December 4, 2013

Ms. Kristin Rehg, P.E.  E-mail: krehg@cityofevanston.org
City of Evanston Utilities Department
555 Lincoln Street, Evanston, Illinois 60201

2013 Inspection of Finished Water Reservoir
Evanston Water Utility, Evanston, IL
CTLGroup Project No. 262675

Dear Ms. Rehg:

As authorized by the City of Evanston, CTLGroup performed a follow-up inspection of the Finished Water Reservoir to continue monitoring conditions of the roof slab. The objectives of the work were to compare current slab conditions with conditions observed in November of 2012. The scope of work included visual examination of the roof slab underside and also examination and limited hammer sounding of upper regions of the walls. CTLGroup was assisted by Hatcher Family Construction and Safety Training Services for confined space monitoring and rescue assistance. CTLGroup also performed laboratory examination of concrete core samples removed from slab topside and upper exterior regions of the east wall.

BACKGROUND

The Finished Water Reservoir was constructed in 1934 of cast-in-place reinforced concrete and is located beneath a parking lot owned by Northwestern University. According to the drawings, the reservoir walls vary in thickness from 2 ft. at the base slab to 1 ft. at the top. The roof slab is 8-1/2-in. thick, and the bottom slab is 6 in. thick. Interior columns are 20-in. diameter and spaced 12 ft. apart throughout the structure.

CTLGroup was retained by the City of Evanston to perform inspection and evaluation of the Finished Water Reservoir in November of 2012. Results of the inspection were documented in a report to the City of Evanston dated December 21, 2012. Findings from the inspection and subsequent laboratory studies performed on representative material samples indicated that the roof slab of the Finished Water Reservoir was in poor condition. Visible surface cracking is extensive in some areas, particularly in the southeast quadrant. Numerous areas of exposed reinforcing steel and/or inadequate concrete cover were noted. Extensive internal surface-parallel cracking was observed throughout all core samples drilled from the interior side of the roof slab. Associated concrete delaminations and spalling due to freeze-thaw damage were also observed. The poor condition of the roof slab was attributed to the abundance of available moisture inside the Finished Water Reservoir, combined with minimal earth cover above, likely creating an aggressive environment with respect to freeze-thaw exposure for concrete that does not incorporate entrained air. Based on extensive internal surface-parallel cracking throughout the roof slab, CTLGroup recommended extensive repairs or complete replacement. It was recommended that loads on the slab should be limited. CTLGroup also recommended that internal inspection of the roof slab be performed annually until either 1) sufficient additional data is generated to justify decreasing the inspection frequency, 2) the recommended repair measures are implemented, or 3) the structure is removed from service.
CTLGroup also recommended that, if the Evanston Water Utility anticipated future long-term use of this structure, complete removal and replacement of the roof slab and associated manholes would be warranted. A cost estimate provided in our 2012 report by Hatcher Family Construction, Inc. utilizing the services of Zera Construction and Plote Construction placed an estimate for roof slab removal and replacement to be on the order of $4,000,000. This cost included provisions for in-kind removal and replacement of both the roof slab and parking lot but did not include allowance for re-design, development of plans, specifications and bid documents, costs associated with selection of contractors, permit costs, construction observation services, and costs associated with loss of use.

**2013 INSPECTION FINDINGS**

On Tuesday, November 12, 2013, Alexis Brackney, Eric VanDuyne and Carlton Olson of CTLGroup performed visual inspection and limited hammer sounding in the Finished Water Reservoir. The inspection was performed from an inflatable raft with the water level in the reservoir dropped to approximately 8 ft. below the roof slab soffit.

In general, visual observations from the 2013 inspection appear consistent with observations from the 2102 inspection. Significant findings are as follows:

1. Concrete roof slab underside is in poor condition. Significant evidence of extensive freeze-thaw damage is present in addition to other deterioration described below.
2. Condensation is present on most areas of the slab underside.
3. Numerous cracks are present in the roof slab, typically coincident with efflorescence. Visible surface cracking is extensive in some areas, particularly in the southeast quadrant where many efflorescence stalactites are present. Crack patterns observed on the interior surface of the slab appear somewhat random and not consistent with damage from excessive gravity loads.
4. Cracks with efflorescence were also observed on column drop panels and a few column capitals.
5. Corrosion of the reinforcing steel and spalling with exposed reinforcement was observed in several areas. Observed corrosion coincides with locations where reinforcement was at the surface of the concrete with inadequate concrete cover.
6. Localized corrosion-product nodules were observed on the slab underside in multiple locations. These nodules were likely caused by corrosion in localized areas of exposed steel or shallow concrete cover over embedded steel elements.
7. No evidence of excessive slab deflection, wide cracking or other distress indicative of an immediate structural integrity concern was observed.
8. Inspection of the upper portions of the concrete walls revealed few cracks and no delaminations of cover concrete identified through hammer sounding.

