-ton powerhouse bridge crane, 200-ton valve chamber bridge crane, and 100-ton erection bay gantry crane.

Engineering and Design Services
Quality Control on modifications to existing 10-unit powerhouse at Wanapum Dam. Provided quality control on the design and specifications for multiple synchronized hoists to facilitate dismantling and erection of the 10 hydraulic turbines to allow installation of physically larger turbine units. Provided quality control on modifications to draft tube gates and hoists, design and installation of the powerhouse crane, installation of erection pedestals, and modifications to the generator barrel and turbine pit.

KOJIMA, Takashi, P. Eng.
Transmission Cable Specialist

More than 40 years of combined experience in both manufacturing and utility industries on design, feasibility studies, trouble shooting of the underground and submarine cable systems and their components ranging from 69 kV through 525 kV voltage level. In addition to work on the ac and dc transmission cable systems of BC Hydro, the work covered projects in Singapore, Egypt and Jordan. Mr. Kojima also has an extensive experience in evaluation of mechanical performance of transmission cables including seismic performance of cables in ducts, buried and tunnel as well as submarine cables installed in slope with potential for slide. Mr. Kojima has been with BC Hydro since 1990 as a senior, specialist and principal engineer. He was previously with Canada Wire and Cable Ltd of Toronto, Ontario, one of the leading cable manufacturers in the world where he was responsible for design of transmission cables, accessories and distribution cables ranging from 5 kV through 345 kV level as well as transmission cable systems design. Mr. Kojima participated in preparation of IEEE1425 standard. Mr. Kojima acted as an advisor to EPRI on several research projects involving XLPE transmission cables.

EDUCATION

1969 Bachelor of Engineering, Mechanical Engineering
Musashi Institute of Technology, Tokyo, Japan

Certificate, Electrical Engineering Technology
Ryerson Polytechnical Institute, Toronto, Canada,

PROFESSIONAL ASSOCIATIONS

Member, Association of Professional Engineers and Geoscientists of British Columbia
Senior member, Institute of Electrical and Electronics Engineers, Power Engineering Societies

PROFESSIONAL EXPERIENCE

1990 to date BC Hydro, Vancouver, Canada

Title: Principal engineer/Specialist Engineer / Sr. Engineer

As a leader or part of an engineering project team, designed and provided engineering inputs for many land and submarine cable systems ranging in voltage level from 69 kV to 525 kV for both BC Hydro and international applications. Activities included technical studies, trouble shooting, cost estimating, land as well as underwater surveys and reviews, route

selection, specification and drawing preparations, accessory designs, bid evaluation, contract negotiations, contractors' design approvals, factory test, site test and report reviews, construction inspection and commissioning test acceptance. Performed studies and investigations to determine optimum cable types and systems; prepared technical specifications, evaluated tenders, and acted as BC Hydro technical representative for a supply and installation contract for 242 kV transmission cable circuits.
Designed/modified straight through and oil stop joints for SCFF cables rated up to 242 kV to suite available cables for speedy restoration of failed cable circuits. Studied and investigated ratings of transmission cable circuits crossing steam pipes, and designed methods of mitigation; reviewed fluid reservoir capacities of various fluid filled cable circuits and upgraded the systems as necessary.
Lead refurbishment project of 525 kV Submarine cable contaminated with moist air due to termination failure using a novel method not experienced previously in the world.

Through BC Hydro International Ltd, performed studies and investigations to determine optimum cable type and system for 400/ 500 kV underground transmission cable circuits for Singapore PUB and prepared technical specifications for a 400 kV cable circuit. . As the owner’s representative, witnessed 400 kV submarine cable laying operation across Gulf of Aqaba between Egypt and Jordan with 850m depth

Planed, coordinated and administered a series of tests to determine mechanical properties required for analyses of thermal-mechanical and seismic performances of various types of transmission cables supplied by different cable manufacturers and recommended allowable limits of deformations for use by BC Hydro.
Conducted seismic performance evaluation of various underground and submarine transmission cables and associated equipment rated up to 525 kV and coordinated seismic upgrade design and site work.
Chaired a meeting attended by geotechnical/geological experts from University of Alberta, University of BC, University of Victoria, Pacific and Atlantic Geo-Science Centres, consulting firms as well as BC Hydro to assess seismic stability of BC Hydro submarine cable corridors.
Coordinated and administered geotechnical studies and field drilling program to determine slope stability of new 242 kV submarine cable corridors as well as to assess performance of submarine cable under expected slope failure.
Coauthored a report on condition assessment of 300 kV DC submarine cables, reviewed various technical reports including vortex shading vibration and lead sheath fatigue of submarine cables submitted by contractors; participated in preparation of IEEE1425 standard and drafted two sections on selection and aging of metal sheaths on SCLF cables.

Represented BCTC and BC Hydro at EPRI Underground Transmission Task Force, and acted as an advisor on several research projects involving XLPE transmission cables.

1985-1990 Canada Wire and Cable Ltd., Toronto, Canada

Title: HV Cable Design Engineer and Supervisor of Drafting Section

Responsible for optimization of the mechanical and electrical design of underground high voltage power transmission cable systems; cables, terminations, joints, oil feeding systems, cross bonding equipment and other related accessories. Responsibilities included development of flexible submarine cable joints, process improvement and trouble shooting related to cable production and installation. Prepared system, cable and associated equipment designs including hydraulic, mechanical and electrical calculations required for various contracts and tenders for domestic and international clients.

Developed a number of computer programs required for cable design, cable accessory design, supporting system, oil feed system designs, oil demand, and cable installation. Carried out analytical studies on behavior of high pressure oil filled pipe type cables installed in slopes.

1975-1985 Canada Wire and Cable Ltd.

Title: Mechanical Engineer, High Voltage Systems

Responsible for the coordination of mechanical design and supply of equipment required for high voltage underground transmission cable systems. Designed accessories including joint, termination and spreader head for 3/C 138 kV high pressure gas filled composite submarine power/communication cable.

Coordinated design and supply of 220 kV high pressure pipe type cable accessories, and handled liaison with three SF6 switchgear suppliers from three different countries for a contract in Cairo, Egypt.

Carried out various analytical and experimental studies on mechanical properties of cables and their components including strain induced along corrugated aluminum sheaths, fatigues and creep properties of aluminum for sheath, and compressive, tensile and bending rigidities of cable cores.

Designed 230 kV self-contained oil filled cable installed in a 600 m deep shaft, accessories, cable support systems and support structures for cable terminations and auxiliary equipment. Prepared a number of technical study reports for approval by customers.

1971-1975 Canada Wire and Cable Ltd.

Title: Senior Draftsman, High Voltage Systems

Responsible for preparation of designs and drawings for cable accessories, pressure vessels and test set-ups.

1969-1971 Aero Auto Engineering, Toronto, Canada

Draftsman, High Voltage Systems (Canada Wire and Cable Ltd

Dispatched to Canada Wire and Cable. Responsible for preparation of designs and drawings for cable accessories for low voltage and high .

TECHNICAL PAPERS - Examples

"A Novel Method of Restoring BCTC 525 kV Submarine Cable Following a Catastrophic Breakage of a Termination at a Cable Landing Site" 2010 CIGRE Summer Meeting, Paris, France (co-authored)

"Dynamic Response of Underground Transmission Cables to Seismic Waive", 1997 IEE of Japan, National Convention, Kyoto, Japan (co-authored)

"Response of Underground Cable Duct System to Travelling Seismic Waves" 2000 Lifeline Conference, Vancouver Canada (co-authored)

"Emergency Operating Temperature for XLPE Cables" 2002 EPRI Underground Transmission Task Force Meeting

"Generic Cable Study and Specific Underground Cable Review" BC Hydro internal report (co-authored)

"500 kV & DC Submarine Cable Terminal Sites – Seismic Evaluation of Non-Early Attention Items" BC Hydro internal report.

"Cable Deformation vs. Electrical Failure" BC Hydro internal report

"60L51/52/53 Hotspot Mitigation & Cable Evaluation" BC Hydro internal report

LANGUAGES

Fluent in English and Japanese

GLENN TARBOX, P.E.

