soil and materials engineers, inc.

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November 1 2001
Mr. Trevor Wagenmaker, PE Capital
Consultants 725 Prudden Street
Lansing, Michigan 48906

RE: Engineering Evaluation Report
Corunna Dam
Dam I.D. No. 379
Corunna, Michigan
SME Project No. LG39939

Dear Trevor:

The Engineering Evaluation of the Corunna Dam, as outlined in our proposal dated April 25, 2001, has been completed. The enclosed report provides a summary of our observations and provides recommendations.

We appreciate this opportunity to serve you. Should you have questions, please contact us.

Yours very truly,

Robert C. Rabeler, PE — Vice President

Jeffery M. Krusinga, PE — Senior Project Engineer

SOIL AND MATERIALS ENGINEERS, INC.

TABLE OF CONTENTS

1. INTRODUCTION

The Corunna Dam was constructed in the mid-1800 to provide power for a mill and is currently used for recreational purposes. The dam has a structural height of about 10 feet, a normal head of 7 feet, and creates an impoundment with a surface area of about 17 acres. The length of the dam is about 200 feet, with a 25-foot-wide stop-log bay section at the right (west) abutment.

The dam was inspected in 1998 (report date April 2, 1998) and again in 2000 (report date September 21, 2000) by the Michigan Department of Environmental Quality (MDEQ). The most recent report indicates the dam is in poor condition and recommends a detailed engineering evaluation. Furthermore, MDEQ recommends the dam remain drawndown until repairs or modifications are made.

The team of Capital Consultants and Soil and Materials Engineers, Inc.. (SME) was retained by the City of Corunna to provide engineering services to assist the City in evaluating the course of action to address these concerns. SME prepared a proposal dated April 25, 2001 for these services. A portion of this scope was authorized, including visual observations of the dam and sampling and evaluating the sediments behind the dam. The evaluation of other environmental issues was not authorized. This report presents the results of the visual observations and sediment testing, as well as recommendations regarding options for removal and repair. Approximate costs related to these repairs will be provided by Capital Consultants.

2. VISUAL OBSERVATIONS

SME visited the site on September 7, 2001 to observe the dam. Normally, the water spills over the top of the dam. In its dewatered condition, we could observe the downstream dam face and the top of the dam, as well as a portion of the upstream slope of the dam.

2.1 Survey Measurements

Survey measurements were obtained to assist in this evaluation. The survey primarily consisted of the collection of spot elevation shots to measure differences in elevation across the top of the dam, its relative elevation to both the east and west shorelines, the upstream water, the downstream water, and the downstream channel. These measurements are depicted on the figure in the Appendix.

2.2 **Embankment**

The embankment for the dam originally consisted of a stone-filled crib that eventually was covered with concrete on the downstream face, on the top of the dam, and slightly upstream. Through gaps in the concrete both immediately upstream and at the downstream face, evidence of the original stone and cribbing is visible.

Regarding the concrete, there are gaps where concrete is missing, and evidence of water flow through the embankment of this dam (see photos 3, 6, and 7). For example, on the western boundary of the embankment with the spillway, through one of the holes in the concrete, water could be seen traveling through the stone. Also, on the more easterly side of the dam, there is a section where a representative from the City of Corunna noted water had been flowing through the dam. In this area, there were a number of large gaps in the concrete where water could easily access the underlying stone and exit at the downstream face (see photo 7). Just downstream of these holes was a large cavity where this water has apparently exited (see photo 8). This cavity extends about 8 to 10 feet into the embankment of the dam.

The downstream face of the embankment is nearly vertical and consists of concrete facing. In some places, particularly on the east side of the dam, there is a downstream apron. However, on the west side of the dam, this apron appears to have eroded away. The downstream channel has been eroded immediately downstream of this dam. Using the survey rod, SME measured a water depth of at least 8 feet deep in this area. The scour could be even deeper in areas not checked. The upstream slope of the dam is relatively flat, with an estimated slope of approximately 5:1 (horizontal to vertical). There are a number of cobbles on the upstream slope.

2.3 **Spillway**

The water level in the reservoir is controlled by a spillway on the west side of the embankment (see photo 10). The spillway consists of two flumes with stop-logs at the upstream face. These stop-logs are being replaced.

The training walls of these flumes are in poor condition. There is evidence of cracks and severe erosion near the water line, especially along the west wall. Water exiting from the flume spills onto a concrete apron and is deflected to the east into the downstream channel. At the southern end of this apron, there are remnants of a concrete wall that is severely eroded (see photo 13). There is also evidence of erosion through the apron at several locations (see photo 14).

