VILLAGE OF BEAR LAKE
MANISTEE COUNTY, MICHIGAN

Water Reliability Study & General Plan Update

November 2013

Project No. 811320
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I. EXECUTIVE SUMMARY

This report reviews the Village of Bear Lake's water system facilities, capacities, and needs through the year 2032. In addition, it provides a master plan for water system improvements to be implemented as the need arises and funding permits.

The system was evaluated in three categories: water supply, water storage, and water distribution. The Village of Bear Lake completed a significant water system improvements project in 2010 and 2011 totaling nearly $1 million dollars that addressed the system's most immediate needs. The project involved a new storage tank, watermain improvements, telemetry upgrade, backup power, and well improvements. In general, the water system was found to have adequate capacity for projected demands but lacks capacity to meet any ISO fire flow classification above the residential classification. It was also found that available flows are limited in the areas of the water system that are served by undersized watermains (4-inch).

A. WATER SUPPLY & TREATMENT

The Village is supplied by two wells, designated No. 2 and No. 3. Both wells are active and the lead well position is rotated after each pumping cycle. The firm capacity is defined as the capacity delivered with the largest well out of service; the rated firm capacity for the Village is 195 gpm with Well No. 3 out of service. The firm capacity was lowered from the previous study period value of 220 gpm because the new water tank was installed at a higher elevation than the old tank and the additional system head reduced the flow rate of the existing wells. The MDEQ recommends the firm capacity of any water supply system meet or exceed the maximum day demands placed on the system. The historic maximum day demand (highest maximum day demand in the last 5 years) is 134 gpm, which is 69% of the Village's firm capacity. The existing firm capacity is adequate to serve existing and future projected maximum day demands.

Well inspections completed as part of the 2010 Water System Improvements Project revealed a reduction in capacity of both of the Village's wells apparently due to age, screen condition, and wear. Well No. 2 was pumping air during testing and the water level at Well No. 3 was drawn down below the top of the pump bowls. The existing wells are not in imminent danger of failure, however, it is recommended that the Village begin planning to eventually replace the existing wells.

The Village currently treats their water with chlorine solution for disinfection. The Village had one incident of disinfection equipment failure within the last 2 years that resulted in water quality issues; the disinfection equipment has been repaired and there have been no water quality issues since.

B. WATER STORAGE

The Village has a 150,000 gallon ground-level steel storage tank that supplies water pressure and emergency storage to the Village water customers. The storage tank is located south of Potter Road between Lynn Street and Smith Street as shown in Figure 1. The tank was constructed in 2011. The tank has operated flawlessly since it's construction.

Based on the Ten State Standards "Recommended Standards for Water Works", the storage capacity of a water system should exceed average daily use. The highest historic average day demand (highest in the past 5 years) was 75,227 gallons and the projected 2032 average day demand is 74,000; the existing storage tank has the required capacity to
meet the existing and projected future average day demands. Tanks are also sized for fire flow capability, and based on current total storage and well capacity, the Village has the capacity to meet a residential ISO fire classification, but lacks the capacity to meet any classification above residential (commercial, industrial, institutional). Storage capacity improvements are not recommended to increase system capacity, as it would promote longer detention time for the water in the storage tank which may result in a degradation of water quality. Instead, it is recommended that the Village install a new well(s) to increase system capacity should they desire to meet a higher fire flow classification.

C. WATER DISTRIBUTION

The water distribution system was analyzed for system pressure and available fire flows. The static system pressures were found to range from 38 psi to 85 psi which is within the accepted range. The available fire flows were found to be lower than recommended in a few areas of the distribution system. The areas of low available flows are: US-31 from Virginia Street to Russell Street, and US-31 from Potter Road to Maple Street. Flows in these areas are restricted by undersized watermains.

The distribution system is comprised of approximately 35% of 4-inch and smaller watermains, which restrict flows throughout the system. It is recommended that the 4-inch watermain in the system be replaced by 8-inch or larger watermain where fire protection is provided.

In addition to the recommended watermain improvements, many old fire hydrants remain in the system and several are reported by the Village to be inoperable or questionable. It is suspected that many of these old hydrants have 4” leads and several do not have auxiliary valves. These hydrants should be replaced with new hydrant assemblies including auxiliary valves.

Distribution system improvements are recommended for the low-flow areas listed above to increase the available flows.

D. RECOMMENDED IMPROVEMENTS

This report recommends improvements to the Village’s water system with costs estimated at $2,555,000. These improvements include:

- **Short-term Improvements:**
  - Replace Well #2 with a new well with a target capacity of 475 gpm.
  - Replace aged hydrants with new hydrants.

- **Long-term Improvements:**
  - Install new 8-inch watermain on Russell Street from US-31 to Main Street.
  - Install new 8-inch watermain on US-31 from Russell Street to Virginia Street.
  - Install new 8-inch watermain on Potter Road from Smith Street to US-31, on US-31 from Potter Road to Stuart Street, on Stuart Street from US-31 to Maple Street, and on Maple Street from Stuart Street to US-31.
  - Replace Well No. 3 with a new well with a target capacity of 475 gpm, and if a higher fire flow classification is desired, install an additional well with a target capacity of 475 gpm.
  - Replace the remaining 4-inch watermain throughout the system with minimum 8-inch watermain where fire protection is provided.
  - Install water meters for Village water customers.
A detailed list of recommended improvements and estimated costs are included in Section VI of this report. The costs are in year 2012 dollars and should be used for budgeting purposes only.
II. BACKGROUND AND PURPOSE

The Village of Bear Lake is in Manistee County, which is located in northwestern Lower Michigan. Bear Lake has a type 1 (public) water supply and distribution system with two water production wells and a 150,000 gallon ground-level storage tank.

