HARPERS FERRY WATER WORKS

EVALUATION AND FEASIBILITY STUDY

WATER TREATMENT FACILITY AND DISTRIBUTION SYSTEM UPGRADES

JEFFERSON COUNTY, WEST VIRGINIA

NOVEMBER 2013

GD&F
GWIN
DOBSON &
FOREMAN
CONSULTING ENGINEERS

November 4, 2013

Harpers Ferry Water Commission
1000 Washington Street
Harpers Ferry, WV 25425

Attn: Barbara Humes, Chairperson

RE: Harpers Ferry Water Works
Water Treatment Facility and Distribution System Upgrades
Evaluation and Feasibility Study

Dear Mrs. Humes:

Pursuant to your request, our office has completed the evaluation and feasibility study for upgrades to the existing water treatment facility and distribution system. Please find enclosed eight (8) copies of the report for your review and consideration.

The report includes a detailed assessment of the existing process treatment system, evaluation of historical raw water and finished water data, review of new process treatment systems, alternatives and cost-effectiveness evaluation, review of distribution system upgrades and probable project costs.

If you have any questions or require additional information, please feel free to contact our office at your convenience.

Respectfully submitted,
GWIN, DOBSON & FOREMAN, INC.

Christopher M. Eckenrode

Christopher M. Eckenrode, P.E.
Project Engineer

Enclosures
CME/amk
13045/Rpt/HarpersFerryFeasStudy_Nov2013.doc
cc: Central File

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WATER TREATMENT FACILITY UPGRADE
EVALUATION AND FEASIBILITY STUDY

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EXECUTIVE SUMMARY

Sources

- The Harpers Ferry Water Works water treatment facility was constructed in 1985 and has a capacity of 0.5 million gallons per day (mgd). Source water is provided by Elk Run, the Town Spring and the Potomac River.

- The current average daily water demand is 0.284 mgd and no projected system demand increases are anticipated.

- Elk Run and the Town Spring are high quality water sources. They are generally characterized by optimum levels of pH, alkalinity and turbidity. Also, the sources have low levels of iron and manganese. No evidence of inorganic or organic (synthetic and volatile) chemicals exists.

Water Treatment Facility

- Harpers Ferry is faced with USEPA regulations including the Stage 2-Disinfection Byproducts Rule and Long Term 2-Enhanced Surface Water Treatment Rule. These rules place emphasis on particle removal, pathogen disinfection, source water contamination testing and disinfection byproducts (DBP) abatement. New treatment techniques and technologies may be necessary for compliance.

- The plant currently achieves compliance with the WV DHHR criteria for turbidity removal and generally conforms to the 0.1 NTU optimization goal. Regulators state that when all filters are not performing consistently at 0.1 NTU, they are not providing the most effective barrier in the passage of cysts and *cryptosporidium.* This level minimizes breakthrough of pathogenic protozoa.

- The regulations will require treatment techniques and "multiple barriers" to achieve future compliance. In other words, newer treatment technologies (ozone, UV, membrane, etc.) used in series and acting as multiple-barriers will be more effective for particle removal than operator optimization of a conventional filter or reliance on the coagulation chemistry currently being utilized.

- After an extensive evaluation of the existing plant, the process is impacted by insufficient sedimentation, prechlorination for CT disinfection, occasional particle breakthrough of the multi-media filters, lack of filter-to-waste ability, inadequate clearwell capacity and lack of system redundancy among others. Many processes and structural elements are approaching 30 years old and are causing extensive maintenance time and cost issues.

- To improve the water treatment system, an upgraded water treatment facility with membrane filtration technology, pretreatment (enhanced coagulation, flocculation and sedimentation) and additional clearwell capacity is the most cost-effective and functional solution for Harpers Ferry. The upgraded system will provide sufficient particle removal and multiple barriers for compliance with the new Long Term 2-Enhanced Surface Water Treatment Rule.

- Membrane technology is considered the superior water treatment technology when compared to conventional multi-media filtration for sub-micron particle removal (including pathogens such as *cryptosporidium* and *giardia*). The membrane system is considered more operationally flexible and easier to operate and maintain.

- Several additional water treatment facility upgrades such as a new raw water pumping station, new raw water valve vault, sedimentation basin upgrades, additional chemical feed systems, finish water pump upgrades, new SCADA and telemetry systems and emergency generator are being recommended.

Storage

- Harpers Ferry has three storage tanks that provide 1.019 million gallons of finish water storage. This is sufficient for current WV DHHR and ISO fire storage guidelines.

- Storage tank repairs and repainting and distribution system waterline upgrades are being recommended.

Distribution System

- Harpers Ferry maintains about 30,000 feet of distribution system piping. We recommend the following upgrades: 1) line replacement; 2) replace 200 feet of 8-inch cast iron piping near existing water treatment plant; 3) install radio read meters; and 4) install booster pump station near existing water storage tank site to increase water pressure in the Bolivar Heights service area.

Overall Project Cost

- The estimated project cost for the water treatment facility upgrades is $6.25 million. We recommend that the funding source be a combination of grants and loans from IJDC and RUS.

PURPOSE AND SCOPE

The purpose and scope of the study included the following:

- Assess effectiveness of existing unit operations and process treatment systems
- Review current and future regulations with implications for the Harpers Ferry Water Works treatment facility
- Evaluate existing filtration process including performance, reliability, redundancy, etc.
- Review plant performance data and perform chemical analysis of raw/finish water
- Review condition of physical plant, structures and surrounding site constraints
- Perform alternatives evaluation of process systems and treatment techniques
- Prepare cost effectiveness analysis of various project upgrades and alternatives
- Assess plant upgrades with new enhancements & technologies
- Report including study results, cost estimates, conclusions, recommendations, mapping, graphics and data
- Meetings with Harpers Ferry Water Commission and Water Works personnel, as required, throughout the study

INTRODUCTION

In September, 2013, the Corporation of Harpers Ferry commissioned Gwin, Dobson & Foreman, Inc. (GD&F) to evaluate possible upgrades to the Harpers Ferry Water Works water treatment plant and domestic water distribution system. Further, GD&F was to assess alternative treatment systems and provide recommendations in a feasibility study. This report is a summary of our treatment plant evaluation and recommendations for water system improvements.

PUBLIC WATER SUPPLY TREATMENT BACKGROUND AND SUMMARY

The Harpers Ferry Water Works currently serves 821 customers, including residences and businesses within the Corporation of Harpers Ferry and the Harpers Ferry National Historical Park. The current treatment facility produces approximately 284,000 gallons of finish water per day.

The primary source of raw water is obtained from a surface water intake on Elk Run located approximately 200 feet west of Bakerton Road. This intake consists of a small surface water impoundment which diverts the flow from Elk Run to a concrete intake box. The intake box has one (1) stainless steel debris screen which must be manually cleaned. The raw water collected is conveyed by gravity to an existing wet well via an 8-inch cast iron (CI) pipe, where the raw water is pumped to an existing concrete pre-sedimentation basin located adjacent to the existing treatment facility.

In addition to the Elk Run intake, raw water is provided to the treatment facility from the Harpers Ferry Town Spring. The raw water at the Town Spring is collected by a precast circular concrete intake and is conveyed by gravity about 2,500 feet via an existing 6-inch ductile iron (DI) pipe to the existing wet well mentioned above. It was reported by the operators that Elk Run is a perennial stream that rarely goes dry.

An emergency raw water intake and pump station is located on the Potomac River approximately 800 feet northeast of the existing treatment facility. The intake consists of a single 12-inch by 14-inch intake screen located about 60 feet offshore of the southern bank of the Potomac River. The intake screen is connected to a precast concrete wet well via a 10-inch ductile iron pipe. An air backwash system is used to clean the intake screen as necessary using a portable compressor system which is charged at the water treatment facility.

The Potomac River intake is considered an emergency back-up and is only utilized during times of insufficient flow from either Elk Run or the Town Spring intakes, or in the event of a release of pollutants into the drainage areas of the primary raw water intakes. The last time the Potomac River intake was utilized dates back several years ago.

The existing wet well consists of dual 10 HP Fairbanks Morse submersible pumps rated at 350 gallons per minute (gpm) which are controlled by the water level in the pre-sedimentation basin. The pre-sedimentation basin (77,000 gallons) is located 300 feet south of the existing treatment facility. This basin removes the heavy suspended solids (sand, grit, etc.) without the use of coagulation chemicals.

The pre-sedimentation tank effluent is conveyed to the treatment facility filters via gravity flow. A turbidimeter is located at the entry point to the plant. The plant can treat water with a maximum turbidity of 70 NTU. When the settled water turbidity exceeds 70 NTU, the plant is shut down.

The settled water is then injected with DelPAC 2020 (polyaluminum chloride) and chlorine (gas) ahead of an in-line static mixer. The DelPAC is fed into the settled water using an LMI chemical metering pump with speed and stroke settings adjusted manually as needed. Chlorine is fed prior to the filters to obtain the required minimum 3-log inactivation of *Giardia* cysts.

The coagulated water is then diverted to two (2) modular Aquarius packaged treatment systems each rated at 350 gpm. The units consist of dual compartment flocculation tanks, sedimentation tanks (with tube settlers) and filter media beds with a design filtration rate of 5 gpm/sq. ft. of filter media area. The design filter bed depth consists of 18-inches of anthracite, 9-inches of silica sand and 3-inches of garnet sand filter media for a total bed depth of 30-inches. The measured filter bed depth during the 2012 Sanitary Survey performed by OEHS was 25-inches.

Dual HACH 1720E online turbidimeters continuously monitor the filter effluent turbidity with records being displayed on chart recorders. In automatic mode, the treatment facility is programmed to shut down if filter effluent turbidity exceeds 0.2 NTU and an autodial system is engaged to notify the operators. Average turbidity being sent to the clear well ranged from a low of 0.02 NTU to a high of 0.26 NTU, with an average turbidity of 0.06 NTU over a recent twelve (12) month period. Results on average are well below the federally regulated limit of 0.3 NTU.

The filters are manually backwashed every 12 hours of operation, unless otherwise prompted by high filter effluent turbidity. Backwash water is provided from the treatment facility clearwell via an Allis Chalmers frame mounted centrifugal pump rated at 500 gpm. The backwash waste is discharged to concrete holding tanks. Effluent from these tanks is discharged to Elk Run downstream of the existing intake. The backwash cycle temporarily causes an increase in the filter effluent turbidity due to lack of a filter-to-waste; however, the turbidity returns to the pre-backwash cycle measurement in about thirty minutes.

The holding tank discharge is regulated under a National Pollutant Discharge Elimination System (NPDES) permit (Permit #WV 0115754) issued by the West Virginia Department of Environmental Protection (WVDEP).

After filtration, the filtered water is injected with chlorine and fluoride prior to entering the clearwell. The clearwell is a 21,000 gallon above grade glass-lined steel tank located adjacent to the treatment facility structure.

Dual HACH CL17 online chlorine residual analyzers continually monitor and record the residual chlorine levels in the finish water. If the residual chlorine drops below 1.0 mg/l, an alarm is sounded and an autodial system is engaged to notify the operators. If the residual chlorine drops below 0.5 mg/l, the facility is shut down.

The finish water is pumped to the existing distribution system by two (2), 75 HP Allis Chalmers split case centrifugal pumps rated at 200 gpm. The finish water flow is metered by a 6-inch Badger turbine meter and the pumps are controlled manually at the treatment facility based upon the water storage tank levels at Bolivar Heights.

The three (3) finish water storage tanks located in Bolivar Heights were constructed from 1964 to 2008. The oldest tank (Tank #2) was constructed in 1964 from welded steel. This tank has a capacity of 278,000 gallons and an overflow elevation of 695.0. The second oldest tank (Tank #1) was constructed in 1987 of welded steel. This tank has a capacity of 500,000 gallons with an overflow elevation of 695.0.

Tank inspections for these tanks were performed in September 2012 by the Pittsburg Tank & Tower Maintenance Company. The inspections indicated significant signs of wear including deteriorating sealant around the perimeter of the base of the tanks and at the roof/shell connections, inadequate safety signage, inadequate access to the roof hatch and missing fall protection rail on the tank roofs. Additional external deficiencies include the omission of frost proof drain valves, lack of an air break in the overflow drains and frost-proof pressure vents.

The interior of the tanks are beginning to show signs of corrosion on both the roof and the liner. In addition to this corrosion, sediment and debris has collected at the bottom of each tank. The exterior coatings of the tanks also show signs of rust and deterioration.

The third tank (Tank #3) was constructed in 2008 of riveted steel to replace a welded steel tank that was constructed in 1927. This newer tank has a capacity of 241,000 gallons. No tank inspection was performed on this tank, and the tank appears to be in fine working order with no external signs of corrosion.

Access to the three (3) tanks is provided from Prospect Avenue and security is provided by a 6-foot high chain link fence, locked ladder guards and access manhole covers.

The Harpers Ferry Water Works public water distribution system consists of approximately 33,000 linear feet of mains ranging in size from 3/4-inch to 10-inches in diameter. The system also includes one (1) pressure reducing vault, 71 fire hydrants and the three (3) finish water storage tanks. Pressures in the existing system range from a minimum of five (5) psi at the Bolivar Heights tanks to a maximum of 167 psi at the Harpers Ferry/Bolivar Wastewater Treatment Facility. The pressures stated above were calculated using public domain software (EPAnet) and the best available records of the existing distribution system.

Unaccounted for water in the existing distribution system ranges from 41% to 62% as recorded by Harpers Ferry Water Works.

PREVIOUS STUDIES

The following reports were used in the preparation of this feasibility study:

- "Sanitary Survey - Harpers Ferry Water Works System, January 2012 " prepared by the State of West Virginia Department of Health and Human Resources (DHHR) - Bureau of Public Health - Office of Environmental Health Services (OEHS), Kearneysville District Health Office

- “Source Water Assessment and Protection Plan for Harpers Ferry Water Works, Jefferson County, September 2006” prepared by Dalip Sarin, West Virginia Rural Water Association, Hurricane, WV

- "Harpers Ferry Prospect Avenue Tank #1 Maintenance Survey, September 2012" prepared by the Pittsburg Tank & Tower Maintenance Company, Incorporated.

- "Harpers Ferry Prospect Avenue Tank #2 Maintenance Survey, September 2012" prepared by the Pittsburg Tank & Tower Maintenance Company, Incorporated.

- "Analysis and Preliminary Engineering Report for Existing Water System, Corporation of Harpers Ferry, Jefferson County, WV, August 2009" prepared by Alpha Associates, Incorporated, Martinsburg, WV.

PERMITS AND APPROVALS

The following is a tabulation of key permits and approvals issued to the Harpers Ferry Water Works:

Date	Permit No.	Description
June 12, 1964	2391	Office of Environmental Health Services (OEHS) - Water Facilities (Storage Tank Construction)
June 30, 1964	2401	Office of Environmental Health Services (OEHS) - Water/ Sewer Facilities
August 2, 1978	7171	Office of Environmental Health Services (OEHS) - Water Facilities
March 1, 1985	9316	Office of Environmental Health Services (OEHS) - Water Treatment Plant
August 13, 1985	9460	Office of Environmental Health Services (OEHS) - Water Treatment Plant
March 27, 2007	17439	Office of Environmental Health Services (OEHS) - 241,000 Gallon Water Tank
July 19, 2013	WV0115754	NPDES General Permit to Discharge for Water Treatment Plants and Swimming Pool Wastewater

SOURCE WATER ASSESSMENT

The Harpers Ferry Water Works utilizes three (3) sources of supply water. The primary source of raw water is a concrete surface water intake on Elk Run located approximately 200 feet west of Bakerton Road.

The Elk Run intake is supplemented by flow provided by the Harpers Ferry Town Spring which is located adjacent to the Baltimore and Ohio Railway northwest of Harpers Ferry. The average flow from this spring is estimated at 85 gpm as determined by the Harpers Ferry Water Works.

The third source of raw water is an existing intake on the Potomac River. This intake is utilized during times of insufficient flow from either Elk Run or the Town Spring intakes, or in the event of contamination to the primary source of raw water.

A report compiled by the West Virginia Rural Water Association (WVRWA) identified several sources of possible surface water and groundwater contamination, including runoff from transportation corridors and construction activities, on-site water and sewer facilities, underground storage tanks, accidental commercial/industrial discharge and upstream water/wastewater treatment facilities.

Other than general recommendations for watershed management and pollution prevention, no specific water quality parameters were offered for either the Elk Run/Town Spring or the Potomac River sources.

WATER ALLOCATION PERMIT

There is currently no water withdrawal permit associated with Elk Run or the Town Spring according to Josh Carter, Harpers Ferry Water Works.

The water allocation permit from the Potomac River was not available for this project.

WATER DEMAND

For purposes of this feasibility study, no projected system demands are being considered to account for population growth or distribution system expansion. Current demands of the existing service area will be analyzed to determine the required remediation of the treatment facility and the distribution system. Harpers Ferry Water Works does not anticipate any foreseeable system extensions.

PLANT OPERATIONS

Oversight of the Water Works is provided by a five (5) member Water Commission appointed by the town council. The Water Commission is chaired by Barbara Humes. The Harpers Ferry Water Works must comply with the WV Public Service Commission Rules for the Government of Water Utilities.

Based on the complexity of treatment and population served, the Harpers Ferry Water System is classified as a Class II public water system. The water system currently employs one (1) Class DW-3 certified operator, one (1) Class DW-2 certified operator, one (1) Class DW-1 certified operator and one (1) Class DW-OIT certified operator. A list of the current certified operators is as follows:

- Joshua Carter (Chief Operator), Class DW-3, Operator ID - WVOP10003
- John Garza, Class DW-2, Operator ID - WVOP10502
- Brandon Chuvalas, Class DW-1, Operator ID - WVOP11459
- Christian Styer, Class DW-OIT Operator ID - WVOP29457

TOTAL PRODUCTION

The average production for the treatment plant is 350 gpm or 284,000 gallons per day (gpd) based on the treatment facility operating 13.5 hours per day. The peak capacity of the facility is 500,000 gpd based on the treatment facility operating 24 hours per day.

UNACCOUNTED FOR WATER (LOST WATER)

This category is the difference between total plant production and metered consumption plus other consumption. The difference is attributable to system leakage, possible inaccuracies in metering/ recording and overflow of finish water at the Bolivar Heights storage tanks. Typically, systems of this age have "lost water" percentages of 15 to 30%. Water loss for the existing distribution system ranges from 41 to 62% of the finish water produced by the treatment facility, as recorded by the Harpers Ferry Water Works. Water loss records indicate a reduction in water loss over the last three (3) years and further action should be taken to reduce this percentage to acceptable levels.

WATER STORAGE

General - State of West Virginia Department of Health and Human Resources (DHHR) requirements specify that a minimum storage of two (2) times the average daily demand of 150 gallons per customer, plus fire flow capacity be provided. For the 821 current customers, this equates to 246,300 gallons. The Bolivar Heights storage tanks have a combined storage capacity of 1,019,000 gallons of finish water.

Table 1 - Bolivar Heights Water Storage Tanks Capacities

Locations	Type	Material	Capacity (gallons)
Tank #1	Ground Level Tank	Welded Steel	500,000
Tank #2	Ground Level Tank	Welded Steel	278,000
Tank #3	Ground Level Tank	Riveted Steel	241,000
		Total	1,019,000

Finish Water Storage Assessment - Based on DHHR criteria, approximately 4.13 days of finish water storage is provided. Although this is sufficient, "water age" can become a factor. Water age (residence time in the tank) does not generally become a problem until six (6) to seven (7) days. At these times, bacteriological growth, disinfection byproducts (DBP) and loss of chlorine residual may become problematic.

Fire Storage Volume - The ISO Public Protection Classification (PPC) program sets forth the requirements for fire suppression flows within a public distribution system based on several factors, such as building construction materials, proximity of buildings to one another and available public protection services. Assuming that no pumping to the Bolivar Heights tanks is being performed during an emergency and a rate of 3,500 gpm is being withdrawn for fire suppression for a period of two (2) hours, the existing distribution system will require approximately 420,000 gallons of water from the Bolivar Heights storage tanks. If the 246,300 gallons required by DHHR for consumer use and these 420,000 gallons are included in the total tank storage requirements, a total of 666,300 gallons is required to fully satisfy DHHR requirements. As shown in Table 1 above, the total capacity of the Bolivar Heights tanks is 1,019,000 gallons and thus is acceptable.

> ***Note***: The 3,500 gpm flow rate for a period of two (2) hours has been assumed as a worst case for the typical type of construction located within Harpers Ferry and the surrounding water distribution area. The actual fire flow requirements are not known at this time and may be higher or lower as determined by an ISO certification.

SOURCE WATER QUALITY

General - Our office has examined four (4) years worth of daily source water quality information for basic parameters such as temperature, turbidity, pH, hardness and alkalinity from the primary intake (Elk Run and the Town Spring). Over this time, treatment facility personnel have recorded 800 measurements of each parameter. A statistical analysis of this data has produced the following:

Table 2 - Elk Run Intake Water Quality Data

Parameter	Range of Values*	Average Value	Maximum Value	Minimum Value
pH	7.5 - 7.9	7.7	8.2	7.1
Alkalinity	245-309 mg/l	277 mg/l	382 mg/l	176 mg/l
Temperature	10.4°C- 18.6°C	14.5°C	23.2°C	5.0°C
Turbidity	2.2 - 11.6 NTU	6.9 NTU	40.7 NTU	0.1 NTU
Hardness	305-353 mg/l	329mg/l	398 mg/l	242 mg/l

*Represents statistical standard deviation

Conclusions - This above water quality data is considered representative of the combined raw water from Elk Run and the Town Spring. These parameters are essential for designing basic treatment operations such as coagulation, sedimentation and filtration. The pH, alkalinity and turbidity are considered ideal for use as a raw water supply. The water hardness is classified as "very hard". The raw water turbidity has been known to spike at times and the plant has shut-down. By upgrading the pre-treatment system with raw water chemical coagulation, flocculation and proper sedimentation baffling/effluent weirs, the settled water turbidity will be reduced significantly.

Distribution System Bacteriological Testing - Monthly distribution system testing of *E. coli* and total coliform revealed "not detected" results. The criteria for testing these microbiological contaminants is based on population served. Two (2) samples are taken monthly. The limit is no more than one positive test for total coliforms.

The 2010 review of source water *cryptosporidium* indicate that no additional treatment beyond the conventional treatment is needed to meet the Long Term 2-Enhanced Surface Water Treatment Rule. The existing treatment plant currently achieves compliance with WV DHHR criteria for turbidity removal and generally conforms to the 0.3 NTU filter effluent optimization goal. A review of recent monitoring results at the entry points to the distribution system has shown all regulated volatile organic compounds (VOCs) and synthetic organic compounds (SOCs) to be at non-detectable levels. Test results for Nitrate, Nitrite, Inorganic and Radionuclides indicate the level of all contaminants to be below the established maximum contaminant levels (MCLs).

Recent DBP testing has indicated that the limits for Haloacetic Acids (HAA5s) and Total Trihalomethanes (TTHMs) are well below the regulatory limits which may be attributed to source water alkalinity and low levels of TOC (Total Organic Carbon) and NPOM (Naturally Present Organic Matter).

The Town is faced with USEPA regulations including the Stage 2-Disinfection Byproducts Rule and Long Term 2-Enhanced Surface Water Treatment Rule which places emphasis on particle removal, pathogen disinfection, source water contamination testing and disinfection byproducts abatement. New treatment techniques and technologies are necessary for compliance.

Summary of Source Water Quality - The Elk Run/Town Spring intake is a high quality primary water source and the Potomac River is a viable secondary source in the event of an emergency. The primary water sources are generally characterized by optimum levels of pH, alkalinity and turbidity. Also, the source has low levels of iron and manganese. No evidence of inorganic or organic (synthetic and volatile) chemicals exists.

The primary source also has characteristics of a shallow, stream intake. The raw water contains naturally present organic matter (NOM); however, based on the most recent LT2 testing results, the facility remains a Bin No. 1 classification. The stream is subject to spikes in turbidity, depending on weather conditions. Temperature effects are also important, especially in the summer. Given increased DBP and filtration regulations, the ability of a treatment process to maintain consistent particle removal is critical. It is with this perspective that we now examine the performance of the treatment plant.

EXISTING WATER TREATMENT FACILITY AND RECOMMENDED UPGRADES

Description - The Harpers Ferry Water Works is a physical-chemical plant consisting of raw water pumping, pre-sedimentation, chemical additions (DelPAC, chlorine, fluoride), packaged sedimentation and filter systems, disinfection (chlorine addition), chlorine contact time (clearwell) and high service pumping to a public distribution system. Related operations include filter backwashing and monitoring, control of basic treatment parameters and manual control of pumping facilities.

A schematic of existing plant operations can be found in Appendix A.

Discussion - The existing plant currently is in compliance with the West Virginia Bureau for Public Health (WVBPH) criteria for turbidity removal. Treatment effectiveness is demonstrated by combined effluent turbidity less than 0.3 NTU of the measurements taken each day.

Although the turbidity standard will continue, the degree of treatment will ultimately be judged by source water sampling for *cryptosporidium* and *E. coli*. The higher the level of cryptosporidium detected, the higher the level of treatment required. Therefore, future treatment performance, though essential, will be more affected by the technology compatible with the level of source water contamination detected.

Treatment techniques and multiple barriers ("log removal") will tend to achieve compliance better than stand-alone, operator-dependent systems. In other words, newer treatment technologies (ozone, UV, membrane, etc.) used in series and acting as multiple-barriers will be more effective for particle removal than operator optimization of a conventional filter or reliance on coagulation chemistry.

The likelihood of *cryptosporidium* detection in Harpers Ferry source water is probable. An assumption can be made that regardless of existing plant performance, the Harpers Ferry Water Works will be faced with improvements to the treatment system beyond just minor modifications.

Unit Operations - The following section provides a general description of each of the major components of the existing treatment facility. Included are deficiencies identified during the evaluation, as well as those identified by OEHS during their Sanitary Survey performed in January 2012, along with recommendations.

Basic Treatment Plant Data - The following plant production data and design criteria is based on current operations:

- Current Daily Production: 284,000 gallons (350 gpm)
- Time of Operation: 13.5 hours per day
- Design Capacity: 500,000 GPD (350 gpm)
- Filtration Rate: 5.0 gpm/sq. ft.

Elk Run/Town Spring Raw Water Intakes - The existing intake and screen on Elk Run has been in service since approximately 1985 and appears to be in good working order. The existing debris screens do not show signs of corrosion and cleaning tools are present at the intake to remove any obstructions within the screens. It was reported that the operators perform a daily inspection of the intake site. It is our opinion that no upgrades/modifications will be required to this intake.