2.4 Downstream Channel

The downstream channel appears to be relatively free of debris (see Photo 5). There is evidence of cobbles and boulders. As mentioned previously, there is some evidence of scour immediately downstream of the dam. The channel is relatively wide.

2.5 **Reservoir**

The reservoir for this dam is relatively narrow and consists of the former river channel with the water slightly elevated because of the dam (see photo 4). The side slopes immediately upstream of the dam are relatively steep, and appeared to be sloped at about 1:1 to 2:1. The westerly bank is protected with riprap, consisting mostly of crushed concrete. Because of the bend in the river channel at this point, water flowing against this bank could result in severe erosion forces during high flows. On the east embankment, with the water depressed at the time of this inspection, sediments were visible that were deposited in this area. No riprap or erosion protection was evident on the east embankment and apparently this protection has not been needed since erosion normally occurs on the west side of the river.

There is some evidence of limbs and trees that have fallen into the upstream channel and that have become lodged on the upstream face of the dam (see photo 9). A log was observed near the east side of the embankment. There were also limbs leaning precariously into the water along the west embankment (see photos 10 and 12).

3. SEDIMENT SAMPLING

As part of our scope of services, samples of sediment upstream of the dam were obtained by SME for analytical testing, which included total polychlorinated biphenyls (PCBs) and Michigan 10 Metals. The sediment samples were collected by inserting a 1.5-inch-diameter plastic tube by hand into the sediment until practical refusal was reached. The samples were collected at depths ranging from the top of the sediment surface to approximately 18 inches below the sediment surface. The samples were obtained at the following five locations: one immediately upstream of the dam, two along the east shore and two along the west shore. The sediment samples were placed in pre-cleaned laboratory grade containers and kept cool until delivery to the analytical laboratory (Brighton Analytical, LLC).

Table 1 in the Appendix contains the analytical results. This table also compares the test results to consensus-based sediment quality guidelines for freshwater ecosystems, which were provided by Mr. Roger Jones of the Surface-Water Quality Division (SWQD) of MDEQ. A copy of this document is included in the Appendix. Specifically, the results were compared to the consensus-based threshold effect concentrations (TEC) and the probable effect concentrations (PEC). The TEC is the concentration below which adverse effects are not expected to occur. The PEC is the concentration above which adverse effects are expected to occur more often than not. All of the constituents analyzed for were either not detected or detected at concentrations below the TEC, except for arsenic. However, the arsenic concentration was below the PEC.

Mr. Roger Jones with MDEQ reviewed the chemical test results on our behalf. Mr. Jones indicated there were no concerns regarding potential aquatic life due to these constituents. A copy of the e-mail from Mr. Jones is included in the Appendix.

We also evaluated the toxicity characteristics of one sample using the leaching procedure (TCLP). The results of these tests are contained in Table 2 in the Appendix. This test was performed to evaluate leaching characteristics in the event sediment were removed from the reservoir.

4. CONCLUSIONS AND RECOMMENMDATIONS

Based on our review of the chemical test results of the sediment as well as feedback from MDEQ, we conclude that the sediments are not environmentally impacted and should not have a negative effect on aquatic life. Therefore, it is our opinion modifications to the dam, including partial or complete removal could likely be performed without negative impacts to aquatic life. As mentioned previously in this report, we have not fully evaluated other environmental impacts (see our proposal dated April 25, 2001). Depending on the alternatives selected, these environmental issues may also need to be addressed.

Regarding the condition of the dam, we concur with the MDEQ opinion that the dam is in poor condition, and corrective action is needed in the near future. Correction options are presented below. Further analysis of these options, including cost opinions, are provided by Capital Consultants.

Complete Removal

One option would be to completely remove the entire structure and return the stream to its original channel configuration. The City would lose the recreational benefit of the

impoundment. MDEQ may have concerns regarding movement of the sediments downstream, and will likely require at a minimum that this removal be done in stages to reduce the movement of sediments. Sediment traps downstream of the dam may also be required.

