

# **Dixon Engineering, Inc.**

Preliminary Maintenance Inspection  
2,000,000 Gallon Concrete Reservoir

Martinsburg, West Virginia

Inspection Performed: December 10, 2019  
Reviewed by Joseph T. Hoban, P.E.: February 12, 2020

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## **CONCLUSIONS:**

1. The exterior concrete is in good condition overall. There are several cracks on the roof and sidewall. There are no spalls on the roof or sidewall. The exterior concrete coating is an acrylic system. The coating is in poor condition overall. Coating deterioration includes delamination and erosion.
2. The interior concrete is in good condition overall. There are no cracks or spalls on the roof. There is a membrane on the concrete sidewall and floor that is in good condition.
3. The interior metal appurtenances are coated in an unknown system that is in poor condition overall.

## **RECOMMENDATIONS:**

Complete the recommended work within the next year. The exterior concrete coating work is for aesthetics only and can be delayed until aesthetics dictate.

1. Low pressure water clean and overcoat the exterior concrete with an acrylic system as aesthetics dictate. The estimated cost is \$100,000.
2. Abrasive blast clean the wet interior piping and repaint with an epoxy system. The cost would be incidental to overflow pipe modifications.
3. Cut the tree branches that are rubbing on the reservoir to prevent damage. The work can be performed by in-house personnel or obtain a quote from a local landscaper.
4. The drainage around the reservoir should be verified before starting a long-term project where the chance for heavy rain can elevate the ground water. Drains, if present, should be tested for proper operation and cleaned or repaired as needed. Work can be performed by in-house personnel.
5. Modify the overflow pipe discharge to bring it into compliance with current West Virginia DEP requirements. The estimated cost is \$8,000.
6. Replace the roof hatch with a prefabricated hatch that has an elevated neck and an overlapping cover. The estimated cost is \$10,000.
7. Replace the roof vent. The estimated cost is \$7,000.
8. Install a fall prevention device on the exterior ladder. The estimated cost is \$4,000.
9. Install a vandal guard on the exterior ladder. The estimated cost is \$2,000.
10. Install a cable fall-prevention device that routes from near the roof vent down to the sidewall. The estimated cost is \$6,000.

**COST SUMMARY:**

Exterior overcoat	\$100,000
Overflow modification	8,000
Roof hatch	10,000
Roof vent	7,000
Fall prevention	4,000
Vandal guard	2,000
Roof fall prevention device	<u>6,000</u>
Sub Total	\$137,000
Engineering and Contingencies	<u>\$28,000</u>
Total	\$165,000

Notes: Exterior repaint can be postponed as aesthetics dictate or the work could coincide with the other improvements.

## **INSPECTION:**

On December 10, 2019, Dixon Engineering, Inc., performed a preliminary maintenance inspection on the 2,000,000 gallon concrete reservoir owned by the City of Martinsburg, West Virginia. Purposes of the inspection were to evaluate the interior and exterior coatings' performance and life expectancy, assess the condition of concrete surfaces and the reservoir's appurtenances, review safety and health aspects and make budgetary recommendations for continued maintenance of the reservoir. All recommendations, with budgeting estimates for repairs, are incorporated in this report.

The inspection was performed by John Watson, Engineering Technician. The inspector was assisted by Paul Moore, ROV Operator. Scheduling and arrangements for the inspection were completed through Narayan Venkatesan.

The wet interior inspection was completed with a remotely operated vehicle (ROV). Video of the inspection and still photos are included with this report. No cleaning was performed in the wet interior during the ROV inspection.

## **GENERAL INFORMATION:**

The original construction date is unknown. The reservoir has a sidewall height of approximately 50 feet and is completely above grade.

The roof was cast-in-place. There is a tension ring around the outer edge of the roof. The sidewall is constructed of formed concrete panels with mortar joints between the panels. The exterior of the walls were wrapped in wire for prestressing and then a layer of gunite or shotcrete was sprayed over the wiring. The floor slab was cast-in-place in one continuous pour.