Photo 1: Elk Run Intake Structure

In addition to the Elk Run intake, raw water is provided to the treatment facility from the Harpers Ferry Town Spring. The raw water at the Town Spring is collected by a precast concrete circular intake and is conveyed by gravity to an existing wet well where it is combined with raw water from the Elk Run Intake. The estimated average amount of flow from this spring is 85 gpm, however; at the time of the site visit for this report the flow was zero (0) gpm. Due to the minimal amount of water collected at this intake and fluctuations in the amount of flow generated by the spring, the Town Spring should not be considered a viable source of raw water. It would be helpful to know the amount of flow that is entering the wet well from the Town Spring, thus Harpers Ferry Water Works may want to consider adding a flow meter to this line.

Photo 2: Existing Town Spring Intake

Potomac River Raw Water Intake - Due to the fact that the Potomac River intake is not the primary source of raw water and is only used during times of low flow in Elk Run or in the event of emergency, it is not recommended that any additional upgrades be performed at this intake. The use of the portable air compressor to clean the intake screen at the Potomac River is not ideal, however, the intake is only used occasionally and a permanent air backwash system is not warranted.

Recommendations:

The Potomac River intake screen should be cleaned and the pumps should be exercised a minimum of once per month to verify working conditions. Additionally, the intake screen should be inspected regularly to ensure unrestricted flow. Check for trees, zebra mussels, algae, etc. that could be blocking the screen.

Raw Water Pumping - Raw water is pumped to the existing treatment facility from an existing concrete wet well. The existing wet well consists of dual 10 HP Fairbanks Morse submersible pumps rated at 350 gpm. The pump controls are currently exposed to the elements and are showing signs of rust and corrosion. The wet well and pump controls are currently located within the 100-year flood elevation. Operators verified that this low lying area is prone to flooding.

Photo 3: Raw Water Wet Well and Pump Controls

Photo 4: Wet Well Submersible Raw Water Pumps

Recommendations:

It is recommended that the submersible pumps be replaced with more efficient vertical turbine pumps with variable frequency drives (VFDs). Vertical turbine pumps are more energy efficient for this application and should require smaller pump motors to operate under the same design conditions as the submersible pumps. VFDs will aid in pump efficiency and offer better flow control to the treatment facility. A new submerged pressure transducer should be installed in the wet well to measure level for pump control.

A new concrete wet well with masonry building structure is recommended at the existing intake location. The building will provide additional security, keep the equipment above the floodplain and provide a temperature controlled environment that will prolong the life of the equipment.

Pre-Sedimentation Basin - An existing 77,000 gallon concrete pre-sedimentation basin is located 300 feet south of the existing treatment facility. At the treatment plant capacity rate of 350 gpm, an approximate detention time of 220 minutes (3.67 hours) is achieved in the basin. This detention time is within the 2-4 hour range as required by WV BPH.

Photo 5 - Pre-Sedimentation Basin

Pre-Sedimentation Basin Deficiencies

The existing pre-sedimentation basin is currently not functioning like a typical sedimentation basin in terms of "pre-treatment". Due to lack of coagulation chemicals fed prior to the sedimentation basin, this basin in its current design is nothing more than a heavy solids (sand, dirt, grit, leaves, etc.) settling basin. Even with over three (3) hours of detention time, the basin does not effectively reduce total organic carbon (TOC) or raw water turbidity. Properly designed sedimentation basins should reduce TOC by 25-40% on average with average settled water turbidity being less than 2.0 NTU. It was

reported that the total solids accumulation in the basin over the last few years was nothing more than a few inches of sediment. It is estimated that the effective rate of TOC removal for the current basin is less than 5%. Higher levels of organics can lead to an increase in the formation of disinfection byproducts (DBPs).

Furthermore, without the use of an oxidant before the sedimentation basin, the soluble forms of metals such as iron, manganese and aluminum cannot be settled or filtered. These metals will pass through the filters and then be oxidized in the clearwell when subjected to chlorine. This can lead to increases in these secondary contaminants in the finish water which can cause health problems and unwanted staining, color, taste or odor.

The existing basin lacks flocculation basins were colloidal "floc" particles are formed allowing for improved settling to occur. The basin also lacks any perforated or inlet baffle walls and effluent weirs/launders which prevent short-circuiting. There is currently no mechanical means of removing sludge in the basins.

New Raw Waterline Vault

It is recommended that a precast concrete vault be placed between the raw water intake building and the pre-sedimentation basin to accommodate chemical injections, a new raw water flow meter and an in-line static mixer.

The amount of raw water entering the existing pre-sedimentation basin is currently unknown due to lack of a flow meter. By adding a new flow meter, the upgraded raw water pumps will be able to maintain a desired plant flow setpoint, while properly pacing the raw water chemicals. Reasons for adding the coagulant (DelPAC 2020) and sodium permanganate to the raw water before it enters the pre-sedimentation basin are as follows:

- Coagulant followed by a new static mixer will allow for proper coagulation of particles which can more easily settle out in the sedimentation basin.
- The sodium permanganate will act as an oxidant to the soluble metals bringing them to an insoluble and settable/filterable state.
- The sodium permanganate will also help prevent the growth of algae in the sedimentation basin and assist in taste and odor removal.

Pre-Sedimentation Basin Modifications

Alterations to the existing pre-sedimentation basin are also recommended. These alterations include the addition of flocculation mixing basins and flocculation mixers. Sluice gates and baffle walls should be included in the new flocculation basin with a minimum detention time of 30 minutes as recommended by WV BPH. The flocculation basins should be designed to provide redundancy in both equipment and detention time.

The sedimentation tank requires the addition of a sludge collection mechanism with a grout sloped bottom and drain which can be discharged into to the existing waste holding tanks. Also, effluent v-notch weirs and launderers and a new combined effluent channel should be added to the basin for discharge of settled water into the treatment facility. Furthermore, a new ultrasonic level transducer should be provided to maintain a level in the sedimentation basin effluent channel.

Additional electrical upgrades are required to be extended from the existing treatment facility to the existing basin and proposed vault to power the above mentioned equipment.

Chemical Treatment - The following chemicals and application points are currently provided at the Harpers Ferry Water Works water treatment plant:

- Coagulation: Polyaluminum Chloride (DelPAC 2020)
- Disinfection: Chlorine Gas (pre-filtration and pre-clearwell chlorination)
- Fluoridation: Sodium Fluoride

Photo 6 - DelPAC 2020 Chemical Feed Equipment

DelPAC 2020 (for coagulation) and chlorine gas (pre-filtration disinfection) are injected ahead of the in-line static mixer prior to the filters. Sodium fluoride for fluoridation and additional chlorine gas is added into the filtered water before entering the clearwell. All chemical feed rates are adjusted manually by the operators. The following are the results of the statistical analysis of chemical addition since 2010:

Table 3 - Summary of Chemical Additions

Parameter	Range of Values*	Average Value	Maximum Value
Coagulant (mg/l) (DelPAC)	11.4 - 22.2 mg/l	16.8 mg/l	46.9 mg/l
Coagulant (lbs/day) (DelPAC)	21 - 44 lbs/day	32 lbs/day	92 lbs/day
Fluoride (gal/day) [Sodium Fluoride]**	12 - 14 gal/day	13 gal/day	33 gal/day
Fluoride (gal/day) [Hexafluorosilic Acid]**	4 - 7 gal/day	6 gal/day	12 gal/day
Pre-Filtration Chlorine (mg/l)	0.5 - 1.2 /mg/l	0.8 mg/l	3.5 mg/l
Post-Filtration Chlorine (mg/l)	1.1 - 2.0 /mg/l	1.5 mg/l	4.2 mg/l
Pre-Filtration Chlorine (lbs/day)	0.9 - 2.4 lbs/day	1.6 lbs/day	5.0 lbs/day
Post-Filtration Chlorine (lbs/day)	2.0 - 4.0 lbs/day	3.0 lbs/day	8.0 lbs/day

*Represents statistical standard deviation

**Sodium fluoride substituted with hexafluorosilic acid in October 2012 (per Harpers Ferry Water Works records)

The average values are typical for chemicals used in similar water treatment operations. The higher dosages of chlorine reflect significant pre-filtration chlorination to achieve CT disinfection during periods of high water temperature and turbidity. The higher dosages of coagulant are due to the lack of detention time in the existing packaged flocculation and filtration tanks. The age of the feed equipment limits the accuracy of the desired feed rate and none of the feed systems are paced with treatment plant flow. Plant personnel do not have the ability to feed multiple coagulants nor does spare chemical feed equipment exist. There is currently no means of adjusting pH in any of the treatment processes.

Recommendations:

Provide a new corrosion resistant shelf with two (2) new peristaltic chemical feed pumps (one as a spare) for both the DelPAC 2020 and Fluoride chemical feed stations. Also provide new chemical resistant 55 gallon drum scales for each chemical with a 4-20 mA output signal for monitoring/reporting at the new plant SCADA. Also, provide the above equipment for new liquid sodium permanganate and a spare chemical feed system. The fluoride should be contained in a permanent air-tight day tank that is vented outside due to toxic and corrosive off-gassing fumes. Harpers Ferry Water Works should also remove the existing soda ash/carbon dry chemical feed system since it is no longer in service.

The existing valves in the gas chlorine room are showing significant signs of corrosion. It is recommended that the manual shut-off ball valves and the electrically actuated solenoid valves in the gas chlorine room be replaced with new 316 stainless steel valves.

Filtration - After chemical addition, the settled water is split and diverted to two (2) modular Aquarius packaged mixed media treatment systems each rated at 350 gpm. The units consist of dual compartment flocculation tanks, tube settlers and filter media beds with a design production rate of 5 gpm/sq. ft. of filter media area.

Photo 7 - Packaged Mixed Media Filter

The basic technical parameters of the existing filtration system are as follows:

- Two (2) packaged filtration units operating in parallel
- Flocculation Detention Time: 15 minutes per unit (2 units)
- Filter Bed Surface Area: 35 sq. ft. per filter (70 sq. ft. total)
- Design Filtration Rate: 5 gpm/sq. ft. (Theoretical at 350 gpm)
- Media (Filter Material)

    a. 12” of anthracite
    b. 10” inches of silica sand
    c. 3” inches of garnet sand

- Backwash Criteria

    a. Run Time: 13.5 hours
    b. Backwash Frequency: 12 hours
    c. Filter Turbidity: < 0.20 NTU

- Backwash Sequence

    a. Filter Drawdown
    b. Surface Wash (1.5 minutes)
    c. Backwash (6 minutes @ 18 gpm/sq.ft.)
    d. Backwash Pump Flow Rate (500 gpm)
    e. Filter Placed Back in Service

As the filter modules remove particles and accumulate headloss, backwashing is required to restore the filter hydraulic capacity. All backwashes are initiated manually by the operator on duty. The backwash waste is diverted to the existing holding tanks.

The packaged filter modules have been in continuous use for nearly 30 years since the treatment plant was constructed in 1985. The filter modules have reached or are near the end of their effective service life. It is our opinion that these filter modules should be replaced. Refer to the Water Treatment Facility Upgrade Alternatives Evaluation located in this report for additional information regarding the filter system options.

Finish Water Clearwell - The filtered water is conveyed to a 21,000 gallon above grade glass-lined clearwell via filtrate pumps. Most recent LT2 testing results require a minimum 2-log deactivation of filtered water prior to distribution. Removal/deactivation of *Giardia* cysts is currently performed in the packaged filters and clearwell prior to the water being pumped into the public water distribution system. Dual HACH CL17 online chlorine residual analyzers continually monitor and record the residual chlorine levels in the finish water. If the residual chlorine drops below 1.0 mg/L, an alarm is sounded and an autodial system is engaged to notify the operators. If the residual chlorine drops below 0.5 mg/L, the facility is shut down.

Photo 8 - Glass-Lined Ground Level Clearwell (21,000 Gallon)

The basic technical parameters of the clearwell are as follows:

- Total Clearwell Volume: 21,000 gallons
- Effective "Contact" Baffling Factor: 0.10 (assumed)
- Total Effective Volume: 2,100 gallons (tank full)

Disinfection Contact Time - The January 2012 OEHS Sanitary Survey determined a 3.20-log deactivation was being achieved by current treatment facility operations (see table below). This level of deactivation was calculated with an assumed removal credit of 2.50-log for filtration.

Table 4 - Calculated CT Values and Log Removals from OEHS Sanitary Sewer, January 2012

	Volume (gallons)	Flow (gpm)	Baffling Factor	Chlorine Residual (mg/L)	Temp. (°C)	pH	CT Value[1] (min mg/L)	Log[2] Removal
Flocculation/Sedimentation in Filter modules	17,500	350	0.70	0.7	9.0	7.4	24.5	0.55
Filters[3]								2.50
Clearwell[4]	19,569	350	0.10	1.3	9.0	7.4	7.26	0.15
								3.20

[1] CT = (Volume/Flow)*(Baffling Factor)*(Chlorine Residual)

[2] General Equation for Temperatures > 5°C
Log Reduction = (CT) / ((0.2828)*($pH^{2.69}$)*(Free $Chlorine^{0.15}$)*(0.933^{T-5}))

[3] Log removal credit for filtration system

[4] Volume of water in the clearwell at the time of testing was used. Maximum capacity of clearwell is 21,000 gallons.

This log reduction value is dangerously close to a minimum 3.0-log inactivation if the system falls into a "future" Bin 2 classification. In fact, a slight decrease in chlorine concentration and/or increase in pH, results in an inactivation less than that which would be required. Also, during current filter backwashing, water is extracted from the clearwell which decreases the log inactivation. The existing clearwell (0.15-log) is significantly undersized per WV BPH requirements. The clearwell should be designed for a minimum 1.0-log removal at worst case water quality conditions. Additionally, 3.0-log reduction should be obtained independently of the filtration units in the event of emergency or if the filtration units need to be taken offline. This would not be possible with the current treatment plant processes and configuration. However, this would be accomplished by placing a new precast concrete vault between the wet well and the pre-sedimentation basin for chlorine injection into the raw water, as recommended earlier in the report. This would allow additional contact time to occur in the new flocculation tanks and sedimentation basin. Please be advised that pending the results of any future Stage 2-Disinfection By-Product Rule Testing, Harpers Ferry Water Works could be required to provide a minimum of 4.0-log inactivation of *Giardia*.

It is not recommended to feed chlorine (except under emergency conditions) at any application point prior to the filters because this will have a negative effect on the finish water quality due to the potential for DBP formation.

Recommendations:

A new 120,000 (+/-) gallon above grade clearwell should be provided adjacent to the existing clearwell in order to create increased contact time for log deactivation prior to finish water being pumped to the distribution system. This new clearwell volume will provide a minimum of 1.0-log removal at worst case water quality conditions. This tank should possess an internal mixing system to increase the baffling factor and thus increasing the effective volume (0.3 minimum). The most economical tank of this size is a bolted or welded stainless steel ground level tank. Stainless steel tanks require minimal upkeep and have long service-lives. Please note that it is not being recommended to construct a concrete baffled clearwell below grade due to the presence of a nearby septic drain field which could potentially contaminate the finish water.

Photo 9 - Proposed Example of a Bolted Stainless Steel Ground Level Tank (165,000 Gallon Shown)

Due to the existing glass-lined tanks age, size and lack of effective volume, it is not considered feasible to utilize this tank in the new design, thus it is recommended to abandon the 21,000 gallon clearwell in place.

Finish Water Pumps and Piping - The finish water is pumped to the existing distribution system by two (2) 75 HP Allis Chalmers split case centrifugal pumps rated at 200 gpm each and a total dynamic head (TDH) rating of 410 feet. The flow from the clearwell is metered by a newly installed and calibrated 6-inch Badger turbine meter. The pumps are controlled manually at the treatment facility based upon the water storage tank levels located in Bolivar Heights.

Photo 10 - Finish Water Pumps and Piping

Pumping Deficiencies

The actual recorded pump flow rate at the time of the study was 350 gpm at 345 feet TDH, meaning that the pump was operating heavily on the right-hand side of the performance curve, which could damage both the motor and impeller. It also means that the pump is not operating efficiently which is critical to ensure long life and minimize energy consumption.

There are no check valves located on the discharge side of either pump; in fact, the operators reported that they can hear the pump impellers rotate in the reverse direction at times when the plant is shut down. There are currently two (2) separate Golden Anderson pressure surge relief valves on the discharge side of the pumps. These valves have been very problematic and were leaking during the site visit.

Recommendations:

It is recommended to provide two (2) new properly sized finish water pumps and motors. It is recommended that silent check valves be installed on the discharge side of each pump, thus omitting the surge pressure relief valves. It is also recommended that the pumps be controlled by new variable frequency drives (VFDs). The VFDs will provide a way of varying the speed/flowrate of the pumps while making them more energy efficient. The drives will also allow adjustments to prolong the acceleration and deceleration set-points, which will reduce distribution system water hammer and pressure surges. These pressure surges are known to be a direct cause of main breaks in old, deteriorated distribution system piping.

Distribution System Piping Near Treatment Plant

There is an existing 8-inch cast iron waterline that exits the treatment facility, crosses beneath Bakerton Road and lies exposed in Elk Run (see below) before it extends to the storage tanks. This section of pipe needs replaced with a new ductile iron pipe that is bored beneath Bakerton Road and Elk Run.

Photo 11 - Exposed 8-inch Distribution System Pipe in Elk Run

Backwash Holding Tanks - Backwash effluent is discharged to two (2) concrete holding tanks located 50 feet north of the existing treatment facility. The solids are held in this tank while the effluent is discharged (via gravity decanting) to an approved NPDES discharge location on Elk Run. The tanks appear to be in good condition and consist of approximately 50,000 gallons of storage per tank for a total of 100,000 gallons.

Photo 12 - Backwash Holding Tanks

Additional waste storage volume is not necessary at this time; however, the holding tanks are in dire need of being cleaned. It is estimated that both tanks are nearly 85% full of accumulated solids, leaving minimal detention time for incoming wastewater. There is currently no easy way of disposing of the solid waste. It appears that the tanks would need dewatered and pumped out with a vacuum truck. This method of disposal is very time consuming and expensive. It may be possible to provide new concrete ramps leading to the bottom of the tanks for cleaning by means of a small excavator. Typically, these waste tanks have dual solids handling pumps so the solids can be conveyed to sand drying beds located at ground level for more efficient drying and cleaning. Due to site restrictions and budget concerns, neither concrete ramps nor sand drying beds may be required at this time but should be considered as a future upgrade. It is estimated that concrete ramps would cost $75,000 and new waste pumps and drying beds would cost approximately $150,000. It is recommended that the waste tanks be cleaned annually.

Plant Electrical/Control System - The plant motor control center, telemetry system and control system are outdated and problematic. The operators reported that many electrical wires and equipment have corroded and failed within the last ten (10) years. This is likely associated with the interior open-top filter tanks and non-contained chemical feed systems which create a damp and chemically concentrated off-gas that leads to steel corrosion. The current telemetry system is not in proper working condition and should be replaced with a new 900 MHz system. The facility lacks a plant Supervisory Control and Data Acquisition (SCADA) system, thus all process control changes and reporting is performed manually. A new SCADA system will save time and provide additional alarming, trending, reporting and security that otherwise exists. All existing and proposed process instruments, control valves, flow meters, scales, motor controls, pump statuses and speeds, etc. should be wired into the new Plant SCADA System for control and monitoring purposes. The existing telemetry system chart recorders can be removed with the addition of a new telemetry system.

The existing facility currently lacks an emergency generator or other secondary source of power. It was reported by the operators that several power failures and surges take place each year, causing disruption of the treatment process, major alarms, equipment failures and manual restarting of the facility. To ensure system reliability, a new emergency generator and automatic transfer switch should be provided which has sufficient capacity for all necessary process electrical loads.

Photo 13 - Plant Motor Control Center

Plant Instrumentation

A. On-line Sampling Equipment - The following instrumentation is utilized at the existing treatment facility:

- One (1) HACH 1720E On-line Turbidimeter (Settled Water)
- Two (2) HACH 1720E On-line Turbidimeter (Combined Filter Effluent)
  a. Calibrated quarterly by a Certified Operator to manufacturer's specifications
  b. Records to a twenty-four (24) chart recorder
- Two (1) HACH CL17 Online Chlorine Analyzers
  a. Measures free chlorine continuously
  b. Records to a twenty-four (24) chart recorder

Recommendations:

A new raw water surface scatter turbidimeter should be installed on the raw waterline. This turbidimeter will assist the operators in the proper dosage rates for the coagulant and sodium permanganate and also show the difference in the raw and settled water turbidity. The chart recorders can be removed with the installation of a new plant SCADA system. The Town may want to consider the addition of a HACH CA610 continuous online fluoride analyzer given the tighter restrictions on maximum fluoride residual.

B. **Laboratory Equipment** - The following laboratory equipment is used to continuously monitor chlorine residual, pH and influent turbidity:

- One (1) HACH 2100N Laboratory Turbidimeter (Raw, Settled and Filtered Water)

  a. Calibrated quarterly by a Certified Operator to manufacturer's specifications

- HACH Pocket colorimeter (Chlorine, Fluoride and pH)

Raw water alkalinity and hardness are calculated via titration and temperature is determined via a thermometer in the laboratory. Proper laboratory equipment is provided, calibrated and maintained.

Finish Water Storage - The three (3) existing water storage tanks are considered adequate based on the WV BPH finish water storage and ISO fire flow criteria. The tanks provide 1,019,000 gallons or 4.13 days of storage.

Photo 14 - Finish Water Storage Tanks

Recommendations:

It is recommended that the repairs to Tank #1 and Tank #2 be made as recommended by the 2012 Pittsburg Tank & Tower Maintenance Company. Refer to Appendices C and D for copies of the tank inspections along with cost estimates. Additionally, the visual tank level gauges should be repaired and a new telemetry system should be installed. This system will allow operators at the treatment plant to remotely view the tank levels while the new SCADA can control the clearwell finish water pumps. In addition to the convenience of remote operation, the telemetry system will reduce the amount of "lost water" due to tank overflows.

New Booster Pump Station - Due to low system pressures along Prospect Avenue (Bolivar Heights), Harpers Ferry should install a new booster pump station. The reason for the low pressures (residuals less than 25 psi) is due to elevation constraints. Most of these homes and fire hydrants are within a few hundred feet of the existing water storage tanks.

Recommendations:

The new booster pump station should be installed along Prospect Avenue in the area shown in the photograph below. This building should consist of a concrete foundation with CMU walls and a wood truss/shingled roof similar to that of the proposed intake building. The proposed building will house the inline booster pumps, valves, piping, electrical components and variable frequency drives. A new telemetry system will enable control of the booster pumps from the water treatment facility.

Photo 15 - Proposed Location of New Booster Pump Station along Prospect Avenue (Near Tanks)

New Radio Read Meters - New radio read water meters are proposed for the distribution system to twenty (20) customers (800 plus). The Town currently utilizes manual read meters and readomatics which are ten (10) years old. A new Sensus FlexNet or Neptune R900 Mobile AMR meter reading system will enable Harpers Ferry to conserve their resources, improve reliability, accuracy and flexibility of their system while providing enhanced customer service. The radio read system uses a single licensed band in a 900 MHz spectrum to record water meter readings. It is recommended that Harpers Ferry Water Works install all meters and radios in-house to save costs, while the Contractor be responsible for installing and programming the software packages.

DISTRIBUTION SYSTEM UPGRADES

The existing Harpers Ferry Water Works distribution system provides service to 821 residential and commercial customers in Harpers Ferry, Bolivar and the surrounding areas. The system also provides water to the Harpers Ferry National Historical Park, the Harpers Ferry/Civil War Battlefields KOA Campground and the former Storer College campus.

The system consists of approximately 30,000 linear feet of distribution mains ranging in size from 3/4-inch to 10-inch. An existing 10-inch PVC (C-900) distribution main leads from the Bolivar Heights finish water storage tanks to Polk Avenue and Washington Street. This existing PVC main continues on Washington Street and transitions to an existing 6-inch asbestos cement (AC) pipe at Columbia Street. This existing AC pipe then continues down High Street to the intersection of High Street and Shenandoah Street. These two (2) mains provide service to the majority of Harpers Ferry and Bolivar, with several other branches providing individual service.

The Harpers Ferry National Historical Park and KOA Campground are serviced by an existing 6-inch PVC main. This main also provides service to the Cavalier Heights and Cavalier Estates subdivisions. In addition to this 6-inch main, both the Cavalier Heights and Cavalier Estates subdivisions are serviced by 8-inch distribution mains accompanied by 2-inch service lines running parallel to the 8-inch distribution lines.

The existing distribution system was modeled using EPAnet, which is a public domain modeling system created by the United States government. The model was calibrated using fire flow test results from tests performed by the Harpers Ferry Water Works in 2011. Pipe sizes, lengths and locations, as well as storage tank information, were based on record drawings provided by the Harpers Ferry Water Works and the best available information at the time of this study.

Due to excessive pressures at the lower elevations within the distribution system (in the vicinity of High Street, Church Street, Shenandoah Street and Potomac Street), a pressure reducing valve (PRV) is located at the intersection of Washington Street and Church Street. This valve reduces the pressure from over 100 psi down to about 60 psi according to the operators.

Based on existing system record drawings, it appears that an existing 6-inch PVC distribution main bypasses the PRV and causes high pressures (approximately 130 psi as determined by EPAnet) to develop in the area of Church Street. It is recommended that this bypass be remediated to reduce the pressure in this area.

High pressures were also located in the area at the intersection of Franklin Street and Washington Street and at the existing Harpers Ferry Wastewater Treatment Facility.

Further investigation of the record drawings indicated that there are multiple areas of redundancy (i.e. service mains running on both sides of the street) located within the existing distribution system. This unnecessary redundancy, as well as the age of the system, contributes to both inefficiency and water loss within the existing system. In addition to the redundancy in the service mains, inaccuracy in the existing service meters and errors in reading the meters may contribute to the high rate of recorded water loss within the system.

There are several areas within the distribution system which do not meet NFPA requirements for fire protection. These areas will require distribution system upgrades to provide emergency services to existing structures at a minimum.