**CONCRETE CORE SAMPLES**

Four concrete core samples, EWC-1, EWC-2, EWC-3, and EWC-4, were extracted from the exterior east wall of the Finished Water Reservoir on November 19, 2013 by Roughneck Coring. Locations of these core samples are included on the condition survey drawing in Appendix A. Cores were cut and lapped and examined using a stereomicroscope. In general, all core
samples appear to be in overall good condition with no evidence of significant deterioration or distress. Photographs of the cut and lapped core samples are included in Appendix B.

Walker Restoration Consultants removed four concrete core samples, C1, C2, C3, and C4, from the topside of the Finished Water Reservoir. Locations of these core samples are shown on the condition survey drawing included in Appendix A. CTLGroup obtained the core samples from Walker and cut, lapped, and examined the samples. All four core samples exhibit extensive surface-parallel cracking. Photographs of the cut and lapped core samples are included in Appendix B.

CONCLUSIONS AND RECOMMENDATIONS

Our 2013 slab underside inspection did not identify any significant change from conditions observed in 2012. Our 2013 inspection also did not identify evidence of any immediate structural integrity concern. Previous inspection findings and laboratory studies performed on representative material samples indicate that the roof slab of the Finished Water Reservoir is in poor condition, due primarily to extensive internal surface-parallel cracking throughout the roof slab. Additional core samples removed from the slab topside in 2013 provided further confirmation of this condition. Cores removed from the upper region of the east wall revealed that the concrete is in generally good condition.

As stated in our 2012 report, the extensive internal surface parallel cracking has likely compromised the load carrying capacity of the roof slab to an extent that is variable and indeterminate. In order to restore the roof slab to a serviceable state, extensive (near full-depth) repairs or complete replacement is recommended. Per recommendations in our 2012 report, the next scheduled slab underside inspection should be performed in Fall 2014 if the reservoir structure is to remain in service. Loads on the top of the slab should be limited to passenger vehicles only, as previously recommended in the 2012 report. No effort to quantify the current load carrying capacity of the slab in the deteriorated condition through calculations and analyses has been made to date.

If you have any questions, please call.

Very truly yours,

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Attachments: Appendix A and B
COA# 184-001246
APPENDIX A

Condition Survey Drawings
1 PARTIAL ELEVATION - EAST WALL

NTS
APPENDIX B

Concrete Core Samples
Fig. 1 Cut and lapped section of Core EWC-1. Top surface at left. No apparent cracks/microcracks are observed in the core.

Fig. 2 Cut and lapped section of Core EWC-2. Top surface at left. A single subvertical microcrack, marked with black marker and indicated with a red arrow, is observed extending from the surface of the core to a depth of 10 mm (0.4 in.).
Fig. 3  Cut and lapped section of Core EWC-3. Top surface at left. No apparent cracks/microcracks are observed in the core.

Fig. 4  Cut and lapped section of Core EWC-4. Top surface at left. No apparent cracks/microcracks are observed in the core.
Fig. 5  Cut and lapped section of Core C1. Top surface at left. Surface-parallel microcracks are tracked with black pen to better show their pattern. Thickness of actual cracks, in general, is much smaller than the thickness of the tracings.

Fig. 6  Cut and lapped section of Core C2. Top surface at left. Surface-parallel microcracks are tracked with black pen to better show their pattern. Thickness of actual cracks, in general, is much smaller than the thickness of the tracings.
Fig. 7  Cut and lapped section of Core C3. Top surface at left. Surface-parallel microcracks are tracked with black pen to better show their pattern. Thickness of actual cracks, in general, is much smaller than the thickness of the tracings.

Fig. 8  Cut and lapped section of Core C4. Top surface at left. Surface-parallel microcracks are tracked with black pen to better show their pattern. Thickness of actual cracks, in general, is much smaller than the thickness of the tracings.