The purpose of this report is to provide the Village with a comprehensive analysis of their water system in order to comply with MDEQ and Act 399. The report evaluates the existing water supply, treatment, storage and distribution, and provides recommendations for improvements to serve the existing and future needs of the Village. This report is intended to be the master plan for guiding the community on the overall future water system capital improvement needs to meet future daily water and fire flow demands.

The study and service area includes the Village of Bear Lake. The service area is located in sections 4 and 5 of Township 23 N, Range 15 W.

The Contingency Plan for the system was last updated in July of 2004.
III. EXISTING WATER SYSTEM

A. WATER SUPPLY

1. Wells

The Village of Bear Lake’s water supply system currently consists of two wells. The wells are designated as Wells No. 2, and No. 3. The wells rotate lead position after each pumping cycle. Both Wells are located west of Smith St. between the Potter Road and Cody Street intersections. Table 1 summarizes selected data for the wells and pumps.

### TABLE 1

<table>
<thead>
<tr>
<th>Well Number</th>
<th>Year Drilled</th>
<th>Diameter (inch)</th>
<th>Depth (feet)</th>
<th>Capacity (GPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1958</td>
<td>8</td>
<td>127</td>
<td>195</td>
</tr>
<tr>
<td>3</td>
<td>1977</td>
<td>12</td>
<td>124</td>
<td>313</td>
</tr>
</tbody>
</table>

The capacity of the wells is lower than the previous water system evaluation because the Village completed a substantial water project in 2010 and 2011 which included a new water tank that was installed at a higher elevation than the old water tank to boost system pressures. The additional system head created by the new water tank slightly reduced the pumping rate of the wells.

Improvements were made to both wells during the 2010-2011 water system improvements project. The control systems for both wells were upgraded and both wells were inspected and cleaned as part of the project. The well cleaning improved the efficiency of both wells, however, during post cleaning performance testing it was noted that Well #2 was pumping air at flow rates over 217 gpm. The post cleaning performance testing for Well #3 found that the water level drawdown was at least down to the top of the pump bowls. Well #3 did not pump air during the testing, but the operation of the pump with the water level approaching the pump bowls is not ideal.

The firm capacity is calculated by removing the capacity of the largest pump from the system. The pumping capacity that remains is the firm capacity. The Village of Bear Lake has a rated firm capacity of 195 gpm. The MDEQ recommends that the firm capacity meet or exceed the maximum day demand. The Village’s historic maximum day demand (over the past 5 years) was 134 gpm, which is 69% of the firm capacity.

Both of the existing wells have decreased in capacity in recent years. Due to these issues, the Village should consider replacement of the existing wells and adding additional pumping capacity to meet future demands and provide a more reliable water source for the Village water system.

2. Well Houses

Well House No. 2 is located west of Smith Street between the Cody Street and Potter Road intersections. The well house is constructed of CMU block and is in fair condition. The distribution piping in the well house has developed a significant amount of rust.
Well House No. 3 is also located west of Smith Street between the Cody Street and Potter Road intersections. The well house is constructed of CMU block/brick and is in good condition.

3. Water Treatment & Quality

The Village treats their water with chlorine for disinfection. The Village chlorinates by injecting a liquid sodium hypochlorite solution into the distribution piping at the well houses.

The Village regularly tests the water quality of its wells and throughout the system per MDEQ requirements. Testing is performed monthly for bacteria, yearly for partial chemical and every 3 years for metals analysis. The Village had to issue a boil water notice in the fall of 2011 due to positive coliform bacteria tests. It was determined that the chlorine injection system had failed and was not injecting chlorine into the distribution system. Since the chlorine injection system was fixed there have been no water quality issues. The metals testing performed in 2008 indicate that the water met State drinking water standards.

The Village tests for lead and copper on a triennial basis. Lead/copper levels met the MDEQ action levels in the most recent testing.

4. Wellhead Protection

The Village has an approved Wellhead Protection Program. It is recommended that the Village keep its Wellhead Protection Program updated.

5. Auxiliary Power

As part of the 2010 Water System Improvements Project, the Village installed a new permanent natural gas fueled stand-by generator. The new generator is located next to Well No. 3 Well house and is capable of operating Well No. 3 and Well No. 2 simultaneously.