QUALITY ASSURANCE / QUALITY CONTROL

KEY QUALIFICTIONS

Mr. Tarbox has 41 years of experience as a civil/structural engineer in all facets of water resource project development and management. He offers expertise in planning, design, management and construction of dams, hydroelectric plants, transmission lines, tunnels and other major civil works projects. His early career developed as a dam design and construction engineer and Assistant Chief, Dams Branch with the U.S. Bureau of Reclamation; the past 22 years have been spent with the private sector. Glenn has served as Design Engineer or Project Manager on more than 23 major domestic and international dams and is often called upon to serve as a dam expert on consulting boards for new or upgraded projects, a FERC certified Part 12 Independent Safety Consultant and as an expert forensics witness related to dams.

EDUCATION

BS/BSc, Civil Engineering, University of Maryland
BS/BSc, Mathematics and Operations Research, University of Colorado (School of Mines)
BS/BSc, Hydraulics, University of Colorado (School of Mines)
BS/BSc, Structures, University of Colorado (School of Mines)
MS/MSc, Master of Science Academic Requirements, University of Colorado

Licenses and Professional Memberships

Professional Engineer, Alaska, 4871
Professional Engineer, Arizona, 16736
Professional Engineer, Colorado, 9311
Professional Engineer, Georgia, 18035
Professional Engineer, Illinois, 062-044980
Professional Engineer, Montana, 8292PE
Professional Engineer, Texas, 59105
Professional Engineer, Utah, 167339-2202
Professional Engineer, Wyoming, 4759
Professional Engineer, Washington, 2201
Professional Engineer, Idaho, 11113
Professional Engineer - Civil, L3458 - New Brunswick

EXPERIENCE RECORD

Seismic Assessment Study for Gene Wash Dam/Reservoir and Copper Basin Dam/Reservoir

Providing evaluation phase oversight of two thin arch dams. Upstream deformation and cracking was observed at both dams immediately after reservoir filling. Studies confirmed the dam concrete was undergoing alkali-aggregate reaction (AAR) contributing to the deformation. Evaluated overall dam performance for earthquake-induced vertical and horizontal deformations based on the Maximum Credible Earthquake. Used three dimensional finite element analyses and a material properties parametric evaluation that considered a substantial reduction in the concrete normal tensile strength due to AAR.

Romaine 1, 2, 3, and 4 Hydroelectric Projects
Member Board of Review to review designs and construction management of the 640MW Romaine 2 Hydroelectric Project as part of the 4 Power Plant Romaine River Developments (1,550MW total installed capacity).

Eastmain 1A & La Sarcelle Hydroelectric Projects
Member Board of Review to review designs and construction management of the 768MW Eastmain 1A and 150MW La Sarcelle Hydroelectric Projects as part of the Rupert Diversion.

Upper San Joaquin River Basin Storage Investigation
QA/QC Manager providing oversight for intake structures, tunnel, and powerhouse features for new dam and reservoir on the San Joaquin River. CONTRACT: IDIQ for Water Resources Planning and Engineering (01CS20210B and BRPS/06CS204097B)

San Vicente Dam Raise
Mr. Tarbox was task leader and principal structural engineer overseeing the design of a 337-ft-high RCC gravity dam (a 117-ft raise from the original height of 220-ft to 337-ft when completed), including RCC mix designs, optimization of raised design cross-section, FEM static and dynamic stress analyses, thermal studies, instrumentation design, facing systems, galleries and saddle dam. The project featured two tunnels, a 9-foot-diameter penetration through the existing dam into a submerged cofferdam at the upstream face, and a 17-foot tunnel and shaft beneath the raised dam while maintaining reservoir levels.

Tekeze Arch Dam & Hydroelectric Project
As Senior Advisor & Principal Structural Engineer, responsible for technical review and field inspection of project works, quarry development, aggregate processing, concrete mix designs, consolidation grouting of foundation and finite element seismic stress analysis for a 190-m-high, thin-arch concrete dam. He reviewed and recommended special foundation shaping studies including rock slope stability assessment, rock reinforcement and anchor design, and design of a combined shaping and thrust block structure to reconstitute left abutment ground contours.

Karahjnukar Dam and Hydroelectric Project
Senior Advisor, Principal Structural Engineer and reviewer for a 200-m-high, concrete-face rockfill dam (CFRD) in Iceland He provided quality assurance (QA) review of foundations; instrumentation; design and analysis of a special 40-m-high concrete gravity toe wall to resist tectonic displacements of faults existing in the foundation; RCC mix design; and PVC water-proofing membrane.

Columbia River Off-Stream Storage Study
Project Manager for the Columbia River Off-Stream Storage Study to identify off-stream versus on-stream reservoir sites of 300,000 feet or larger for pumped storage and/or modification of existing facilities to allow for additional storage.

Santa Anita Dam Re-Analysis
Principal-in-Charge for re-analysis of Santa Anita Dam, a 225-foot high concrete arch dam built in 1924-27. The primary issues of concern include Alkali-Aggregate Reaction (AAR) within the dam concrete, seismic stability to withstand the current Maximum Credible Earthquake (MCE), and hydraulic adequacy of the existing spillway to handle updated Probable Maximum Flood (PMF). Performed an engineering/safety inspection and investigation of the dam. Cores were obtained to assess the existing condition of the concrete (including petrographic analysis). Design earthquakes were developed using actual ground motion records scaled to spectrally match a target spectrum. Linear-elastic and non-linear finite element analyses were performed to assess the seismic stability of the dam. Updated hydrologic analyses were performed to develop inflow hydrology for evaluation of the existing spillway.

Baise Multipurpose Dam Project
Project Manager for the review of designs, operating policy, environmental impact assessment, economic and financial analysis and alternative flood protection possibilities for the $500 million Baise multipurpose Project that includes a 130-m-high (430 ft), 2 million cubic meter, RCC dam, two rockfill dams and a 540-MW underground powerplant

Big Tujunga Dam Stability Evaluation/Big Tujunga Dam Seismic Rehabilitation and Spillway Modification Project
As Principal-in-Charge, provided oversight of the final design and stability evaluation of a 251-foot-high concrete arch dam. He performed a seismic dynamic finite element analyses of the dam using ground motion records modified to spectrally match a target spectrum. He developed six general rehabilitation concepts and analyzed each concept using the finite element method. The selected concept consisted of placing RCC on the existing dam's downstream side to transform it from a thin to a thick arch dam, to achieve seismic strengthening and spillway modifications for hydraulic rehabilitation. (1999 - Present). Big Tujunga Seismic Rehabilitation and Spillway Modification Project received the National Rehabilitation Project of the Year Award, Association of State Dam Safety Officials (ASDSO), 2011. The 244-foot-high, variable radius thin-arch Big Tujunga Dam required modifications to strengthen the dam for seismic events and to create additional spillway capacity. (Ongoing)

Mactaquac Generating Station
Member Board of Review for annual review and evaluation of monitoring and mitigation programs conducted by NB Power dealing with severe autogenous growth problems in the concrete of the head works dam, spillways and powerhouse structures due to AAR (Alkali Aggregate Reactivity). Unprecedented expansion due to AAR has resulted in NB Power adopting a range of measures to combat the ongoing expansion including a regular program of saw-cutting monolith blocks in the head works adjacent to the spillway, between generation bays in the powerhouse, and in spillway access bridge slabs, excising portions of six penstock encasements and replacement with expansion couplings and a program of continuous realignment of the turbine and generator shafts to accommodate out-of-round and out-of-plumbness of the units due to the AAR expansion.

Olivenhain RCC Dam
Project Manager overseeing the detailed design of this 318-foot-high, 1.4 million cubic yard RCC gravity dam with a six-level selective withdrawal I/O tower and a stair-stepped cascade spillway on the dam's downstream face. The dam will create an offstream reservoir to provide emergency water supply to 3.5 million San Diego County residents in the event an earthquake severs the region's water delivery aqueducts and pipelines. The $140 million dam is part of the $850 billion Emergency Storage Project and will be the highest RCC dam in North America and the first new RCC dam constructed in California. The design included the Lake Hodges Portal, tunnel stub, and shaft for the future Lake Hodges Pumped Storage Project. The Team prepared specifications, drawings and contract documents for four separate construction contracts and is providing engineering services to the Authority during construction. (1998-Present) Olivenhain Dam received the ASCE Opal Award of Merit, 2005 and Milestone RCC Project 1987-2007, 5th International Symposium on RCC Dams, Guiyang, China, 2007

Xiaolangdi Multipurpose Dam Project
Served on the Xiaolangdi Dam Consulting Board. The Xiaolangdi Dam, on the Yellow River in Henan Province, consists of a 505-foot-high earth and rockfill dam, 15 outlet and power tunnels, an intake structure, an 1800 MW underground powerhouse and a concrete-lined plunge pool stilling basin. The intake structure consists of ten towers with a height of 367 feet and a total volume of more than 4.4 million cubic yards of concrete. There were three 60-foot diameter, 3,600-foot long diversion tunnels, six 25-foot diameter power tunnels and three 39-foot wide by 62-foot high by 2,950-foot long tailrace tunnels. There are also six 21-foot diameter post-tensioned pre-stressed tunnels for sluicing of sediment.