## **CONDITIONS AND RECOMMENDATIONS:**

### **EXTERIOR STRUCTURE AND COATING CONDITIONS:**

The roof is in good condition overall. There are a few cracks that are randomly located throughout. The edges of the cracks are intact. The cracks likely formed shortly after the original construction and are likely inactive. No efflorescence is present on the roof at the cracks.

The sidewall is in fair condition overall. There are several cracks that run horizontally along the circumference of the sidewall. The edges of the cracks are intact. The cracks likely formed shortly after the original construction and are likely inactive. Efflorescence is present on the walls at all cracks. The efflorescence in the cracks is likely due to moisture vapor entering and exiting the cracks rather than leaking through the concrete. Slight buildup of efflorescence is common. Moisture migrating into and out of the crack will leave a deposit of efflorescence on the surface. This deposit can act like a scar sealing the crack.

There is coating on the sidewall and roof. A coating sample was taken and sent to Tnemec Paint Company for lab analysis. Lab results indicate that the exterior coating is an acrylic system.

The roof coating is in poor condition with numerous failures. Primary modes of deterioration are erosion and delamination to the concrete.

The sidewall coating is in poor condition with numerous failures. Primary modes of deterioration are erosion and delamination to the concrete. There is lettering that states "MARTINSBURG, WEST VA" on the sidewall in one location. The sidewall is covered with heavy mildew growth.

#### **EXTERIOR STRUCTURE AND COATING RECOMMENDATIONS:**

The exterior coating is primarily for aesthetic purposes though the coating can provide some protection from weathering. If exterior coating is desired, the recommended procedure is to low-pressure water clean (3,500 to 5,000 psi) the exterior to remove any delaminating or flaking coating and any contaminants.

The exterior would be overcoated with two full coats of acrylic. The purpose of this procedure is to remove all the poorly adhering topcoat, leaving the tightly adhered coating in-place. The reservoir would be removed from service during the painting project. This is necessary to reduce moisture condensation on the surface. The estimated cost to overcoat with an acrylic system is \$100,000.

#### **INTERIOR STRUCTURE AND COATING CONDITIONS:**

The interior roof is not able to be inspected with the ROV, interior roof inspection is limited to the portion visible from the roof hatch. The roof appears to be in good condition overall with no deterioration visible.

The sidewall and floor concrete is covered in a rubber membrane. The rubber membrane is in good condition.

The wet interior metal appurtenances include the fill/draw pipe and overflow pipe. The appurtenances are coated in an unknown system. The coating is in fair condition with a few failures.

#### **INTERIOR STRUCTURE AND COATING RECOMMENDATIONS:**

The interior concrete structure has not deteriorated to the point of needing repairs.

Repaint the wet interior piping when the overflow modification is made. The cost would be incidental to the overflow modification.

**SITE CONDITIONS:**

The reservoir is located on a fenced site that is adjacent to residential and commercial development. Tree branches are rubbing on the sidewall.

**SITE RECOMMENDATIONS:**

Cut the tree branches that are rubbing on the reservoir to prevent damage.

**SITE DRAINAGE CONDITIONS:**

Drawings were not available for review during the inspection. It is unknown if the reservoir was constructed with drainage piping. AWWA Standard D-110 requires the contractor to plan for and construct the reservoir with proper drainage. This standard is intended for prestressed reservoirs but should also apply to standard cast-in-place construction. We assume that the reservoir was constructed with proper drainage. If there is not proper drainage the pressure from the groundwater could upheave the floor when the reservoir is drained.

**DRAINAGE RECOMMENDATIONS:**

The drainage around the reservoir should be verified before starting a long-term project where the chance for heavy rain can elevate the ground water. Drains, if present should be tested for proper operation and cleaned or repaired as needed. Work can be performed by in-house personnel.

**OVERFLOW PIPE CONDITIONS:**

The reservoir has an overflow pipe that extends down along the interior of the sidewall and penetrates into the floor. The discharge of the overflow pipe is unknown.

The overflow pipe is supported by braces on the sidewall. There is no coating on the braces and there is minor corrosion.