B. DISTRIBUTION SYSTEM

1. Pipe Condition

The Village of Bear Lake’s water distribution system is composed of ductile iron, cast iron, and PVC watermain. Table 2 provides a breakdown of the water distribution system’s watermain inventory by size.
TABLE 2
WATERMAIN INVENTORY

<table>
<thead>
<tr>
<th>Watermain Size (inches)</th>
<th>Length (feet)</th>
<th>Percent of Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>9,730</td>
<td>35%</td>
</tr>
<tr>
<td>6</td>
<td>7,403</td>
<td>27%</td>
</tr>
<tr>
<td>8</td>
<td>8,483</td>
<td>31%</td>
</tr>
<tr>
<td>10</td>
<td>1,375</td>
<td>5%</td>
</tr>
<tr>
<td>12</td>
<td>421</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27,412</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

2. Low Flow Areas

The watermain improvements and the new tank installed as part of the recent water system improvements project improved system flows substantially. Adequate fire flows can be supplied throughout the majority of the Village, however there are still a few areas with lower than recommended flows. These areas of low flows are areas served by small diameter watermains (4-inch). The low flow areas are:

- The residential area along US-31 between Virginia Street and Russell Street.
- The commercial area along US-31 between Potter Road and Maple Street.

Many old fire hydrants exist throughout the water system. Several of these old hydrants were reported to be inoperable or questionable. It is suspected that these old hydrants have 4-inch leads and may not have auxiliary valves. It is recommended that old hydrants throughout the system be replaced with new hydrant assemblies (including 6-inch leads and auxiliary valves).

3. System Pressures

The new storage tank was installed at a higher elevation than the old storage tank to boost system pressures. With the new tank, system pressures range from 38 psi to 85 psi. The pressures are within the acceptable range.

C. WATER STORAGE

1. Specifications

The Village of Bear Lake has a 150,000 gallon ground-level steel storage tank that was constructed in 2011. The water tank provides water storage and pressure for the Village water system. The storage tank has a head range of 29 feet and the Village operates the tank between 15 and 27 feet of head. The 2011 average day demand is 61,320 gpd, the historic maximum average day demand (highest average day in the last 5 years) is 75,227 gpd, and the projected 2032 average day demand is 74,000 gpd. It is recommended that storage capacity meet average day demands. The new storage tank exceeds current and projected average day demands.

2. Tank Maintenance

The storage tank was constructed in 2011 and has not been in-service long enough to warrant a maintenance inspection. Maintenance inspections are generally
recommended every five years. The Village should plan to have the storage tank inspected around the tank's 5-year anniversary.

D. CONTROLS

1. Telemetry

A new controls system was installed as part of the 2010/2011 water system improvements project. The control system operates by using a pressure transducer to monitor water level at the storage tank. The control system includes alarms for high water, low water, power failure, etc. An autodialer was also installed that calls the system operators in the event of an alarm condition.

E. SYSTEM OPERATIONS

1. Operators

The Village of Bear Lake’s water system is classified as S-4/D-4. The Village has two S-4/D-4 certified operators. The MDEQ recommends having a minimum of two people certified to operate the water system; the Village is in compliance with this recommendation. It is recommended that the Village operators maintain their licenses for system operation.

2. Meters

The Village currently does not meter any of their water customers. It is recommended that the Village install water meters for all water customers to provide equitable billing and provide a basis to track system leakage. It is unknown when the master meters at the Village’s wells were last calibrated; master meters should be calibrated at least every ten years. It is recommended that the Village have their master meters calibrated.

3. Maintenance

The Village flushes their water system bi-annually. During flushing, hydrants associated with the Village’s flushing program are operated. It is recommended that the Village develop a program to operate all valves annually and hydrants bi-annually. Detailed records should be kept of valve turning and hydrant flushing.

4. Parts

The Village stocks a variety of spare parts for the major items in the system. Some of the parts include: repair sleeves, sections of pipe for watermain repair, and service fittings. The Village utilizes several reliable local suppliers for any parts not in their inventory.
IV. WATER USE AND FIRE PROTECTION

A. WATER USE

1. Customers

The Village of Bear Lake’s water system currently serves 173 customers, consisting of roughly 16% commercial users and 84% residential users. Past water usage data is presented in Table 3 below. Peak hour demands are estimated based on a peaking factor of 4.0 applied to the average day demand.