Served on the Xiaolangdi Dam Consulting Board, the Xiaolangdi Dam on the Yellow River in Henan Province, consisting of a 505-ft-high earth and rockfill dam, 15 outlet & power tunnels, an intake structure, an 1800-MW underground powerhouse and a concrete-lined plunge pool stilling basin. The intake structure consisted of ten towers with a height of 367-ft & a total volume of more than 4.4 million cubic yards of concrete. There were three 60-ft-dia, 3600-ft long diversion tunnels, six 25-ft diameter power tunnels & three 39-ft wide by 62-ft high by 2,950 ft long tailrace tunnels. There are also six 21-ft dia post tensioned pre-stressed tunnels for sluicing of sediment.

Bear River Risk Assessment
Project Manager for the risk assessment of a series of dams on the Bear River. The study demonstrated an Incremental Consequence Assessment (ICA) for the four dams: Soda Point, Grace, Oneida and Cutler. The results were presented to the Federal Energy Regulatory Commission (FERC) by the Owner to illustrate the threat posed to downstream dams by upstream dams in a cascading failure scenario in probabilistic, economic and safety terms. The Owner's proposals for upgrading the dams were based on the results of the risk assessment and were accepted by the FERC.

Rocky Mountain Hydroelectric Project
Responsibilities as chief engineer included an overall QA/QC program for the Rocky Mountain Hydroelectric Project. He was Vice President of Engineering during project design, which included an upper reservoir ring embankment dam, eight lower reservoir dams and a 750-MW pumped storage power station.

Feasibility Investigation and Design Study
Dwaar Kill Reservoir
Senior staff member responsible for conceptual designs and overall quality control for a feasibility investigation and design study of a water supply project that involved a 267-meter-long embankment dam and a 256-meter-long roller compacted concrete dam designed to impound a 16-million-cubic-meter reservoir. (1988-1990)

Upper San Joaquin River Basin Storage Project, Reclamation
Served on a team that suggested alternative ideas and solutions to perform functions, consistent with identified criteria, at a lower cost or increase in long-term value. They evaluated, analyzed, and prioritized ideas. The best ideas were developed to a level suitable for comparison, decision making, and adoption. The total dollar value of all alternative ideas represented an estimated reduction in costs of approximately $650M of the estimated $2B project feasibility cost estimate. MWH provides engineering design, cost estimating, environmental compliance, modeling, planning, cultural resource studies, economic evaluations, and stakeholder/public outreach services to Reclamation for the Upper San Joaquin River Basin Storage Investigation (USJRBSI) project. (Ongoing)

BRUNO TROUILLE. P.E.

ECONOMICS / PRO FORMA
SR. PROJECT MANAGER

KEY QUALIFICATIONS

Mr. Trouille has been the Lead Economic and Financial Consultant on a number of water resources and energy projects. He developed pro-forma financial spreadsheet models to analyze both public and private project financing. He worked closely with World Bank teams and private developers to develop short-term investment programs and detailed financial analyses of water, wastewater and hydro projects. He wrote papers on hydropower financing and economic trade-offs between power and non-power benefits.

He serves as Senior Project Manager on water resources and energy projects (master plans, feasibility studies, due diligence), irrigation and flood control projects, water supply and power system expansion studies, regional market analyses, water supply, and hydrologic studies. He supervises and coordinates other engineers, scientists, and subcontractors involved in complex water resources and energy projects. He has led many master plans, feasibility studies, and (re)licensing studies of small run-of-river hydro facilities to very large multi-purpose projects. For a master plan study of the Jordan Rift Valley between Jordan and Israel, he prepared Project Profiles for a wind farm, a solar power plant, and a regional energy center. He is Chair of MWH Committee on renewable energy.

Mr. Trouille has directed training and transfer of technology programs on most of the overseas projects he has been responsible for. These programs included on-the-job training of counterpart personnel in their native countries and various internships, tours, seminars and workshops in the US.

EDUCATION

MS/MSc, Industrial Relations, Loyola University
MS/MSc, Civil Engineering, Institut Catholique des Arts et Métiers (Lille)
BS/BSc, Mechanical Engineering, Institut Catholique des Arts et Métiers (Lille)

EXPERIENCE RECORD

Belesar-Peares III Pumped Storage Project
Led a team of Senior Experts to provide an overall due diligence and fatal flaw analysis of the proposed layouts of a 200-MW pumped storage project, as well as a more detailed analysis of the hydraulic transients. The major technical tasks included review of geology, geotechnical aspects, general layout, unit size, tunnel design criteria, cavern design, intake submergence, and selection of electromechanical and hydro-mechanical equipment. A team of 7 Engineers came from Spain and spent one week in the Chicago office.

Moraca Hydro Projects
Montenegro
Assisted the IFC Team in reviewing the proposed projects (up to 4 projects with a total installed capacity of 235 MW) and preparing draft concession agreements for private developers/investors, project technical specifications and Instructions to Bidders. Participated in meetings with the 4 short listed bidders during the bidding phase.

Inver Small Hydro Scheme
Provided general Quality Control of the feasibility studies. Reviewed hydrology analysis, reservoir operation studies, and project economics. The project would have an installed capacity of 1 or 2 MW.

Pumped Storage and Integration with Wind Power in the Pacific Northwest
Led the preparation of a white paper which provides an overview of pumped storage hydropower, focusing on the technical and operational aspects, characteristics and benefits of pumped storage for integrating large quantities of wind power development into the Pacific Northwest power grid. Analysis of adjustable speed technologies was also included.

Kafue Gorge Lower Hydropower
Project Manager for the feasibility study of a 750-MW hydro power project, and preparation of RFQ and RFP documents to select a private developer/investor for the project. Various sites were first investigated to recommend final project location and overall layout. Alternative CFRD and RCC options were examined for the 120-m-high dam. A 5-unit underground powerhouse was selected. Additional aerial and seismic surveys were done. Climate change impacts on river hydrology was investigated. A Strategic Options Report was prepared for the Government of Zambia to describe alternative private and Public Private Partnership options to develop and finance the $1.5 billion project. Selection criteria for the RFQ and RFP phases were presented in the report. A detailed technical and economic feasibility study was prepared.

Mt. Elbert Pumped Storage Plant, Reclamation
Lead Project Economist for the condition assessment of Mt. Elbert. Tasks included a risk assessment of major electrical and mechanical equipment, development of improvement options, economic evaluation of opportunities, and development of investment scenarios. The main objective of the study was to provide the Bureau and its partners with a cost effective investment strategy that will result in maintaining the reliability and availability of the Mt. Elbert pumped storage plant, as well as safety for the personnel and the public, for the next thirty or more years. The second objective was to identify and assess viable plant opportunities such as improved efficiencies, improved range of operation and ancillary services, and reduced cost of operations and maintenance.

Renewable Energy Credits
As a Senior Advisor, provided input and comments to develop a strategy to successfully assist the City of Peru, IL obtain Renewable Energy Credits (RECs) for its 8-MW hydro facility that generates, on average, 40,000 MWH annually. In both 2008 and 2009, we assisted the City of Peru respond to RFPs issued by the two large Illinois utilities to purchase RECs. Tasks included confirming the eligibility of the hydropower facility, setting up an account with a REC Tracking System, identifying the requirements in each RFP, and strategizing on a bid approach for the City of Peru. The City of Peru was awarded all its REC bids made, and has been receiving significant additional revenues from their existing hydropower facility.