Recommendations:

To address both the deficiencies and water loss within the existing system, our office recommends the following:

W. Spring Street

- Abandon the existing 1-1/4-inch IP service main
- Install 813 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Elm Street and W. Spring Street

E. Spring Street

- Abandon the existing 1-inch IP and 2-inch PVC service mains
- Install 730 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Cooper Street and E. Spring Street

Elm Street

- Abandon the existing 3/4-inch IP, 1-1/4-inch IP and 2-inch PVC service mains
- Install 1140 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Elm Street and Washington Street

Spruce Street

- Abandon the existing 1-inch IP service main and 6-inch AC distribution main
- Install 775 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Elm Street and Washington Street

Day Street

- Abandon the existing 3/4-inch and 1-inch PVC service mains
- Install 964 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Day Street and Bland Street and one (1) at the terminus of the proposed C-900 main

Bland Street

- Abandon the redundant existing 1-inch IP and 2-inch PVC service mains
- Install 522 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Polk Street

- Install one (1) fire hydrant at the corner of Polk Street and Rowles Street

Clay Street

- Abandon the redundant existing 2-inch PVC service main near the intersection with Taylor Avenue
- Provide domestic connections as necessary to the existing 6-inch C-900 distribution main

Taylor Street (East of Jackson Street)

- Abandon the redundant existing 3/4-inch and 2-inch PVC service mains
- Install 240 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Install one (1) fire hydrant at the terminus of the proposed C-900 main

Park Avenue

- Abandon the existing 4-inch C-900 distribution main
- Install 420 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Park Avenue and Madison Street

Warren Street

- Abandon the existing 2-inch PVC service main and 4-inch C-900 distribution main
- Install 227 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Mercer Street

- Abandon the existing 2-inch PVC service main
- Install 392 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Mercer Street and Jefferson Street

Jefferson Street

- Abandon the redundant existing 3/4-inch IP service main
- Provide domestic connections as necessary to the existing 6-inch C-900 distribution main
- Extend 721 LF of 6-inch C-900 distribution main with appropriate trench bedding and thrust blocking to Primrose Alley
- Install one (1) fire hydrant at the corner of Primrose Alley and Jefferson Street

Primrose Alley

- Abandon the existing 3/4-inch IP service main
- Install 201 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Union Street

- Install one (1) fire hydrant at the corner of Union Street and US 340 and one (1) fire hydrant in front of Parcel 147

Gilbert Street

- Abandon the existing 1-1/4-inch IP service main
- Install 734 LF of 8-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking. Use existing 8-inch tees in Washington Street and Ridge Street
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Gilbert Street and Washington Street

Cleveland Street

- Abandon the existing 1-inch IP service
- Install 360 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Root Street

- Install one (1) fire hydrant at the terminus of existing 6-inch PVC distribution main

Stevenson Street

- Abandon the existing 3/4-inch IP service main
- Install 460 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Old Furnace Road

- Extend 1060 LF of 6-inch C-900 distribution main from Mudfort Drive with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Old Furnace Road and Pauling Street and one (1) fire hydrant at the corner of Old Furnace Road and Stevenson Street

Fisher Street / Alley

- Abandon the existing 2-inch PVC service main
- Install 753 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Fisher Street and Fisher Alley

Marion Street

- Abandon the existing 3/4-inch IP service main
- Install 560 LF of 8-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking. Use existing 8-inch tees in Washington Street and Ridge Street
- Provide domestic connections to the new C-900 distribution main

Putnam Street

- Abandon the existing 4-inch C-900 distribution main
- Install 853 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Boundary Street

- Abandon the existing 2-inch IP service main
- Install 602 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant at the corner of Fillmore Street and Boundary Street

Mason Way

- Abandon the existing 2-inch IP service main
- Install 362 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Fillmore Street

- Abandon the existing 2-inch IP service main
- Extend 890 LF of 6-inch C-900 distribution main with appropriate trench bedding and thrust blocking. Provide connection to existing 6-inch CI at Jackson Street and extend new main to Boundary Street
- Provide domestic connections to the new C-900 distribution main and existing CI distribution main as necessary
- Install one (1) fire hydrant near the corner of Fillmore Street and Zachary Taylor Street in front Parcel 9

Zachary Taylor Street

- Abandon the existing 2-inch IP service main
- Install 393 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

McDowell Street

- Abandon the existing 1-inch IP and 2-inch PVC service mains
- Install 1022 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Extend main to Cliff Street
- Provide connection to existing 10-inch C-900 in Washington Street
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant on McDowell Street between Washington Street and Fillmore Street and one (1) fire hydrant at the corner of McDowell Street and Cliff Street

Gilmore Street

- Abandon the existing 3/4-inch and 1-inch IP service mains
- Install 1022 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Extend main to Cliff Street
- Provide connection to existing 10-inch C-900 in Washington Street
- Provide domestic connections to the new C-900 distribution main

Cliff Street

- Install 255 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Columbia Street

- Abandon the existing 1-inch and one and 1-1/4-inch IP service mains and 6-inch AC distribution main
- Provide connection to existing 10-inch C-900 in Washington Street
- Install 705 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant on Columbia Street between Washington Street and Fillmore Street

York Street

- Install 209 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking. Provide connection of proposed C-900 main at the intersection of York Avenue and Henry Clay street and extend connection to tie in at Washington Street
- Provide domestic connections to the new C-900 distribution main

Clay Street

- Turn off existing 6-inch isolation valve prior to connection with existing 6-inch C-900 distribution main within Church Street. Closing this valve will force the water to the York Street distribution main extension and prevent the flow from bypassing the existing pressure reducing valve (PRV).

Church Street

- Abandon existing 6-inch C-900 bypass of existing PRV.
- Install 6-inch x 6-inch wye and provide 6-inch C-900 connection after the existing PRV.

Public Way

- Abandon the existing 2-inch PVC service main
- Install 485 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking. Provide 6-inch C-900 distribution main extension to existing 6-inch C900 distribution main in Church Street
- Provide domestic connections to the new C-900 distribution main

Shenandoah Street

- Abandon the existing 8-inch CI and 6-inch AC distribution mains
- Install 808 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Potomac Street

- Provide connection to existing 6-inch CI at the corner of Hog Alley and Potomac Street. Install 260 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking and provide connection to proposed 6-inch C-900 distribution main in Shenandoah Street
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant in front of Parcel 20 and one (1) fire hydrant at the end of the existing 6-inch CI

Washington Street (Elm Street to Polk Street)

- Abandon the existing 2-inch PVC service main
- Install 822 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking. Provide 6-inch C-900 distribution main extension from proposed 6-inch C-900 distribution main at Elm Street and connect to existing 10-inch C-900
- Provide domestic connections to the new C-900 distribution main

Washington Street (Polk Street to Clay Street)

- Abandon the existing 2-inch PVC service main
- Provide domestic connections as necessary to the existing 10-inch C-900 distribution main

Washington Street (Clay Street to Jackson Street)

- Abandon the existing 2-inch PVC service main
- Provide 33 LF of 6-inch C-900 connection from Jackson Street
- Provide domestic connections as necessary to the existing 10-inch C-900 distribution main

Washington Street (Jackson Street to Panama Street)

- Abandon the existing 2-inch PVC service main
- Provide domestic connections as necessary to the existing 10-inch C-900 distribution main

Washington Street (Madison Street to Fisher Alley)

- Abandon the existing 2-inch PVC service main
- Provide domestic connections as necessary to the existing 10-inch C-900 distribution main

Washington Street (Boundary Street to Zachary Taylor Avenue)

- Abandon the existing 2-inch IP service main
- Provide 6-inch C900 connection from Boundary Street and Zachary Taylor Street
- Provide domestic connections as necessary to the existing 10-inch C-900 distribution main

Washington Street / High Street (Columbia Street to Shenandoah Street)

- Abandon the existing 6-inch AC distribution main
- Install 2384 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main
- Install one (1) fire hydrant in front of Parcel 17 on High Street

Columbia Avenue

- Abandon the existing 2-inch PVC distribution main
- Install 2137 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Cavalier Drive

- Abandon the existing 2-inch PVC distribution main
- Install 1013 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Kenneth Street

- Abandon the existing 2-inch PVC distribution main
- Install 247 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

Cavalier Estates Drive

- Abandon the existing 2-inch PVC distribution main
- Install 1054 LF of 6-inch PVC C-900 distribution main with appropriate trench bedding and thrust blocking
- Provide domestic connections to the new C-900 distribution main

It should be noted that the distribution system improvements shown above are preliminary and may be revised prior to the final design, pending further detailed hydraulic analyses and actual field surveys.

WATER TREATMENT FACILITY UPGRADE ALTERNATIVES EVALUATION

Review and analysis of historical operating and water quality data allowed for a characterization of the water quality and overall facility operations. This review coupled with the overall process assessment provided further insight into the treatment needs for compliance with current and future regulations; thereby, establishing the selected means and methods for effective and efficient water treatment.

To address the current and future needs, various alternatives were considered for the upgrades to the existing facility, including the following:

1. Replace the existing packaged media filters in kind with similar (updated) packaged filters.

2. Replace the existing packaged media filters with a new membrane filtration system with automatic clean-in-place.

3. Renovate the existing treatment facility floor plan by demolishing the existing filters to accommodate an office, laboratory and break room / kitchen.

4. Add an office, laboratory and break room/ kitchen to the mezzanine level above the existing laboratory.

5. Expand upon other available water treatment technologies.

Renovating Existing Filters - The existing packaged filters have been in continuous service for approximately 30 years and have reached their expected service life and thus should be replaced. The existing filters lack influent or effluent flow meters, the steel tanks are showing signs of rusting and corrosion, they do not have the ability to perform a filter-to-waste and several mechanical and instrumentation failures have occurred on the units. Also, the filter media is currently about 6-inches deficient of a full media bed depth. There is currently no redundancy regarding the backwash or surface wash pumping systems (only 1 pump each). Due to lack of a filter-to-waste piping configuration, the filtered water turbidity increases on average by a factor of three (3) after a backwash. Although the filters have performed well with respect to finish water quality, they have reached their useful life.

The use of similar packaged media filters would allow a new filter to be placed in the same footprint as the existing filter while utilizing some existing piping. The existing filters would need to be taken out of service in order to install the new filters, thus limiting the production capacity and redundancy of the treatment facility during the installation. A probable cost estimate to install two (2) new packaged filters is listed below:

Table 5 - Cost Estimate - Two New Packaged Filters

	Item Description	Estimated Cost
1.	Demolish Existing Filters, Pumps and Piping	$40,000
2.	Two (2) New Packaged Filters with Instrumentation/Control/SCADA	$700,000
3.	New Backwash Pumps and Air System with Redundancy	$120,000
4.	New Piping and Electrical	$90,000
	Total Estimated Construction Cost:	**$950,000**

Membrane Filtration

As an economical alternative to conventional filtration, membrane filtration technology offers a cost effective treatment solution giving water suppliers the ability to meet current and future water quality requirements. Membrane filtration has the following advantages over conventional filtration: greatly reduces filtered water turbidity (by a factor of 10); provides an absolute, physical particle barrier for removal of bacteria, *cryptosporidium* and *giardia*; utilizes a smaller footprint; generates less backwash wastewater; adapts easily to change in filter flow rates; module racks are easily expandable; requires low maintenance and minimal labor; additional clearwell volume is not required for backwashing, features much smaller backwash pumps and is more adaptable to stringent future regulations (greater "log" removal). Membrane system disadvantages include: costly and time consuming pilot studies; periodic chemical cleaning required; produces concentrated chemical waste; daily integrity tests required; automation requires higher level of sophisticated maintenance; higher capital costs and high replacement module costs than conventional media.

The major difference when comparing conventional filtration to membrane filtration is that membranes provide an absolute physical barrier for the removal of suspended particles, algae and bacteria without the use of chemicals, while conventional filtration relies heavily on proper coagulation chemistry. Capital costs of membrane filtration have dropped significantly over the last ten years, thus making membrane filtration a viable option for water treatment.

The other alternative is to install two (2) membrane filters with N-1 capacity adjacent to or in place of the existing packaged filters. Membrane technology is considered the superior water treatment technology when compared to conventional multi-media filtration for sub-micron particle removal (including pathogens such as *cryptosporidium* and *giardia*). Membrane systems are considered more operationally flexible and easier to operate and maintain than conventional filtration. This system will provide sufficient sub-micron particle removal and multiple barriers for compliance with the Long Term 2-Enhanced Surface Water Treatment Rule. These treatment techniques have gained rapid acceptance as processes that provide a reliable and very high level of particle, turbidity and microorganism removal.

Additionally, the use of membrane filter technology will allow the new filters to be installed prior to the removal of the existing packaged filters. This will minimize any production interruptions at the treatment facility due to the proposed upgrades. A minimum 6 week pilot study to determine the effectiveness of membrane filter technology is required by WV BPH. A probable cost estimate for this alternative is listed below.

Proposed Membrane Filtration System

The proposed membrane system would consist of two (2) pressure cartridge module rack systems (skids). The membrane systems have a small footprint, high recovery rate, low solids production and modular arrangement to allow future system expansion.

The membrane filtration system would contain two (2) module racks each capable of treating 0.5 mgd at an average flux rate of 35 gfd; thereby, meeting the current and future system demands with the potential for future expansion. The effectiveness of the membrane filtration system will be documented through the results of the 6-week microfiltration (MF) pilot study.

Each skid assembly will be provided with approximately 25 modules or a total filtration area of 13,450 square feet. Two (2) units will be provided for operation one (1) unit providing standby capability. Each skid would consist of a feed tank and pump and reverse filtration tank and pump.

Each skid assembly has the capability to automatically backwash and chemically clean the filters. The system can provide periodic clean-in-place (CIP) washes or more frequent enhanced-flux-maintenance (EFM) cleanings depending on membrane performance using a combination of citric or hydrochloric acid, sodium hypochlorite and caustic soda.

The MF system will require more thorough and routine cleaning than that provided via reverse filtration and air scrubbing. Cleaning chemicals will be added to the system and recirculated as required to restore lost performance of the modules. The CIP process is a semi-automatic process initiated by the operator when transmembrane pressures (TMP) exceed established limits. Filtered water is heated to 75-95°F (25-35°C) combined with sodium hydroxide or sodium hypochlorite and circulated for at least 60 minutes, drained and rinsed for approximately 30-45 minutes. The system is filled a second time with heated filtered water to which acid is added and circulated for at least another 60 minutes. The system is drained and rinsed prior to returning to service until pH levels are within 1 unit of the raw water.

The selection of the chemical to be used first (i.e. sodium hydroxide or acid) is dependent upon the water quality characteristics which are fouling the membranes. Until the system is operated under varying water quality conditions, it is unknown which chemical scenario will best clean the modules and restore performance.

Typically both chemicals are used to clean the system thereby ensuring sufficient cleaning has occurred. Upon operating experience under varying water quality conditions, the operator may learn that it is only necessary to clean with one or the other of the cleaning agents based on seasonal conditions etc. Standard practice is to monitor the transmembrane pressure to assure performance standards. If the operator chooses to only clean with one chemical and the performance standards are not regenerated (i.e. TMP), then the second chemical would be initiated.

The CIP wastewater can be neutralized by the volume of the wastewater in the existing holding tanks. Past experience has shown that neutralization typically occurs through the recirculation process and rinsing of the actual CIP process. However, the waste tank can serve as a neutralization vessel, if necessary.

Upon start-up of a facility a new membrane system will typically have a transmembrane pressure (TMP) of 4 to 6 prior to operation. Most CIP's that do not occur on a routine cleaning schedule will clean the modules when TMP reaches 15-20 psi. Upon completion of the CIP, the TMP should return to less than 5-7 psi. Membrane manufacturers recommend performing a CIP on each unit every one (1) to three (3) months.

Prior to the membranes, the filter system will feature in-line automatic backwashing, 300 micron prestrainers to protect the membranes. Each skid will have one (1) forward filtration horizontal centrifugal feed to pressurize the membrane modules and one (1) reverse filtration horizontal centrifugal pumps which will provide backwash capabilities. Also, a feed tank and reverse flow tank are required. A compressed air system is required for integrity testing (IT), backwash air and pneumatic control valve operation. This will consist of redundant air compressors and an air receiver tank.

Photo 16 - Two (2) Proposed Membrane Skids (Pall Corporation AP-4s)

Photo 17 - Proposed Membrane Module Rack (18 Pall Corporation Modules Shown)

Membrane filtration will allow for the effective removal of particle matter, pathogens and natural organic material. Additionally, membrane filtration will allow for a reduction in color, tastes, odors and compliance with proposed future regulated contaminants.

Typical microfiltration membranes have a nominal pore size of 0.1 micron can achieve a 5-log reduction in *Giardia* and a 6-log reduction in *Cryptosporidium* oocysts, while tighter ultrafiltration membranes (0.01 micron pore size) can achieve even greater levels of particulate removal, including viruses.

Table 6 - Cost Estimate - New Membrane Filtration Units

	Item Description	Estimated Cost
1.	Pilot Study	$30,000
2.	New Membrane System with CIP, Air Supply System and SCADA	$1,100,000
3.	Building Demolition and Retrofitting	$40,000
4.	New Piping and Electrical	$80,000
	Total Estimated Construction Cost:	**$1,250,000**

Renovating the Existing Facility - The existing treatment facility was constructed of insulated metal wall panels and structural steel in 1985. The interior walls are constructed of concrete masonry units (CMU) and there is an existing wooden storage platform located above the existing laboratory/office. Some of the wall and ceiling insulation is exposed and peeling and there are various places of surface corrosion on the metal building liner panels.

The Harpers Ferry Water Works would like to utilize the existing storage space above the office/laboratory (mezzanine) as additional space for an office, break room and conference room. The use of this area for additional usable space (approximately 520 square feet) would require minimal construction within the existing structure. The following table is a preliminary cost estimate for providing additional usable space above the existing laboratory.

Photo 18 - Overview of Mezzanine Level

Table 7 - Construction Cost Estimate - Office, Break and Conference Rooms on Mezzanine

	Task Element	Estimated Cost
1.	Construct Office, Break and Conference Rooms on Mezzanine	$75,000
2.	Aluminum Stairs and Vent Relocations	$25,000
	Total Estimated Construction Cost:	**$100,000**

It appears that the existing mezzanine sub-floor (bracing, flooring, joists, etc.) is adequate for the addition of the rooms listed above. However, the average clear space from the existing mezzanine floor to the steel roof support structure is 6'-6" at the lowest end. The mezzanine option will require stairs, relocation of vent piping and results in very low ceiling heights. Furthermore, the rooms will in no way be handicap accessible which may cause issues with code reviewers/inspectors. Further structural investigations are necessary if this option is selected.

The second alternative is to revise the operating floor plan of the existing treatment facility to accommodate additional usable space (approximately 450 square feet). This would include removing at least one (1) existing packaged filter unit and constructing the rooms in the given space between the laboratory and chlorine room. Utility water piping would need relocated. The estimated cost of this alternative is listed below.

Table 8 - Construction Cost Estimate - Office, Break and Conference Rooms on First Floor

	Task Element	Estimated Cost
1.	Construct Office, Break and Conference Rooms on First Floor	$70,000
2.	Relocating Existing Windows and Utilities	$10,000
3.	Demolish Existing Filter and Patch Floor	$20,000
	Total Estimated Construction Cost:	**$100,000**

Recommendations:

It is recommended that the Town construct an office, break and conference room on the first floor level between the existing laboratory and chlorine room. This would be a Phase II project that could be performed following installation and successful start-up of the new filter system. It would require demolition of at least one (1) package filter and piping and reconstruction of the concrete floor.

Other recommended building improvements include repainting of the metal roof and interior/ exterior metal building panels ($40,000). Also the existing building ventilation system appears to be significantly undersized. Properly sized and corrosion resistant exhaust fans should be provided ($20,000). The building lighting is outdated and the lights should be replaced with new energy efficient fluorescent T-5 fixtures ($25,000).

NEW TREATMENT TECHNOLOGIES

The ever-changing regulations will require treatment techniques and "multiple barriers" to achieve future compliance. New treatment technologies (ozone, UV, membrane, granular activated carbon, etc.) used in series (as multiple-barriers) will be more effective for particle and virus removal. Each technique has advantages and disadvantages associated with treating drinking water.

A. UV Disinfection System

Ultraviolet (UV) disinfection can be used as an additional treatment barrier to ensure compliance with the Long Term 2-Enhanced Surface Water Treatment Rule and associated "bin" classification. Depending upon the ultimate "bin" classification, additional treatment could be required to achieve 1.0 to 2.5-log (90-99.7% reduction) for *Cryptosporidium*.

Ultraviolet disinfection of water consists of a purely physical, chemical-free process. UV disinfection uses a UV light source, which is enclosed in a transparent protective quartz sleeve. It is mounted so that water can pass through a flow chamber, and UV rays are emitted and absorbed into the stream. When ultraviolet energy is absorbed by the reproductive mechanisms of bacteria and viruses, the genetic material (DNA/RNA) is rearranged so they can no longer reproduce. They are therefore considered "dead" and the risk of disease has been eliminated. UV disinfects water without adding chemicals and does not create new chemical complexes. Also UV does not change the taste or odor of the water, nor remove beneficial minerals.

The UV process is cost effective, does not use chemicals and slightly reduces post-filtration chlorine demand (10-15% on average). The reduced chlorine usage typically reduces the formation of disinfection by-products and further aid in compliance with the Stage 2-Disinfection Byproducts Rule.

Due to this new technology, UV disinfection cannot be used as a stand-alone finish water disinfectant. Proper chlorine residual is still currently required even if UV treatment is implemented. Capital costs and space requirements of UV disinfection systems are minimal; however, O&M costs will increase with additional power requirements, lamp/ballast replacements, validations, etc.

The Town should consider UV disinfection as a multi-barrier application that will assist in the deactivation of pass-through pathogens and protozoa. The approximate cost estimate to install two (2) units each rated for 350 gpm with automatic cleaning systems is $120,000.

B. Ozone

Ozone gas is considered to be the optimal disinfectant and oxidant. It is typically injected in the raw water of water treatment facilities as an oxidizer to various metals such as iron, manganese and aluminum. It can also be used as a means of disinfection, however is very expensive to implement.

The cost of ozone generators, air dryers, contactor tanks, diffusers, destructors and monitoring instrumentation is very expensive and requires extensive space. O&M costs are also high due to all the required equipment electrical costs and ozone gas is considered highly hazardous. The use of ozone gas at the Harpers Ferry Water Treatment facility is not being recommended nor desired.

C. Granular Activated Carbon (GAC)

Granular activated carbon (GAC) consists of pressure vessels with activated carbon intended to remove small particulates, pathogens, viruses, etc. GAC is a highly adsorbent material used to remove contaminants from drinking water. Activated carbon can remove a plethora of unwanted matters such as taste, odor and color issues, volatile organic chemicals, pesticides and trihalomethanes (suspected carcinogens). Carbon is able to achieve such removal of contaminants due to its large surface area. In fact, the surface area of one pound of activated carbon is equal to 125 acres. Activated carbon is the preferred method of water treatment by the EPA due to its ability to reduce/remove such a high level of potentially hazardous and carcinogenic chemicals.

GAC features very expensive associated capital and O&M costs. The GAC filters require a large amount of surface area to account for a 50% bed expansion during backwashing and large feed pumps are required to pressurize the vessels. Depending on the level of contaminants, the surface of the GAC will eventually become covered and clogged. This could potentially be months or years depending on the influent water quality. Once the GAC filter has reached its adsorption capacity, it must be regenerated (similar to an ion-exchange softening system). The GAC is regenerated using a heating process or it is replaced in-full with a new bed of activated carbon. A disadvantage of GAC is the tendency of the filter beds to grow bacteria. Typically, GAC systems are only installed in large scale water systems were major taste and odor issues are present or when the trihalomethane levels are elevated.

PROBABLE PROJECT COSTS

This section contains the Engineer's Opinion of Probable Project Costs for the above mentioned water treatment facility upgrades. The total overall capital construction cost estimate is $5.0 million assuming all upgrades, while the total overall project cost estimate is $6.25 million. These cost estimates were derived from recent bids and manufacturer budgetary cost proposals. These preliminary cost estimates are based on concept design. The probable costs assumed that rock excavation would be minimal and no deep foundations are required. The location and condition of rock will be determined by a geotechnical consultant at a later date. The costs also do not include any archaeological investigations. Please refer to Appendix E for the Engineer's Opinion of Probable Construction Costs breakdown.

A. Operation and Maintenance Costs

Proposed labor costs will presumably decrease with a new fully automated membrane filtration plant; however, membrane module replacement costs will be greater than current filter media replacement costs. The chemical costs of a proposed membrane plant will be similar to current treatment facility costs. Although DelPAC 2020 and chlorine consumption will be reduced significantly with the proposed treatment facility, the required membrane system cleaning chemicals will offset this difference. Electrical costs for the new plant should decrease with the addition of energy efficient pumps and variable frequency drives. A new membrane treatment system will significantly reduce the current equipment maintenance, repairs and replacement costs. It should be noted that the membrane module replacement costs are subject to the manufacturer.

PUBLIC HEALTH BENEFITS

There are numerous public health benefits associated with the proposed project, the foremost being membrane filtration. With increased public awareness and growing concerns for drinking water quality, combined with increasingly stringent water quality regulations, the demand for effective and efficient water treatment solutions is ever growing. Besides providing pathogen free water, public utilities are being compelled to avoid chemical treatments for water. These factors in addition to decreasing sources of fresh water are propelling growth of physical treatments such as microfiltration membranes. As an economical alternative to conventional filtration, microfiltration provides an absolute physical barrier for the removal of suspended particles, algae, and bacteria without the use of chemicals; thereby ensuring the highest quality of water. Thus, membrane technology provides a cost effective treatment solution, coupled with ease of operation, small building footprints and ability to meet current and future water quality requirements. Membrane filtration will ensure future regulatory compliance for *Giardia* and *Cryptosporidium* removal while providing long-term acceptable filter performance, via effective and efficient treatment means.

A properly designed sedimentation basin for pre-treatment along with an adequately sized clearwell yields a reduction in disinfection byproducts and enhanced disinfection. The resultant of the proposed treatment facility is enhanced water quality which leads to better health.

A new distribution system pump station along with waterline upgrades will provide the Town with constant adequate water pressure and fire flow to restricted areas, reduce the amount of water loss and lower system risks.

CONCLUSIONS

The filter equipment in the existing water treatment facility suffers from extensive wear and has reached the end of its useful life. The raw water and finish water high service pumps are not efficient and operate at a constant rate. The plant also lacks proper SCADA and instrumentation to optimize operation.

The plant also has numerous process deficiencies that will contribute to the inability to meet current and future proposed drinking water standards. Current pretreatment operations remove heavy solids only and do not effectively reduce turbidity or TOC. The sedimentation basin lacks baffles, does not have sludge collecting capabilities and lacks overflow effluent weirs.

The conventional multi-media filters require proper coagulation at all times and may not be capable of meeting the Long Term 2-Enhanced Surface Water Treatment Rule. Filter backwashing consumes finish water and there is no way of performing a filter-to-waste. The filters lack redundancy in that there is only one backwash and surface wash pump. The clearwell is not large enough to meet required chlorine contact demands of a 0.5 MGD treatment facility, and also experiences short circuiting caused by insufficient baffling. Inadequate wastewater storage volume due to current excessive solids accumulation in the holding tanks is limiting the overall effectiveness of the wastewater holding facilities.

