

June 11, 2015

Mr. Gordon Stinson  
Department of Natural Resources  
La Crosse Service Center  
3550 Mormon Coulee Road  
La Crosse, WI 54601

Re: Seepage Inspection  
Little Falls Dam  
Willow River State Park

Dear Mr. Stinson:

Ayres Associates completed a seepage evaluation at the Little Falls Dam in Willow River State Park. The purpose of this evaluation was to observe, quantify and qualify seepage at the Little Falls Dam prior to the planned drawdown.

The investigation was conducted on June 1, 2015, by Chris Goodwin and Ryan Pichler from Ayres Associates. Aaron Mason, Willow River Park Supervisor, accompanied Ayres Associates on the beginning of the inspection to show us where he has observed seepage on the downstream left embankment. Two locations were identified by Mr. Mason, one near the riprap downstream of the arch buttress section of the dam and one area along the foot path leading to fishing areas on the plunge pool. These areas are shown on the attached figures and discussed in more detail below. Additional photos of seepage observed are included in Attachment I.

Mr. Mason departed and Ayres Associates proceeded to inventory and evaluate the seepage at the dam. Five areas of seepage were noted and are described as follows:

### **Seepage Area 1 – Flowing Seepage Downstream of Riprap on Left Downstream Embankment**



This area consists of saturated soils and standing water with minimal flow. No observed boils or sediment movement were noted. We flagged this area and the photo to the left shows the typical seepage at this location. As noted on Figure 1 there is an area of seepage upstream of this area where the soils are saturated but no standing water is present. There is also a slightly elevated area between these two areas that is drier.

The seepage at this location concentrates into a channel as shown on Figure 1 and outlets on the bank of the downstream pool. We quantified this seepage at less than ½ gallon per minute.

### **Seepage Area 2 - Wet soil seepage Along Hillside, Left Side of Dam**

This seepage is noted as wet soil seepage on Figure 1 and no standing water or water at the surface was observed. As shown on Figure 1, it is about the same elevation as the flagged seepage upstream, but is not exiting at the surface. We did not map out this area, only noted its location on Figure 1.

### **Seepage Area 3 – Seepage at End of Foot Path**



This seepage is quite downstream of the dam and is only indicative by a wet spot on the path (see photo to left). It is not from surface drainage as the path is continuously graded to the stream. But due to its distance downstream of the dam we do not believe it is a seepage area of concern.

### **Seepage Area 4 – Seepage Measured at Weir Left of Gate 1 Abutment**

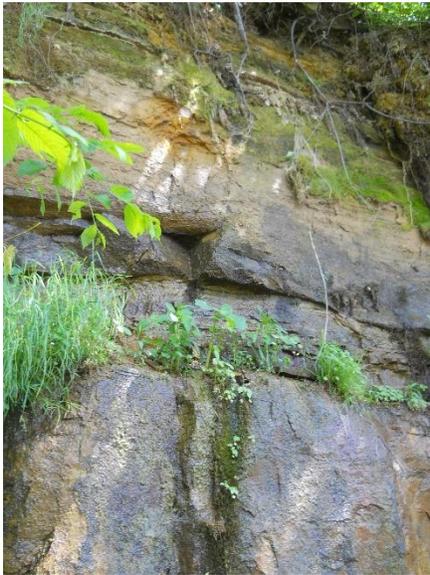


A seepage weir box is located downstream of the arch buttress section and adjacent to the abutment for Tainter Gate 1. The foundation under Tainter Gate 1 is an open concrete foundation (hollow) and the standing water is present under this area. The seepage out letting at the weir traces back to the area under Tainter Gate 1. We measured the water surface elevation within the riprap at the highest point and it is the same elevation as the water under Tainter Gate 1.

We measured the weir and the dimensions, shown on Figure 1. On the day of our visit water was flowing 1.25 inches deep in the weir which equals a flow of 1.23 gallons per minute. The seepage in this area was clear.

### **Seepage Area 5 – Seepage from Bedrock on Right Downstream Bank**

We waded around the downstream end of the plunge pool area and made our way to the bedrock area downstream of the fixed crest overflow spillway's right abutment. We could not get all the way to the right abutment as water depths were too great.