**OVERFLOW PIPE RECOMMENDATIONS:**

Remove the existing overflow pipe and install a new pipe that exits the upper sidewall and route along the exterior sidewall to a splash pad. Orient discharge vertical maintaining a 12-24 inch air gap and install a screened flap gate. This will bring the overflow pipe discharge into compliance with current West Virginia DEP requirements. The work would need to be performed by the tank manufacturer to ensure the wires on the sidewall are avoided during installation. The estimated cost is \$8,000.

**HATCH AND MANWAY CONDITIONS:**

There is a 36 inch square shaped roof hatch that is in good condition. The cover is a

piece of flat sheet metal fastened to the concrete curb. The cover does not meet West Virginia DEP requirements.

**HATCH AND MANWAY RECOMMENDATIONS:**

Replace the cover with a new 36 inch prefabricated hatch that has an elevated neck and overlapping cover with a lockable hasp. The estimated cost is \$10,000.

**VENT CONDITIONS:**

There is one roof vent that is in good condition. The vent is 36 inches in diameter with a flow-through design. There is a vertical screen on the roof vent that is in good condition. The screen is not covered to prevent rain from entering the wet interior. The West Virginia DEP requires a shroud cover over the vertical screens.

**VENT RECOMMENDATIONS:**

Replace the roof vent with a properly shielded vent. The estimated cost is \$7,000.

**LADDER CONDITIONS:**

The exterior sidewall ladder starts at ground level and extends up to the roof. The ladder is not equipped with a fall prevention device. There is no vandal guard on the sidewall ladder.

The wet interior ladder appears to be covered with the rubber membrane and is unusable without damaging the membrane. Access to the floor can be obtained using a portable ladder.

**LADDER RECOMMENDATIONS:**

Install a rail-type fall prevention device on the exterior ladder. The estimated cost is \$4,000.

Install a vandal guard on the exterior ladder. The estimated cost is \$2,000.

Install a cable fall-prevention device that routes from near the roof vent down to the sidewall. The estimated cost is \$6,000.

**FILL/DRAW PIPE CONDITIONS:**

The reservoir fills and draws from a single pipe. The fill/draw pipe penetrates through floor and terminates with an elbow approximately 4 inches above the floor.

**DIXON ENGINEERING, INC.**  
**CONCRETE TANK FIELD INSPECTION REPORT**

DATE: December 10, 2019

OWNER: City of Martinsburg  
CLIENT CODE: 48-02-02-01  
LOCATION: Address: 1505 W. Stephen St.  
City: Martinsburg  
State: West Virginia  
TANK SIZE: Capacity: 2,000,000 gallons  
Diameter: 100 feet (estimated)  
Overflow (HWL): 38 feet (estimated)  
Sidewall height: 40 feet (estimated)  
CONSTRUCTION: Pre-stressed  
Type of roof: Dome  
Layout: Above grade  
YEAR CONSTRUCTED: Unknown  
MANUFACTURER: Unknown  
CONTRACT NUMBER: Unknown

PERSONNEL: Inspector John Watson, ROV operator Paul Moore  
TYPE OF INSPECTION: Preliminary Maintenance  
METHOD OF INSPECTION: ROV  
YEAR LAST INSPECTED: Unknown

**SITE CONDITIONS**

Fenced: Yes  
Site large enough for contractor's equipment: Yes  
Control building: Yes  
Neighborhood: Residential and commercial  
Power lines within 50 feet: Yes  
Are power lines attached to the structure: No  
Site drainage: Away from tank  
Indications of underground leakage: No  
Shrub, tree, etc. encroachment: Yes  
Rubbing on the tank: Yes  
Interference with future containment: No