Based on the above findings and the logistics of maintaining facility operations at all times, Harpers Ferry is faced with only one viable option to adequately meet the long term water supply needs of the service area and maintain compliance with current and proposed future regulatory requirements. The ultimate conclusion of this feasibility study is that Harpers Ferry Water Works upgrade the existing water treatment facility with membrane filtration along with the other recommendations mentioned below.

RECOMMENDATIONS

In order to address the long term water treatment needs of Harpers Ferry Water Works, the following general recommendations have been derived from the feasibility study.

1. Due to the current age and condition of the existing treatment plant, we recommend the following upgrades. Installation of new raw water pumping station, enhanced pretreatment (coagulation, mixing, multi-stage flocculation and sedimentation), membrane filtration technology, a new clearwell along with new finish water pumps and upgraded liquid chemical feeds. This upgraded system will provide sufficient sub-micron particle removal and multiple barriers for compliance with the new Long Term 2-Enhanced Surface Water Treatment Rule. The entire particle removal and treatment process, along with an adequately sized clearwell, will eliminate the need for settled water chlorination.

2. The raw water pump station should be upgraded with new pumps, VFDs, level control and a new building structure.

3. Install new valve vault at raw waterline for chemical injection, mixing and flow monitoring.

4. Provide new single-stage flocculation tanks with baffle wall, mechanical sludge collection and effluent weirs in the existing sedimentation basin.

5. To improve its water treatment system, we recommend use of new membrane filtration technology with a fully automated system including CIPs, air supply system and SCADA. Proceed with implementation of a pilot study for demonstrating treatment capability with membrane technology on the Elk Run, Town Spring and Potomac River water sources.

6. Upgrade chemical feed systems by adding sodium permanganate and spare chemical feed equipment.

7. Replace finish water pumps with new energy efficient pumps, motors, VFDs and check valves.

8. Install a new adequately sized ground level clearwell with a mixing system.

9. Provide new 8-inch finish waterline to replace existing line in Elk Run.

10. Install new office, kitchen and conference room on first floor of treatment plant, if the budget allows.

11. Install new emergency generator at treatment plant with automatic transfer switch.

12. Install new telemetry system for monitoring offsite storage tank levels.

13. Upgrade distribution system waterlines and provide new booster pump station near Bolivar Heights storage tanks.

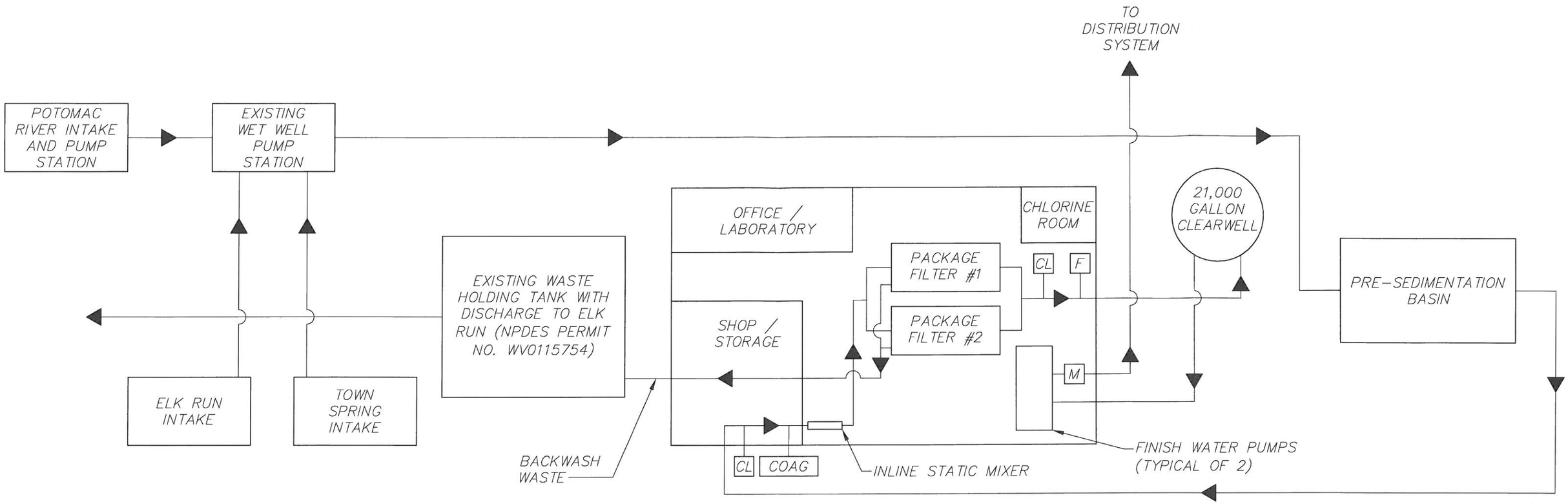
14. Perform required repairs and repaint the two older steel water storage tanks.

15. Replace all residential and commercial water meters with new radio read meters.

16. Remove accumulated solids from existing waste holding tanks. Continue to dispose of solids annually.

APPENDIX A

EXISTING WATER TREATMENT FACILITY
SIMPLIFIED PROCESS FLOW SCHEMATIC



LEGEND:

F	SODIUM FLUORIDE
CL	CHLORINE GAS
COAG	COAGULANT
M	FLOW METER

EXISTING WATER TREATMENT FACILITY SIMPLIFIED PROCESS FLOW SCHEMATIC

HARPERS FERRY WATER WORKS

FEASIBILITY STUDY

HARPERS FERRY, WEST VIRGINIA

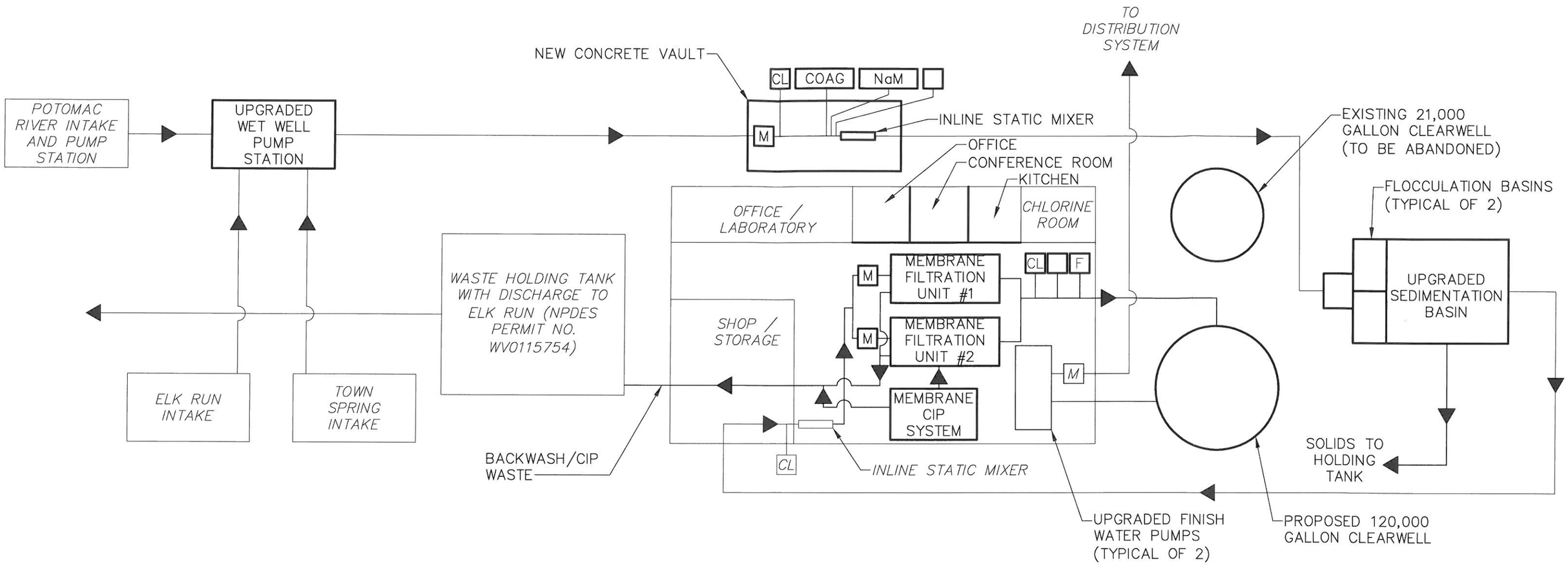
DATE:	JOB: 13045	SCALE: AS SHOWN
FILE: EX-SYSTEM-FLOW	DRAWN BY: KWB	CHECKED BY: CME

GD&F
GWIN DOBSON & FOREMAN INC.
Consulting Engineers
3121 Fairway Drive
Altoona, PA 16602

SHEET NO: 1

APPENDIX B

PROPOSED WATER TREATMENT FACILITY
SIMPLIFIED PROCESS FLOW SCHEMATIC



LEGEND:

COAG	COAGULANT
NaM	SODIUM PERMANGANATE
F	SODIUM FLUORIDE
CL	CHLORINE GAS
	SPARE CHEMICAL FEED
M	FLOW METER

PROPOSED WATER TREATMENT FACILITY SIMPLIFIED PROCESS FLOW SCHEMATIC

HARPERS FERRY WATER WORKS

FEASIBILITY STUDY

HARPERS FERRY, WEST VIRGINIA

DATE:	JOB: 13045	SCALE: AS SHOWN
FILE: PRO-SYSTEM-FLOW	DRAWN BY: KWB	CHECKED BY: CME

GD&F

GWIN DOBSON & FOREMAN INC.

Consulting Engineers

3121 Fairway Drive
Altoona, PA 16602

SHEET NO: 2

APPENDIX C

STORAGE TANK NO. 1 INSPECTION REPORT

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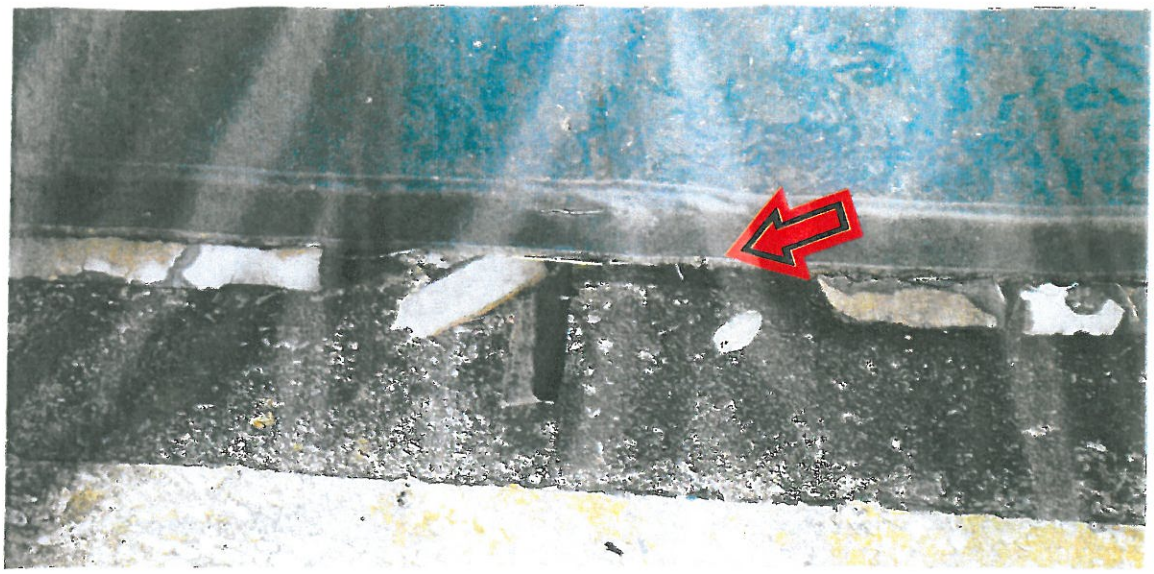
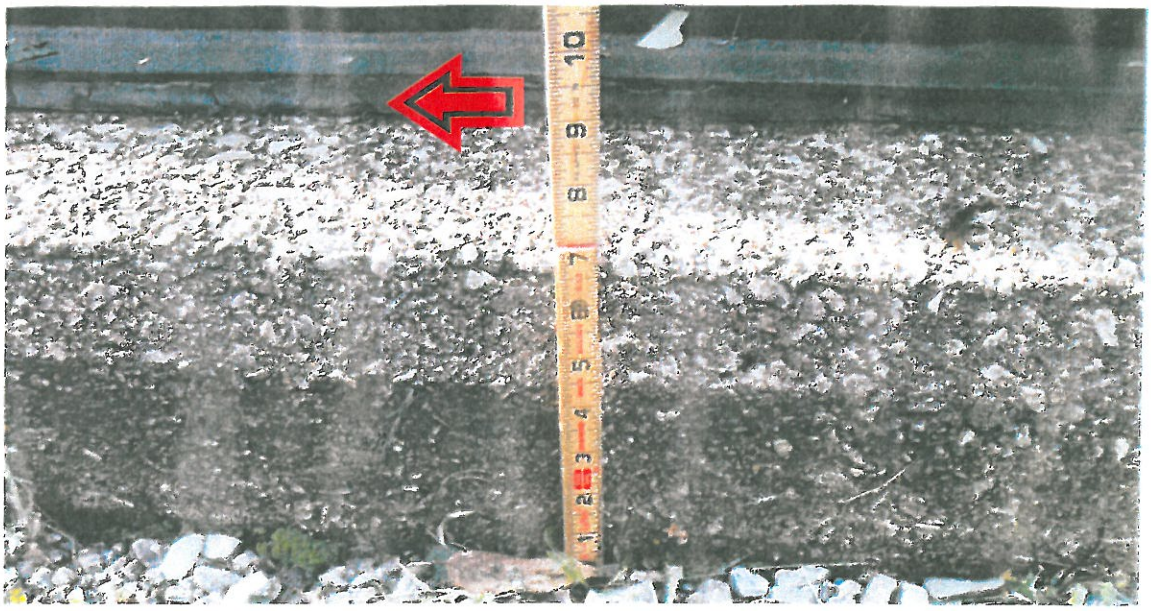
Harpers Ferry
1435 Bakerton Road
Harpers Ferry, WV 25425
RE: Prospect Avenue Tank 1
400,000 Gallon G.S.T.
September 19, 2012
Josh Carter, Water System Manager
(304) 535-6555
Job No. 312346-A

If you would like to speak with Patrick Heltsley concerning this report, call (270) 826-9000, Ext.253
For additional copies of this report call (270) 826-9000 Ext. 253





Photos show the condition of the foundation. We recommend removing damaged grout, then re-grouting and re-caulking around the base of the tank to foundation connection to prevent water from entering under the tank and sealing the foundation with a sealant.

We also recommend electrically grounding the tank for lightning protection as required by OSH Act 29 CFR 1926, Subpart K.

We further recommend inserting sacrificial cathodic protection rods, radially every 15', beneath the floor of the tank, to prevent corrosion

Photo shows the condition of the shell. Currently there is no drain valve. We recommend installing a frost proof drain valve near the shell-to-floor connection, complete with locking device to prevent unauthorized draining of the tank and a splash pad to direct water away from the foundation.

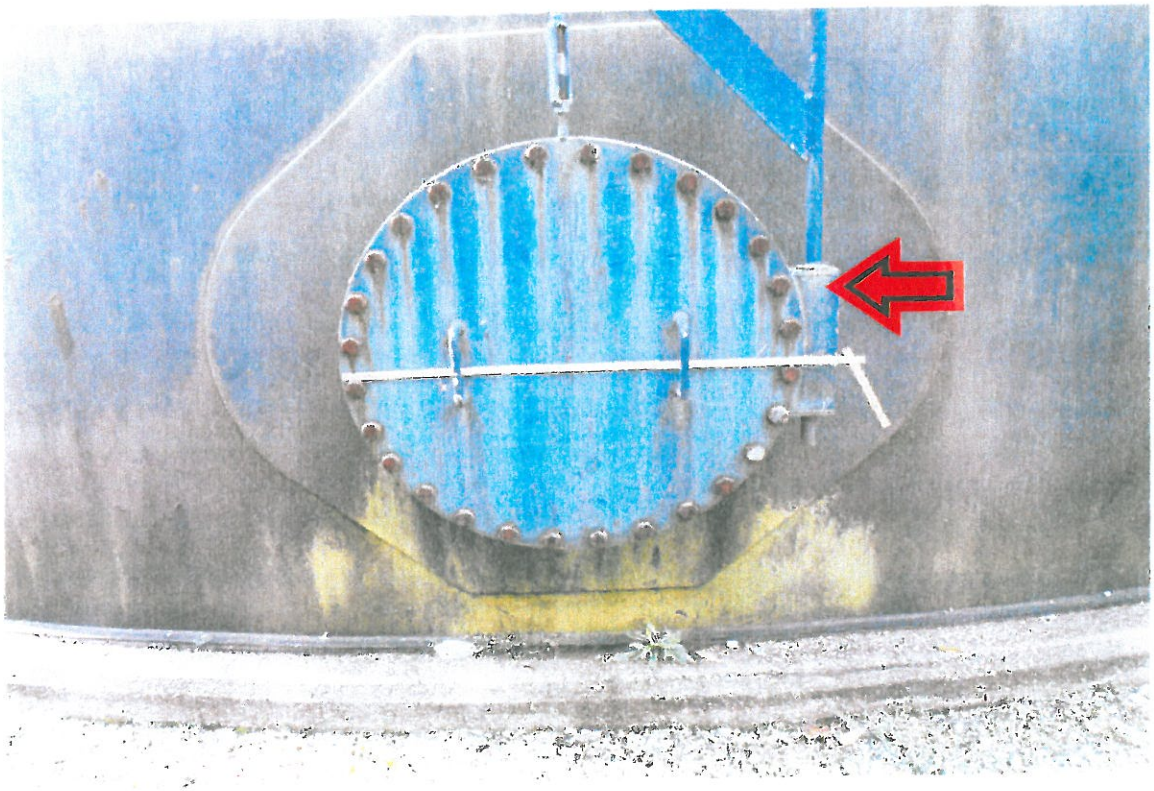


Photo shows the condition of the existing 30" primary shell manway. The manway is in compliance with AWWA D 100-11 Shell manholes 7.4.4.

We recommend:

Posting a **Confined Space Entry** sign in accordance with OSHA 1910. Confined spaces
Install galvanized bolts on existing primary manway

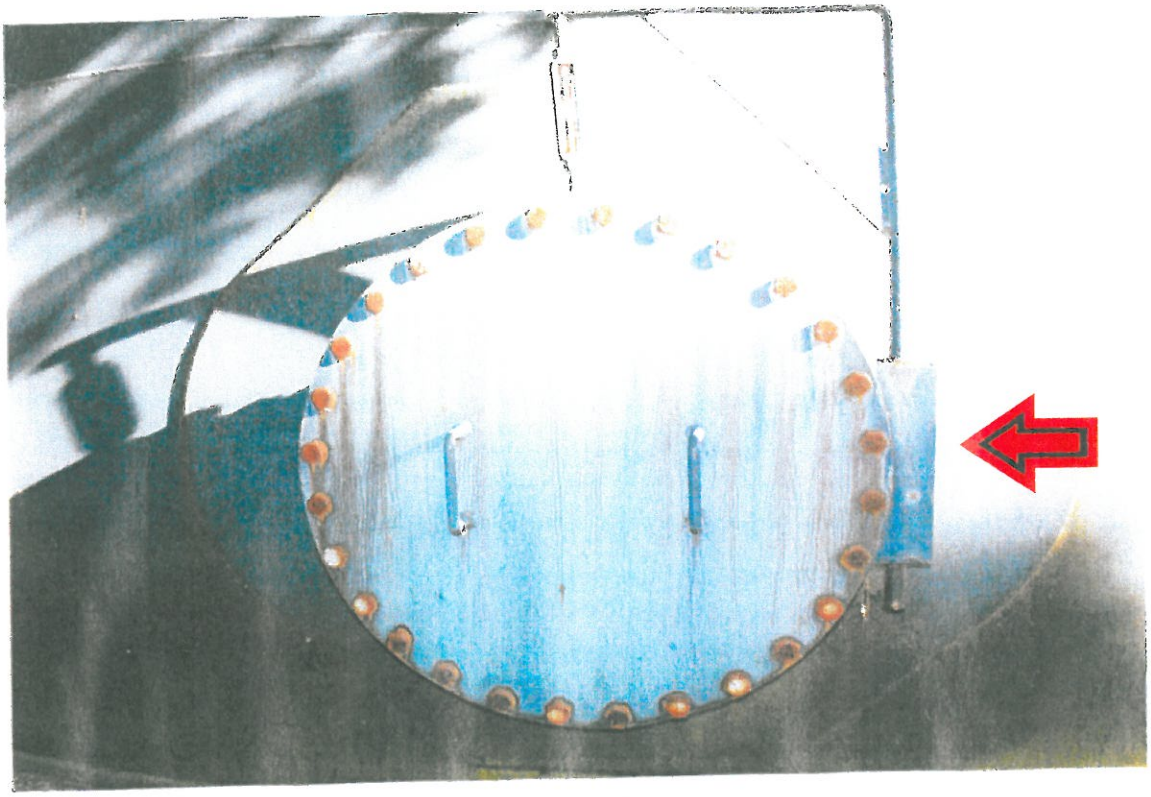


Photo shows the condition of the existing 30" secondary shell manway. The manway is in compliance with AWWA D 100-11 Shell manholes 7.4.4.

We recommend:

Post **Confined Space Entry** signs in accordance with OSHA 1910. Confined spaces
Install galvanized bolts on existing secondary manway

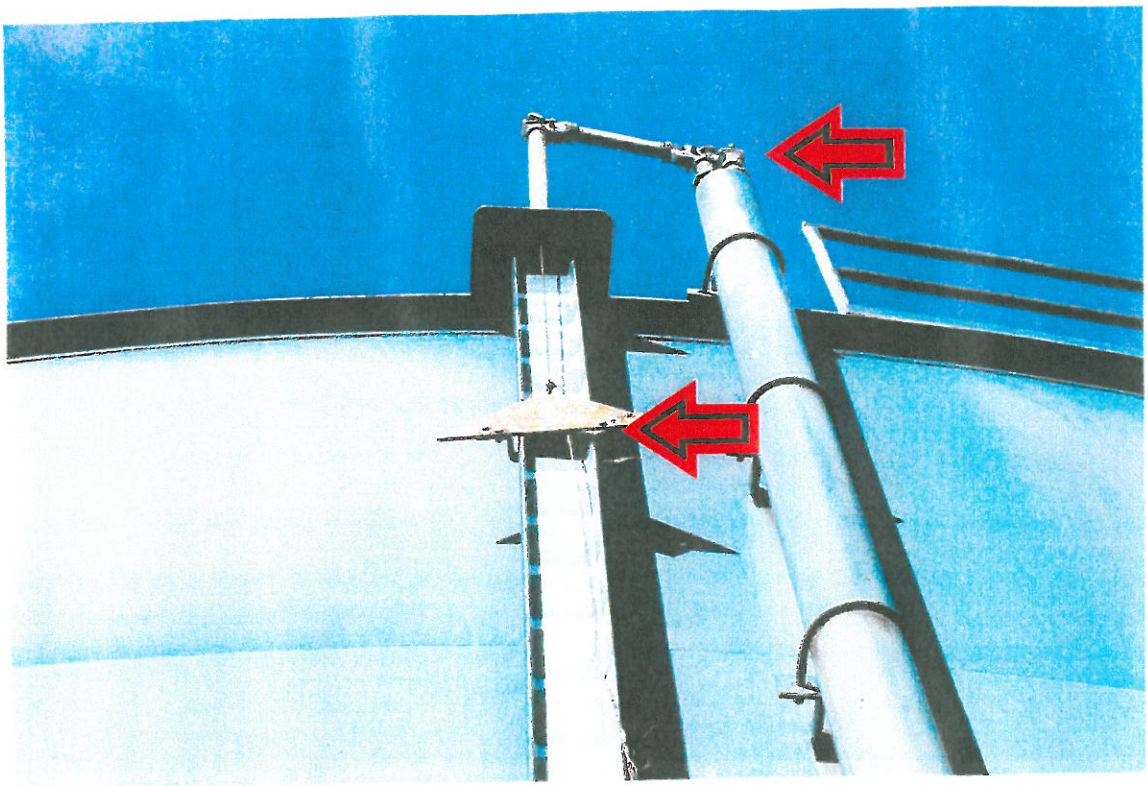
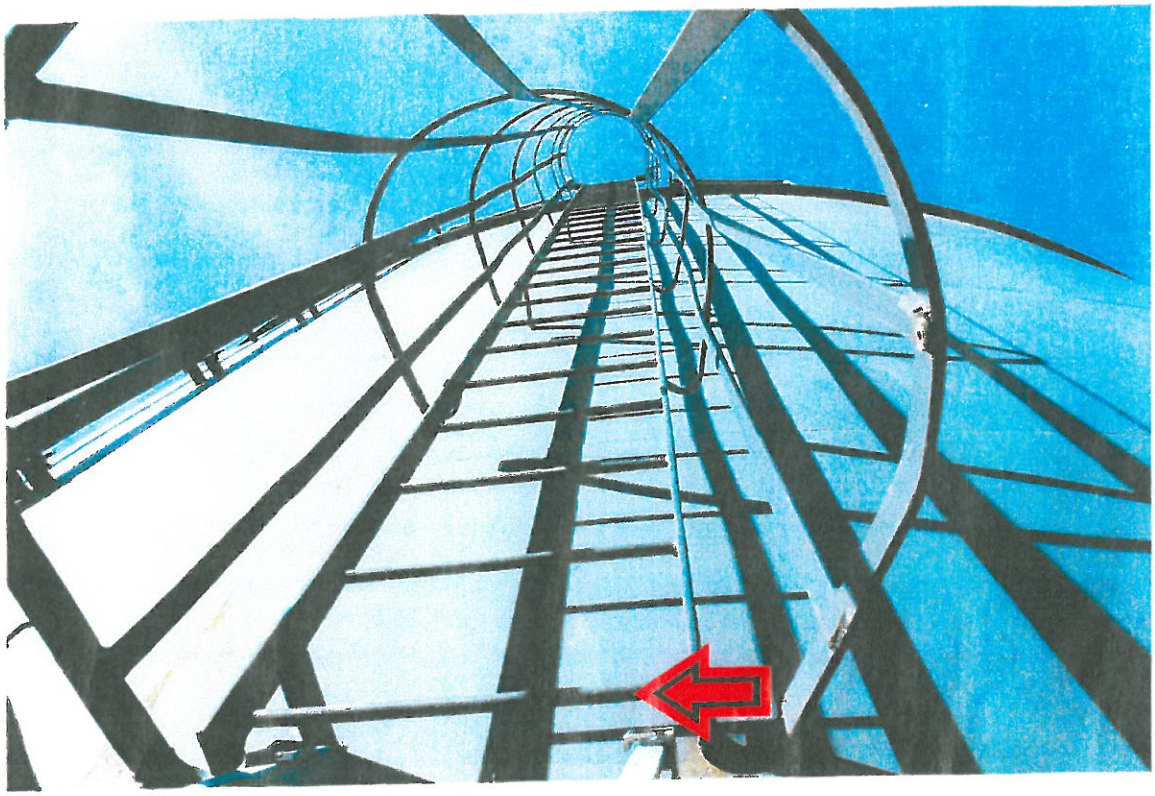


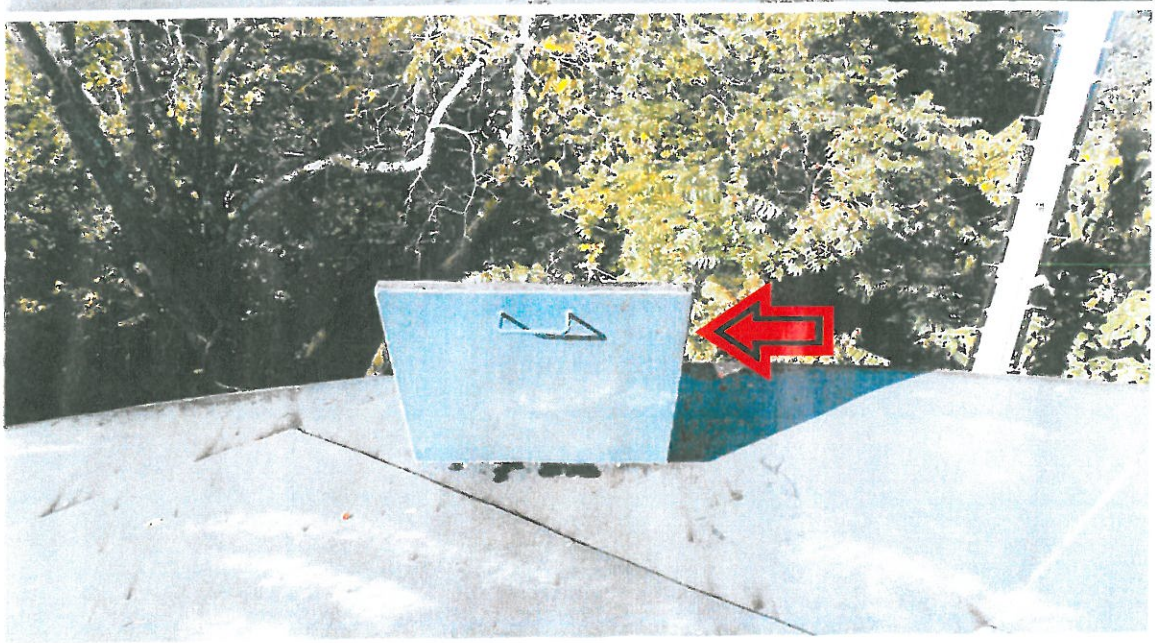
Photo shows the condition of the liquid level indicator. We recommend cleaning and lubricating all moving parts on the liquid level indicator for preventative maintenance, adjusting and calibrating the unit.



