

# RECLAMATION

*Managing Water in the West*

## **Intake Diversion Dam**

Assessment of High Elevation Intake Gates

**Lower Yellowstone Project – Montana – North Dakota**



BUREAU OF RECLAMATION

Date: January 11, 2008

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**Region: Great Plains Region, Montana Area Office**

**Project: Lower Yellowstone Intake Diversion**

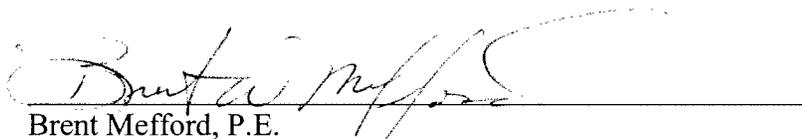
**Feature: Intake Diversion Headworks**

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**Subject: Assessment of High Elevation Intake Gates**

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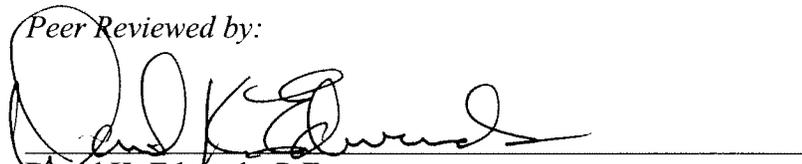


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# Background

An assessment study of the viability of adding high elevation intakes through the existing canal headworks structure was conducted. The study is the result of a recommendation made by the Biological Review Team working on pallid sturgeon protection and passage at Intake Diversion Dam. Reclamation in 2004 (Christensen et al.) prepared a concept level design for an in-canal fish screen to protect pallid sturgeon. The proposed screen was located in the canal several hundred feet downstream of the headworks structure. Fish entrained into the canal would be screened and then carried back to the river through a fish bypass structure. The Biological Review Team recommended against passing adult pallid sturgeon through the headworks gates as intended in the original screening concept. The team felt the risk of injury to adult sturgeon passing through the gates was significant and should be avoided. Concern was also expressed that large adult pallids entrained into the canal would hold downstream of the headworks and not pass downstream through the bypass structure. Two recommendations were proposed to prevent entrainment of adult pallids; construct a trashrack in front of the headworks as an entrainment barrier and add additional diversion capacity at an elevation well above the river invert. The later recommendation relies on the strong bottom oriented behavior of adult pallid sturgeon to avoid entrainment. A separate concept study of a trashrack alternative was conducted in September 2007 (Cha, C. 2007).

The existing headworks have 11- 5 ft x 5 ft diversion gates located near the river invert, figure 1. A vertical section through the structure is shown in figure 2. There are currently no trashracks in front of the intake gates that prevent pallid sturgeon entrainment with canal diversion flow. Above the intake tubes, 12 inch square timbers on 18 inch centers are mounted horizontally on the face of the structure to protect the gate stems against impact by large debris. The timber beams do not extend over the gate openings. Figure 3 shows 2007 river bathymetry in the area near the diversion intake. The bathymetry shows a distinct channel thalweg turning into the diversion headworks. The current river bed elevation immediately in front of the intake gates is about 1981.7 which is about 4 ft below the invert of the diversion tubes. Figure 3 shows the existing diversion withdrawal zone relative to the upstream river water surface elevations (WSE) for several flows ranging from 5,000 ft<sup>3</sup>/s to 40,000 ft<sup>3</sup>/s. At 40,000 ft<sup>3</sup>/s river flow the diversion gates are submerged about 5 ft.

# Study Results

This study does not include a structural assessment of the headworks. A structural assessment would require a field investigation including core drilling the headworks concrete to determine its structural integrity. For this assessment an assumption was made that separation between the existing tubes and new high elevation tubes would require more separation than exists between the old tubes

(due to the reduced section of the structure at higher elevations). A minimum separation of 5 ft was assumed required for structural competency between the existing tube crown and the invert of the proposed high level intakes. Eleven-3.5-ft-diameter intake tubes centered about elevation 1997.7 were found to provide the lowest possible river WSE for full diversion (figure 4). The gates on the high level intakes are shown mounted on the downstream end of the intake tubes to avoid interference with the existing gate stems. Water surface elevations for several flows are shown on figure 4. The invert of the high level gates would be above the average WSE for June. During a river flow of about 60,000 ft<sup>3</sup>/s, the gates would be about 50% submerged and capable of diverting about 350 ft<sup>3</sup>/s. Diversion of 1,400 ft<sup>3</sup>/s flow through the proposed high level intakes would require a river WSE of about 2001.5.