<table>
<thead>
<tr>
<th>MONTH</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1,345,900</td>
<td>2,052,500</td>
<td>1,439,300</td>
<td>1,294,600</td>
<td>1,078,600</td>
</tr>
<tr>
<td>February</td>
<td>1,148,700</td>
<td>1,949,000</td>
<td>1,819,200</td>
<td>1,431,300</td>
<td>1,318,800</td>
</tr>
<tr>
<td>March</td>
<td>1,250,700</td>
<td>2,123,800</td>
<td>1,944,700</td>
<td>1,851,200</td>
<td>1,195,800</td>
</tr>
<tr>
<td>April</td>
<td>1,402,800</td>
<td>1,854,600</td>
<td>1,676,500</td>
<td>2,272,300</td>
<td>1,294,900</td>
</tr>
<tr>
<td>May</td>
<td>2,356,300</td>
<td>2,256,700</td>
<td>2,114,400</td>
<td>2,254,400</td>
<td>1,858,500</td>
</tr>
<tr>
<td>June</td>
<td>3,371,800</td>
<td>2,546,300</td>
<td>2,530,700</td>
<td>3,020,600</td>
<td>2,528,900</td>
</tr>
<tr>
<td>July</td>
<td>3,903,800</td>
<td>2,604,700</td>
<td>2,701,500</td>
<td>2,896,800</td>
<td>3,447,300</td>
</tr>
<tr>
<td>August</td>
<td>3,891,800</td>
<td>2,956,000</td>
<td>2,526,100</td>
<td>3,396,600</td>
<td>3,845,600</td>
</tr>
<tr>
<td>September</td>
<td>2,521,300</td>
<td>3,960,800</td>
<td>2,404,800</td>
<td>2,077,800</td>
<td>2,030,400</td>
</tr>
<tr>
<td>October</td>
<td>2,348,200</td>
<td>1,432,300</td>
<td>1,287,600</td>
<td>1,746,500</td>
<td>1,325,700</td>
</tr>
<tr>
<td>November</td>
<td>1,801,400</td>
<td>1,110,300</td>
<td>1,224,400</td>
<td>1,584,900</td>
<td>1,225,800</td>
</tr>
<tr>
<td>December</td>
<td>2,115,000</td>
<td>1,449,800</td>
<td>1,238,900</td>
<td>1,067,700</td>
<td>1,213,400</td>
</tr>
<tr>
<td>TOTAL</td>
<td>27,457,700</td>
<td>26,296,800</td>
<td>22,908,100</td>
<td>24,894,700</td>
<td>22,381,700</td>
</tr>
<tr>
<td>AVG DAY</td>
<td>75,227</td>
<td>72,046</td>
<td>62,762</td>
<td>68,205</td>
<td>61,320</td>
</tr>
<tr>
<td>MAX DAY*</td>
<td>192,400</td>
<td>147,600</td>
<td>147,600</td>
<td>167,000</td>
<td>185,600</td>
</tr>
<tr>
<td>Max/Ave Day Ratio</td>
<td>2.6</td>
<td>2.0</td>
<td>2.4</td>
<td>2.4</td>
<td>3.0</td>
</tr>
</tbody>
</table>

* Includes high usage days caused by hydrant flushing, tank outages, etc.

1. Historical Water Loss

The Village of Bear Lake does not meter any water customers, so system water loss cannot be estimated. It is recommended that the Village install water meters for all customers so water usage can be tracked accurately and system loss can be estimated.

B. POPULATION PROJECTIONS

The projected 20-year water demand for the Village was estimated using the past and estimated current population numbers obtained from the U.S. Census Bureau. The population of Bear Lake has experienced fluctuations since 1960, but is currently down from it's peak in 1980. The Manistee County Planning Department predicts a growth rate of 0.37% per year between the years 2010-2020 for Manistee County, this growth rate has been applied to the current population of the Village to predict populations throughout the study period. Table 4 below shows the past and projected populations for the Village.
C. PROJECTED WATER DEMANDS

The projected water demands for the 20-year study period were calculated using projected population and the current average usage per capita. Table 5 shows the current per capita water usage. Estimated populations are from the U.S. Census Bureau and report projections.

### TABLE 5
PER CAPITA WATER USAGE

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Day Demand (gpd)</th>
<th>Estimated Population</th>
<th>Average Day Demand (gpcd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>75,227</td>
<td>316</td>
<td>238</td>
</tr>
<tr>
<td>2008</td>
<td>72,046</td>
<td>310</td>
<td>232</td>
</tr>
<tr>
<td>2009</td>
<td>62,762</td>
<td>298</td>
<td>211</td>
</tr>
<tr>
<td>2010</td>
<td>68,205</td>
<td>286</td>
<td>238</td>
</tr>
<tr>
<td>2011</td>
<td>61,320</td>
<td>287</td>
<td>214</td>
</tr>
</tbody>
</table>

This study assumes the water usage will increase proportionally as population increases. The highest usage rate over the last 5 years (238 gpcd) will be used for analysis. Since 2007, the peaking factor (maximum day demand divided by average day demand) has averaged 2.5. Based on this, a maximum day peaking factor of 2.5 is used in this report to estimate future maximum day demands. Table 6 shows the projected water demands.
### TABLE 6

defined water demands

<table>
<thead>
<tr>
<th></th>
<th>2017 (5 yr Estimate)</th>
<th>2032 (20 yr Estimate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>292</td>
<td>309</td>
</tr>
<tr>
<td>Average Usage (gpcd)</td>
<td>238</td>
<td>238</td>
</tr>
<tr>
<td>Average Day Demand (gallons)</td>
<td>69,500</td>
<td>74,000</td>
</tr>
<tr>
<td>Average Day Demand (gpm)</td>
<td>48</td>
<td>51</td>
</tr>
<tr>
<td>Peaking Factor</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Maximum Day Demand (gallons)</td>
<td>174,000</td>
<td>185,000</td>
</tr>
<tr>
<td>Maximum Day Demand (gpm)</td>
<td>121</td>
<td>128</td>
</tr>
<tr>
<td>Peak Hour Peaking Factor</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Peak Hour Demand (gpm)</td>
<td>193</td>
<td>206</td>
</tr>
</tbody>
</table>

### D. FIRE PROTECTION

1. **ISO Rating System**

   The Insurance Services Office (ISO) establishes suggested fire flow protection standards based on various factors including building construction type, area, height, type of development and density. These factors and others such as fire fighting capabilities, when combined, result in an ISO rating of between 1 and 10, 1 being the best and 10 being the worst. This rating is used by insurance companies to determine appropriate insurance rates for its customers that live within the water supply system. The Village of Bear Lake currently has an ISO rating of 6. The current rating is based on an evaluation received in January of 2009. It is recommended that the Village have an updated ISO report completed that takes into account the recent water system improvements.