Amaila Falls Hydroelectric Project
Project Manager for the review and update of the feasibility study that was done in 2001, and preparation of a Project Brief and EPC tender documents. The Project is located at the confluence of the Kuribrung and Amaila Rivers, just above Amaila Falls, approximately 250 kilometers from Georgetown, Guyana The Project would divert about 33 m3/sec through a low pressure headrace tunnel, a vertical shaft, a pressure tunnel and a penstock for a distance of about 3 km, leading to a surface powerhouse located below Amaila Falls, utilizing the available gross head of approximately 360 m for electricity production. The installed capacity was increased from 100 to 140 MW. The original cost estimate was updated to reflect current market conditions. An alternative dam and spillway configuration (RCC versus CFRD) was analyzed, as well as an increased dam height of 2 to 8 meters. Power system studies were also conducted to analyze how the hydro project would be integrated into the total power system of Guyana. Assistance was also provided to the Client in promoting the project to potential EPC Contractors.

Amman Wastewater Master Plan
Performed an economic evaluation of investment and O&M costs for various alternative development plans over the period 2007-2035. Developed funding scenarios (public, private, public-private partnership) to finance the recommended treatment plant and related conveyance systems (a total investment cost of about $160 million).

Lima Pumped Storage Feasibility Study
MWH Project Manager for the site selection studies, feasibility studies and preparation of tender documents of a 1,500-MW pumped storage project in South Africa. Four alternative locations were analyzed with heads ranging from 550 to 850 meters. A detailed feasibility study, construction schedule and cost estimate were performed for the selected alignment. Cost estimates were updated. Besides a reference cost estimate, low and high cost estimates were developed to reflect variations of key commodities and equipment prices. A Risk Register was developed and each risk was assessed according to the severity of the potential impact and the probability of occurrence. Tender design, specifications and documents for the Main Access and Cable tunnels were prepared.

Water and Hydropower Development
Project Manager for Reconnaissance and Pre-Feasibility studies to evaluate investment opportunities in water supply and hydropower facilities to serve the Federal Capital of Nigeria. Hydropower projects range from 10 to 150 MW. Water supply projects range from 1 to 3 cubic meter per second. Visited the project area and worked very closely with two Nigerian engineering companies. Assisted our Client, a Nigerian-US investor, during various oral presentations to the Minister of Power and other High-Level Representatives from the Federal and State Governments.

Dnister Pumped Storage Project
Economic and Financial Analyst to review and assess the viability of completing the construction of the first 3 units. An analysis of the Ukrainian existing and forecasted electricity demand and supply was performed as well as the integration of the proposed project into the hourly dispatch of power system. The first 3 units have a total installed capacity of 1,050 MW. The analysis was part of a due diligence study performed for the World Bank that is interested in investing as much as $200 million to complete construction of the first 3 units (Phase 1).

Development of HOGK Strategy and Investment Program
Assisted HOGK Executive Board of Directors and Senior Management in developing a 3-year strategy for the new company created from RAO UES, the Russian national electric power company. Assets of the new company include 22,000 MW of existing hydro facilities as well as about 10,000 MW under construction. Study focused on the ownership, organizational structure and management of the new company, development of a priority investment program in rehabilitation and upgrade, completion of new projects and start up of new ventures.

Site Selection Studies for Kafue Gorge Lower
In collaboration with ZESCO staff, carried out a reservoir operation study, updated cost estimates, and benefit-cost analysis to determine the most appropriate site to locate the dam for the proposed 750-MW Kafue Lower Project. A detailed hourly optimization model was created to simulate the operation of both the existing Kafue Upper (900 and up to 1500 MW) and Kafue Lower projects. Construction cost estimates were updated for the three dam location alternatives that were under review.

Generation and Transmission Investment Study
The main objective of the proposed study was to assist the European Commission, International Financing Institutions (World Bank, EBRD, EIB) and donors in identifying an indicative priority list of investments in power generation and related regional transmission interconnections from the regional perspective and in line with the objectives of South East Europe Regional Electricity Market. Led a team of experts to develop 20-year expansion plans for each country and for the region as a whole, taking into account constraints in transmission interconnections. Run various computer models including WASP, GTMax and PSS/E and computed hourly marginal costs under various hydrological conditions. Developed specific recommendations and short-term priority actions.

Finchaa-Amerti-Neshe (FAN) Multipurpose Project
Development of hydropower and irrigation potential of the Neshe River with respect to the optimum allocation of water resources, existing infrastructure in the area (2 existing reservoirs, 130 MW Finchaa hydropower station and 7,000 Ha Finchaa Sugar Estate). The hydro project consist of a 22-m-high dam, a 0.4-km low-pressure pipe, a 180-m vertical shaft, a 1.1-km tunnel, a 1.2-km surface penstock, and a 2-unit Pelton powerhouse. Project Manager and Financial Analyst for the feasibility study of a 100-MW hydro project and a 35-km transmission line. Performed all the economic and financial analyses.

Russian Power Sector Restructuring Project
Consultant to the Russian Ministry of Energy who assisted with the restructuring and liberalization of the Russian Power Sector. More specifically, developed a program of State incentives for new investments into the power sector, which are to be integrated into State policies for the restructuring effort. As part of this assignment, identified and analyzed investment risks, recommended options to lower risk, developed sample models for investment projects (BOT, BOOT, BOO, etc.), recommended optimal financial structures, developed tax, tariff, and

Assessment of a 330-kV Transmission Line for Two New Mines
Project Manager for the preparation of a bankable document to build the 190-km 330-kV line between the existing Luano substation and a new mining development in Kansanshi (80 MW0 and Lumwana (45 MW) in the northern province. A feasibility report, environmental impact assessment and tender documents were prepared. The country power sector was reviewed to analyze future demand and supply for electricity and cost of production over the next 15 years. Financing options for the construction of the line were discussed with the power utility, representatives of the Ministry and the mining developers.

Water & Wastewater Systems Environmental Audit
MWH was retained to conduct an environmental audit of the City of Bucharest's Water and Sewerage System to identify the nature and importance of environmental hazards and liabilities resulting from past and present operations. Mr. Trouille served as the lead corporate contact for the client. In this capacity he was responsible for selecting local subcontractors, preparing a proposal, overseeing project scheduling and maintaining communications with the client.

Trans-Balkan Power Line Project
The objective of the study was to analyze the technical/environmental feasibility and financial viability of constructing two new transmission interconnections to improve the power transfer capabilities between Albania, Bulgaria and the Former Yugoslav Republic of Macedonia. The first line is a 400-kV line connecting Radomir in Bulgaria and Dubrovo in the Former Yugoslav Republic of Macedonia. The second line is a 220-kV line connecting Vrutok in the Former Yugoslav Republic of Macedonia and Burrel in Albania. In addition, the legal and institutional framework in each country was assessed to identify any legal, regulatory, political or other institutional problems or constraints that might be imposed on the participation of the private sector in these two projects.

Least Cost Expansion Program
Project Manager for the 20-year development of the recommended least-cost expansion program. Three scenarios of future energy and electricity demand were developed for the period (2000-2020) using the MAED model. Existing thermal and hydro powerplants were assessed, along with new generation options (gas-fired, nuclear, and renewables). The least cost capacity expansion plan was developed in association with Argonne National Laboratory, using the VALORAGUA and WASP models.

Macedonia Power Distribution System
Prepared the economic analysis and ranking of a 5-year investment program for each of the 28 electric distribution companies. Benefits included reduction in energy distribution and transmission losses due to improved networks, reduction in energy not served due to less frequent forced outages, and reduction in energy not sold due to the replacement of old equipment and investment to serve new customers.

RESUME

CHRISTOPHER WOODWORTH-LYNAS, Ph.D. P. GEO

GEOLOGIST

FUGRO GEOSURVEYS INC.

Last Update: May 2009

EDUCATION

B.Ed. (High School): Memorial University of Newfoundland, Canada	1996
Ph.D., Marine Geology University of Wales, U.K.	1992
M.Sc., Geology Memorial University of Newfoundland, Canada	1982
B.Sc. (Hons.), Geology Liverpool University, U. K.	1977

SAFETY TRAINING

WHMIS Frontline Safety, Dartmouth, NS	2007
MED A1 Fisheries & Marine Institute Memorial University of Newfoundland	1999

EXPERIENCE

The following is a sample of Mr. Woodworth-Lynas' experience:

- Over 25 years experience in marine geophysical survey and interpretation.
- Onboard geoscientist during detailed offshore and landing site geophysical investigation for proposed High Voltage Direct Current power cables for Strait of Belle Isle and Cabot Strait site surveys offshore Nova Scotia and Newfoundland including 2D high resolution seismic surveys (EnCana and Husky).