## Conclusions

Constructing new intakes to protect adult pallid sturgeon from entrainment is not a viable alternative. The main reasons supporting the conclusion are:

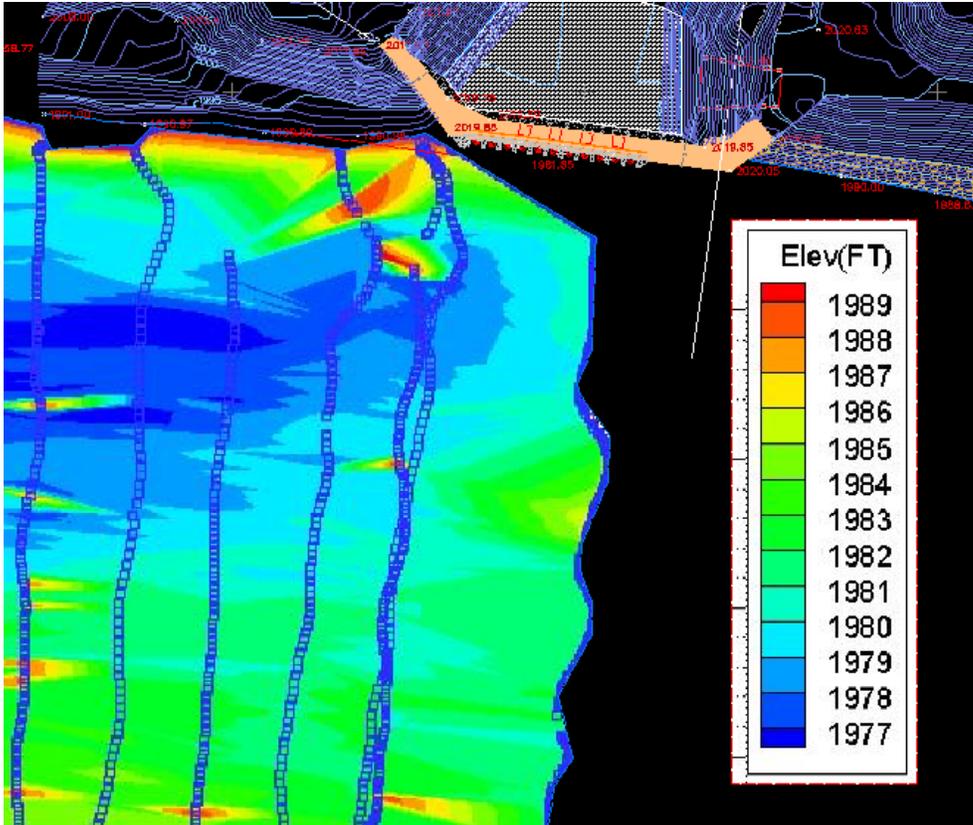
- Uncertainty associated with the structural integrity of the 100 year old structure and,
- Intake Diversion Dam has a 670 ft long crest that results in relatively small increases in river stage for large increases in flow. The slow rise in river stage limits the use of higher intakes to extreme flow events.

## References

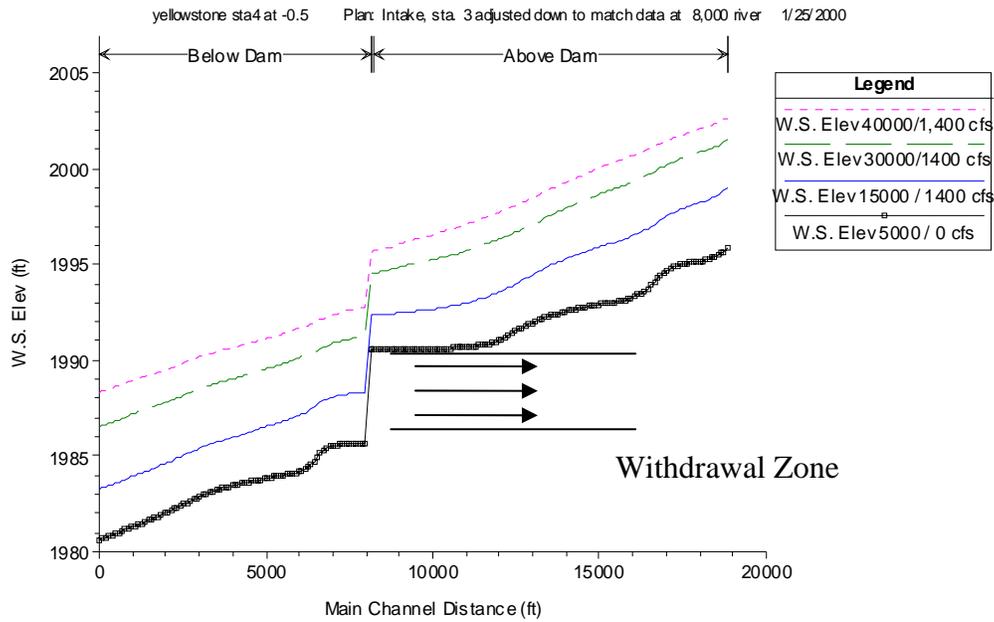
Christensen, R., Glickman, A., Leavitt, M., Mefford, B., April 2004. Intake Diversion Dam Yellowstone River, Montana – Fish Protection and Passage Concept Study Report II, Bureau of Reclamation, Technical Services Center, Denver, Co., April 2004.