**EXPOSED PIPING**

N/A



**FOUNDATION:**

Foundation exposed: **No**

**DRAINAGE**

Access manholes: **No**

**EXTERIOR - GENERAL**

Concrete condition: **Fair**

Rusting at surface: **No**

Coating present: **Yes**

Location: **Entire sidewall/roof, west side wall 20 x 60 feet**

Type of coating: **Acrylic**

Coating condition: **Poor**

Describe coating: **Delaminating, erosion**

Lettering/Logo: **Yes**

Number: **1**

Description: **MARTINSBURG, WEST VA**

Lettering comments: **It is very difficult to see**

Comments: **20 x 60 foot area on west side coated for lettering. Black letters on white background. Sidewall covered with cracks, mildew, and efflorescence. There is heavy erosion of the coating on sidewall and the roof**

**EXTERIOR SIDEWALL**

**Cracking:**

Number of cracks: **500±**

Total length of cracking: **800 feet**

Total length of cracking requiring repair: **0 feet**

Crack descriptions:

Location: **Throughout sidewall**

Grade: **4 and 5**

Length: **1- 10 feet (total of 800 feet)**

Orientation: **Horizontal**

Efflorescence present: **Yes**

Any exterior sidewall cracks appear to be leaking: **No**

**Spalling:**

Number of areas spalled: **None**

## **EXTERIOR ROOF**

### **Cracking:**

Number of cracks: 5

Total length of cracking: 20-30 feet

Total length of cracking requiring repair: 0 feet

Location: Throughout the roof

Grade: 3

Length: 5- 10 feet (total of 30 feet)

Orientation to the wall: Parallel

Efflorescence present: No

Any exterior roof cracks appear to be leaking: No

### **Spalling:**

Number of areas spalled: None

### **Sidewall to roof connection:**

Type of bearing pads: Unknown, not visible

## **EXTERIOR APPURTENANCES:**

### **Exterior ladder:**

Height to start of ladder: 1 foot

Ladder material: Galvanized steel

Toe clearance: 7 inches or greater

Width of rungs: 16 inches

Thickness of rungs: 3/4 inches

Shape of rungs: Round

Coating condition: Not coated

Material condition: Good

Fall prevention device: No

Vandal guard: No

### **Roof handrail:**

N/A

### **Roof hatch:**

Neck size: 36 inch square

Curb height: 4 inches

Cover overlap: 0 inches

Hatch security: None

## **EXTERIOR APPURTENANCES:**

Coating condition: **Not coated**

Metal condition: **Good**

Hatch comments: **The hatch cover is a flat piece of sheet metal anchored to the concrete curb with screws**

## **Ventilation:**

Number: **1**

Type: **Flow-through**

Location: **Roof**

Size: **36 inches**

Vent material: **Steel**

Coating condition: **Poor**

Material condition: **Good**

Screen condition: **Fair**

Mesh size: **4 & 24 (2 screens)**

Percent of screen open: **100**

## **WET INTERIOR GENERAL**

Membrane present: **Yes**

Location: **Entire sidewall and floor**

Membrane condition: **Good**

## **WET INTERIOR ROOF**

### **Cracking:**

Number of cracks: **Could not inspect with ROV**

### **Interior Roof Comments:**

Number of areas spalled: **Inspection was limited to the portion visible from the roof hatch. The roof appeared to be in good condition with no cracks or spalls**

## **WET INTERIOR SIDEWALL**

### **Cracking:**

Number of cracks: **None visible, there is a rubber membrane present**

### **Spalling:**

Number of areas spalled: **None visible, there is a rubber membrane present**

## **WET INTERIOR FLOOR**

### **Cracking:**

Number of cracks: **None visible, there is a rubber membrane present**

### **Spalling:**

Number of areas spalled: **None visible, there is a rubber membrane present**

Interior floor comments: **There is uniform sediment build-up on the floor and approximately 30 sediment piles on the floor**

### **Wall to floor junction:**

Comments: **Not visible, there is a rubber membrane covering the wall to floor junction**

### **Sediment:**

Sediment depth: **1-4 inches (estimated)**

Sediment distribution: **Uniform**

Could sediment distribution indicate a leak: **No**

Comments: **There are many piles of sediment on the floor, 2 to 20 inches in height (estimated)**

## **WET INTERIOR APPURTENANCES**

### **Expansion joints:**

**N/A**

### **Tank ladder:**

Interior ladder comments: **It appears the ladder is covered with the rubber membrane**