Repair Existing Dam

Another option would be to repair the existing dam. This would require removal of the existing concrete cap, as well as removal and replacement of the by-pass spillway area of the west side of the dam. Furthermore, the downstream apron has been eroded and will also require repair. Constructability of repairs will be complicated because of the existing stream flow. Also, placing a new cap over the existing stone cribbing may not stop the seepage as there may be permeable soils upstream of the concrete cap allowing water to flow underneath the dam. Additional measures, such as driving sheet piling to stop this seepage may be necessary. We expect the capacity of the spillway will need to be increased by lengthening the spillway. Also, this alternative should be considered only an interim or temporary measure. Because of all these issues, it may be difficult to obtain a permit from MDEQ for this alternative.

New **Dam**

Another option would be to construct an entirely new structure, likely immediately downstream of the existing dam. One advantage of this option is that the existing dam can serve as a coffer dam to assist in the construction of the new dam. The new structure could be constructed in a variety of different ways, such as an earthen structure, a concrete dam, or simply a sheetpile barrier. A spillway structure should be utilized to assist with the control of the water flow. Details regarding a proposed design are outside the scope of services for this project.

Partial Removal

A final option would be to partially remove the existing dam. In essence, this would convert the facility from a dam to a rapids. This would require removal of the concrete cap. The spillway structure on the west side could be filled in with the concrete rubble to complete the rapids effect. If the height of the structure can be reduced to less than 6 feet, it would no longer be classified as a dam under the Natural Resources and Environmental Protection Act, Act 451 of 1994, Part 315 Dam Safety, hi our opinion, this would be the most attractive option from several vantage points. This would likely be the least costly

alternative. Furthermore, reasonable containment of sediments would likely occur. Although the impoundment would be somewhat lower than the existing impoundment, there will still be some water retained by the lowered structure.

5.0 GENERAL COMMENTS

This report was prepared based on our observations and measurements in the field, the results of chemical testing of sediments, and on our conversations with MDEQ. Our professional opinion is provided. No warranty is either provided or intended.

Additional services will be needed regardless of the option selected. SME would be pleased to assist you as needed with these additional engineering services.

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November 19, 2001

Mr. Joseph Sawyer, City Manager
City of Corunna 402 North
Shiawassee Street Corunna, MI
48817

RE: Shiawassee River Dam Report

Dear Mr. Sawyer:

Please find enclosed with this letter the Engineering Evaluation Report prepared by Soil and Materials Engineers, Inc. (SME) for the above referenced project.

This report contains an examination of the condition of the existing dam, the results from the River sediment testing and options for repair, replacement or removal of the dam.

We have developed a summary of the options presented in SME's report for repair, replacement or removal of the dam. Included with this summary are opinions of probable project costs associated with each option and an indication of the likelihood of outside funding source availability. This summary is given on the following page in the form of a matrix.

As you are aware, the State has classified the dam as a significant hazard potential. In their recent inspection of the dam, the State stated that the dam is in "poor condition," and required the City to keep the dam drawn down until repairs are made to it. Thus, the City should proceed with either the repair or replacement option presented in this report in the near future if it would like to receive the beneficial use of the dam again (or proceed with removal of the Dam).

In making the decision of which option to pursue, the City should consider all of the issues surrounding its implementation. For instance, the relative difficulty associated with obtaining State approval for any proposed construction activity must be considered. In the recent past, the State has encouraged the removal of existing dams, not the construction of new ones. A number of public and private agencies will be able to provide input on any proposed construction activity during the permitting process, and this input could affect the option chosen.

We note that the costs presented in the matrix are conceptual in nature. Due to the uncertainty in final design configuration and State permitting constraints that may be placed upon any construction activity in the Shiawassee River, these costs should be viewed primarily as relative cost differences between the options. The rankings presented for funding and permitting issues are based on our preliminary discussions with the State and with others who have recently been through this process. More definite input regarding any of these items can be provided to the City as the project progresses and more investigation is done.

Options Matrix

Option (each option is described in the attached report)	Project Cost (Construction, Engineering, Contingency - 15%)	Outside Funding (availability of State, Federal or private grants)
Total Removal of Dam	$750,000	Possible (up to 100% of costs)
Partial Removal of Dam (creation of River rapids)	$450,000	Possible (up to 100% of costs)
Repair/Upgrade of Existing Dam to MDEQ Standards	$850,000	No known sources
Construction of New Dam	$1,800,000	No known sources

We trust that this analysis and report provides sufficient input to allow the City to proceed with this project.

Please contact us with any questions you may have. Thank You.

Sincerely,

CAPITAL CONSULTANTS, INC./LANSING

Trevor S. Wagenmaker, P.E.
Project Manager

Garyy D. Arnold, P.E.
Principal