We observed the seepage existing the bedrock at a point about 12 to 15 feet above the water surface (left photo above). This is about the same elevation, maybe slight higher, than were seepage is exiting the ground on the left downstream embankment. The seepage occurs over about a 30 foot length of bedrock outcrop and is exiting at a more fractured layer of limestone bedrock. The bedrock under this layer is more massive and likely a vertical barrier to water movement and the water daylights above this layer. We did not try to quantify the seepage over this area. According to Mr. Mason this seepage has always been present at this location and is quite apparent in the winter due to ice formations.

### **Summary and Conclusions**

The data and observations obtained in this investigation can be used to compare the seepage observed on June 1, 2015, to past levels of seepage as well as changes in seepage after the drawdown occurs. Depending on what repairs are selected, some of these areas may remain intact after the repair and can be used to compare seepage levels before and after construction.

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We believe that the seepage levels observed are not a dam safety concern. Flow rates are generally very low and no signs of material movement are present. These areas should be continually monitored and if seepage levels increase then additional investigations are warranted.

Sincerely,

Ayres Associates Inc

A handwritten signature in black ink, appearing to read "Chris Goodwin". The signature is written in a cursive, flowing style.

Christopher T. Goodwin, PE

Manager – Water Resources

Direct: 715.831.7682

Cell: 715.829.6941

GoodwinC@AyresAssociates.com