### **Overflow:**

Type of inlet: **Funnel**

Condition: **Fair**

Coating condition: **Fair**

Overflow comments: **The overflow pipe, straps, and braces have corrosion**

### **Fill pipe:**

Diameter: **10-12 inches (estimated)**

Height above floor: **4 inches**

Configuration: **Stubs at floor**

## **WET INTERIOR APPURTENANCES**

Deflector on end: **No**

Coating condition: **Fair**

Metal condition: **Good**

Fill pipe comments: **Penetrates the floor and terminates with an elbow near the overflow and below the hatch**

### **Separate draw pipe:**

**N/A**

### **Drain pipe:**

**N/A**

### **Sump:**

**N/A**

### **Mixer:**

**N/A**

### **Other roof penetrations (not previously noted):**

**N/A**

## **CRACK GRADES**

<b>Crack Grade</b>	<b>Width</b>
1	Tight, no separation
2	Tight to up to fingernail width
3	Fingernail width up to 1/8 inch
4	1/8 up to 1/4 inch
5	Greater than 1/4 inch

Field Inspection Report is prepared from the contractor's viewpoint. It contains most of the information the contractor needs to prepare his bid for any repairs or repainting. The Engineer uses it to prepare the engineering report. Cost estimates are more accurate if contractor problems can be anticipated. While prepared from the contractor's viewpoint, the only intended beneficiary is the owner. These reports are completed with diligence, but the accuracy is not guaranteed. The contractor is still advised to visit the site.



2,000,000 gallon reservoir owned by the City of Martinsburg, West Virginia.



1) The sidewall concrete is in fair condition overall.

2) There is cracking with efflorescence present on the sidewall.



3) Same.



4) The sidewall coating is in poor condition.

5) The exterior ladder is in good condition. The ladder is not equipped with a fall prevention device.



6) The tension ring at the top of the sidewall is in good condition.





7) The roof concrete is in good condition overall.

8) There is cracking on the roof.



9) The roof coating is in poor condition.



10) The roof vent is in fair condition. The vent does not have a rain shield.

11) The vent screens are in fair condition.

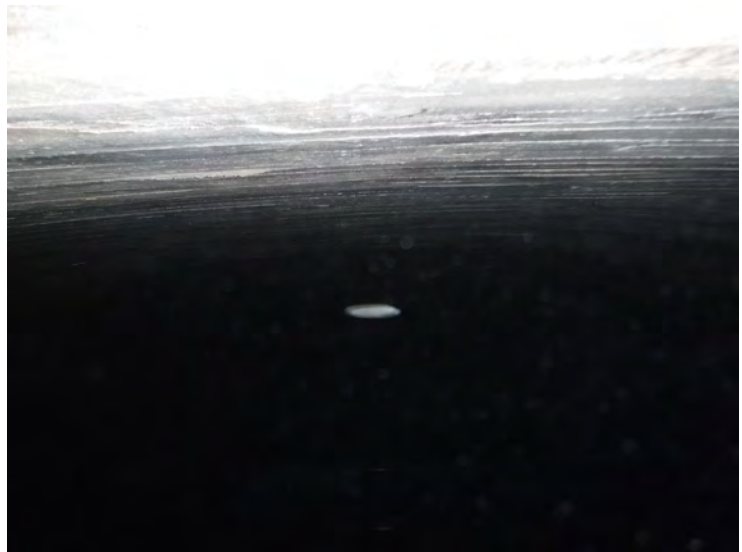


12) The concrete roof hatch curb is in good condition.



13) The roof access opening is covered with a flat piece of sheet metal.

14) The wet interior roof concrete is in good condition.



15) The sidewall is covered with a rubber membrane. The membrane is in good condition.



16) The overflow intake is in good condition. There is corrosion on the braces.

17) The overflow pipe coating is in fair condition.



18) The rubber membrane on the sidewall is in good condition.



19) Same.

20) The fill/draw pipe is in good condition.



21) The floor was covered in sediment.