GEI assisted Minnesota Power (MP) in an options evaluation for repair of their aged 1924, 18-foot-diameter penstock. The thorough options evaluation led to MP selecting the slip-lining rehabilitation option. The 16.4-foot-diameter slip-lined pipe design was prepared and submitted to FERC for approval. Following FERC acceptance of the design, GEI supported MP and Brennan Construction through successful and efficient completion of construction.

After MP identified deficiencies within an 18-foot-diameter riveted steel penstock built in 1924, GEI was asked to assess the existing conditions with respect to safe access into the penstock and to assess rehabilitation options. The options included further assessment and repair of the existing pipe, encasement within reinforced concrete, slip-lining with a new pipe, or complete replacement of the pipe. The assessment included preliminary design concepts and development of preliminary cost-estimates. Using a comparison matrix that identified the pros and cons for each option, GEI assisted MP in making an informed decision to move forward with the slip-lining option. This option was chosen due to the limited disturbance to the site, 100-year reliability, lower relative cost and more attractive construction schedule.

Due to the desire to return the project to service as quickly as possible, GEI suggested that MP’s preferred construction contractor (J.F. Brennan) be involved in the design process. This pseudo-design build process allowed GEI to incorporate means-and-methods into the design with contractor buy-in for preparation of the final design. To access and create a breach within the existing buried penstock, GEI designed an excavation that included a soil-nail retaining wall to support the existing step slope. GEI used detailed survey...

Key Elements
- Assessment of non-traditional existing large D/t ratio penstock that is supported on saddles and buried.
- Facilitated a thorough assessment of available penstock rehabilitation options for MP consideration.
- GEI used a pseudo-design build process to expedite the design process while also providing confidence that the construction would proceed smoothly.
- Design package was approved by FERC with no comments or questions in their construction authorization acceptance letter.
- A wide-range of GEI disciplines were used to prepare the design including survey data process, 3D modeling, subsurface exploration, retaining wall design, crane platform design, civil site design, hydraulic evaluation, pipe stress analyses, and construction support services.
data from within the existing penstock to maximize the size of the proposed slip-lined pipe. Due to the existing pipe being slightly out-of-round, a 16.4-foot-diameter slip-lined pipe was proposed. Hydraulic calculations showed that no net loss of generation would occur due to size reduction, primarily due to the smoother steel liner versus the relatively rough riveted existing penstock. A low-strength cementitous grout was proposed to be pumped in lifts into the annulus between the old and new pipes. GEI conducted 3D finite element modeling of the pipe shell with the imposed buoyancy effect of the grout to develop an appropriate design for the size and location of temporary stalls within the pipe sections. GEI also prepared the designs for a new access road to the dam and a crane relieving platform for the 250-ton crane proposed for the project. A design basis report including supporting analyses, design drawings and technical specifications were submitted to the Federal Energy Regulatory Commission (FERC) on August 18, 2012 for review and acceptance. The FERC accepted the design with no questions or comments in September and October 2012 response letters.

During construction, GEI assisted with oversight of the soil nail wall construction, submittal and shop-drawing reviews, responses to requests-for-information, and attendance to weekly progress meetings. Due to the efforts made during the design process, the construction proceeded smoothly and was completed on schedule with minimal deviations. The new slip-lined pipe segments were slid into position on rails, and as anticipated in the design, the clearance with the old pipe was nearly touching in several areas. This provided confirmation that the largest diameter slip-lined pipe possible was installed.