2. **Recommended Fire Flows**

   The ISO establishes suggested fire flows at various locations throughout a community during a survey. It is not always cost-effective for a community to build a water system that meets all of the suggested ISO fire flows. In such a situation, the community can choose to adopt target fire flow values. Table 7 below presents the suggested ISO fire flows and recommended target fire flow values. These recommended target fire flows were obtained from tabular values presented in the “Fire Protection Handbook”, the “2006 International Fire Code”, and the AWWA's Manual of Water Supply Practices – “Distribution System Requirements for Fire Protection”. It will be necessary for the Village to decide as to whether these recommended target fire flows provide the desired level of protection.
3. Hydrant Flow Tests

Fleis & VandenBrink Engineering and Village staff performed fire hydrant flow tests at select locations throughout the system (See Figure 2) on May 6, 2009 in order to obtain information used in calibration of the WaterCAD hydraulic computer model. The calibration was applied to the water system prior to the 2010 Water System Improvements. This initial calibrated model was modified to reflect the improvements completed in 2010-2011 and thus remains calibrated to the Village's water system. Table 8 provides the results of the fire hydrant tests. The available fire flow amount at the minimum residual pressure of 20 psi was calculated using the following formula:

\[
\text{AVAILABLE FIRE FLOW @ 20 psi} = \frac{\text{Hydrant Flow} \times (\text{Static Pressure} - 20)^{0.54}}{(\text{Static Pressure} - \text{Residual Pressure})^{0.54}}
\]

### TABLE 7
ISO SUGGESTED AND RECOMMENDED TARGET FIRE FLOW VALUES AND DURATIONS

<table>
<thead>
<tr>
<th>Classification</th>
<th>ISO Suggested Fire Flows @ 20 psi</th>
<th>Recommended Target Fire Flows @ 20 psi</th>
<th>Duration (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,000-1,500</td>
<td>1,000</td>
<td>2</td>
</tr>
<tr>
<td>Commercial</td>
<td>2,500</td>
<td>2,500</td>
<td>2</td>
</tr>
<tr>
<td>Industrial</td>
<td>3,000</td>
<td>3,000</td>
<td>3</td>
</tr>
<tr>
<td>Institutional</td>
<td>3,500</td>
<td>3,500</td>
<td>3</td>
</tr>
</tbody>
</table>

### TABLE 8
AVAILABLE FIRE FLOW @ 20 PSI FOR SELECT LOCATIONS (COMPLETED PRIOR TO 2010 WATER SYSTEM IMPROVEMENTS PROJECT)

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Location</th>
<th>Actual Hydrant Flow (gpm)</th>
<th>Static Pressure (psi)</th>
<th>Residual Pressure (psi)</th>
<th>Calculated Fire Flow @20psi (gpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Potter Street at Russell St. int.</td>
<td>500</td>
<td>26.5</td>
<td>21</td>
<td>547</td>
</tr>
<tr>
<td>2</td>
<td>Main Street between Smith St. and Russell St.</td>
<td>840</td>
<td>53</td>
<td>33.5</td>
<td>1,116</td>
</tr>
<tr>
<td>3</td>
<td>Smith Street between Stuart St. and Main St.</td>
<td>670</td>
<td>48</td>
<td>28</td>
<td>803</td>
</tr>
<tr>
<td>4</td>
<td>South Shore Dr. west of US-31</td>
<td>840</td>
<td>69</td>
<td>33</td>
<td>992</td>
</tr>
<tr>
<td>5</td>
<td>US-31 between Smith St. and Russell St.</td>
<td>580</td>
<td>60.5</td>
<td>34</td>
<td>729</td>
</tr>
</tbody>
</table>
V. EVALUATION OF SYSTEM CAPACITY

A. HYDRAULIC MODEL ANALYSIS

1. Model Description

In order to evaluate the water distribution system, a computer model was developed to simulate the existing system. The software used was WaterCAD V8i developed by Bentley. The watermain sizes, configuration, friction factors, well pump curves, topographic information, flow demands and storage tank data were input into the model to simulate the existing and proposed water distribution systems. Watermain friction factors were estimated based on values required to achieve model calibration to within ±10% of the calculated available fire flow at 20 psi residual for the test locations. Table 9 presents the comparison of the calculated available fire flow at 20 psi to the values obtained in the calibrated WaterCAD model for the test locations listed.