  Onboard geoscientist during site surveys offshore Nova Scotia for EnCana

  Onboard geoscientist during site surveys offshore Newfoundland for Husky.
- Offshore geophysical/geological experience from Canadian Arctic, Labrador Sea, S. China Sea, Gulf of Thailand, Arabian Gulf, Caribbean and Venezuela.

- Use of processing software Kingdom Suite 2d/3d PAK and CARIS HIPS/SIPS.
- Recently completed analytical reports on establishing an ocean observatory in the northwest Atlantic
- Recently completed a concept study for an Aquatic Research Centre and realtime watershed and coastal observation system for Sir Wilfrid Grenfell College, Memorial University of Newfoundland.
- Led a 2-year, $2.7 million project that resulted in the successful design, build and demonstration of a unique, parametric sonar system to detect and classify buried landmines (anti-personnel and anti-tank) in ½ m-deep water. Involved construction of a complete test site in an abandoned shallow tailings pond.
- Performed a series of sonar discrimination tests on UXO: 20 mm, 75 mm, 81 mm (mortar), 105 mm and 155 mm artillery shells and shrapnel.
- Performed concept study for ONR on feasibility of small UUV's in littoral mine detection using parametric sonar array.
- Expert on seafloor ice scour, especially in the mechanics of soil deformation.
- Assessment of the effects of ice on movement of unexploded ordnance in Lac St. Pierre, St. Lawrence River (Dept. of National Defence).

PROFESSIONAL ASSOCIATIONS

- Professional member of the Association of Professional Engineers and Geoscientists of Newfoundland (APEGN).

ANDREA WISEMAN, Dipl. Chem. Tech., Dipl. Env. Tech., EPt

CANADA SAFETY ADVISOR, ENVIRONMENTAL TECHNOLOGIST

KEY QUALIFICATIONS

Andrea has diplomas in Chemical Technology and Environmental Technology from the Southern Alberta Institute of Technology. She has 11 years experience in quality, health, safety and environment (QHSE) for the mining, chemical and oil and gas industries. With a background in chemical technology Andrea has experience of the analytical requirements of the environmental industry. She also has experience in health and safety and has assisted in developing Best Practices for the calcium carbonate mining industry. As the Canada Safety Advisor, Andrea coordinates and updates the Canadian Health and Safety Program to maintain compliance for MWH Canada expansion and growth. She has experience with QHSE Audits, Environmental Field Reports, Detailed Site Assessments, Phase I and II Environmental Site Assessments, Reclamation Certificate Applications, Conservation and Reclamation Plans, Government Approval Programs, groundwater monitoring and pre and post water well testing for seismic programs. Andrea also manages a portion of the Indian Oil and Gas (IOGC) Environmental Audit program. Andrea is a member of the Environmental Careers Organization (ECO) Canada as an Environmental Professional-in-Training since February 2007.

EDUCATION

Environmental Technology, Southern Alberta Institute of Technology, 2003
Chemical Technology, Southern Alberta Institute of Technology, 2001

Licenses and Professional Memberships

Environmental Careers Organization (ECO) Canada – Environmental Professional in Training (EPt)
Member of the Advisory Board for the Environmental Technology Program at the Southern Alberta Institute of Technology (SAIT), Calgary, Alberta

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EXPERIENCE RECORD

- 2010 – present Canada Safety Advisor, MWH Canada, Inc.
- 2008 – present Environmental Technologist, MWH Canada, Inc.
- 2007 – 2008 Environmental Technologist, Northern EnviroSearch Ltd.
- 2005 - 2007 Environmental Technician, Northern EnviroSearch Ltd.
- 2004 - 2005 Customer Service Team Leader, QA/QC Assistant, Laboratory Analyst, Kaizen Environmental Services Inc.
- 2002 - 2003 HSE Consultant, Graymont Western Canada Inc.
- 2000 Co-op Lab Technologist, NOVA Chemicals Technology Center

PROJECT ACTIVITIES

- Development and management of the IOGC Environmental Audit Program.
- QHSE Audits for Acquisition/Divestiture Programs.
- Completion of Alberta and Saskatchewan Detailed Site Assessments, Phase I and II Environmental Assessments and Reclamation Certificate Applications.
- Completion of Conservation and Reclamation Plans, including Environmental Protection Plans, for Class I Pipeline Applications.
- Management of Post-Construction Pipeline Inspections.
- Completion of Indian Oil and Gas Canada Environmental Assessments and Audits.
- Completion of Acquisition/Divestiture Audits and Phase I Assessments.
- Completion of commercial and municipal Phase I and Phase II Environmental Assessments.

MWH

- Completion of Soil and Groundwater Monitoring as per Alberta Environment Approvals.
- Development and monitoring reclamation projects.
- Evaluation of laboratory analytical results and research into analytical reporting anomalies.
- Initiating line locates, landowner consultations and government inquires.
- Performed water quality testing, sampling and chemistry results comparisons.
- Consulted with clients on a multitude of environmental and health issues and assisted with Quality Assurance and Quality Control in an Environmental Lab.
- Performed chemical, microbiological and toxicological analyses on a wide range of environmental, chemical and plastic samples.
- Designed and performed modified air quality test of stacks.
- Performed and analyzed noise dosimetry of high risk areas and high risk activities.
- Development and Coordination of Safety Manuals, Safe Work Procedures, New Task Training Program, Confined Space Policy, Violence Prevention Policy, Emergency Response Plans, Ground Disturbance procedures, and Crisis Management Procedures.
- Management and designing assistance of on-line database system for analytical reporting.

OTHER QUALIFICATIONS (COURSES/CERTIFICATION)

- Hazard Assessment (Enform 2012)
- Incident and Accident Investigation (Enform 2012)
- Canadian Registered Safety Professional (CRSP) Exam Preparation (IQSEM 2011)
- Safety Program Development (Enform 2011)
- Ground Disturbance II™ (2009)
- H_2S Alive (2009)
- Petroleum Safety Training – Industry Recommended Practice (IRP) 16 – Administrator (2009)
- Red Cross - Standard First Aid / CPR (2009)
- Environmental Field Report Workshop (Enform)
- Reclamation Criteria for Wellsites and Associated Facilities (Enform)
- Alberta/Canada Safety Council ATV Rider Course (2006)
- TDG/WHMIS (2007)
- AutoCAD Level 1 (2004)
- Environmental Practitioner Certificate, SAIT (2002)

JOHN YOUNG, P.Eng.

PRINCIPAL GEOTECHNICAL ENGINEER

KEY QUALIFICATIONS

John Young is an experienced geological engineer with over 30 years experience in the geotechnical and geological engineering aspects of major hydroelectric projects in Canada and overseas. Main responsibilities include geological investigations, geotechnical design and construction supervision for dams, tunnels and underground powerhouses, grouting design and supervision. Project highlights include:

Resident Geotechnical Engineer during construction of the 200-m-high arch dam and 2000 MW underground powerhouse of the Karun 3 project in Iran during 1997 to 2005;

Senior Rock Mechanics Reviewer for the Shuibuya hydroelectric project in China during 2002 and 2003;

Principal Geotechnical Engineer for the Lesotho Highlands Development Authority in Lesotho in 1996. Responsible for various consultants' activities on the Katse arch dam, the water transfer tunnels, the Mohale dam and powerhouse, and the Matsuko diversion project;

Senior Geotechnical Specialist for British Columbia Hydro during investigations and remedial works to repair sinkholes in the 200-m-high rockfill Bennett Dam in 1996;

Geotechnical Liaison Engineer during a major program of trial excavations, in-situ rock mechanics testing, trial grout tests and grout curtain construction for the planned Conawapa Generating Station in Manitoba, Canada;

Geotechnical Coordinator for detailed site investigations and rock mechanics design work for over 30 km of tunnels and an underground powerhouse in 1994 and 1995 at the Alto Cachepoal Project in Chile; and

Design and construction supervision for embankment dams in Canada and the United States.

EDUCATION

BS/BSc, Geology Memorial University of Newfoundland, Canada
MS/MSc, Engineering Geology and Geotechnics University of Leeds, UK

Licenses and Professional Memberships
Professional Engineers of Ontario and Newfoundland and Labrador,

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EXPERIENCE RECORD

Ladore Falls Dam Geotechnical Services
BC Hydro and Power Authority
Provide studies and derive geotechnical parameters for stability analyses of the bedrock foundation of the Dam.