Cha, C., 2007. Intake Diversion Dam Preliminary Trashrack Concept Design for Intake Headworks Lower Yellowstone Project, Montana- North Dakota, Bureau of Reclamation, Technical Services Center, Denver, Co.

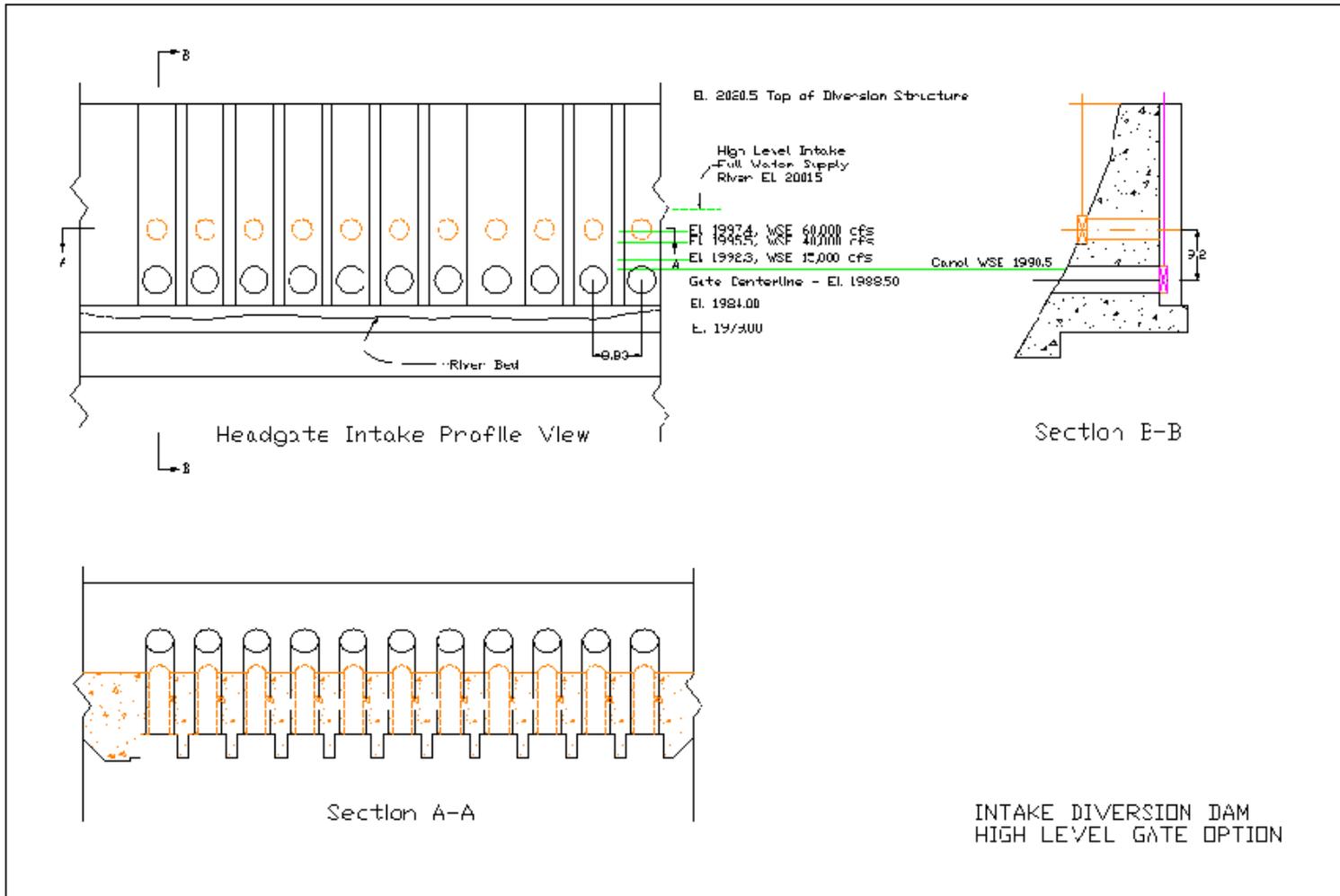




**Figure 1 – Yellowstone River bathymetry in front of the Main Canal headworks.**



**Figure 3 – Existing diversion withdrawal elevation compared to river WSE above the diversion.**



**Figure 4 – Drawing showing river WSE compared to high elevation intake gate option.**