

Village of



# Memorandum

**To:** President Russell  
Board of Trustees  
Barbara Adams, Village Counsel

**From:** Patrick Brennan, Village Manager

**Re:** Elevated Water Tank Stability vis-à-vis Cellular Antenna

**Date:** December 29, 2014

## Statement of Problem

The presence of cellular antennas on the elevated water tank requires a 20% reduction in water storage capacity and other operational restrictions during periods of potential or forecasted high winds.

## Background & Summary

Kenilworth constructed the elevated water storage tank at the southwest corner of Roger Avenue and Exmoor Road in 1976. Universal Tank and Iron Works of Indianapolis, Indiana designed the tank with a capacity of 200,000 gallons of water, the tank stands approximately 116' above grade and is in good condition.

Between 1999 and 2001 the Village entered into several lease agreements with wireless carriers to locate equipment both on and within the water tower. Currently, three carriers, AT&T; Sprint; and T-Mobile (see table below), have active lease agreements with Kenilworth.

Carrier	# of antennas	Next Expiration Period
AT&T Wireless	6	March 31, 2019
Sprint	3	January 2, 2018*
T-Mobile	6	March 31, 2019*

In 2012, Sprint filed a permit with Village requesting alteration of their equipment on the elevated water tank. The permit application called for removing three of the six existing antennas and replacement of the remaining three with a different antenna type. At approximately the same time, AT&T filed a request for the installation of antennas and equipment.

Following common practice when structural elements are changed or added to elevated tanks, the Village commissioned Klein and Hoffman, Inc. to conduct a

\*Exact expiration date is based upon effective date of agreement which must be confirmed

structural analysis of the impact of the permit requests. In conducting their work, Klein and Hoffman assessed the proposed structural stability of the elevated tank using engineering studies and data provided by both Sprint and AT&T in addition to the construction drawings for the water tank. In their report dated March 9, 2012, the Klein and Hoffman determined that:

“...the existing water tank capacity will be adequate to support the new loads, adhering to the limitations presented in the next section.”

The limitations section noted that the tank can perform its functions if the limitations (below) are observed during high wind events. The engineers specified “high” winds to be 75 mph. The limitations specified were:

1. A minimum of 20,000 gallons of water be maintained in the tank to bring stresses in anchor bolts within permissible limits; and
2. Ensure that the tank does not exceed 160,000 (a 20% capacity reduction) gallons of water to maintain the foundation stresses within permissible limits.

The Village approved the permit requests from both Sprint and AT&T and the work was completed. Village Administration is unable to locate any record or directive that indicates that the operational limitations were communicated to Public Works or instituted.

On July 31, 2014, Sprint submitted a permit request for installation of three new cellular antennas on the elevated water tank. In response to the permit request, Village Administration reviewed the historical files and reviewed the March 2012 Klein and Hoffman report. It was during this review that the Village Manager became aware of the operational limitations recommended by Klein and Hoffman.

Noting that Sprint removed three of their cellular antennas from the tank in 2012, staff sought an update to the Klein and Hoffman report. Further, to determine if the removal of the antennas warranted lifting the limitations. In the time since the 2012 analysis, Klein and Hoffman divested the structural stability analysis unit to a new entity, The Burns Group. The Village contracted with The Burns Group to update the prior study and determine what conditions would need to be met to remove the operational limitations upon the tank. The resulting report, dated November 11, 2014, reaffirms the 160,000 gallon limitation on the water tank during periods of high winds. The limitation is designed to maintain soil bearing pressure within allowable limits. The report noted that:

“The tank can be used to full capacity without any limitation if all of the antennas are removed from the tank top.”

The report offered the option of engaging the services of a Geotechnical Engineer to evaluate the bearing capacity of the soil and provide recommendations regarding suitable methods to increase the soil bearing capacity.

The operational limitations imposed upon the elevated water tank have a direct impact upon the operation of Kenilworth's water system. Currently, the water distribution system operates on available storage capacity from both the clear wells located at the water plant and the elevated water tank. When utilizing the full capacity of both, there is adequate storage to meet typical water demands during the periods between 11:00 p.m. and 7:00 a.m.; this allows the water plant to essentially "hibernate" overnight and therefore does not require the presence of a water operator. Reducing the available water storage would reduce the number of hours that the plant is able to hibernate overnight, resulting in the need to add labor hours.

When operational limitations are in place, the storage capacity of the water tank is reduced from 200,000 gallons to 160,000 gallons, a 20% reduction in tank storage capacity. Additionally, the water level in the elevated tank directly impacts water pressure in the system. When the elevated tank is allowed to reach lower levels, complaints of low water pressure have been received in the past. The loss of 40,000 gallons of storage necessitates adding staff to the overnight hours to produce additional water. The number of work hours needed is somewhat dependent upon the time of year and timing of the high wind event. The operational limitations are only required when high wind gusts occur, but such gusts are not always predicted in advance. When active, the limitations would have a direct impact on expenses within the Water Fund. The anticipated cost is variable based upon the current water needs (seasonal), timing of the storm event, and frequency of wind events during the budget year. For example, one extra 8-hour shift at the water plant would cost \$418.<sup>1</sup> No overtime funds were budgeted in FY15 for addressing operational limitations.