Shell access ladder in above photo is not equipped with anti-skid rungs. OSHA 29 CFR 1926.1050-1060 states: "Rungs must be corrugated, knurled, dimpled, coated with skid-resistant material or treated to minimize slipping". We recommend installing an OSHA approved shell access ladder complete with standoffs every 10' on center, a cable type ladder safety device, a lockable ladder guard to prevent unauthorized access and posting a **Fall Protection Required** sign.

Photo shows the condition of the overflow pipe. We recommend disconnecting the pipe from the underground drain then installing an air break complete with an AWWA D100-11 7.3: Overflow, approved flapper valve and screen to prevent the ingress of contaminants into the water supply.

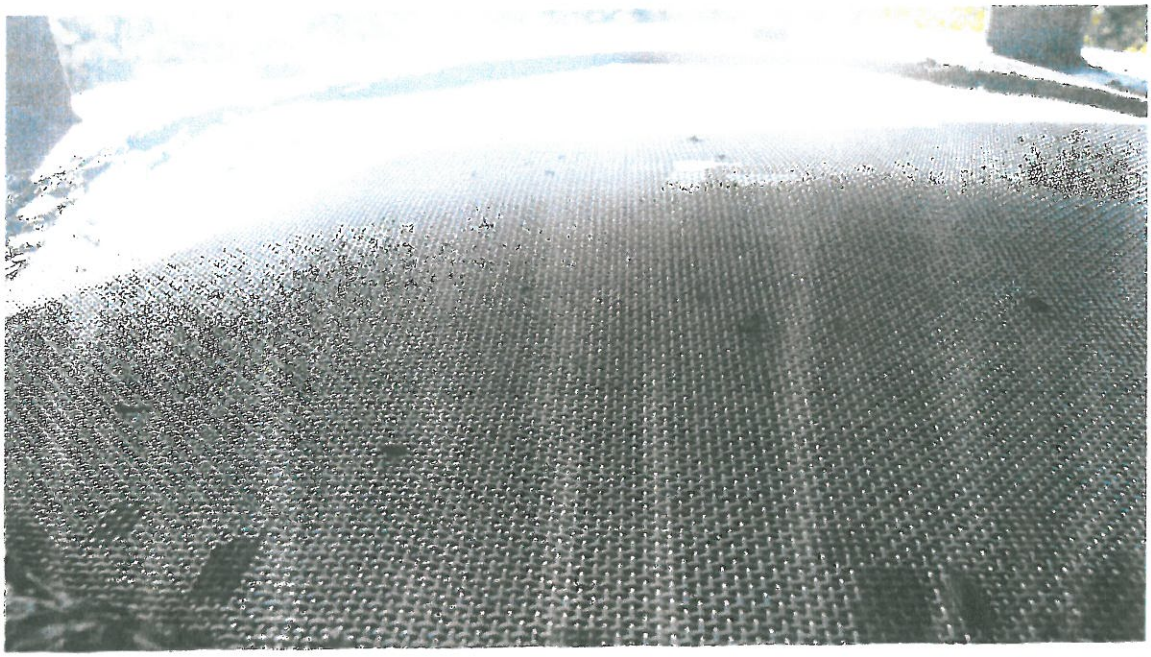
Photo shows the tank roof is not equipped with a required fall protection system. OSHA 29 CFR 1910.23(a)(1) requires fall protection on the edges of all walking, working surfaces. The tank is equipped with handrails to the right and left of the access ladder. OSHA 1910.23 Subpart c requires fall protection to encompass all walking, working surfaces. We recommend extending the handrails around the circumference of the tank roof, complete with a toeboard, an intermediate rail and a stainless steel gate chain at the junction of the shell-to-roof access ladder and tank roof.



Photos show the condition of the roof manways. Roof openings on this tank require the following to be in compliance with TSS 7.0.8.2, AWWA D100-11, 7.4.3: Roof openings.

We recommend:

Post **Confined Space Entry** signs
Install new locks on existing manways



Photos show the condition of the existing roof vent and screen. AWWA D100-11, 7.5.2 requires a vacuum/pressure device on all vents that require an insect proof screen. This vent is allowing the ingress of rain and wind-borne contaminants into the water system. **An improperly vented tank may cause external pressure to act on the tank which can cause buckling even at low pressure differential.** We recommend replacing the existing roof vent with a vacuum-pressure, frost proof vent and screen.

Photos show the tank exterior coating system. We recommend pressure washing the tank exterior with biodegradable detergent injection (minimum 3,500 psi at 3.0 gpm) then remove all loose rust and scale with wire brushes and hand scrapers in accordance with SSPC#2 (hand tool cleaning), spot prime and apply one (1) finish coat of alkyd enamel.

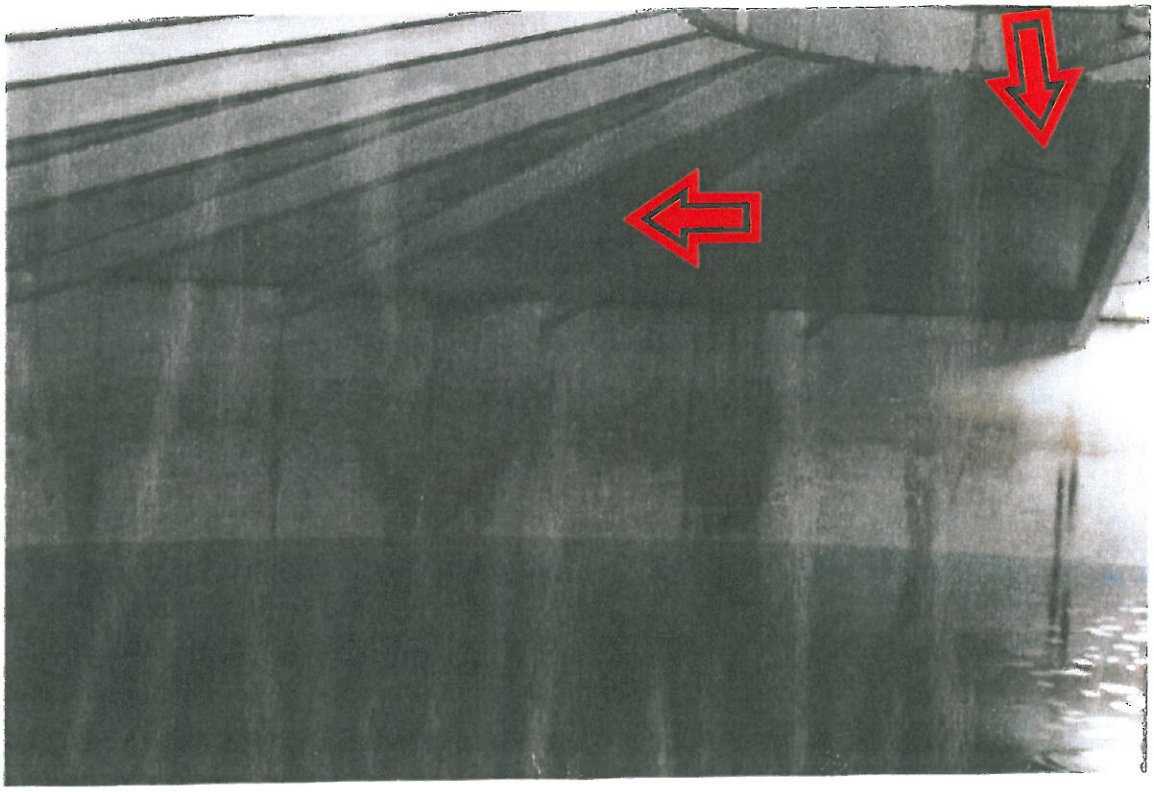


Photo shows the condition of the interior roof. Notice the rust forming at the roof lap seams. We recommend, seam sealing all un-welded interior roof lap seams with Sika-Flex 1A to prevent failure of a new interior liner.

Photo shows the condition of the interior roof-to-rim angle connection. Notice the rust forming in the crevice between the roof and rim angle. We recommend seam sealing the roof to rim angle with Sika-flex 1A to prevent failure of a new interior liner.

Photo shows the condition of the rafter-to-support column and rafter-to-shell connections. We recommend rewelding the rafter-to-support column and rafter-to-shell connections to reinforce.

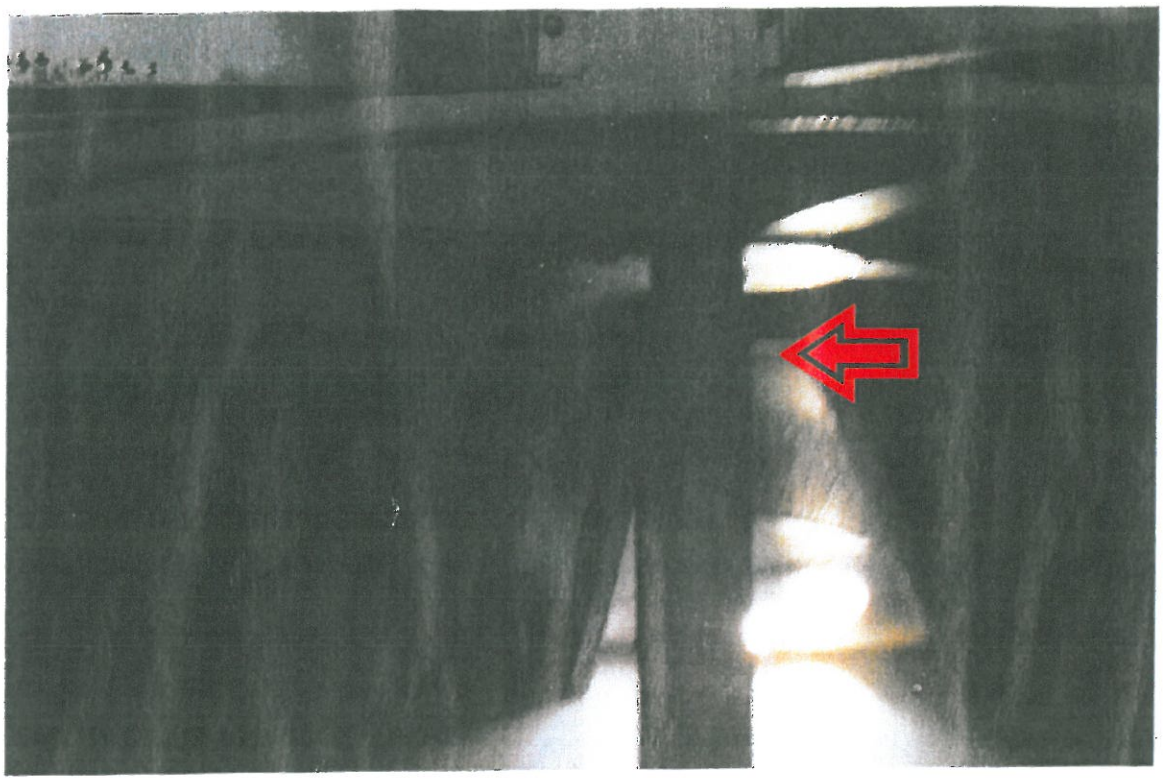
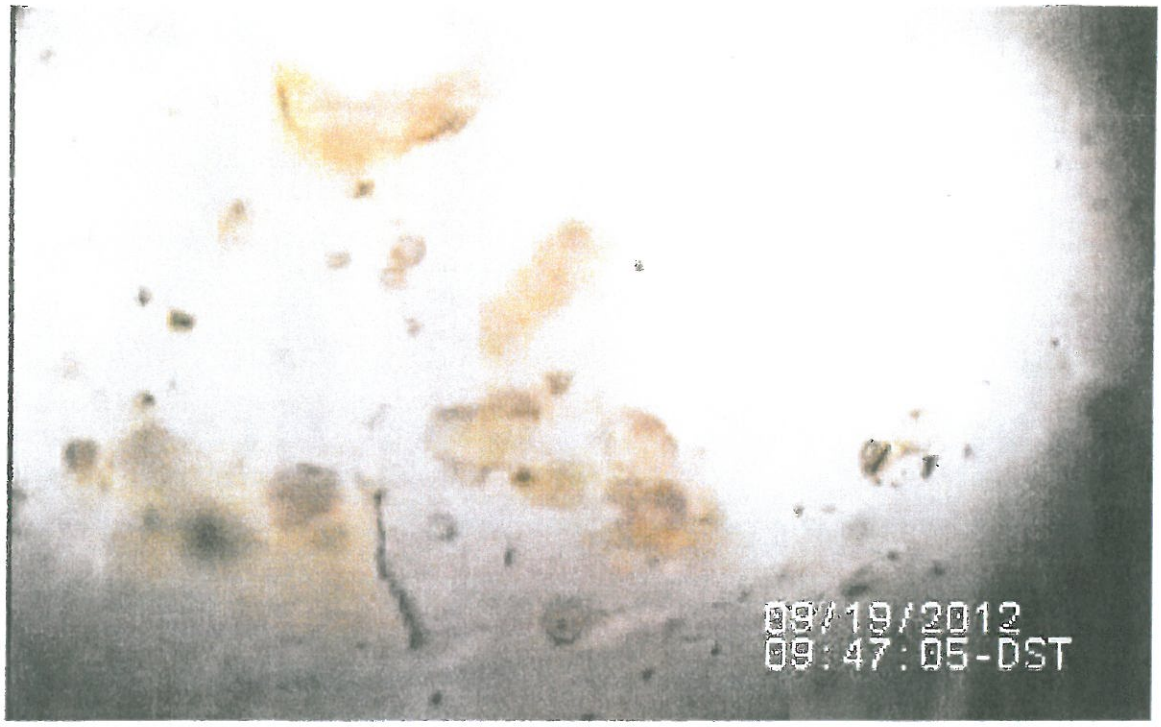


Photo shows the condition of the center support column. We recommend the underside of the cap plate be reinforced with 1/2" gussets equally spaced as needed.

We also recommend the base-plate of the center column be reinforced with 1/2" gussets equally spaced as needed.

Photo shows sediment and debris in the tank. We recommend that cleaning be performed to avoid the problems associated with excessive sediment buildup.

We also recommend installing a passive cathodic protection system.



Photos show the condition of the interior liner. We recommend sandblasting all rusted and abraded areas of the tank interior to an SSPC #10 (near white blast) condition, brushblast all remaining areas, stripe coating all seams and welds, then applying an epoxy liner to achieve 8-10 mils of dry film thickness.

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GROUND STORAGE INSPECTION REPORT

JOB NO: 312346-A INSPECTOR: Adam Newcomb

TANK OWNER: Harpers Ferry

OWNER'S REPRESENTATIVE: Josh Carter TITLE: Water System Manager

MAILING ADDRESS: P.O. Box 217

PHYSICAL ADDRESS: 1435 Bakerton Road

E-MAIL ADDRESS: harpersferry2@frontier.com

CITY, STATE: Harpers Ferry, WV ZIP: 25425

COUNTY TANK IS LOCATED IN: Jefferson

TELEPHONE: (304) 535-6555 FAX: (304) 535-6520

LOCATION OF TANK: Prospect Avenue Tank 1

Harpers Ferry
1435 Bakerton Road
Harpers Ferry, WV 25425
September 19, 2012
Josh Carter,
Water System Manager
(304) 535-6555

ORIGINAL CONTRACT NO: unknown YEAR BUILT: 1954

ORIGINAL MANUFACTURER: unknown CAPACITY: 400,000 Gallon

DATE OF LAST INSPECTION: unknown TYPE: Potable water

DIAMETER: 46-6" HEIGHT: 32'-0"

OVERFLOW: 8" INLET: Not provided

TYPE CONSTRUCTION: WELDED: X RIVETED: _____ BOLTED: _____

ACCOUNT EXECUTIVE: Hugh McGee

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GROUND STORAGE TANK CODE UPDATES

Item	Deficiency	Not-Applicable	Codes as Applicable
Lightning Protection	X		OSH Act 29 CFR 1926, Subpart K NFPA 780 2011 4.5 Lightning protection
Shell Manways		X	AWWA D 100-11 Shell manholes 7.4.4
Manway Davit(s)		X	AWWA D 100-11 Shell manholes 7.4.4
Confined Space Entry Signs	X		TSS Sec. 7 7.0.12 Safety OSHA 1910. Confined spaces
Shell Ladder	X		OSHA 1926.1053(a) AWWA D 100-11, 7.4.1 Ladders General
Safety Climb Devices		X	AWWA D 100-11, 7.4.1 Ladders General
Standoffs on 10' Centers		X	AWWA D 100-11 7.4.1 Ladders General
Roof Handrails	X		AWWA D 100-011, OSHA 29 CFR 1910.23(a)(1)
Safety Chain in Handrail Opening	X		AWWA D 100-11, OSHA 29 CFR 1910.23(a)(1)
Screen on Overflow	X		AWWA D 100-11, 7.3: Overflow
Vent	X		AWWA D 100-11, 7.5.2
Roof Manway		X	AWWA D 100-11, 7.4.3: Roof openings TSS 7.0.8.2
Interior Shell Ladders		X	OSHA 1926.1053(a) AWWA D 100-11, 7.4.2.4

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RECOMMENDATIONS

NUMBERS REFER TO REPORT PAGES
00. INDICATES THERE WAS NO PHOTOGRAPH AVAILABLE TO DEMONSTRATE

00. Stabilize the floor by cutting holes, as required, installing couplings in the tank floor and pumping grout to the underneath side of the floor, at 15# p.s.i. by hand pump where the buckling is occurring, to fill the voided areas where buckling is occurring. Then, as a preventive measure, inserting sacrificial cathodic rods, radially beneath the floor of the tank to prevent corrosion. The weld seams will then be vacuum tested to detect defective welds, and any floor seams with cracked welds will be rewelded to prevent any further buckling

2. Remove damaged grout, then re-grout and re-caulk around the base of the tank to foundation connection to prevent water from entering under the tank and sealing the foundation with a sealant

Electrically ground the tank for lightning protection

Insert sacrificial cathodic protection rods, radially every 15', beneath the floor of the tank

3. Install a frost proof drain valve, complete with locking device and a splash pad

4,5. Post **Confined Space Entry** signs on existing shell manways
Install galvanized bolts on existing manways

6. Clean and lubricate all moving parts on the liquid level indicator, adjust and calibrate the unit

7. Install an OSHA approved, anti-skid rung equipped, shell ladder complete with standoffs every 10' on center
Install a cable type ladder safety climb device
Install an aluminum lockable ladder guard
Post a **Fall Protection Required** sign

RECOMMENDATIONS

NUMBERS REFER TO REPORT PAGES

8. Disconnect the pipe from the underground drain then install an air break complete with an EPA approved flapper valve and screen

9. Extend the existing handrail system around the circumference of the tank roof, complete with toeboard, install an intermediate rail and a stainless steel gate chain at the junction of the shell-to-roof access ladder and tank roof

10. Post **Confined Space Entry** signs on existing roof manways
Install new locks on existing manways

11. Replace existing roof vent with a vacuum/pressure, frost proof vent and screen

13. Seam seal all un-welded interior roof lap seams with Sika-Flex 1

14. Seam sealing the roof-to-rim angle connection with Sika-Flex 1

15. Reweld the rafter-to-support column and rafter-to-shell connections

16. Reinforce underside of the cap plate with 1/2" gussets equally spaced as needed

Reinforce base-plate of the center column with 1/2" gussets equally spaced as needed

17. Clean tank out
Install a passive cathodic protection system

12. EXTERIOR COATING SYSTEM: Pressure wash the tank exterior with biodegradable detergent injection (minimum 3,500 psi at 3.0 gpm) then remove all loose rust and scale with wire brushes and hand scrapers in accordance with SSPC#2 (hand tool cleaning), spot prime and apply one (1) finish coat of alkyd enamel

RECOMMENDATIONS

NUMBERS REFER TO REPORT PAGES

18. INTERIOR COATING SYSTEM: Sandblast all rusted and abraded areas of the tank interior to SSPC #10 (near white blast) condition, brush-blast all remaining areas, stripe coat all seams and welds, then apply an epoxy liner to achieve 8-10 mils dry film thickness

Pittsburg Tank & Tower can perform all work recommended in this report.

BASED ON THE NUMBER OF ITEMS ACCEPTED, PRICES MAY VARY.
All prices are in USD
If union labor or prevailing wage is required please advise
For additional copies of this inspection report call (270) 826-9000 Ext. 253.

The inspection report and comments reflect the general condition of the tank. However, we can not guarantee that additional deficiencies may not become apparent during the cleaning, repair or paint process of the tank.

This tank may not be consistent with seismic zone requirements for this type of structure in this zone. Consideration should be given to performing a structural analysis to determine if any changes are needed to meet design requirements.

The handling, removal and/or disposal of hazardous or contaminated materials such as asbestos, lead, chemical or any like substance that requires special handling is not included in the price submitted for work herein. Paint prices do not include logo, lead abatement or containment.

Cross Hatch	3B @ 6.8 mils	
Lead Test	Interior	Exterior
	Negative	Negative

Mil-T Paint Thickness Test

	Roof	8.9	10.7						
		10.8	4.1						
		4.4	4.0						
	Ring 5	13.8	12.4						
	Ring 4	8.8	9.6						
	Ring 3	9.9	6.9						
	Ring 2	4.6	7.8						
Shell	Ring 1	7.6	7.7	6.8	6.7	5.2	8.2	11.2	10.3

Ultrasonic Metal Thickness Test

		0.161	0.181						
		0.172	0.177						
Roof		0.183	0.178						
	Ring 5	0.288	0.291						
	Ring 4	0.291	0.288						
	Ring 3	0.271	0.243						
	Ring 2	0.236	0.244						
Shell	Ring 1	0.427	0.434	0.435	0.443	0.446	0.435	0.424	0.438

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October 9, 2013
BUDGET

Mr. Josh Carter
Manager
Harpers Ferry Water Works
217 Prospect Avenue
Harpers Ferry, WV 25425
304-535-6555
304-535-6520 Fax
harpersferry2@frontier.com

Josh,

We are pleased to provide you with a **BUDGET** quotation to repair and recoat one (1) 400,000 gallon welded, ground storage tank – Tank #1 and one (1) 300,000 gallon welded, ground storage tank – Tank #2.

Pittsburg has been serving the nation's tank needs for more than ninety years and our fully equipped and experienced crews specialize in all the services listed above in our letterhead. **We are a veteran owned company.**

We will furnish ten million dollars ($10,000,000) worth of insurance for our mutual protection.

To accept our proposal, just sign and return one (1) copy to our Henderson, Kentucky office.

Respectfully,
Pittsburg Tank & Tower Maintenance Co., Inc.

Patrick Heltsley
VP of Specialty Projects
270-826-9000 ext 253
270-748-1325 Cell
pheltsley@watertank.com

cc: Greg Kimble
Sales
270-826-9000 Ext 350
800-934-0801 Fax
gkimble@pttmco.com

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http://www.watertank.com Email: sales@watertank.com

TO: Harpers Ferry Water Works
217 Prospect Avenue
Harpers Ferry, WV 25425
EMAIL: harpersferry2@frontier.com

ATTN: Mr. Josh Carter
Manager
PHONE: 304-535-6555
FAX: 304-535-6520

In accordance with price, terms and conditions quoted below, we propose to furnish all labor, material, equipment and insurance necessary to complete the following to **one (1) 400,000 gallon welded, ground storage tank – Tank #1:**

SCOPE OF WORK

Stabilize the floor by cutting holes, as required, installing couplings in the tank floor and pumping grout to the underneath side of the floor, at 15# psi by hand pump where the buckling is occurring. Then, as preventive maintenance, insert sacrificial cathodic rods, radially beneath the floor of the tank to prevent corrosion. The weld seams will then be vacuum tested to detect defective welds, and any floor seams with cracked welds will be rewelded to prevent any further buckling.