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Location</th>
<th>Available Fire Flow @ 20 psi (Calculated) (gpm)</th>
<th>Available Fire Flow @ 20 psi (WaterCAD) (gpm)</th>
<th>Difference Between Calculated &amp; WaterCAD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Potter Street at Russell St. intersection</td>
<td>547</td>
<td>597</td>
<td>9%</td>
</tr>
<tr>
<td>2</td>
<td>Main Street between Smith St. and Russell St.</td>
<td>1,116</td>
<td>1,221</td>
<td>9%</td>
</tr>
<tr>
<td>3</td>
<td>Smith Street between Stuart St. and Main St.</td>
<td>803</td>
<td>869</td>
<td>8%</td>
</tr>
<tr>
<td>4</td>
<td>South Shore Dr. west of US-31</td>
<td>992</td>
<td>938</td>
<td>-5%</td>
</tr>
<tr>
<td>5</td>
<td>US-31 between Smith St. and Russell St.</td>
<td>729</td>
<td>663</td>
<td>-9%</td>
</tr>
</tbody>
</table>

2. Test Results

As the results of Table 9 show, the difference between the calculated available fire flow at 20 psi from hydrant testing and that predicted by the calibrated WaterCAD model is within a +/- 10% tolerance. Therefore, the model is an accurate approximation of the system.

3. Fire Flow Results

Fire flows were simulated throughout the Village's water system. The simulations were completed under existing firm capacity conditions. The elevated tank water levels were set at average operating depth. MDEQ recommends a minimum of 20 psi residual pressure in the system at all times. This is to ensure that positive water pressure remains in the distribution system for customer use and to ensure safe water quality. Table 10 highlights areas throughout the system that have lower than recommended fire flows.
Figure 4 shows the existing available fire flow, expressed as contours, throughout the Village under the historic maximum day demand (highest in the last 5 years).

### TABLE 10
**COMPARISON OF TARGET FIRE FLOWS TO WATERCAD FIRE FLOWS**

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Location</th>
<th>Recommended Target Fire Flow @ 20 psi (gpm)</th>
<th>Available Fire Flow @ 20 psi (WaterCAD) (gpm)</th>
<th>Difference Between Target &amp; Available (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>US-31 at the Russell Street intersection</td>
<td>1,000</td>
<td>916</td>
<td>-8%</td>
</tr>
<tr>
<td>2</td>
<td>US-31 at the Potter Road Intersection</td>
<td>2,500</td>
<td>1,310</td>
<td>-48%</td>
</tr>
<tr>
<td>3</td>
<td>US-31 at the Stuart Street Intersection</td>
<td>2,500</td>
<td>1,303</td>
<td>-48%</td>
</tr>
</tbody>
</table>

In order to meet recommended fire flows, undersized watermains should be replaced with larger sized watermains.

### B. WATER SUPPLY

The MDEQ recommends that the firm capacity of a community’s water supply be greater than its maximum day demand. Currently, the firm capacity of the Village’s water supply is 195 gpm, the historic maximum day (highest maximum day in the last 5 years) is 134 gpm. The historic maximum day demand is 69% of the firm capacity.

### C. WATER STORAGE

The recommended target fire flow for commercial areas is 2,500 gpm for two hours. To provide the required volume of water to combat a fire of this duration, 300,000 gallons of water would be used (2,500gpm times 120 minutes). Table 11 compares the volume of available water using current total well capacity and the existing storage volume for each of the classifications of recommended target fire flows and fire flow durations for the historic maximum day demand.

### TABLE 11
**REQUIRED STORAGE CAPACITY FOR FIRE FIGHTING (HISTORIC MAXIMUM DAY DEMAND)**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Desired Fire Flow @ 20 psi (gpm)</th>
<th>Duration (hr)</th>
<th>Historic Maximum Day Demand (gpm)</th>
<th>Total Flow Required (system outflow)</th>
<th>Well Capacity (gpm)</th>
<th>Net System Outflow (gpm)</th>
<th>Total Storage Required (gallons)</th>
<th>Existing Storage (gallons)</th>
<th>Additional Capacity Required (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,000</td>
<td>2</td>
<td>134</td>
<td>1,134</td>
<td>508</td>
<td>626</td>
<td>75,120</td>
<td>150,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Commercial</td>
<td>2,500</td>
<td>2</td>
<td>134</td>
<td>2,634</td>
<td>508</td>
<td>2,126</td>
<td>255,120</td>
<td>150,000</td>
<td>105,120</td>
</tr>
<tr>
<td>Industrial</td>
<td>3,000</td>
<td>3</td>
<td>134</td>
<td>3,134</td>
<td>508</td>
<td>2,626</td>
<td>472,680</td>
<td>150,000</td>
<td>322,680</td>
</tr>
<tr>
<td>Institutional</td>
<td>3,500</td>
<td>3</td>
<td>134</td>
<td>3,634</td>
<td>508</td>
<td>3,126</td>
<td>562,680</td>
<td>150,000</td>
<td>412,680</td>
</tr>
</tbody>
</table>

As the data in Table 11 shows, the Village’s existing storage tank and wells can meet the capacity requirement for a residential fire classification but would require additional capacity to meet a commercial or better fire flow classification. Under existing conditions, an additional 105,120 gallons of system capacity would be required to meet the demand for a commercial classification fire event. If the Village desires to meet commercial fire flows, the Village would need to increase well capacity to meet desired fire flow demands. Additional
Fire flow capacity could be supplied by additional storage, however, this is not recommended because additional storage may affect water quality. The 150,000 gallon capacity of the existing water tank is approximately 2 times the current average day demand, meaning the water in the tank “turns-over” every 2 days. Adding storage would increase the detention time of the water in the tank under average demand conditions, which may result in deterioration of water quality and ice concerns in the winter. It is recommended that the Village add capacity to the water system by the adding well capacity. The additional well capacity required to meet a commercial fire flow classification would be approximately 876 gpm (to supply the needed 105,120 gallons over the 2 hour duration).