WAC Bennett Dam –Dam Safety Review
BC Hydro and Power Authority
Project Engineer to identify performance expectations, including flood and earthquake criteria, based on the BC Hydro Dam Safety Management Manual and 1007 CDA Guidelines; Review available documents for evidence of conformance with dam safety requirements; Determine the dam's conformance with the set of dam safety expectations; Identify any additional dam safety requirements to enhance risk management and to incorporate appropriate international practices.

MWH

White River Hydro Project
Regional Power Opco, Inc.
Project Engineer for the White River Hydroelectric Project. White River project consists of two hydroelectric projects located approximately 30 km northwest of White River, Ontario, consisting of (i) Gitchi Animki Bezhig facility (the "Upper White River Project") being located approximately 3.2 km downstream of the existing MNR-operated White Lake Dam, and (ii) Gitchi Animki Niizh facility (the "Lower White River Project") being located approximately 1.6 km downstream of Chicagonce Falls. The two sites are situated approximately 12 km apart on the river. MWH is involving in Preliminary/Detail/Final design as well as Support during construction and commissioning.

Kalai II Hydroelectric Project
Larsen and Toubro
Senior Geotechnical Engineer for feasibility investigations and geotechnical design a 160 m dam, alternative surface and underground powerhouses and associated tunnels for the 1200 MW hydroelectric project in northern India.

Susitna-Watana Hydroelectric Project
Alaska Energy Authority
Provide review of site conditions and geotechnical design criteria review.

Oskan and Berkman Hydroelectric Projects
AEI Services LLC
Lead Geotechnical Engineer to perform due diligence services for the Oskan and Berkman Hydroelectric Projects on the Ceyhan River, in southern Turkey. This project is at an advanced stage of construction and consists of two nearly identical hydroelectric developments that consist of 25 to 30 m high embankment dams, concrete gate structures and surface powerhouses of 25 and 35 MW capacity. Visited the site and reviewed and the design documents of the facilities. Carried out a number of limit equilibrium and finite element analyses to verify various project designs. The work included assessments of the embankment dams which are founded on thick alluvium at both sites, bedrock foundations of the concrete spillways and powerhouses, grout curtain designs, seismicity parameters and the stability of the100 m high excavated rock slope at the Oskan site.

Panama Canal,Third Set of Locks Project
Impregilo
Senior Geotechnical Reviewer for ongoing design work for excavation for the locks and lock chambers on the Pacific and Atlantic ends of the Panama Canal. The Lock excavations will be 20 to 40 m deep and will be cut into overburden and bedrock in an area subject to intense earthquake activity

Huanza Hydroelectric Project
Empresa de Generación Huanza S.A (Minera Buenaventura)
Senior Geotechnical Engineer for geotechnical evaluations and design of a 90 MW surface powerhouse, 10 km long and 4 m wide power tunnel and a 25-m-high RCC dam of the Huanza Hydroelectric Project in the Andes Mountains of central Peru. Developed and monitored a program of geological mapping, geology compilation work, structural interpretations and geo-mechanical assessments in a sequence of folded and faulted andesite, pyroclastic and sedimentary rocks. Carried out geotechnical assessments and developed geotechnical design parameters for surface and underground works. Currently working on final geotechnical designs and construction drawings. Construction of the project will commence in early 2010.

La Higuera Hydroelectric Project
Pacific Hydro
Senior Geotechnical Engineer for due diligence review and design studies to assess squeezing rock problems and remedial designs for 16 km long and 5.9 m wide power tunnel. The tunnel is constructed in non-durable argillaceous tuffs that are susceptible to time dependant squeezing deformations.

Chicayes Hydroelectric Project
Astaldi
Senior geotechnical engineer for geotechnical assessment and design work for design-build contract design of 8 km long power tunnels, 10 km long canal and a 150 MW surface powerhouse in the Andes Mountains of central Chile. Actively involved in geotechnical design and construction aspects of this ongoing EPC contract.

Singoli Bhatwari Project
Larsen and Toubro
Senior Geotechnical Engineer for design and construction review of the 90 MW surface powerhouse, 10 km long power tunnel and a 10-m-high concrete dam of the Singoli Bhatwari hydroelectric project in northern India.Carried site inspections, data assessment, detailed geotechnical designs and reviews of all geotechnical design aspects of the project. Ensured that the geotechnical aspects of the projects complied with internationally accepted standards.

Waneta Hydroelectric Project
Client: Kiewit
Senior geotechnical engineer for geotechnical assessment and design work for design-build contract design of twin power tunnels and a 400 MW surface powerhouse in southern British Columbia.Assessed the engineering geology and geotechnical design of the existing gravity dam and power facilities. Directed additional field investigations for the planned new power facilities.Produced geotechnical designs for underground works, surface excavations, cofferdams and related facilities.

Cachapoal Hydroelectric Project
Client: Pacific Hydro
Senior geological engineer in charge of geological mapping, drilling and geotechnical laboratory testing in the Andes Mountains of Chile. The planned project consists of four tunnels with a combined length of over 30 kilometres, four river diversion structures and an underground powerhouse with a planned capacity of 300MW.Supervised geological mapping, geology compilation work, structural interpretations and geo-mechanical assessments in a sequence of complexly folded and faulted andesite, pyroclastic and sedimentary rocks. Carried out a geological hazard risk assessment of the project. Produced regional and local geological maps and profiles for the various underground and surface structures.Participated in value engineering work with the owner?s design engineers and the lending bank?s review engineers to optimize all aspects of project design, excavation methodology and rock mechanics measures

Dasu Hydropower Project
Client: Water and Power Development Authority
Chief Geotechnical Engineer. Responsible for feasibility investigations and geotechnical design of the dams and underground powerhouse structures in the Himalayan Mountains of the Northwest Frontier Province of Pakistan.?The project concept consists of 235-m-high concrete-faced rockfill dam (CFRD) and 105-m-long reservoir. The spillway will have six radial gates, each 20 m^2, and design flood capacity 23,000 m^3/s. The project has a 25 m wide, 400 m long, 60 m high underground powerhouse and five 10 m diameter tailrace tunnels that will be 5 to 7 km long. Total installed capacity of the power facilities will be 2,700-MW with 10 units.?Carried out walkover field assessments of the various alternative dam and powerhouse sites during the Phase 1 site selection studies. Participated in site comparison studies and the selection of a final scheme that was studied to full feasibility level. Supervised a comprehensive site investigation program that included regional and detailed geological mapping, drilling of 25 boreholes, construction of two exploratory adits, materials testing and geophysical studies. Carried out geotechnical assessments of the investigations results, rock mechanics design of the dam, surface excavations and underground structures. Supervised all limit equilibrium and finite element stability studies for the slopes, tunnels and underground powerhouse.

Jinping Project Technical Review
Client: ERTAN
Senior Geotechnical Engineer. This project includes the world?s highest arch dam, which is 230 m high, and underground powerhouse constructed in Sichuan Province. Participated in two missions, one-month duration each, to the Jinping project site in China.?Responsible for review and revision of rock mechanics designs for the arch dam. Carried out a series of finite element and a limit equilibrium analyses to verify project designs and geotechnical parameters.

Dniester Pumped Storage Project
Client: EDF/World Bank
Lead Geotechnical Engineer to perform due diligence services for the proposed World Bank investment program to complete the first phase (3 units, each 350 MW, out of a potential 7 units) of the Dniester pumped storage project. Visited the site and worked with the local Design Institute and Hydro Company to review and assess the design of the facilities. Carried out a number of limit equilibrium and finite element analyses to verify various project designs. The project consists of an artificial upper reservoir created by means of a 7 km long ring earth fill dam 26 m high; a water intake structure joining 7 separate intakes; vertical shafts (depth around 100 m and 7.5-m diameter), inclined penstocks (400-m length and 7.5-m diameter); individual pit powerhouses; and downstream inclined tunnels (120 to 150-m length and 8.2-m diameter 8.2 m). Served as lead geotechnical engineer to perform due diligence services for the proposed World Bank investment program to complete the first phase (three units, each 350 MW, out of a potential seven units) of the Dniester pumped storage project. Carried out site inspections and worked with the local Design Institute and Hydro Company to review and assess the design of the surface and underground facilities. The findings of this work were included in the World Bank assessment of the viability of this project.