Remove damaged grout, then re-grout and re-caulk around the base of the tank to foundation connection to prevent water from entering under the tank and sealing the foundation with a sealant.

Electrically ground the tank for lightning protection.

Insert sacrificial cathodic protection rods, radially every 15', beneath the floor of the tank.

Install a frost proof drain valve, complete with locking device and a splash pad.

Post **Confined Space Entry** signs on existing shell manways.
Install galvanized bolts on existing manways.

Clean and lubricate all moving parts on the liquid level indicator, adjust and calibrate the unit.

Install an OSHA approved, antiskid rung equipped, shell ladder complete with standoffs every 10' on center.
Install a cable type ladder safety climb device.
Install an aluminum lockable ladder guard.
Post a **Fall Protection Required** sign.

Disconnect the pipe from the underground drain then install an air break complete with an EPA approved flapper valve and screen.

Extend the existing handrail system around the circumference of the tank roof, complete with toeboard, an intermediate rail and a stainless steel gate chain at the junction of the shell-to-roof access ladder and tank roof.

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Post **Confined Space Entry** signs on existing roof manways.
Install new locks on existing manways.

Replace existing roof vent with a vacuum/pressure, frost proof vent and screen.

Seam seal all unwelded interior roof lap seams with Sikaflex 1a.

Seam seal the roof-to-rim angle connection with Sikaflex 1a.

Reweld the rafter-to-support column and rafter-to-shell connections.

Reinforce the underside of the cap plate with ½" gussets equally spaced as needed.

Reinforce the base-plate of the center column with ½" gussets equally spaced as needed.

Clean tank out.
Install a passive cathodic protection system.

EXTERIOR COATING SYSTEM: Pressure wash the tank exterior with biodegradable detergent injection (minimum 3,500 psi at 3.0 gpm) then remove all loose rust and scale with wire brushes and hand scrapers in accordance with SSPC#2 (hand tool cleaning), spot prime and apply one (1) finish coat of alkyd enamel.

INTERIOR COATING SYSTEM: Sandblast all rusted and abraded areas of the tank interior to SSPC#10 (near white blast) condition, brushblast all remaining areas, stripe coat all seams and welds, then apply an epoxy liner to achieve 8-10 mils dry film thickness.

The above to be completed for the BUDGET lump sum of……..$208,000.00
Two Hundred Eight Thousand Dollars and Zero Cents

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APPENDIX D

STORAGE TANK NO. 2 INSPECTION REPORT

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Harpers Ferry
1435 Bakerton Road
Harpers Ferry, WV 25425
RE: Prospect Avenue Tank 2
300,000 Gallon G.S.T.
September 19, 2012
Josh Carter, Water System Manager
(304) 535-6555
Job No. 312346-B

If you would like to speak with Patrick Heltsley concerning this report, call (270) 826-9000, Ext.253
For additional copies of this report call (270) 826-9000 Ext. 253

Photos show the condition of the foundation. We recommend removing deteriorated caulk and debris from the tank to foundation connection, then re-caulking around the base of the tank to foundation connection to prevent water from entering under the tank and sealing the foundation with a sealant.

We also recommend electrically grounding the tank for lightning protection as required by OSH Act 29 CFR 1926, Subpart K.

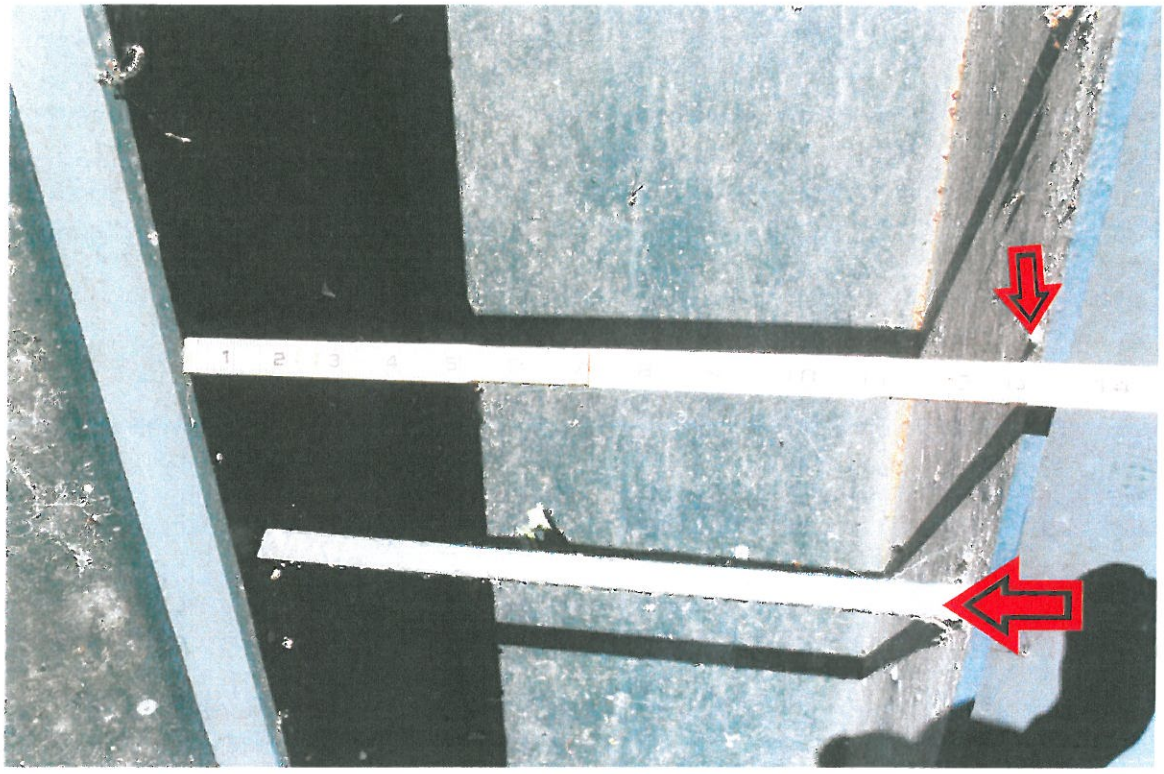
We further recommend inserting sacrificial cathodic protection rods, radially every 15', beneath the floor of the tank, to prevent corrosion

Photo shows the condition of the shell. Currently there is no drain valve. We recommend installing a frost proof drain valve near the shell-to-floor connection, complete with locking device to prevent unauthorized draining of the tank and a splash pad to direct water away from the foundation.

Photo shows the condition of the existing 18" X 24" ' primary shell manway. The manway is in compliance with AWWA D 100-11 Shell manholes 7.4.4.

We recommend:

Install a 30" secondary manway 180° from primary manway
Post **Confined Space Entry** signs in accordance
with OSHA 1910. Confined spaces
Install galvanized bolts on existing manway



Photos show the tank shell ladder is equipped with anti-skid rungs but is only 13" wide. OSHA 19.27 Ladders states: "Minimum clear distance between the sides of individual rung/step ladders and between the side rails of other fixed ladders must be 16 inches (41 cm)." We recommend installing an OSHA approved shell access ladder complete with standoffs every 10' on center, a cable type ladder safety device, a lockable ladder guard to prevent unauthorized access and posting a **Fall Protection Required** sign.

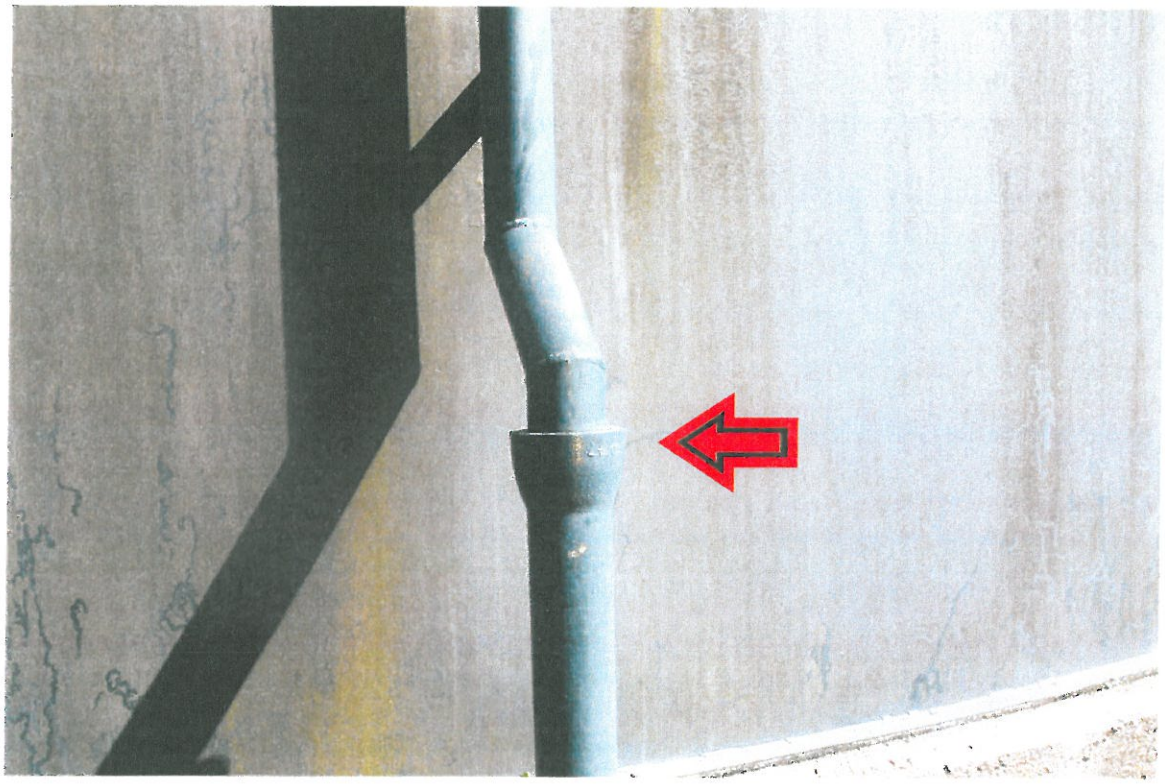


Photo shows the condition of the overflow pipe. We recommend disconnecting the pipe from the underground drain then installing an air break complete with an AWWA D100-11 7.3: Overflow, approved flapper valve and screen to prevent the ingress of contaminants into the water supply.

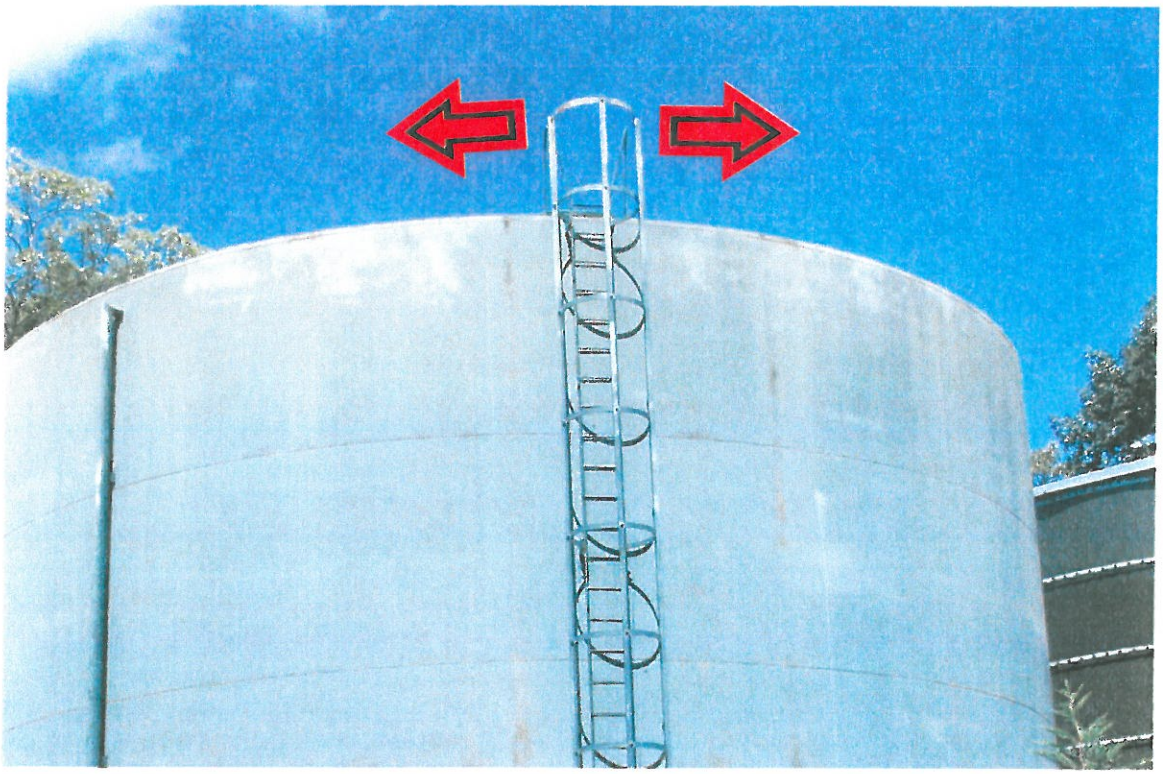


Photo shows the tank roof is not equipped with a required fall protection system. OSHA 29 CFR 1910.23(a)(1) requires fall protection on the edges of all walking, working surfaces. OSHA 1910.23 Subpart c requires fall protection to encompass all walking, working surfaces. We recommend installing 42" high handrails around the circumference of the tank roof, complete with a toeboard, an intermediate rail and a stainless steel gate chain at the junction of the shell-to-roof access ladder and tank roof.

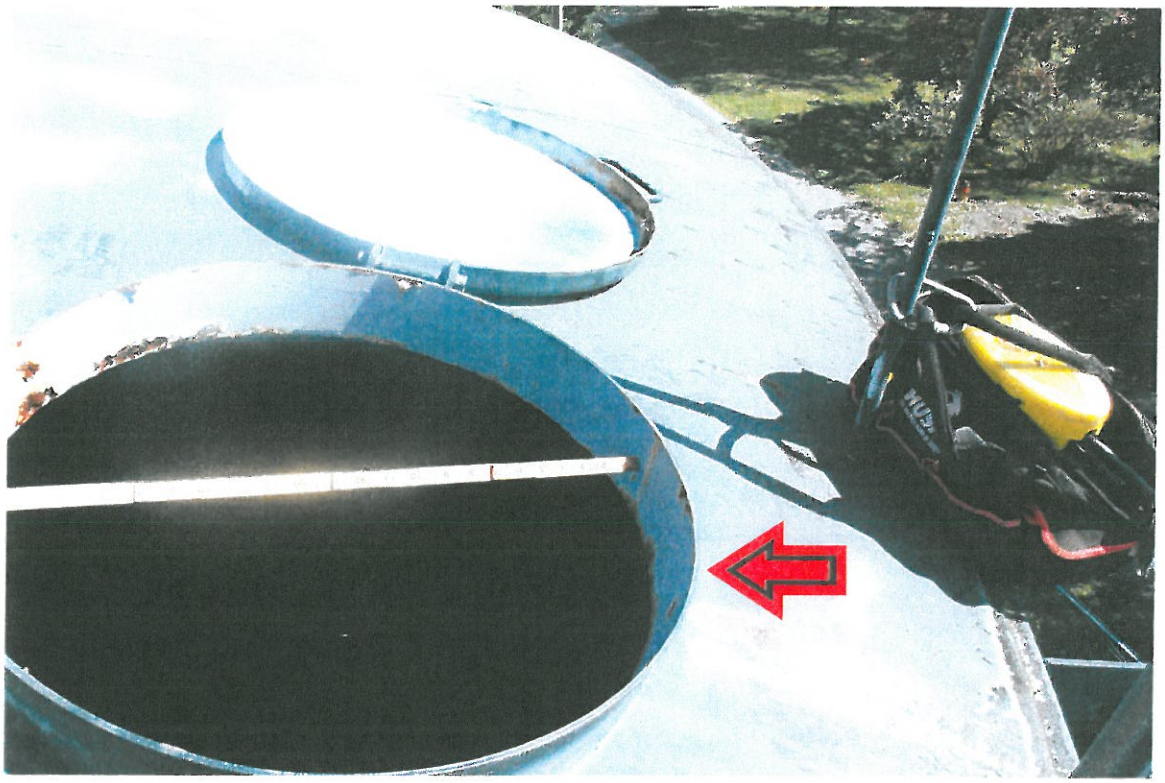
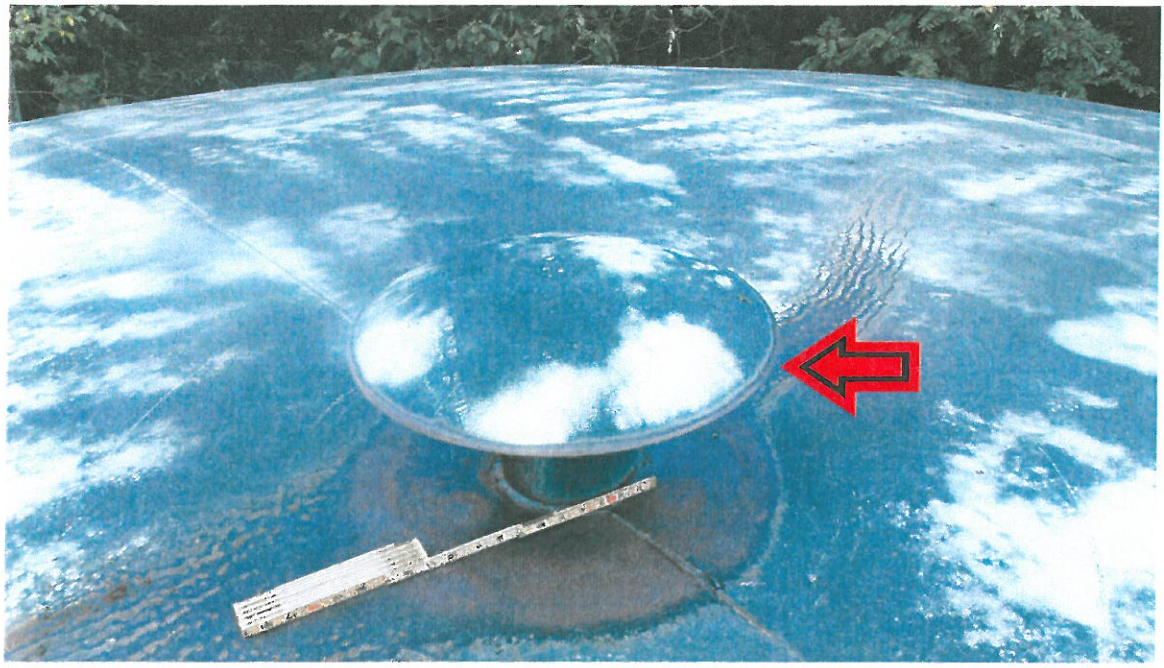
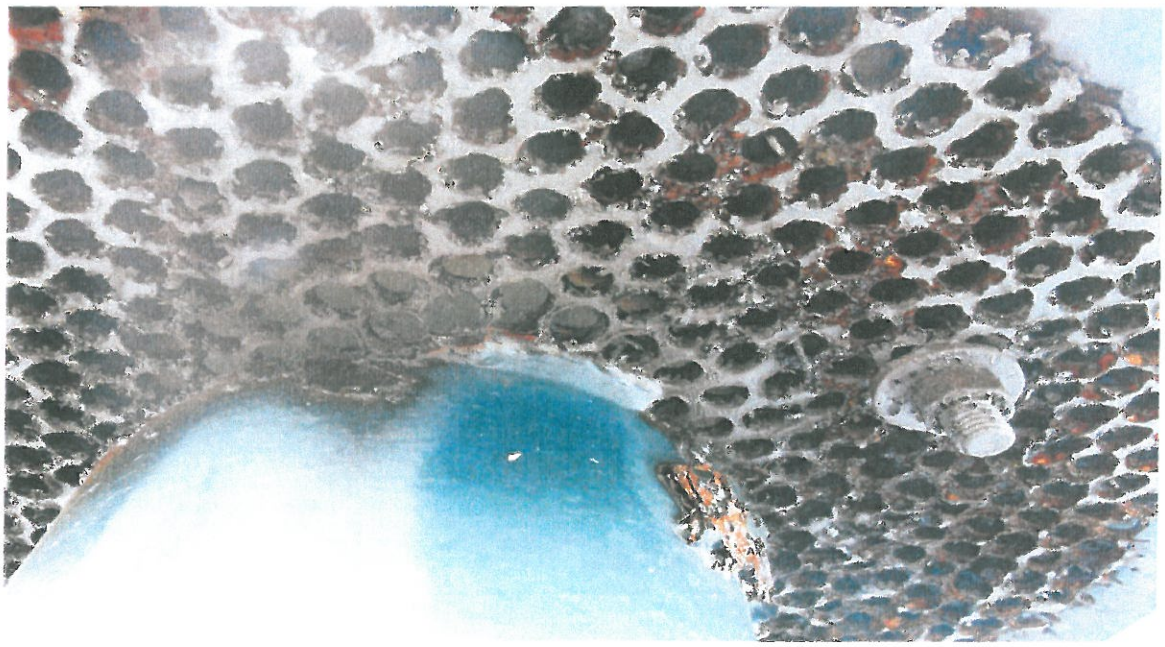


Photo shows the condition of the 24" roof manway. Roof openings on this tank require the following to be in compliance with TSS 7.0.8.2, AWWA D100-11, 7.4.3: Roof openings.

We recommend:

Post **Confined Space Entry** sign
Install new lock on existing manway





Photos show the condition of the existing roof vent and screen. AWWA D100-11, 7.5.2 requires a vacuum/pressure device on all vents that require an insect proof screen. This vent is allowing the ingress of rain and wind-borne contaminants into the water system. **An improperly vented tank may cause external pressure to act on the tank which can cause buckling even at low pressure differential.** We recommend replacing the existing roof vent with a vacuum-pressure, frost proof vent and screen.

Photos show the tank exterior coating system. We recommend pressure washing the tank exterior with biodegradable detergent injection (minimum 3,500 psi at 3.0 gpm) then remove all loose rust and scale with wire brushes and hand scrapers in accordance with SSPC#2 (hand tool cleaning), spot prime and apply one (1) finish coat of alkyd enamel.

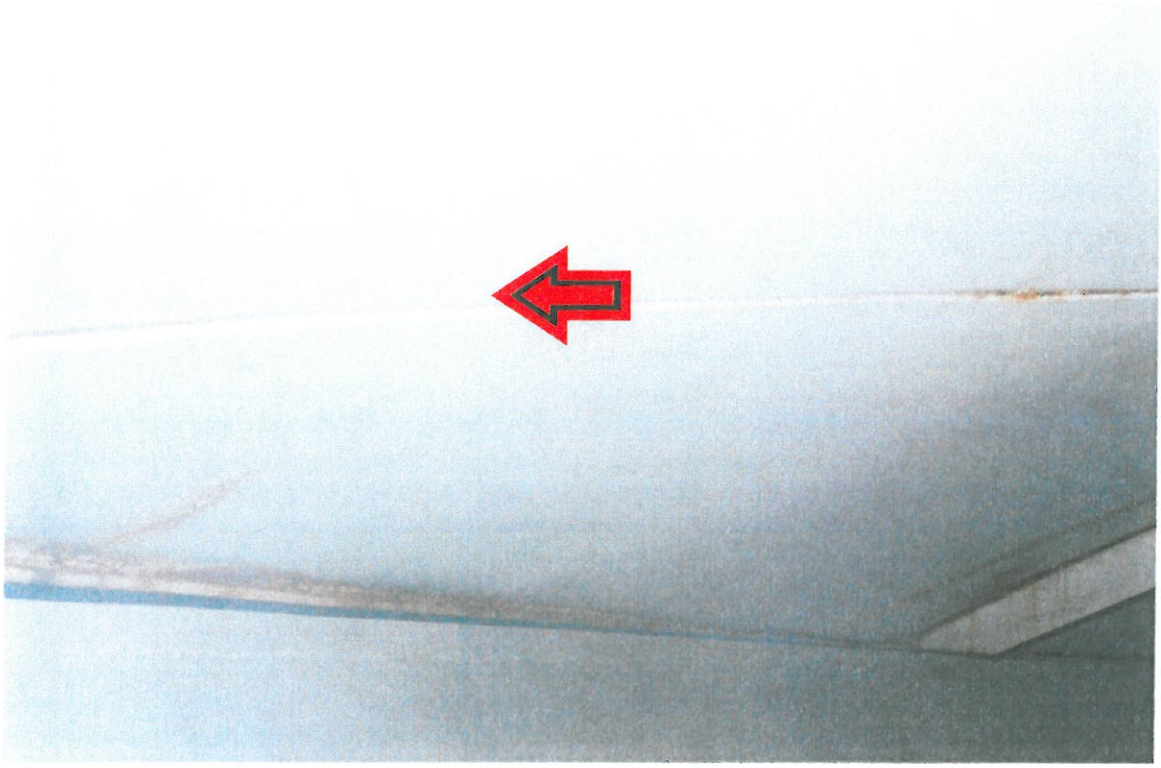


Photo shows the condition of the interior roof. Notice the rust forming at the roof lap seams. We recommend, seam sealing all un-welded interior roof lap seams with Sika-Flex 1A to prevent failure of a new interior liner.