### **Current Status**

The most recent tank stability analysis commissioned by the Village has determined that the elevated water tank should have operational limitations imposed due to the presence of cellular antennas on the tank and the wind loading thereto during periods of high wind causing:

1. excessive shear pressure on the foundation bolts (near empty tank); and
2. soil loads exceeding bearing capacity with over 160,000 gallons of water stored in the tank.

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<sup>1</sup> Salary+fringe cost for one Operator at overtime rate.

The Village Manager imposed operational limitations on the elevated water tank through an Administrative Order dated October 7, 2014 for periods when the National Weather Service predicts wind gusts to reach or exceed 50 m.p.h.

On July 31, 2014, Sprint requested that the Village consider and approve its request to add three new antennas to the elevated tank. Generally, the lease grants the carrier the ability to replace their equipment so long as their installation is in compliance with the lease and applicable laws, ordinances and codes.

On September 18, 2014 the Village received a written request from Verizon Wireless to have a new cellular antenna presence in the Village. Verizon Wireless does not have a physical presence within the Village for cellular antenna.

On November 12, 2014, AT&T submitted a request for removal and replacement of six antennas on the elevated water tank, and replacement of cables and equipment within the base of the structure. As noted above, generally, the lease grants the carrier the ability to replace their equipment so long as their installation is in compliance with the lease and applicable laws, ordinances and codes.

T-Mobile does not have any active permit requests at this time.

### **Options / Decision Points**

The utilization of wireless communication has changed significantly in the time since the Village first leased space on the water tank. Wireless carriers are experiencing both an increase in data transmission needs and an increase in overall subscribers. The combination of these service demands results in more frequent equipment change outs and requests for additional points of presence within communities. Absent a dramatic shift in technology, the Village Manager recommends that the Village prepare for either addressing requests for additional points of presence (antennas), or addressing concerns over a lack of cellular/data coverage.

#### *Primary Options for Consideration:*

1. Maintain the current operational restrictions and consider wireless carrier requests on a first-come first served basis. Under this option it is recommended that requests which further restrict the operational limitations are either rejected, or brought forward to the Village Board for consideration. Under this scenario, it is likely that the Village would not be able to address the Verizon Wireless request at the water tank. Additionally, permit requests for either additional or larger antennas may not be approved due to the impact vis-a-vis the operational restrictions. If this option is chosen, it is recommended that village counsel review the current lease agreements to further refine the Village's options.
2. Engage a Geotechnical Engineer to identify options to increase soil bearing capacity. Village staff has not spoken with engineers to determine what methods exist to increase soil bearing capacity under and around the foundation for the water tank. If soil bearing capacity can be increased a

cost/benefit analysis would be the next logical step as well as a reevaluation of the operational limitations to see if they can be lifted.

3. Investigate alternate cellular antenna locations. One of the three carriers has requested the Village consider providing a site for construction of a monopole within the Village. The carrier indicated that they would construct and transfer the monopole to the Village and engage in an agreement to abate lease fees until the construction costs are recaptured. If this option is chosen, staff would ascertain the willingness of the other carriers to relocate to a new location if provided. If successful, this option will eliminate the operational restrictions upon the water tank. Additionally, capacity may be available to respond to the Verizon Wireless request for new antennas which would generate an additional \$40,000 to \$50,000 annually.
4. Effectuate the removal of all cellular antennas from the water tank due to safety concerns. Under this scenario, staff would contact each of the carriers to request compliance with the Village request. Absent identification of an alternate location on Village property, this option will have a budgetary impact of approximately \$121,000 annually. Additionally, a change in wireless coverage areas would occur absent identification of a suitable alternate location. With the cellular antennas removed, the operational limitations would not be necessary. Before pursuing this option, consultation with village counsel would be necessary.

#### *Staff Recommendation*

It is recommended that the Village Board direct staff to begin work on **Option 3 – Investigate alternate cellular antenna locations.** Staff is recommending this option for the following reasons:

1. It is likely residents will continue to increase their dependence upon wireless cellular/data services, and have an increased expectation for connectivity within their home. Wireless carriers indicate a need to modify existing equipment to meet current consumer demands. The additional equipment request cannot be met on the water tank and it is believed that two cellular antenna sites within the Village would not be desirable.
2. Continued use of the elevated water tank for cellular equipment will require continued operational limitations, negatively impact our ability to efficiently deliver potable water, while restricting the Village's ability to adequately respond to the needs of residents and cellular providers.