Slave River Project
Client: Trans Canada Pipeline
Senior geotechnical engineer for hydroelectric planning and feasibility studies on the Slave River in Northern Alberta. Carried out geotechnical feasibility level design works and assessments for the 2 km long, 45 m high planned Slave River Dam and 1200 MW surface powerhouse. This site is characterized by granitic riverbed foundation and glacio-fluvial riverbank deposits.

Karcham Wangtoo Project, India
Client: Jaiprakash Associates Limited (Employer:Hatch Acres Ltd)
Senior Geotechnical Engineer for a due diligence review of the 100 MW underground powerhouse, 17 km long power tunnel and a 40-m-high concrete dam of the Karcham Wangtoo hydroelectric project in northern India. Acting as lender's engineer, carried out a site inspection and a detailed geotechnical review of all geotechnical design aspects of the project.

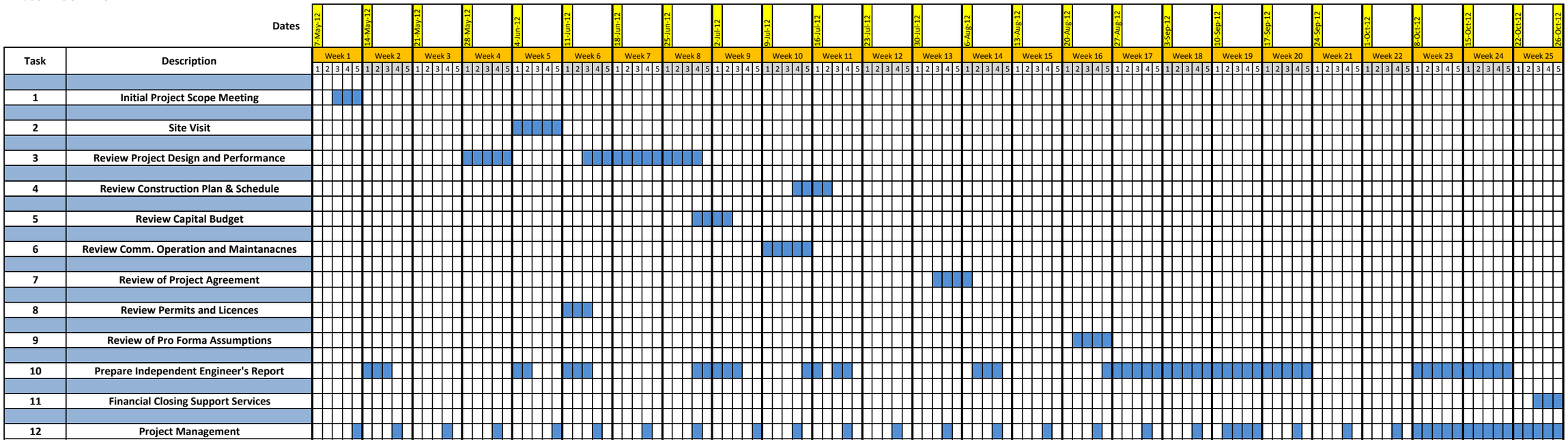
Khazir Gomel Project
Client: Ministry of Water Resources, Republic of Iraq
?Assessed the engineering geology and geotechnical design of the planned 105 m high Bakerman damsite. ?Reviewed geotechnical criteria for arch dam and RCC alternative designs. Established geotechnical design parameters for the new RCC dam design.. Produced design drawings and contributed to schedules and cost estimating for this project.

Albany River Project
Client: OPG
Senior geotechnical engineer for geotechnical design for hydroelectric planning and pre-feasibility studies on the Albany River in Northern Ontario. Carried out geotechnical prefeasibility level design works and assessments for the Chard and Hat Island damsites. These sites are characterized by karstic limestone and weak shales foundations. The final dam will be a 25 to 35 m embankment structure with a surface powerhouse.

Dniester Pumped Storage Project
Client: EDF/World Bank
The project consists of an artificial upper reservoir created by means of a ring earth fill dam 26 metres high and 7,35 kilometres long; a water intake structure joining seven separate intakes; vertical shafts (depth around 100 metres and 7.5-metres diametre), inclined penstocks (400-meters length and 7.5-meter diametre); individual pit powerhouses; and downstream inclined tunnels (120 to 150 metres in length and 8.2-metre diameter). Served as lead geotechnical engineer to perform due diligence services for the proposed World Bank investment program to complete the first phase (three units, each 350 MW, out of a potential seven units) of the Dniester pumped storage project. Carried out site inspections and worked with the local Design Institute and Hydro Company to review and assess the design of the surface and undergorund facilities. The findings of this work were included in the World Bank assessment of the viability of this project.

Summary Schedule

Phase I - SCHEDULE



Notes:

1 - 90% Data Assumed Available at Start of Week 4
2 - 100% Data Assumed Available at Start of Week 11
3 - End of 4th "Week" Invoices
4 - QA/QC Review during Week 19
5 - Client Review of Draft IE Report Week 21 and 22
6 - Final Report Submitted Week 24
7- Financial Closing support Services Week 25
8- This schedule is developed based on several assumptions and is presented as a sample. A more detailed schedule will be prepared once additional information is provided.
9 - Start of the project is assumed May 7, 2012

Phase II - SCHEDULE

Task No.	Description	Year 1												Year 2												Year 3												Year 4												Year 5												Year 6											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	**Attend Project Review Meetings**																																																																																
1.1	*First Year*																																																																																
1.1.1	Travel and Visit																																																																																
1.1.2	Report - 12 Reg'd																																																																																
2.1	*Second Year*																																																																																
2.1.1	Travel and Visit																																																																																
2.1.2	Report - 12 Reg'd																																																																															
3.1	*Third Year*																																																																															
3.1.1	Travel and Visit																																																																															
3.1.2	Report - 12 Reg'd																																																																															
4.1	*Fourth Year*																																																																															
4.1.1	Travel and Visit																																																																															
4.1.2	Report - 12 Reg'd																																																																															
5.1	*Fifth Year*																																																																															
5.1.1	Travel and Visit																																																																															
5.1.2	Report - 12 Reg'd																																																																															
6.1	*Sixth Year*																																																																															
6.1.2	Travel and Visit																																																																															
6.1.3	Report - 12 Reg'd																																																																															
2	**Services Ralating to Engineering**																																																																															
3	**Services Relating to Procurement**																																																																															
4	**Services Related to Construction Start-up**																																																																														
5	**Review Change Orders**																																																																														
6	**IE Periodic Report**																																																																														
7	**IE Draw Certification**																																																																														
8	**Verify Project Completion**																																																																														
9	**Project Management**																																																																														

Notes:

1. We reserve the right to adjust our manpower scheduling to accommodate the Project Schedule, based on the adopted construction schedule, the "PROJECT SCHEDULE", We can only adjust our proposed schedule when we view the Project Schedule and feel comfortable that it is satisfactory.
2. We have assumed Muskrat Falls generating Station requires 6-years to construct and commission.
3. We have assumed the transmission Links require 4-years to construct and one year to commission.

Sample Reports/Certificates

MWH
MWH Americas, Inc.

Jose E. Mayen
Principal Consultant
1-312-831-3010 (office voice)
1-312-831-3999 (fax)
jose.e.mayen@mwh.global.com

May 6, 2011
Project No. 1005456-0102
CF - NOF(39) Certificate

[redacted]
as Construction Facility Administrative Agent
[redacted]
New York, New York 10036
Attention: [redacted]
Telephone: [redacted]
Telecopier: [redacted]

Gentlemen,

Reference is made to (i) the Common Agreement, dated as of October 19, 2007 (as amended, supplemented or otherwise modified from time to time, the "Common Agreement") among [redacted], as Intercreditor Agent, as Working Capital Facility Administrative Agent and as Construction Facility Administrative Agent, the Working Capital Facility Lenders from time to time party thereto, the Construction Facility Lenders from time to time party thereto, [redacted] as Onshore Collateral Agent and the other Lenders and Lender Representatives from time to time party thereto and (ii) the Construction Facility Notice of Borrowing No. 39 (CF - NOF(39)) dated May 5, 2011 (the "Construction Facility Notice of Borrowing"), both in regards to the construction of the [redacted]ct (the "Project"). All capitalized terms used herein and not otherwise defined herein shall have the meanings specified in the Common Agreement.