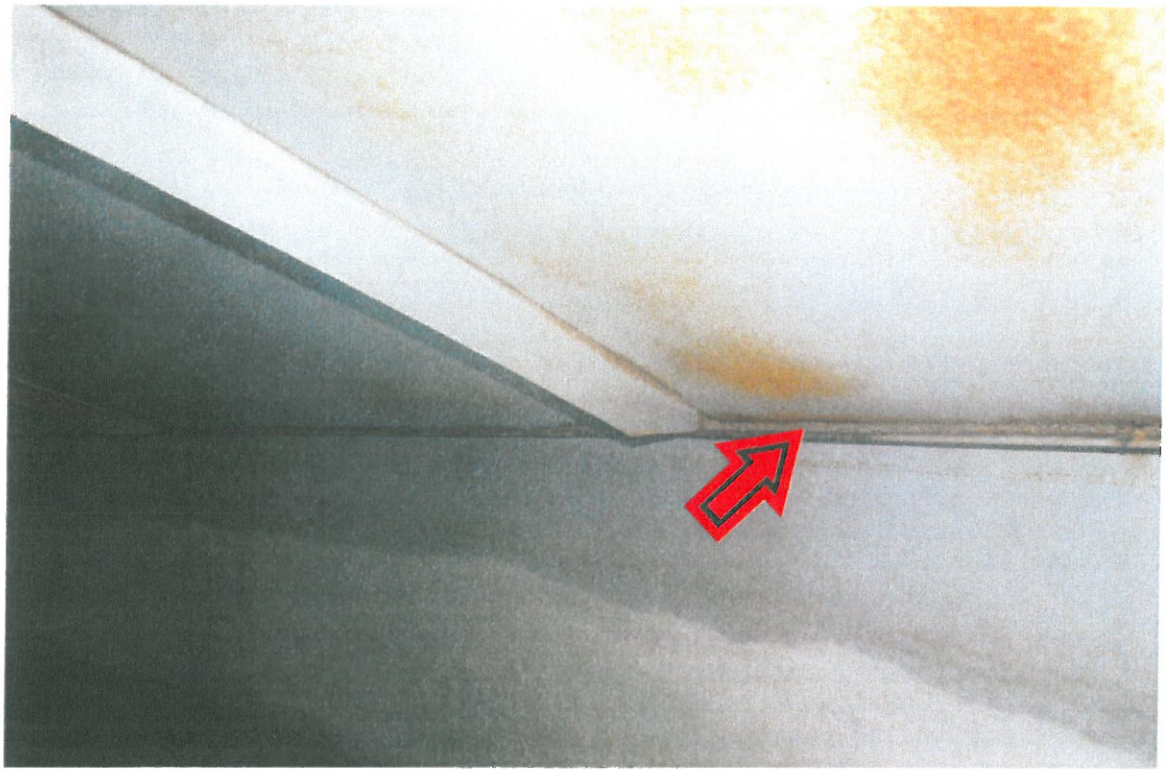


Photo shows the condition of the interior roof-to-rim angle connection. Notice the rust forming in the crevice between the roof and rim angle. We recommend seam sealing the roof to rim angle with Sika-flex 1A to prevent failure of a new interior liner.

Photo shows sediment and debris in the tank. We recommend that cleaning be performed to avoid the problems associated with excessive sediment buildup.

We also recommend installing a passive cathodic protection system.

Photos show the condition of the interior liner. We recommend sandblasting all rusted and abraded areas of the tank interior to an SSPC #10 (near white blast) condition, brushblast all remaining areas, stripe coating all seams and welds, then applying an epoxy liner to achieve 8-10 mils of dry film thickness.

Pittsburg Tank & Tower Maintenance Co., Inc.®

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GROUND STORAGE INSPECTION REPORT

JOB NO: 312346-B INSPECTOR: Adam Newcomb

TANK OWNER: Harpers Ferry

OWNER'S REPRESENTATIVE: Josh Carter TITLE: Water System Manager

MAILING ADDRESS: P.O. Box 217

PHYSICAL ADDRESS: 1435 Bakerton Road

E-MAIL ADDRESS: harpersferry2@frontier.com

CITY, STATE: Harpers Ferry, WV ZIP: 25425

COUNTY TANK IS LOCATED IN: Jefferson

TELEPHONE: (304) 535-6555 FAX: (304) 535-6520

LOCATION OF TANK: Prospect Avenue Tank 2

Harpers Ferry
1435 Bakerton Road
Harpers Ferry, WV 25425
September 19, 2012
Josh Carter,
Water System Manager
(304) 535-6555

ORIGINAL CONTRACT NO: 9-0891 YEAR BUILT: 1964

ORIGINAL MANUFACTURER: CBI CAPACITY: 300,000 Gallon

DATE OF LAST INSPECTION: unknown TYPE: Potable water

DIAMETER: 40'-0" HEIGHT: 32'-0"

OVERFLOW: 4" INLET: Not provided

TYPE CONSTRUCTION: WELDED: X RIVETED: BOLTED:

ACCOUNT EXECUTIVE: Hugh McGee

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GROUND STORAGE TANK CODE UPDATES

Item	Deficiency	Not-Applicable	Codes as Applicable
Lightning Protection	X		OSH Act 29 CFR 1926, Subpart K NFPA 780 2011 4.5 Lightning protection
Shell Manways	X		AWWA D 100-11 Shell manholes 7.4.4
Manway Davit(s)		X	AWWA D 100-11 Shell manholes 7.4.4
Confined Space Entry Signs	X		TSS Sec. 7 7.0.12 Safety OSHA 1910. Confined spaces
Shell Ladder	X		OSHA 1926.1053(a) AWWA D 100-11, 7.4.1 Ladders General
Safety Climb Devices		X	AWWA D 100-11, 7.4.1 Ladders General
Standoffs on 10' Centers		X	AWWA D 100-11 7.4.1 Ladders General
Roof Handrails	X		AWWA D 100-011, OSHA 29 CFR 1910.23(a)(1)
Safety Chain in Handrail Opening		X	AWWA D 100-11, OSHA 29 CFR 1910.23(a)(1)
Screen on Overflow	X		AWWA D 100-11, 7.3: Overflow
Vent	X		AWWA D 100-11, 7.5.2
Roof Manway		X	AWWA D 100-11, 7.4.3: Roof openings TSS 7.0.8.2
Interior Shell Ladders		X	OSHA 1926.1053(a) AWWA D 100-11, 7.4.2.4

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RECOMMENDATIONS

NUMBERS REFER TO REPORT PAGES
00. INDICATES THERE WAS NO PHOTOGRAPH AVAILABLE TO DEMONSTRATE

00. Stabilize the floor by cutting holes, as required, installing couplings in the tank floor and pumping grout to the underneath side of the floor, at 15# p.s.i. by hand pump where the buckling is occurring, to fill the voided areas where buckling is occurring. Then, as a preventive measure, inserting sacrificial cathodic rods, radially beneath the floor of the tank to prevent corrosion. The weld seams will then be vacuum tested to detect defective welds, and any floor seams with cracked welds will be rewelded to prevent any further buckling

2. Remove deteriorated caulk from the tank to foundation connection, then caulking around the base of the tank to foundation connection to sealing the foundation with a sealant

   Electrically ground the tank for lightning protection

   Insert sacrificial cathodic protection rods, radially every 15', beneath the floor of the tank

3. Install a frost proof drain valve, complete with locking device and a splash pad

4. Install a 30" secondary manway 180° from primary manway
   Post **Confined Space Entry** signs
   Install galvanized bolts on existing manway

5. Install an OSHA approved, anti-skid rung equipped, shell ladder complete with standoffs every 10' on center
   Install a cable type ladder safety climb device
   Install an aluminum lockable ladder guard
   Post a **Fall Protection Required** sign

RECOMMENDATIONS

NUMBERS REFER TO REPORT PAGES

6. Disconnect the pipe from the underground drain then install an air break complete with an EPA approved flapper valve and screen

7. Install a 42" high handrail system around the circumference of the tank roof, complete with toeboard, install an intermediate rail and a stainless steel gate chain at the junction of the shell-to-roof access ladder and tank roof

8. Post **Confined Space Entry** sign
Install new lock on existing manway

9. Replace existing roof vent with a vacuum/pressure, frost proof vent and screen

11. Seam seal all un-welded interior roof lap seams with Sika-Flex 1

12. Seam sealing the roof-to-rim angle connection with Sika-Flex 1

13. Clean tank out
Install a passive cathodic protection system

10. EXTERIOR COATING SYSTEM: Pressure wash the tank exterior with biodegradable detergent injection (minimum 3,500 psi at 3.0 gpm) then remove all loose rust and scale with wire brushes and hand scrapers in accordance with SSPC#2 (hand tool cleaning), spot prime and apply one (1) finish coat of alkyd enamel

RECOMMENDATIONS

NUMBERS REFER TO REPORT PAGES

14. INTERIOR COATING SYSTEM: Sandblast all rusted and abraded areas of the tank interior to SSPC #10 (near white blast) condition, brush-blast all remaining areas, stripe coat all seams and welds, then apply an epoxy liner to achieve 8-10 mils dry film thickness

Pittsburg Tank & Tower can perform all work recommended in this report.

BASED ON THE NUMBER OF ITEMS ACCEPTED, PRICES MAY VARY.
All prices are in USD
If union labor or prevailing wage is required please advise
For additional copies of this inspection report call (270) 826-9000 Ext. 253.

The inspection report and comments reflect the general condition of the tank. However, we can not guarantee that additional deficiencies may not become apparent during the cleaning, repair or paint process of the tank.

This tank may not be consistent with seismic zone requirements for this type of structure in this zone. Consideration should be given to performing a structural analysis to determine if any changes are needed to meet design requirements.

The handling, removal and/or disposal of hazardous or contaminated materials such as asbestos, lead, chemical or any like substance that requires special handling is not included in the price submitted for work herein. Paint prices do not include logo, lead abatement or containment.

Cross Hatch	3B @ 6.4mils	
Lead Test	Interior	Exterior
	Negative	Negative

Mil-T Paint Thickness Test

	Roof	10.1	11.7				
		9.6	.10.1				
		5.5	9.1				
	Ring 4	8.1	3.2				
	Ring 3	9.1	5.4				
	Ring 2	5.6	8.8				
Shell	Ring 1	3.5	6.4	5.6	4.4	8.9	6.6

Ultrasonic Metal Thickness Test

		0.178	0.168				
		0.162	0.164				
	Roof	0.172	0.160				
	Ring 4	0.261	0.251				
	Ring 3	0.236	0.259				
	Ring 2	0.210	0.217				
Shell	Ring 1	0.255	0.248	0.245	0.246	0.252	0.257

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http://www.watertank.com Email: sales@watertank.com

TO: Harpers Ferry Water Works
217 Prospect Avenue
Harpers Ferry, WV 25425
EMAIL: harpersferry2@frontier.com

ATTN: Mr. Josh Carter
Manager
PHONE: 304-535-6555
FAX: 304-535-6520

In accordance with price, terms and conditions quoted below, we propose to furnish all labor, material, equipment and insurance necessary to complete the following to **one (1) 300,000 gallon welded, ground storage tank – Tank #2:**

SCOPE OF WORK

Stabilize the floor by cutting holes, as required, installing couplings in the tank floor and pumping grout to the underneath side of the floor, at 15# psi by hand pump where the buckling is occurring. Then, as preventive maintenance, insert sacrificial cathodic rods, radially beneath the floor of the tank to prevent corrosion. The weld seams will then be vacuum tested to detect defective welds, and any floor seams with cracked welds will be rewelded to prevent any further buckling.

Remove damaged grout, then re-grout and re-caulk around the base of the tank to foundation connection to prevent water from entering under the tank and sealing the foundation with a sealant.

Electrically ground the tank for lightning protection.

Insert sacrificial cathodic protection rods, radially every 15', beneath the floor of the tank.

Install a frost proof drain valve, complete with locking device and a splash pad.

Install a 30" secondary manway 180° from primary manway.
Post **Confined Space Entry** signs.
Install galvanized bolts on existing manway.

Install an OSHA approved, antiskid rung equipped, shell ladder complete with standoffs every 10' on center.
Install a cable type ladder safety climb device.
Install an aluminum lockable ladder guard.
Post a **Fall Protection Required** sign.

Disconnect the pipe from the underground drain then install an air break complete with an EPA approved flapper valve and screen.

Install a 42" high handrail system around the circumference of the tank roof, complete with toeboard, an intermediate rail and a stainless steel gate chain at the junction of the shell-to-roof access ladder and tank roof.

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Post **Confined Space Entry** sign.
Install new locks on existing manway.

Replace existing roof vent with a vacuum/pressure, frost proof vent and screen.

Seam seal all unwelded interior roof lap seams with Sikaflex 1a.

Seam seal the roof-to-rim angle connection with Sikaflex 1a.

Clean tank out.
Install a passive cathodic protection system.

EXTERIOR COATING SYSTEM: Pressure wash the tank exterior with biodegradable detergent injection (minimum 3,500 psi at 3.0 gpm) then remove all loose rust and scale with wire brushes and hand scrapers in accordance with SSPC#2 (hand tool cleaning), spot prime and apply one (1) finish coat of alkyd enamel.

INTERIOR COATING SYSTEM: Sandblast all rusted and abraded areas of the tank interior to SSPC#10 (near white blast) condition, brushblast all remaining areas, stripe coat all seams and welds, then apply an epoxy liner to achieve 8-10 mils dry film thickness.

The above to be completed for the BUDGET lump sum of.....$165,000.00
One Hundred Sixty-five Thousand Dollars and Zero Cents

DEPENDING ON THE NUMBER OF ITEMS ACCEPTED PRICES MAY VARY.

IN THE EVENT INTERIOR AND/OR EXTERIOR COMPLETE TANK REPAINTING IS NOT INCLUDED IN THIS SCOPE OF WORK, ALL NEW TANK APPURTENANCES FURNISHED AND INSTALLED BY PITTSBURG TANK & TOWER MAINTENANCE CO. INC AS PART OF THIS SCOPE OF WORK SHALL BE FIELD PRIMED AND FINISH COATED TO MATCH EXISTING COATING SYSTEM(S). COLOR TO MATCH AS CLOSE AS POSSIBLE.

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CONTRACTOR FURTHER AGREES

- If needed a pressure release valve will be furnished during the cleaning and painting operation.
- Handling, removal, and/or disposal of hazardous or contaminated material (e.g., asbestos, lead, chemicals, etc.) requiring special handling or transportation to a specific disposal site are not included in the submitted quotation for work.
- This quote does not provide for the shrouding or containment of blast media and paint.
- If necessary, Customer will be required to clear/move vehicles and equipment a safe distance from the job site to prevent damage and place physical barricades around the perimeter to restrict access.
- Owner understands and agrees any Federal, State, and Municipal taxes imposed on Contractor with respect to the outlined work are additional expenses not included in the contract and further assumes the obligation of paying said additional costs incurred by Contractor.
- This contract is governed by the laws of the Commonwealth of Kentucky and any claims should be filed with the Commonwealth of Kentucky.
- Warning: Do not attach any additional loading to your tank/tower unless structural integrity is known to be sufficient. For analysis call Pittsburg Tank & Tower Maintenance Co., Inc.

QUALITY CONTROL

- All labor will be provided by mechanics skilled in their trade.
- All workmanship is guaranteed for twelve (12) months after completion.
- No paint shall be applied during wet, damp, or inclement weather.
- All paint will be delivered to the job site in original containers with contents identified by the manufacturer.

INSURANCE

Prior to start of work, Owner will be furnished a certificate of insurance covering Workman's Compensation, Occupational Disease, Employer's Liability, and Public Liability.

TERMS

50% With Order; Balance Upon Completion OR Mutually Agreed Payment Terms

MasterCard, Visa and American Express are accepted

The parties approving this contract certify that they are fully authorized to do so, and that all legal requirements have been complied with. You are hereby authorized to furnish all labor, material, equipment and insurance required to complete the work mentioned in the above proposal, for which the undersigned agrees to pay the amount mentioned in said proposal and according to the terms thereof. In the event purchaser fails to abide by the terms and conditions of the contract requiring Pittsburg Tank & Tower Maintenance Co, Inc to collect on amounts due and owing, purchaser agrees to pay all attorney fees and all costs incurred by Pittsburg Tank & Tower Maintenance Co, Inc to secure said payments from purchaser.

ALL QUOTATIONS SUBJECT TO ACCEPTANCE WITHIN 60 DAYS

Accepted: _____, 20_____ **Respectfully Submitted by:**

Harpers Ferry Water Works **PITTSBURG TANK & TOWER MAINTENANCE CO, INC.**

By:_____ **By:** _____

Title: _____ **Don Johnston, President**

APPENDIX E

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

HARPERS FERRY WATER TREATMENT FACILITY UPGRADES
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
(PRELIMINARY) NOVEMBER 2013

Item Description	Unit Cost	Units	Qty	Cost
General Conditions				
Mobilization/Demobilization	$80,000	LS	1	$80,000
Bonds and Insurance	$55,000	LS	1	$55,000
Start-up Services	$15,000	LS	1	$15,000
O & M Manuals	$5,000	LS	1	$5,000
Testing Allowance (Soils, Concrete, Paving)	$10,000	LS	1	$10,000
Spare Parts	$6,000	LS	1	$6,000
				$171,000
New Elk Run Intake Pump Station Building				
E&S/Excavation/Demolition	$20,000	LS	1	$20,000
Site Work	$25,000	LS	1	$25,000
Concrete Foundation	$60,000	LS	1	$60,000
Masonry Building Structure with Wood Truss Roof	$60,000	LS	1	$60,000
New Pumps/Piping	$50,000	LS	1	$50,000
New Pump Variable Frequency Drives	$15,000	LS	1	$15,000
New Level Controller	$5,000	LS	1	$5,000
Misc. Aluminum Appurtences	$20,000	LS	1	$20,000
Electrical	$10,000	LS	1	$10,000
Fencing	$5,000	LS	1	$5,000
				$270,000
New Raw Waterline Vault				
Excavation/Backfill	$10,000	LS	1	$10,000
Concrete Vault	$15,000	LS	1	$15,000
Chemical Feed Lines	$15,000	LS	1	$15,000
New Surface Scatter Turbidimeter	$6,000	LS	1	$6,000
In-line Static Mixer	$6,000	LS	1	$6,000
Piping and Flow Meter	$10,000	LS	1	$10,000
Misc. Appurtenances	$5,000	LS	1	$5,000
Electrical	$3,000	LS	1	$3,000
				$70,000
Retrofit Sedimentation Basin				
E&S/Excavation/Backfill	$20,000	LS	1	$20,000
Demolition	$10,000	LS	1	$10,000
Concrete	$80,000	LS	1	$80,000
Slide Gates	$16,000	LS	1	$16,000
Flocculators	$28,000	LS	1	$28,000
Sludge Collector Drive	$50,000	LS	1	$50,000
FRP Weirs and Troughs	$8,000	LS	1	$8,000
Grout	$5,000	LS	1	$5,000
Piping	$25,000	LS	1	$25,000
New Level Controller	$5,000	LS	1	$5,000
New Fencing	$8,000	LS	1	$8,000
Electrical	$15,000	LS	1	$15,000
				$270,000

New Membrane Filtration System				
Pilot Study	$30,000	LS	1	$30,000
Demolition/Retrofitting	$40,000	LS	1	$40,000
New Membrane System with Automated CIP and SCADA	$1,100,000	LS	1	$1,100,000
Piping	$30,000	LS	1	$30,000
Electrical	$50,000	LS	1	$50,000
				$1,250,000
Finish Water Pump Modifications				
Demolition	$5,000	LS	1	$5,000
New Finish Water Pumps/Motors	$30,000	LS	1	$30,000
Pump Variable Frequency Drives	$25,000	LS	1	$25,000
Check Valves and Piping	$10,000	LS	1	$10,000
Electrical	$15,000	LS	1	$15,000
				$85,000
New 120,000 Gallon Bolted Stainless Steel Clearwell Tank				
120,000 Gallon SS Tank and Foundation	$140,000	LS	1	$140,000
Site Work (Excavation/Backfill/Stone, etc.)	$20,000	LS	1	$20,000
New Level Controller	$5,000	LS	1	$5,000
Piping	$10,000	LS	1	$10,000
New Tank Mixing System	$15,000	LS	1	$15,000
				$190,000
Miscellaneous Improvements				
New Chemical Feed Equipment	$30,000	LS	1	$30,000
New Telemetry System	$40,000	LS	1	$40,000
Conference Room, Office and Kitchen	$100,000	LS	1	$100,000
Emergency Generator (w/Automatic Transfer Switch)	$90,000	LS	1	$90,000
				$260,000
Water Storage and Distribution System Upgrades (See Separate Attachment for Detailed Estimates)				
All Distribution System Waterline Upgrades	$1,550,000	LS	1	$1,550,000
New Booster Pump Station on Prospect Avenue	$250,000	LS	1	$250,000
New Radio Read Water Meters	$261,000	LS	1	$261,000
Repaint/Repair 400,000 Gallon Water Tank No. 1	$208,000	LS	1	$208,000
Repaint/Repair 300,000 Gallon Water Tank No. 2	$165,000	LS	1	$165,000
				$2,434,000
TOTAL CAPITAL CONSTRUCTION COST ESTIMATE FOR ALL UPGRADES				**$5,000,000**

HARPERS FERRY WATER TREATMENT FACILITY UPGRADES
ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS
(PRELIMINARY) NOVEMBER 2013

1.	Total Capital Construction Cost Estimate for All Upgrades (from above)	$5,000,000
2.	Engineering Design, Construction Administration & Inspection, Start-Up, Commissioning & Operational Assistance	$600,000
3.	Legal/Fiscal	$50,000
4.	Construction Contingency (10% of Estimated Construction Costs)	$500,000
5.	Land Acquisition/ROWs	$50,000
6.	Permits	$10,000
7.	Bond Counsel and Bank Registrar Fee	$40,000
TOTAL ESTIMATED SOFT COSTS (No.'s 2 Through 7)		**$1,250,000**
TOTAL OVERALL PROJECT COST ESTIMATE		**$6,250,000**

GD&F

GWIN
DOBSON &
FOREMAN

CONSULTING ENGINEERS

PROJECT: Harper Ferry Water Works - Feasibility Study

DATE: November 2013 **PROJECT NO:** 13045

DISTRIBUTION SYSTEM UPGRADE PROBABLE CONSTRUCTION COSTS

E. Spring Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	730	$ 20.00	$ 14,600.00
#57 Stone Trench Bedding	CY	41	$ 30.00	$ 1,230.00
3/4" Water Service Connection	LF	141	$ 25.00	$ 3,525.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	406	$ 4.75	$ 1,928.50
Trench Backfill	CY	406	$ 2.25	$ 913.50
Pavement Removal	SY	243	$ 3.75	$ 911.25
Pavement Restoration	SY	243	$ 23.00	$ 5,589.00
			Total	$ 35,127.25

W. Spring Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	813	$ 20.00	$ 16,260.00
#57 Stone Trench Bedding	CY	45	$ 30.00	$ 1,350.00
3/4" Water Service Connection	LF	250	$ 25.00	$ 6,250.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
45° Bend	EA	2	$ 98.00	$ 196.00
90° Bend	EA	1	$ 98.00	$ 98.00
Valves and Boxes	EA	1	$ 865.00	$ 865.00
Concrete Thrust Blocks	CY	0.35	$ 400.00	$ 140.00
Trench Excavation	CY	602	$ 4.75	$ 2,859.50
Trench Backfill	CY	602	$ 2.25	$ 1,354.50
Pavement Removal	SY	451	$ 3.75	$ 1,691.25
Pavement Restoration	SY	451	$ 23.00	$ 10,373.00
			Total	$ 45,937.25

Elm Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	1140	$ 20.00	$ 22,800.00
#57 Stone Trench Bedding	CY	63	$ 30.00	$ 1,890.00
3/4" Water Service Connection	LF	452	$ 25.00	$ 11,300.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
90° Bend	EA	1	$ 98.00	$ 98.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	3	$ 865.00	$ 2,595.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	633	$ 4.75	$ 3,006.75
Trench Backfill	CY	633	$ 2.25	$ 1,424.25
Pavement Removal	SY	380	$ 3.75	$ 1,425.00
Pavement Restoration	SY	380	$ 23.00	$ 8,740.00
			Total	$ 58,136.00

Spruce Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	775	$ 20.00	$ 15,500.00
#57 Stone Trench Bedding	CY	43	$ 30.00	$ 1,290.00
3/4" Water Service Connection	LF	225	$ 25.00	$ 5,625.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
6" x 6" Tee	EA	2	$ 157.00	$ 314.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Trench Excavation	CY	702	$ 4.75	$ 3,334.50
Trench Backfill	CY	702	$ 2.25	$ 1,579.50
Pavement Removal	SY	421	$ 3.75	$ 1,578.75
Pavement Restoration	SY	421	$ 23.00	$ 9,683.00
			Total	$ 45,134.75

Day Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	964	$ 20.00	$ 19,280.00
#57 Stone Trench Bedding	CY	54	$ 30.00	$ 1,620.00
3/4" Water Service Connection	LF	242	$ 25.00	$ 6,050.00
Fire Hydrants	EA	2	$ 4,500.00	$ 9,000.00
6" x 6" Wye	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	4	$ 865.00	$ 3,460.00
Concrete Thrust Blocks	CY	1	$ 400.00	$ 400.00
Trench Excavation	CY	547	$ 4.75	$ 2,598.25
Trench Backfill	CY	547	$ 2.25	$ 1,230.75
Pavement Removal	SY	107	$ 3.75	$ 401.25
Pavement Restoration	SY	107	$ 23.00	$ 2,461.00
			Total	$ 46,658.25

Bland Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	522	$ 20.00	$ 10,440.00
#57 Stone Trench Bedding	CY	29	$ 30.00	$ 870.00
3/4" Water Service Connection	LF	130	$ 25.00	$ 3,250.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
45° Bend	EA	2	$ 98.00	$ 196.00
Valves and Boxes	EA	1	$ 865.00	$ 865.00
Concrete Thrust Blocks	CY	0.75	$ 400.00	$ 300.00
Trench Excavation	CY	290	$ 4.75	$ 1,377.50
Trench Backfill	CY	290	$ 2.25	$ 652.50
Pavement Removal	SY	174	$ 3.75	$ 652.50
Pavement Restoration	SY	174	$ 23.00	$ 4,002.00
			Total	$ 27,105.50

Polk Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	10	$ 20.00	$ 200.00
#57 Stone Trench Bedding	CY	2	$ 30.00	$ 60.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	1	$ 865.00	$ 865.00
Concrete Thrust Blocks	CY	0.25	$ 400.00	$ 100.00
Trench Excavation	CY	8	$ 4.75	$ 38.00
Trench Backfill	CY	8	$ 2.25	$ 18.00
Pavement Removal	SY	4	$ 3.75	$ 15.00
Pavement Restoration	SY	4	$ 23.00	$ 92.00
			Total	$ 5,888.00

Clay Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
3/4" Water Service Connection	LF	38	$ 25.00	$ 950.00
Trench Excavation	CY	44	$ 4.75	$ 209.00
Trench Backfill	CY	44	$ 2.25	$ 99.00
Pavement Removal	SY	27	$ 3.75	$ 101.25
Pavement Restoration	SY	27	$ 23.00	$ 621.00
			Total	$ 1,980.25