The historic average day demand is larger than the projected average day demand for 2032. The existing system storage capacities are adequate for 2032 average day demand.
VI. RECOMMENDED IMPROVEMENTS

It has been determined that the Village's water system has areas of low available flows and lacks sufficient capacity to meet a fire flow classification above a residential classification. Distribution system improvements and water system capacity improvements are recommended to address the deficiencies of the water system.

Recommended Improvements to Increase System Capacity:

In order to improve the water system's capacity, it is recommended that the Village increase pumping capacity. An additional 900 gpm would add enough capacity to meet a commercial fire flow classification for the current and projected demands of the water system. In the short-term, it is recommended that the Village replace Well No.2 with a new well with a target capacity of 475 gpm. In the long-term, it is recommended that the Village monitor the performance of and be prepared to replace Well No. 3 as the well's age and loss of capacity worsens. Well No. 3 should be replaced with a new well with a target capacity of 475 gpm. Also in the long-term, if the Village desires to add capacity to meet a commercial fire flow classification, it is recommended that an additional well with a target capacity of 475 gpm be installed.

Table 12 shows the system capacity with an additional 900 gpm of well capacity. The historic maximum day demand was used for the capacity analysis because the historic maximum day demand is larger than the projected future demands for the study period.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Desired Fire Flow @ 20 psi (gpm)</th>
<th>Duration (hr)</th>
<th>Maximum Day Demand (gpm)</th>
<th>Total Flow Required (system outflow) (gpm)</th>
<th>Well Flow (system inflow) (gpm)</th>
<th>Net System Outflow (gpm)</th>
<th>Total Storage Required (gallons)</th>
<th>Existing Storage (gallons)</th>
<th>Add'l Storage Required (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,000</td>
<td>2</td>
<td>134</td>
<td>1,134</td>
<td>1,408</td>
<td>-274</td>
<td>-32,880</td>
<td>150,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Commercial</td>
<td>2,500</td>
<td>2</td>
<td>134</td>
<td>2,634</td>
<td>1,408</td>
<td>1,226</td>
<td>147,120</td>
<td>150,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Industrial</td>
<td>3,000</td>
<td>3</td>
<td>134</td>
<td>3,134</td>
<td>1,408</td>
<td>1,726</td>
<td>310,680</td>
<td>150,000</td>
<td>160,680</td>
</tr>
<tr>
<td>Institutional</td>
<td>3,500</td>
<td>3</td>
<td>134</td>
<td>3,634</td>
<td>1,408</td>
<td>2,226</td>
<td>400,680</td>
<td>150,000</td>
<td>250,680</td>
</tr>
</tbody>
</table>

As you can see in Table 12, with the recommended well improvements, the Village will have the capacity to meet recommended flows for residential and commercial fire classification.

Recommended Distribution System Improvements to Increase Available Flows:

The distribution system contains a significant amount of 4-inch and smaller watermains that limit available flows in certain areas of the system. The areas found to have low flows were: US-31 between the Smith Street and Russell Street intersections, and US-31 between the Potter Road and Maple Street intersections. Low flows are a problem in areas where fire protection is provided and can pose problems in adequately flushing watermains. Below are recommendations to improve flows in these areas:
US-31 from the Smith Street Intersection to the Russell Street Intersection:

The land-use along this section of US-31 is residential and the current available flows cannot supply recommended fire flows for a residential area (1000 gpm). To increase flows in this area, it is recommended that new 8" watermain be installed on Russell Street from approximately 300’ north of the Main Street intersection to the US-31 intersection and on US-31 from the Russell Street intersection to the Virginia Street intersection.

US-31 from Potter Road to Maple Street:

The area along US-31 from Potter Road to Maple Street includes some commercial properties, so the recommended flow for this area was chosen to be 2,500 gpm. In order to provide 2,500 gpm flows in this area, the watermain on Potter Road (from Smith Street to US-31) and the watermain on US-31 (from Potter Road to Maple Street) should be replaced with 8-inch watermain.

If the improvements listed above are completed, recommended fire flows and capacity for a commercial classification fire event can be met. Table 13 shows available fire flow for the areas listed in Table 10 after the completion of the recommended improvements.

### TABLE 13
COMPARISON OF AVAILABLE FIRE FLOW TO TARGET FIRE FLOWS
AFTER COMPLETION OF RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Location</th>
<th>Recommended Target Fire Flow @ 20 psi (gpm)</th>
<th>Available Fire Flow (WaterCAD) @ 20 psi (gpm)</th>
<th>Difference Between Target &amp; Available (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>US-31 at the Russell Street intersection</td>
<td>1,000</td>
<td>3,469</td>
<td>+247%</td>
</tr>
<tr>
<td>2</td>
<td>US-31 at the Potter Road Intersection</td>
<td>2,500</td>
<td>3,510</td>
<td>+40%</td>
</tr>
<tr>
<td>3</td>
<td>US-31 at the Stuart Street Intersection</td>
<td>2,500</td>
<td>4,057</td>
<td>+62%</td>
</tr>
</tbody>
</table>

As seen in Table 13, the recommended distribution system improvements increase the available fire flows to meet or exceed the recommended fire flow.