Attach: The Burns Group report dated, November 11, 2014  
Klein and Hoffman, Inc. report dated, March 09, 2012

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**M E M O R A N D U M**

date: November 11, 2014  
to: Patrick Brennan  
from: Rajendra Garg, P.E. and Tony Ondrus, S.E.  
subject: Report on Structural Evaluation of Water Tower  
reference: Water Tower at the corner of Roger Avenue &  
Exmoor Road, Kenilworth, Illinois  
job number: 2014-168.00

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Burns Engineering, Inc. (Burns) has completed its review of the stability of the existing water tank at the corner of Roger Avenue and Exmoor Road in Kenilworth, IL with regard to the impact of proposed AT&T and Sprint telecommunication antenna modifications for the Village of Kenilworth (Village). A summary of the findings and recommendations is presented herein.

**I. Executive Summary**

Overall Stability of Water Tower.

- The allowable soil bearing pressure of 6,000 psf as shown on the Universal Tank drawings is exceeded with the tank full and maximum wind load.
- Storage in the tank should be limited to 160,000 gallons of water to keep the soil bearing pressure within allowable limit.
- The tank can be used to full capacity without any limitation if all the antennas are removed from tank top.

**II. Background and Data Provided by the Village**

The steel water tank was designed and constructed by Universal Tank & Iron Works, Inc. in 1976. The tank is of spheroid shape and is supported on shaft and bell sections. The tank bell is supported on a concrete ring beam with a donut-shaped foundation footing. The top of the tank is about 116 feet above grade. As per specifications for the project, the tank was designed based on the AWWA D100-1973 provisions.

At present, the tank is supporting antennas from Sprint, AT&T and T-Mobile. The review of the tank was initiated by the Village due to proposed upgrading of antennas by Sprint and AT&T. Sprint and AT&T are proposing to replace existing antennas with larger antennas. No information was provided on the

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modification plan from T-Mobile. It is assumed that no such modifications are anticipated. Currently, the tank is supporting antennas with RRH units and cables supported on rails at the top of the tank. For details, see Attachment A.

The Village has provided the following documents for Burns’ review:

- a. Structural Calculations – New Antenna Installation on Existing 110.5’ Spheroid Water Tank, July 29, 2014
- b. Design Calculations prepared by Apex Engineers, Inc., July 7, 2005
- c. Existing steel tank drawings titled, “200,000 Gal Spheroid” and prepared by Universal Tank & Iron Works, Inc.
- d. Sprint Drawings dated July 30, 2014
- e. T-Mobil Permit Drawings dated August 7, 2012
- f. AT&T Permit Drawings dated May 22, 2014

**III. Wind Loading Requirements**

The wind loading calculations submitted by Sprint are based on the following Codes:

- a. Existing Tank – AWWA D100 -73
  - Spheroid shape of Tank      15 psf
  - Shaft section                      18 psf
  - Bell section                        18 psf
- b. Antenna and antenna supporting structure – TIA/EIA-222-F, 1996 based on 75 mph wind

The original tank design was also based on AWWA D100 as per project specifications but no information is available regarding antennas in the project specifications as antennas were not commonly installed on water towers in 1976.

The design wind loading required by AWWA D100-73 was also compared to loading required by the AWWA D100-2005. There was no change in the wind loads applied to the tank from D100-1973 to D100-2005.

**IV. Review Comments on Sprint Calculations**

General comments on Sprint calculations and drawings are as follows:

- a. There are discrepancies in the tank dimensions between the information shown on the 1976 Universal Tank and Iron Works drawings, submitted calculations and design drawings provided by Sprint.
- b. Sprint calculations were not based on latest AT&T permit application.

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- c. The calculations did not verify the adequacy of the water tower foundation due to cumulative effect of wind load on all antennas.

For detailed calculations of the impacts of all antennas based on the information made available by the Village, see Attachment A.

#### **V. Verifying the Adequacy of Foundations and Tank**

Computations were performed by Burns to verify the adequacy of the tank foundation under the combined impact of antennas from all the providers. Based on calculations, the existing water tank will be able to support the new loads provided that the limitations of tank storage presented in the next section are adhered to.

#### **VI. Limitations of Tank Storage**

Under the additional wind loading from the proposed replacement antennas, the tank structure and the foundations will be overstressed under high wind conditions based on the allowable soil bearing pressure of 6000 psf as specified on Universal Tank & Iron Works, Inc. drawings. The tank can perform its functions if the following limitations are adhered to during high wind events on the order of 75 mph:

- Tank storage should be limited to 160,000 gallons of water in order to keep the soil bearing pressure within allowable limit.

During normal operation, the tank can function without any limitation of storage volume of water. Storage beyond the recommended limit above during high wind event will require additional modifications which are beyond the scope of this review.

#### **VII. Recommendations**

- a. One option is that the Village engage the services of a Geotechnical Engineer to evaluate the bearing capacity of the soil, and whether it can safely carry the calculated bearing pressure, and also provide recommendations regarding suitable methods to increase the bearing capacity of the foundation soil.
- b. Burns can assist the Village in recommending the Geotechnical Engineer for this project.

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c. Alternatively, Burns can provide assistance in providing solutions to reduce overstressing of the soil pressure.

We hope that this report will meet your needs. If you have any questions, or need additional information, please advise.