# Attachment I

**Seepage Investigation of Willow River State Park Little Falls Dam  
September 30, 2014**



Little Falls Dam  
Seepage Area 1



Little Falls Dam  
Seepage Area 1



Little Falls Dam  
Seepage Area 1



Little Falls Dam  
Seepage Area 1



Little Falls Dam  
Seepage Area 1



Little Falls Dam  
Seepage Area 3



Little Falls Dam  
Seepage Area 4



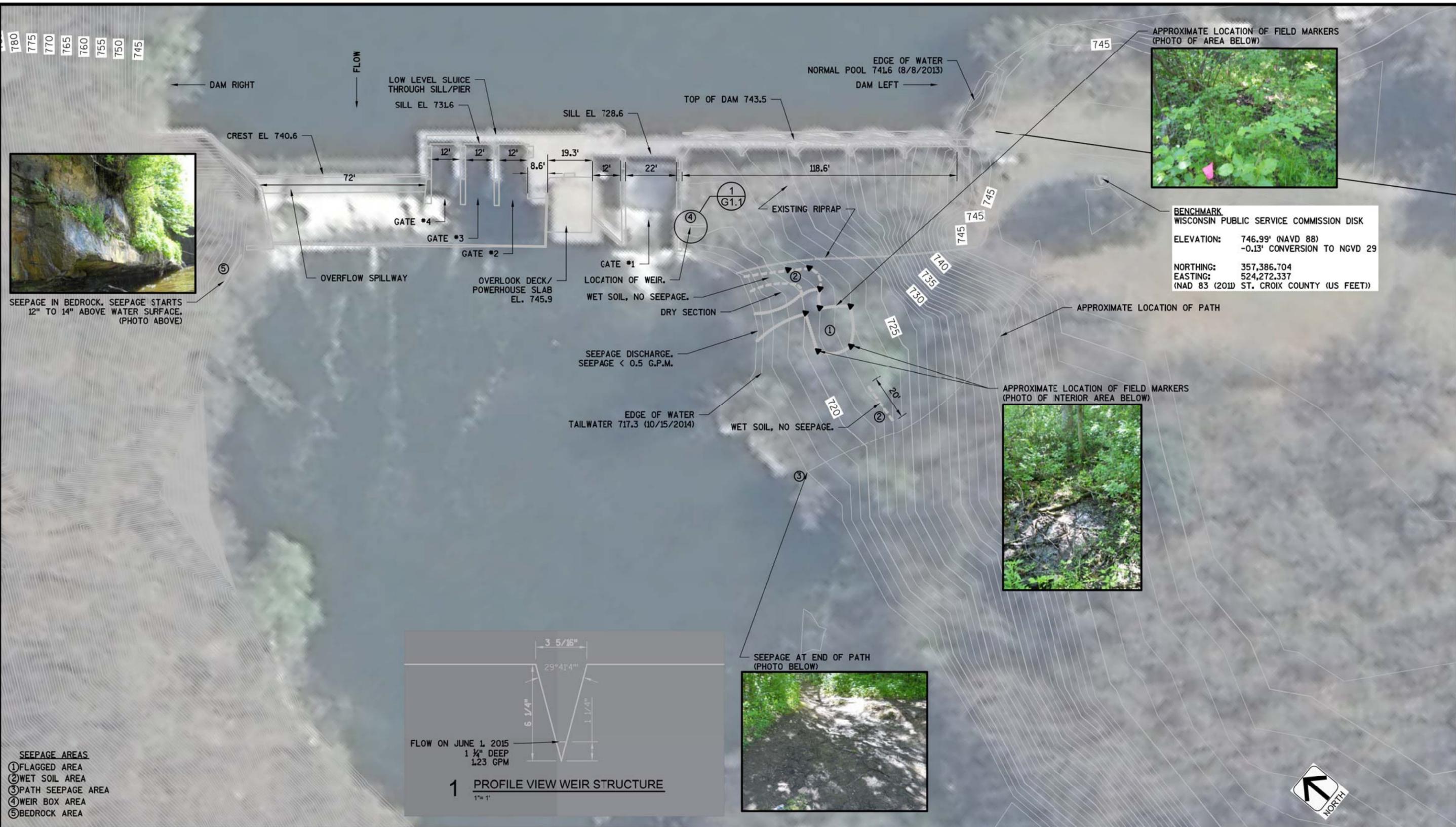
Little Falls Dam  
Seepage Area 5



Little Falls Dam  
Seepage Area 5



Little Falls Dam  
Seepage Area 5



APPROXIMATE LOCATION OF FIELD MARKERS  
(PHOTO OF AREA BELOW)



BENCHMARK  
WISCONSIN PUBLIC SERVICE COMMISSION DISK  
ELEVATION: 746.99' (NAVD 88)  
-0.13' CONVERSION TO NGVD 29  
NORTHING: 357,386.704  
EASTING: 524,272.337  
(NAD 83 (2011) ST. CROIX COUNTY (US FEET))

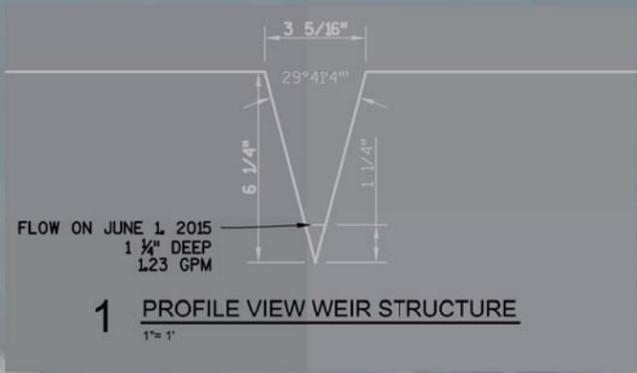
SEEPAGE IN BEDROCK. SEEPAGE STARTS  
12" TO 14" ABOVE WATER SURFACE.  
(PHOTO ABOVE)



APPROXIMATE LOCATION OF FIELD MARKERS  
(PHOTO OF INTERIOR AREA BELOW)



SEEPAGE AT END OF PATH  
(PHOTO BELOW)

- SEEPAGE AREAS**
- ① FLAGGED AREA
  - ② WET SOIL AREA
  - ③ PATH SEEPAGE AREA
  - ④ WEIR BOX AREA
  - ⑤ BEDROCK AREA

**NOTES:**

1. CONTOURS SHOWN ARE FROM FROM LIDAR-BASED TOPOGRAPHY PROVIDED BY ST. CROIX COUNTY.
2. ELEVATIONS IN NAVD 88.
3. SEEPAGE INSPECTION PERFORMED ON JUNE 1ST 2015.



AA-Standards 06/17/2015  
Water Resource Engineering 2015 Little Falls Seepage Evaluation/CAD Existing Conditions Seepage Indicated.dwg

DES BY	RDP	BOOK NO			
DR BY	RDP, GJS, JSS	PROJ NO	26-0827.20		
CHK BY	CTG	DATE	JUNE 2015	NO	DATE
				REVISION	

**NOT FOR CONSTRUCTION**

Little Falls Dam Reconstruction  
Wisconsin Department of Administration  
Willow River State Park, St. Croix County, WI

**AVRES**  
ASSOCIATES  
EAU CLAIRE, WI

G1.1 EXISTING CONDITIONS - SEEPAGE INDICATED

SHEET NO  
**1**