**Recommended Improvements – Estimated Cost**

Distribution system improvements are recommended to improve available fire flows and overall system reliability. These improvements should be considered and implemented by Village officials as deemed necessary. The Village should plan on replacing old 4-inch water mains as road improvements are conducted in the Village. These 4-inch lines should be replaced with minimum 8-inch lines in areas where fire protection is provided.

Estimated costs are included with the recommended improvements. These costs are meant to be rough estimates for budgeting purposes only. The estimated costs include appurtenances such as valves, hydrants, fittings, water services, restoration, engineering and contingencies. A unit price of $100 per foot was used for 8-inch watermain. This cost does not include roadway replacement or repairs. The costs are estimated to increase by anywhere from $50 per foot to $100 per foot if watermain must be constructed within the paved roadway, depending on the amount and type of road construction.
Short Term Improvements (0 to 5 Years)

- Replace Well No. 2 with a new well with a minimum pumping capacity of 475 gpm.  
  $400,000

- Replace aged hydrants with new hydrants.  
  $50,000

**TOTAL COST OF SHORT TERM RECOMMENDED IMPROVEMENTS:** $450,000

Long Term Improvements (20 Years)

- Replace 2,400 feet of 4-inch watermain on US-31 from Virginia Street to Russell Street, and on Russell Street from US-31 to 300’ north of Main Street with 8-inch Watermain.  
  $240,000

- Replace Well No. 3 with a 475 gpm well, and if the Village desire to meet a commercial fire flow classification, install an additional new 475 gpm well.  
  $800,000

- Replace 3,400 feet of 4-inch and 6-inch watermain on Potter Road (from approximately 300’ west of Smith Street to US-31) and US-31(Potter Road to Maple Street) with 8-inch watermain.  
  $340,000

- Replace 4-inch watermains that provide fire protection with minimum 8-inch watermain at the following locations:
  - 730 feet on Maple Street
  - 2,050 feet on Wise Street
  - 340 feet on Stuart Street
  - 660 feet on Cody Street
  - 1,000 feet on Virginia Street
  - 740 feet on Locust Street and Euclid Street  
  $552,000

- Install water meters for all Village water customers  
  $173,000

**TOTAL COST OF LONG TERM RECOMMENDED IMPROVEMENTS:** $2,105,000

**TOTAL COST OF ALL RECOMMENDED IMPROVEMENTS:** $2,555,000
VII. FUNDING SOURCES

Five possible sources of funding have been identified for the Village of Bear Lake to complete the recommended improvement projects. A brief description of each follows:

Drinking Water Revolving Fund

The Drinking Water Revolving Fund is a low interest loan program sponsored by the Michigan Department of Environmental Quality. The current interest rate is 2-1/2 percent.

The program is competitive and projects are scored on a point system that ranks them on a priority list. Not all projects submitted are funded so it is important to maximize points on the application. Requirements include a fairly extensive project plan, but most expenses, including the project plan, are eligible activities that can be rolled into the loan. In order for a community to be competitive, they should have a completed wellhead protection program. Applications are submitted by May 1st of every year.

USDA - Rural Utilities Service Grants or Loans (formerly FHA)

Rural Utility Service offers grants and loans for water improvements to communities with a low to moderate average household income. Since the Village’s median average household income is below the low to moderate range, the Village may qualify to receive grant dollars to apply toward a portion of a project. There are two types of loans available from RUS: direct loans and guaranteed loans.

Direct loans are only issued if the Village is unable to obtain funding from other sources at reasonable rates. The current interest rate is approximately 2.75 percent.

Guaranteed loans are made and serviced by lenders such as banks and savings and loan associations. Guarantees will not exceed 80 percent on any loss of interest and principal on the loan.

Special Assessment Bonds

Special assessments levied under PA 188 of 1954 are one of the most common ways to finance infrastructure improvements. The Village may levy special assessments against properties that receive special benefits from a public improvement. Property owners have petition rights that must be satisfied before the special assessment can go forward. The current bond rate is approximately 4.5 percent.

Special assessments typically can be repaid in installments with interest. The bonds may not exceed the amount of the special assessment roll, and may be secured secondarily by a pledge of the Village’s full faith and credit.

Revenue Bonds

Revenue bonds are authorized by PA 94 of 1933. They authorize the Village to borrow money and issue bonds. They are paid from user fees generated by the operation of the improvements.

Revenue bonds are subject to the right of referendum. Petitions for a public vote can be filed by registered Village voters during a 45-day referendum period. Voter approval is not required if the referendum period expires without petitions being filed. The current bond rate is approximately 4.5 percent.
Contract Bonds

Contract bonds are authorized by several state laws. They authorize the Village to enter into an agreement with the County or a public authority in order to have the County or authority issue bonds on behalf of the Village.

The Village may want to consider a contract bond as the County may be able to borrow at a more favorable rate than the Village if they are willing to pledge its taxing power as secondary security for repayment of the bonds. Also contract bonds may be paid back by a number of sources including: specials assessments, connection fees, and user fees. The current bond rate is approximately 4.5 percent.