Taylor Street (East of Jackson Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	240	$ 20.00	$ 4,800.00
#57 Stone Trench Bedding	CY	13	$ 30.00	$ 390.00
3/4" Water Service Connection	LF	128	$ 25.00	$ 3,200.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	133	$ 4.75	$ 631.75
Trench Backfill	CY	133	$ 2.25	$ 299.25
Pavement Removal	SY	75	$ 3.75	$ 281.25
Pavement Restoration	SY	75	$ 23.00	$ 1,725.00
			Total	$ 17,757.25

Park Avenue				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	420	$ 20.00	$ 8,400.00
#57 Stone Trench Bedding	CY	23	$ 30.00	$ 690.00
3/4" Water Service Connection	LF	194	$ 25.00	$ 4,850.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
90° Bend	EA	2	$ 98.00	$ 196.00
Valves and Boxes	EA	3	$ 865.00	$ 2,595.00
Concrete Thrust Blocks	CY	1	$ 400.00	$ 400.00
Trench Excavation	CY	233	$ 4.75	$ 1,106.75
Trench Backfill	CY	233	$ 2.25	$ 524.25
Pavement Removal	SY	138	$ 3.75	$ 517.50
Pavement Restoration	SY	138	$ 23.00	$ 3,174.00
			Total	$ 26,953.50

Warren Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	227	$ 20.00	$ 4,540.00
#57 Stone Trench Bedding	CY	13	$ 30.00	$ 390.00
3/4" Water Service Connection	LF	112	$ 25.00	$ 2,800.00
90° Bend	EA	1	$ 98.00	$ 98.00
Valves and Boxes	EA	3	$ 865.00	$ 2,595.00
Concrete Thrust Blocks	CY	0.75	$ 400.00	$ 300.00
Trench Excavation	CY	201	$ 4.75	$ 954.75
Trench Backfill	CY	201	$ 2.25	$ 452.25
Pavement Removal	SY	121	$ 3.75	$ 453.75
Pavement Restoration	SY	121	$ 23.00	$ 2,783.00
			Total	$ 15,366.75

Mercer Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	392	$ 20.00	$ 7,840.00
#57 Stone Trench Bedding	CY	22	$ 30.00	$ 660.00
3/4" Water Service Connection	LF	50	$ 25.00	$ 1,250.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
90° Bend	EA	2	$ 98.00	$ 196.00
Valves and Boxes	EA	5	$ 865.00	$ 4,325.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	218	$ 4.75	$ 1,035.50
Trench Backfill	CY	218	$ 2.25	$ 490.50
Pavement Removal	SY	131	$ 3.75	$ 491.25
Pavement Restoration	SY	131	$ 23.00	$ 3,013.00
			Total	$ 24,758.25

Jefferson Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	721	$ 20.00	$ 14,420.00
#57 Stone Trench Bedding	CY	40	$ 30.00	$ 1,200.00
3/4" Water Service Connection	LF	20	$ 25.00	$ 500.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
45° Bend	EA	1	$ 98.00	$ 98.00
90° Bend	EA	1	$ 98.00	$ 98.00
Valves and Boxes	EA	10	$ 865.00	$ 8,650.00
Concrete Thrust Blocks	CY	2.5	$ 400.00	$ 1,000.00
Trench Excavation	CY	697	$ 4.75	$ 3,310.75
Trench Backfill	CY	697	$ 2.25	$ 1,568.25
Pavement Removal	SY	240	$ 3.75	$ 900.00
Pavement Restoration	SY	249	$ 23.00	$ 5,727.00
			Total	$ 41,972.00

Primrose Alley				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	201	$ 20.00	$ 4,020.00
#57 Stone Trench Bedding	CY	12	$ 30.00	$ 360.00
3/4" Water Service Connection	LF	72	$ 25.00	$ 1,800.00
6" x 6" Tee	EA	2	$ 157.00	$ 314.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	1	$ 400.00	$ 400.00
Trench Excavation	CY	112	$ 4.75	$ 532.00
Trench Backfill	CY	112	$ 2.25	$ 252.00
Pavement Removal	SY	67	$ 3.75	$ 251.25
Pavement Restoration	SY	67	$ 23.00	$ 1,541.00
			Total	$ 11,200.25

Union Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	20	$ 20.00	$ 400.00
#57 Stone Trench Bedding	CY	4	$ 30.00	$ 120.00
Fire Hydrants	EA	2	$ 4,500.00	$ 9,000.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	16	$ 4.75	$ 76.00
Trench Backfill	CY	16	$ 2.25	$ 36.00
Pavement Removal	SY	8	$ 3.75	$ 30.00
Pavement Restoration	SY	8	$ 23.00	$ 184.00
			Total	$ 11,776.00

Root Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	10	$ 20.00	$ 200.00
#57 Stone Trench Bedding	CY	2	$ 30.00	$ 60.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	1	$ 865.00	$ 865.00
Concrete Thrust Blocks	CY	0.25	$ 400.00	$ 100.00
Trench Excavation	CY	8	$ 4.75	$ 38.00
Trench Backfill	CY	8	$ 2.25	$ 18.00
Pavement Removal	SY	4	$ 3.75	$ 15.00
Pavement Restoration	SY	4	$ 23.00	$ 92.00
			Total	$ 5,888.00

Gilbert Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
8" PVC C-900 Water Line	LF	734	$ 25.00	$ 18,350.00
#57 Stone Trench Bedding	CY	41	$ 30.00	$ 1,230.00
3/4" Water Service Connection	LF	210	$ 25.00	$ 5,250.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
45° Bend	EA	2	$ 170.00	$ 340.00
8" x 8" Tee	EA	1	$ 203.00	$ 203.00
Valves and Boxes	EA	2	$ 1,065.00	$ 2,130.00
Concrete Thrust Blocks	CY	1.5	$ 400.00	$ 600.00
Trench Excavation	CY	408	$ 4.75	$ 1,938.00
Trench Backfill	CY	408	$ 2.25	$ 918.00
Pavement Removal	SY	245	$ 3.75	$ 918.75
Pavement Restoration	SY	245	$ 23.00	$ 5,635.00
			Total	$ 42,012.75

Cleveland Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	360	$ 20.00	$ 7,200.00
#57 Stone Trench Bedding	CY	20	$ 30.00	$ 600.00
3/4" Water Service Connection	LF	95	$ 25.00	$ 2,375.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	200	$ 4.75	$ 950.00
Trench Backfill	CY	200	$ 2.25	$ 450.00
Pavement Removal	SY	120	$ 3.75	$ 450.00
Pavement Restoration	SY	120	$ 23.00	$ 2,760.00
			Total	$ 16,872.00

Stevenson Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	460	$ 20.00	$ 9,200.00
#57 Stone Trench Bedding	CY	26	$ 30.00	$ 780.00
3/4" Water Service Connection	LF	126	$ 25.00	$ 3,150.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.75	$ 400.00	$ 300.00
Trench Excavation	CY	256	$ 4.75	$ 1,216.00
Trench Backfill	CY	256	$ 2.25	$ 576.00
Pavement Removal	SY	153	$ 3.75	$ 573.75
Pavement Restoration	SY	153	$ 23.00	$ 3,519.00
			Total	$ 21,044.75

Old Furnace Road				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	1060	$ 20.00	$ 21,200.00
#57 Stone Trench Bedding	CY	59	$ 30.00	$ 1,770.00
3/4" Water Service Connection	LF	90	$ 25.00	$ 2,250.00
Fire Hydrants	EA	2	$ 4,500.00	$ 9,000.00
45° Bend	EA	5	$ 98.00	$ 490.00
Valves and Boxes	EA	4	$ 865.00	$ 3,460.00
Concrete Thrust Blocks	CY	1.5	$ 400.00	$ 600.00
Trench Excavation	CY	589	$ 4.75	$ 2,797.75
Trench Backfill	CY	589	$ 2.25	$ 1,325.25
Pavement Removal	SY	354	$ 3.75	$ 1,327.50
Pavement Restoration	SY	354	$ 23.00	$ 8,142.00
			Total	$ 52,362.50

Fisher Street / Alley				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	753	$ 20.00	$ 15,060.00
#57 Stone Trench Bedding	CY	57	$ 30.00	$ 1,710.00
3/4" Water Service Connection	LF	70	$ 25.00	$ 1,750.00
Valves and Boxes	EA	3	$ 865.00	$ 2,595.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	567	$ 4.75	$ 2,693.25
Trench Backfill	CY	567	$ 2.25	$ 1,275.75
Pavement Removal	SY	340	$ 3.75	$ 1,275.00
Pavement Restoration	SY	340	$ 23.00	$ 7,820.00
			Total	$ 34,979.00

Marion Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
8" PVC C-900 Water Line	LF	560	$ 25.00	$ 14,000.00
#57 Stone Trench Bedding	CY	32	$ 30.00	$ 960.00
3/4" Water Service Connection	LF	108	$ 25.00	$ 2,700.00
45° Bend	EA	1	$ 170.00	$ 170.00
Valves and Boxes	EA	3	$ 1,065.00	$ 3,195.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	311	$ 4.75	$ 1,477.25
Trench Backfill	CY	311	$ 2.25	$ 699.75
Pavement Removal	SY	187	$ 3.75	$ 701.25
Pavement Restoration	SY	187	$ 23.00	$ 4,301.00
			Total	$ 28,404.25

Putnam Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	853	$ 20.00	$ 17,060.00
#57 Stone Trench Bedding	CY	48	$ 30.00	$ 1,440.00
3/4" Water Service Connection	LF	90	$ 25.00	$ 2,250.00
6" x 8" Cross	EA	1	$ 203.00	$ 203.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	6	$ 865.00	$ 5,190.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	474	$ 4.75	$ 2,251.50
Trench Backfill	CY	474	$ 2.25	$ 1,066.50
Pavement Removal	SY	284	$ 3.75	$ 1,065.00
Pavement Restoration	SY	284	$ 23.00	$ 6,532.00
			Total	$ 42,515.00

Boundary Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	602	$ 20.00	$ 12,040.00
#57 Stone Trench Bedding	CY	34	$ 30.00	$ 1,020.00
3/4" Water Service Connection	LF	160	$ 25.00	$ 4,000.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
45° Bend	EA	2	$ 98.00	$ 196.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	4	$ 865.00	$ 3,460.00
Concrete Thrust Blocks	CY	1	$ 400.00	$ 400.00
Trench Excavation	CY	335	$ 4.75	$ 1,591.25
Trench Backfill	CY	335	$ 2.25	$ 753.75
Pavement Removal	SY	163	$ 3.75	$ 611.25
Pavement Restoration	SY	163	$ 23.00	$ 3,749.00
			Total	$ 32,478.25

Mason Way				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	362	$ 20.00	$ 7,240.00
#57 Stone Trench Bedding	CY	21	$ 30.00	$ 630.00
3/4" Water Service Connection	LF	60	$ 25.00	$ 1,500.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.75	$ 400.00	$ 300.00
Trench Excavation	CY	201	$ 4.75	$ 954.75
Trench Backfill	CY	201	$ 2.25	$ 452.25
Pavement Removal	SY	153	$ 3.75	$ 573.75
Pavement Restoration	SY	153	$ 23.00	$ 3,519.00
			Total	$ 17,056.75

Fillmore Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	890	$ 20.00	$ 17,800.00
#57 Stone Trench Bedding	CY	183	$ 30.00	$ 5,490.00
3/4" Water Service Connection	LF	497	$ 25.00	$ 12,425.00
Fire Hydrants	EA	2	$ 4,500.00	$ 9,000.00
6" x 6" Tee	EA	6	$ 157.00	$ 942.00
2" x 6" Wye	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	16	$ 865.00	$ 13,840.00
Concrete Thrust Blocks	CY	6	$ 400.00	$ 2,400.00
Trench Excavation	CY	1825	$ 4.75	$ 8,668.75
Trench Backfill	CY	1825	$ 2.25	$ 4,106.25
Pavement Removal	SY	900	$ 3.75	$ 3,375.00
Pavement Restoration	SY	900	$ 23.00	$ 20,700.00
			Total	$ 98,904.00

Zachary Taylor Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	393	$ 20.00	$ 7,860.00
#57 Stone Trench Bedding	CY	22	$ 30.00	$ 660.00
3/4" Water Service Connection	LF	264	$ 25.00	$ 6,600.00
6" x 10" Cross	EA	1	$ 203.00	$ 203.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	218	$ 4.75	$ 1,035.50
Trench Backfill	CY	218	$ 2.25	$ 490.50
Pavement Removal	SY	131	$ 3.75	$ 491.25
Pavement Restoration	SY	131	$ 23.00	$ 3,013.00
			Total	$ 22,283.25

McDowell Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	1022	$ 20.00	$ 20,440.00
#57 Stone Trench Bedding	CY	57	$ 30.00	$ 1,710.00
3/4" Water Service Connection	LF	192	$ 25.00	$ 4,800.00
Fire Hydrants	EA	2	$ 4,500.00	$ 9,000.00
6" x 10" Cross	EA	1	$ 203.00	$ 203.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
90° Bend	EA	1	$ 98.00	$ 98.00
Valves and Boxes	EA	6	$ 865.00	$ 5,190.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	567	$ 4.75	$ 2,693.25
Trench Backfill	CY	567	$ 2.25	$ 1,275.75
Pavement Removal	SY	341	$ 3.75	$ 1,278.75
Pavement Restoration	SY	341	$ 23.00	$ 7,843.00
			Total	$ 55,488.75

Gilmore Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	1022	$ 20.00	$ 20,440.00
#57 Stone Trench Bedding	CY	57	$ 30.00	$ 1,710.00
3/4" Water Service Connection	LF	336	$ 25.00	$ 8,400.00
6" x 10" Cross	EA	1	$ 203.00	$ 203.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
45° Bend	EA	2	$ 98.00	$ 196.00
Valves and Boxes	EA	7	$ 865.00	$ 6,055.00
Concrete Thrust Blocks	CY	2.5	$ 400.00	$ 1,000.00
Trench Excavation	CY	567	$ 4.75	$ 2,693.25
Trench Backfill	CY	567	$ 2.25	$ 1,275.75
Pavement Removal	SY	341	$ 3.75	$ 1,278.75
Pavement Restoration	SY	341	$ 23.00	$ 7,843.00
			Total	$ 51,251.75

Cliff Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	255	$ 20.00	$ 5,100.00
#57 Stone Trench Bedding	CY	15	$ 30.00	$ 450.00
3/4" Water Service Connection	LF	30	$ 25.00	$ 750.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	1	$ 400.00	$ 400.00
Trench Excavation	CY	142	$ 4.75	$ 674.50
Trench Backfill	CY	142	$ 2.25	$ 319.50
Pavement Removal	SY	85	$ 3.75	$ 318.75
Pavement Restoration	SY	85	$ 23.00	$ 1,955.00
			Total	$ 11,697.75

Columbia Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	705	$ 20.00	$ 14,100.00
#57 Stone Trench Bedding	CY	40	$ 30.00	$ 1,200.00
3/4" Water Service Connection	LF	168	$ 25.00	$ 4,200.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
6" x 6" Cross	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	5	$ 685.00	$ 3,425.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	392	$ 4.75	$ 1,862.00
Trench Backfill	CY	392	$ 2.25	$ 882.00
Pavement Removal	SY	239	$ 3.75	$ 896.25
Pavement Restoration	SY	239	$ 23.00	$ 5,497.00
			Total	$ 37,519.25

York Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	209	$ 20.00	$ 4,180.00
#57 Stone Trench Bedding	CY	12	$ 30.00	$ 360.00
6" x 6" Tee	EA	1	$ 98.00	$ 98.00
Valves and Boxes	EA	3	$ 865.00	$ 2,595.00
Concrete Thrust Blocks	CY	1	$ 400.00	$ 400.00
Trench Excavation	CY	116	$ 4.75	$ 551.00
Trench Backfill	CY	116	$ 2.25	$ 261.00
Pavement Removal	SY	98	$ 3.75	$ 367.50
Pavement Restoration	SY	98	$ 23.00	$ 2,254.00
			Total	$ 11,066.50

Church Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	20	$ 20.00	$ 400.00
#57 Stone Trench Bedding	CY	2	$ 30.00	$ 60.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	1	$ 865.00	$ 865.00
Concrete Thrust Blocks	CY	0.25	$ 400.00	$ 100.00
Trench Excavation	CY	11	$ 4.75	$ 52.25
Trench Backfill	CY	11	$ 2.25	$ 24.75
Pavement Removal	SY	92	$ 3.75	$ 345.00
Pavement Restoration	SY	92	$ 23.00	$ 2,116.00
			Total	$ 8,463.00

Public Way				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	485	$ 20.00	$ 9,700.00
#57 Stone Trench Bedding	CY	27	$ 30.00	$ 810.00
3/4" Water Service Connection	LF	120	$ 25.00	$ 3,000.00
45° Bend	EA	3	$ 98.00	$ 294.00
Valves and Boxes	EA	3	$ 865.00	$ 2,595.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	269	$ 4.75	$ 1,277.75
Trench Backfill	CY	269	$ 2.25	$ 605.25
Pavement Removal	SY	162	$ 3.75	$ 607.50
Pavement Restoration	SY	162	$ 23.00	$ 3,726.00
			Total	$ 23,415.50

Shenandoah Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	808	$ 20.00	$ 16,160.00
#57 Stone Trench Bedding	CY	45	$ 30.00	$ 1,350.00
3/4" Water Service Connection	LF	138	$ 25.00	$ 3,450.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
45° Bend	EA	4	$ 98.00	$ 392.00
Valves and Boxes	EA	4	$ 865.00	$ 3,460.00
Concrete Thrust Blocks	CY	2	$ 400.00	$ 800.00
Trench Excavation	CY	449	$ 4.75	$ 2,132.75
Trench Backfill	CY	449	$ 2.25	$ 1,010.25
Pavement Removal	SY	269	$ 3.75	$ 1,008.75
Pavement Restoration	SY	269	$ 23.00	$ 6,187.00
			Total	$ 36,107.75

Potomac Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	260	$ 20.00	$ 5,200.00
#57 Stone Trench Bedding	CY	15	$ 30.00	$ 450.00
Fire Hydrants	EA	2	$ 4,500.00	$ 9,000.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	144	$ 4.75	$ 684.00
Trench Backfill	CY	144	$ 2.25	$ 324.00
Pavement Removal	SY	87	$ 3.75	$ 326.25
Pavement Restoration	SY	87	$ 23.00	$ 2,001.00
			Total	$ 19,915.25

Kenneth Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	247	$ 20.00	$ 4,940.00
#57 Stone Trench Bedding	CY	14	$ 30.00	$ 420.00
3/4" Water Service Connection	LF	80	$ 25.00	$ 2,000.00
Valves and Boxes	EA	2	$ 750.00	$ 1,500.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	137	$ 4.75	$ 650.75
Trench Backfill	CY	137	$ 2.25	$ 308.25
Pavement Removal	SY	83	$ 3.75	$ 311.25
Pavement Restoration	SY	83	$ 23.00	$ 1,909.00
			Total	$ 12,239.25

Columbia Avenue				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	2137	$ 20.00	$ 42,740.00
#57 Stone Trench Bedding	CY	119	$ 30.00	$ 3,570.00
3/4" Water Service Connection	LF	180	$ 25.00	$ 4,500.00
6" x 6" Tee	EA	2	$ 157.00	$ 314.00
45° Bend	EA	3	$ 98.00	$ 294.00
90° Bend	EA	1	$ 98.00	$ 98.00
Valves and Boxes	EA	6	$ 865.00	$ 5,190.00
Concrete Thrust Blocks	CY	4	$ 400.00	$ 1,600.00
Trench Excavation	CY	1187	$ 4.75	$ 5,638.25
Trench Backfill	CY	1187	$ 2.25	$ 2,670.75
Pavement Removal	SY	333	$ 3.75	$ 1,248.75
Pavement Restoration	SY	333	$ 23.00	$ 7,659.00
			Total	$ 75,522.75

Cavalier Drive				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	1013	$ 20.00	$ 20,260.00
#57 Stone Trench Bedding	CY	56	$ 30.00	$ 1,680.00
3/4" Water Service Connection	LF	220	$ 25.00	$ 5,500.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
45° Bend	EA	2	$ 98.00	$ 196.00
Valves and Boxes	EA	5	$ 865.00	$ 4,325.00
Concrete Thrust Blocks	CY	3	$ 400.00	$ 1,200.00
Trench Excavation	CY	562	$ 4.75	$ 2,669.50
Trench Backfill	CY	562	$ 2.25	$ 1,264.50
Pavement Removal	SY	338	$ 3.75	$ 1,267.50
Pavement Restoration	SY	338	$ 23.00	$ 7,774.00
			Total	$ 46,293.50

Cavalier Estates Drive				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	1054	$ 20.00	$ 21,080.00
#57 Stone Trench Bedding	CY	59	$ 30.00	$ 1,770.00
3/4" Water Service Connection	LF	200	$ 25.00	$ 5,000.00
45° Bend	EA	2	$ 98.00	$ 196.00
90° Bend	EA	3	$ 98.00	$ 294.00
Valves and Boxes	EA	5	$ 865.00	$ 4,325.00
Concrete Thrust Blocks	CY	3	$ 400.00	$ 1,200.00
Trench Excavation	CY	586	$ 4.75	$ 2,783.50
Trench Backfill	CY	586	$ 2.25	$ 1,318.50
Pavement Removal	SY	351	$ 3.75	$ 1,316.25
Pavement Restoration	SY	351	$ 23.00	$ 8,073.00
			Total	$ 47,356.25

Washington Street (Elm Street to Polk Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	822	$ 20.00	$ 16,440.00
#57 Stone Trench Bedding	CY	46	$ 30.00	$ 1,380.00
3/4" Water Service Connection	LF	344	$ 25.00	$ 8,600.00
6" Wye	EA	1	$ 157.00	$ 157.00
Valves and Boxes	EA	2	$ 865.00	$ 1,730.00
Concrete Thrust Blocks	CY	0.5	$ 400.00	$ 200.00
Trench Excavation	CY	456	$ 4.75	$ 2,166.00
Trench Backfill	CY	456	$ 2.25	$ 1,026.00
Pavement Removal	SY	274	$ 3.75	$ 1,027.50
Pavement Restoration	SY	274	$ 23.00	$ 6,302.00
			Total	$ 39,028.50

Washington Street (Polk Street to Clay Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
3/4" Water Service Connection	LF	320	$ 25.00	$ 8,000.00
Trench Excavation	CY	115	$ 4.75	$ 546.25
Trench Backfill	CY	115	$ 2.25	$ 258.75
Pavement Removal	SY	71	$ 3.75	$ 266.25
Pavement Restoration	SY	71	$ 23.00	$ 1,633.00
			Total	$ 10,704.25

Washington Street (Clay Street to Jackson Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	33	$ 20.00	$ 660.00
#57 Stone Trench Bedding	CY	3	$ 30.00	$ 90.00
3/4" Water Service Connection	LF	126	$ 25.00	$ 3,150.00
Trench Excavation	CY	172	$ 4.75	$ 817.00
Trench Backfill	CY	172	$ 2.25	$ 387.00
Pavement Removal	SY	91	$ 3.75	$ 341.25
Pavement Restoration	SY	91	$ 23.00	$ 2,093.00
			Total	$ 7,538.25

Washington Street (Panama Street to Fisher Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
3/4" Water Service Connection	LF	615	$ 25.00	$ 15,375.00
Valves and Boxes	EA	5	$ 865.00	$ 4,325.00
Trench Excavation	CY	522	$ 4.75	$ 2,479.50
Trench Backfill	CY	522	$ 2.25	$ 1,174.50
Pavement Removal	SY	313	$ 3.75	$ 1,173.75
Pavement Restoration	SY	313	$ 23.00	$ 7,199.00
			Total	$ 31,726.75

Washington Street (Wager Street to Union Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
3/4" Water Service Connection	LF	120	$ 25.00	$ 3,000.00
Trench Excavation	CY	129	$ 4.75	$ 612.75
Trench Backfill	CY	129	$ 2.25	$ 290.25
Pavement Removal	SY	387	$ 3.75	$ 1,451.25
Pavement Restoration	SY	387	$ 23.00	$ 8,901.00
			Total	$ 14,255.25

Washington Street (Boundary Street to Zachary Taylor Street)				
Item	Unit	Quantity	Unit Cost	Total Item Cost
3/4" Water Service Connection	LF	100	$ 25.00	$ 2,500.00
Trench Excavation	CY	508	$ 4.75	$ 2,413.00
Trench Backfill	CY	508	$ 2.25	$ 1,143.00
Pavement Removal	SY	305	$ 3.75	$ 1,143.75
Pavement Restoration	SY	305	$ 23.00	$ 7,015.00
			Total	$ 14,214.75

Washington Street / High Street				
Item	Unit	Quantity	Unit Cost	Total Item Cost
6" PVC C-900 Water Line	LF	2384	$ 20.00	$ 47,680.00
#57 Stone Trench Bedding	CY	132	$ 30.00	$ 3,960.00
3/4" Water Service Connection	LF	620	$ 25.00	$ 15,500.00
6" x 6" Tee	EA	1	$ 157.00	$ 157.00
45° Bend	EA	1	$ 98.00	$ 98.00
90° Bend	EA	2	$ 98.00	$ 196.00
Fire Hydrants	EA	1	$ 4,500.00	$ 4,500.00
Valves and Boxes	EA	9	$ 865.00	$ 7,785.00
Concrete Thrust Blocks	CY	4	$ 400.00	$ 1,600.00
Trench Excavation	CY	1324	$ 4.75	$ 6,289.00
Trench Backfill	CY	1324	$ 2.25	$ 2,979.00
Pavement Removal	SY	795	$ 3.75	$ 2,981.25
Pavement Restoration	SY	795	$ 23.00	$ 18,285.00
			Total	$ 112,010.25

DISTRIBUTION SYSTEM SUBTOTAL	$ 1,496,367.00

ELK RUN 8" WATERLINE BORING REPLACEMENT				
Item	Unit	Quantity	Unit Cost	Total Item Cost
8" Ductile Iron Water Line Installed via Horizontal Boring	LF	200	$ 250.00	$ 50,000.00

ELK RUN WATERLINE SUBTOTAL	$ 50,000.00

NEW WATER METERS				
Item	Unit	Quantity	Unit Cost	Total Item Cost
Radio Read Water Meters	EA	821	$ 275.00	$ 225,775.00
Vehicle Based Meter Reader	LS	1	$ 35,000.00	$ 35,000.00

WATER METER SUBTOTAL	$ 260,775.00

TOTAL PROBABLE CONSTRUCTION COSTS FOR DISTRIBUTION SYSTEM UPGRADES	**$ 1,807,142.00**

APPENDIX F

EXISTING DISTRIBUTION SYSTEM DRAWING

APPENDIX G

PROPOSED DISTRIBUTION SYSTEM DRAWING