Pursuant to Section 4.04(d) of the Common Agreement, the Independent Engineer hereby certifies as follows:

(i) The Independent Engineer has reviewed the current CF - NOF(39) requesting an amount of US$ 97,046,890.91 and, although the requested borrowing is about 10 times the budgeted amount, does not disagree in any material respect with any of the statements or calculations therein, because the recognition [redacted] for the previous month was also about 10 times the budgeted amount.

(ii) The Accumulated Value (AV) of the [redacted] Project recognized by the [redacted] Project owner as of April 30, 2011, was US$ 811,281,720.37.

(iii) In the opinion of the Independent Engineer, the Provisional Acceptance of the First Unit is expected to occur not later than the date set by the Contractual Provisional Acceptance Date of the First Unit plus the Permissible Provisional Acceptance Delays for the First Unit.

(iv) In the opinion of the Independent Engineer, the Project Completion Date is expected to occur not later than the date set by the Contractual Project Completion Date plus the Permissible Project Completion Delays.

(v) The status of the recognitions by CFE of the work done in the Project and of the disbursements from the Construction Facility (CF), in US$, after disbursing the requested funds, will be as follows:

RECOGNITIONS (US$)[1]				
	During April 2011		Cumulative End of April. 2011	
	Budget	Actual	Budget	Actual
Lump Sum Prices		9,463,745.42		429,383,664.89
Unit Prices		87,072,938.76		302,980,836.73
Non-amortized Expenses Recognized- Lump Sum Portion		-962,152.20		19,628,730.76
Non-amortized Expenses Recognized - Unit Prices Portion		0.00		0.00
Non-amortized Expenses Recognized - Electromechanical		1,231,077.00		21,411,137.64
Enterprise tax		0.00		8,668,584.83
Lump sum preoperational costs		-1,147,311.57		16,319,181.21
Extraordinary works preoperational costs		5,135,173.86		12,889,584.31
TOTALCFE RECOGNITION	**10,493,026.47**	**100,793,471.27**	**709,976,075.77**	**811,281,720.37**

1 - Monthly recognized values shown correspond to the work done during April 2011. Current month borrowing request (on May 5, 2011) is based on those values.

MWH
MWH Americas, Inc.

[redacted]

CF - NOF(39) CERTIFICATE

BORROWINGS REQUESTS (US$) [1] (previous page)				
	On May 5, 2011 (current)		Cumulative to May 5, 2011	
	Budget	Actual	Budget	Actual
Amount repaid to the Working Capital Facility		96,598,789.32		714,666,897.42
Interests and fees		448,101.59		15,485,916.99
NOTICE OF BORROWING REQUEST	**9,443,723.82**	**97,046,890.91**	**638,978,468.20**	**730,152,814.41**

The cumulative level of recognitions is 10% above the cumulative borrowings amount from this facility, as required in the credit agreement.

IN WITNESS WHEREOF, the undersigned has caused this Certificate to be duly executed and delivered as of the day and year first above written.

By: _____
José E. Mayén
Principal Consultant

Reviewed and approved

By: _____
Gabriel Llort
Vice President

cc: [redacted]

MWH

MWH Americas, Inc.

Jose E. Mayen
Principal Consultant
1-312-831-3010 (office voice)
1-312-831-3999 (fax)
jose.e.mayen@mwh.global.com

May 6, 2011
Project No. 1005456-0102
WCF- NOF(43) Certificate

[redacted]
as Working Capital Facility Administrative Agent
[redacted]
New York, New York 10036
Attention: [redacted]
Telephone: [redacted]
Telecopier: [redacted]

Gentlemen,

Reference is made to (i) the Working Capital Facility Credit Agreement, dated as of October 19, 2007 (as amended, supplemented or otherwise modified from time to time, the "Working Capital Facility Credit Agreement", including the Amendment and Restatement dated October 13, 2010) among [redacted]., as Borrower, the several Working Capital Facility Lenders from time to time party thereto and [redacted] New York Branch, as Working Capital Facility Administrative Agent and (ii) the Working Capital Facility Notice of Borrowing No. 43 (WCF-NOF(43)) dated May 5, 2011 (the "Working Capital Facility Notice of Borrowing"). All capitalized terms used herein and not otherwise defined herein shall have the meanings specified in the Working Capital Facility Credit Agreement.

Pursuant to Section 4.2(c) of the Working Capital Facility Credit Agreement, MWH Americas Inc., acting in its role as the Independent Engineer, hereby certifies as follows:

(i) The Independent Engineer has reviewed the WCF-NOF(43) requesting an amount of US$ 31,000,000.00 in Tranche A-1 loans and does not disagree in any material respect with any of the statements or calculations therein .

(ii) In the opinion of the Independent Engineer all Works for which payment will be made with the proceeds of such Working Capital Facility Borrowing and all other Works for which payment was made with the proceeds of all prior Working Capital Facility Notices of Borrowing are

being performed in accordance with the Public Works Contract and all other Project Documents.

(iii) In the opinion of the Independent Engineer, and according to the observations made during the last site visit on March 24, 2011, construction of the Project is proceeding substantially in accordance with the Public Works Contract and all other Project Documents and the Borrower will achieve each main milestone event not later than the date set forth therefor in the Construction Schedule plus the allowed extension of not more than two hundred seventy (270) days for Permissible Critical Event Delays, Permissible Provisional Acceptance Delays, or Permissible Project Completion Delays, as applicable.

(iv) The status of disbursements for the project from the Working Capital Facility, in US$, after the present disbursement and the repayments from the Construction Facility to date, will be:

	Current Month		Cumulative
	Budget	Actual	
DIRECT COSTS	11,955,440.26	27,109,543.12	644,049,700.01
INDIRECT COSTS	2,180,072.25	3,208,530.27	83,154,555.18
TOTAL HARD COSTS (A)	**14,135,512.51**	**30,318,073.39**	**727,204,255.19**
DEBT SERVICE (B)	**2,340,667.92**	**681,926.61**	**35,908,590.93**
OTHER FINANCING RELATED EXPENSES (C)	**178,795.17**	**0.00**	**18,395,635.72**
TOTAL BORROWING (A+B+C)	**16,654,975.60**	**31,000,000.00**	**781,508,481.84**
REPAYMENT FROM CF	**-**	**96,598,789.32**	**714,666,897.42**
OUTSTANDING AMOUNT	**-**	**-**	**66,841,584.42**

IN WITNESS WHEREOF, the undersigned has caused this Certificate to be duly executed and delivered as of the day and year first above written.

By: _____
José E. Mayén
Principal Consultant

Reviewed and approved

By: _____
Gabriel Llort
Vice President

cc: [redacted]

MWH

MWH Americas, Inc.

La Yesca Hydroelectric Project
Independent Engineer Technical Review Report

Prepared for

WestLB

WestLB AG, New York Branch

September 2007
Rev. 1 – November 2007

LA YESCA HYDROELECTRIC PROJECT

INDEPENDENT ENGINEER TECHNICAL REVIEW

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

APPENDIXES

A. Project General Arrangement

B. Project Organization Chart

C. Project Schedule and Milestone Dates

Section 3-4 - Appendix 6 - Subcontractor Table

	ROLE	RESPONSIBILITIES	CONFIRMATION OF AVAILABILITY
Bernardo Fernandes ***(EnVenture)***	Project Specialist	Review contracts and project agreements, permits, the pro forma,and be available for meetings with lenders	YES
Ewan Cumming (***Fugro)***	Project Engineer	Submarine Geotechnical Support	YES
Christopher Woodwroth-Lynas ***(Fugro)***	Project Engineer	Submarine Geotechnical Support	YES
John Landva ***(Fugro)***	Project Engineer	Submarine Geotechnical Support	YES
Bevin LeDrew (***Sikumit Environmental Mgt. Co. NFLD)***	Project Specialist	Bevin will review all aspects of the permits and licenses, discuss current status with agency personnel, and be the principal author of report sections dealing with these topics.	YES
Kojima Takashi ***(Independent Consultant)***	Project Engineer	Will review all mechanical aspects related to transmission, submarine cables, and converter stations	YES
Graham Lawson ***(Energy Cable Consultants Inc.)***	Submarine Cable Lead	Responsible for all aspects of the HVDC cables engineering and will be the author of the sections of the report pertaining to these aspects.	YES
Ali Moshref ***(Quanta Technology)***	Project Engineer	HVDC transmission lines, system study	YES
Aty Edris ***(Quanta Technology)***	Project Engineer	Reviewing all aspects of HVDC transmission lines and converter station	YES

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