NORTH Dakota | Water Commission
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DEVILS LAKE OUTLET
OPERATIONAL GUIDE

JANUARY 2020

ON JANUARY 1, 2020, THE DEVILS LAKE WATER SURFACE ELEVATION WAS 1448.9 FEET.

NOTE ON VERTICAL DATUM

All elevations noted in this document are based on the National Geodetic Vertical Datum of 1929 (NGVD 29). This datum has been used consistently with the Devils Lake Outlet projects and the United States Geological Survey (USGS) Devils Lake and Stump Lake gage stations.

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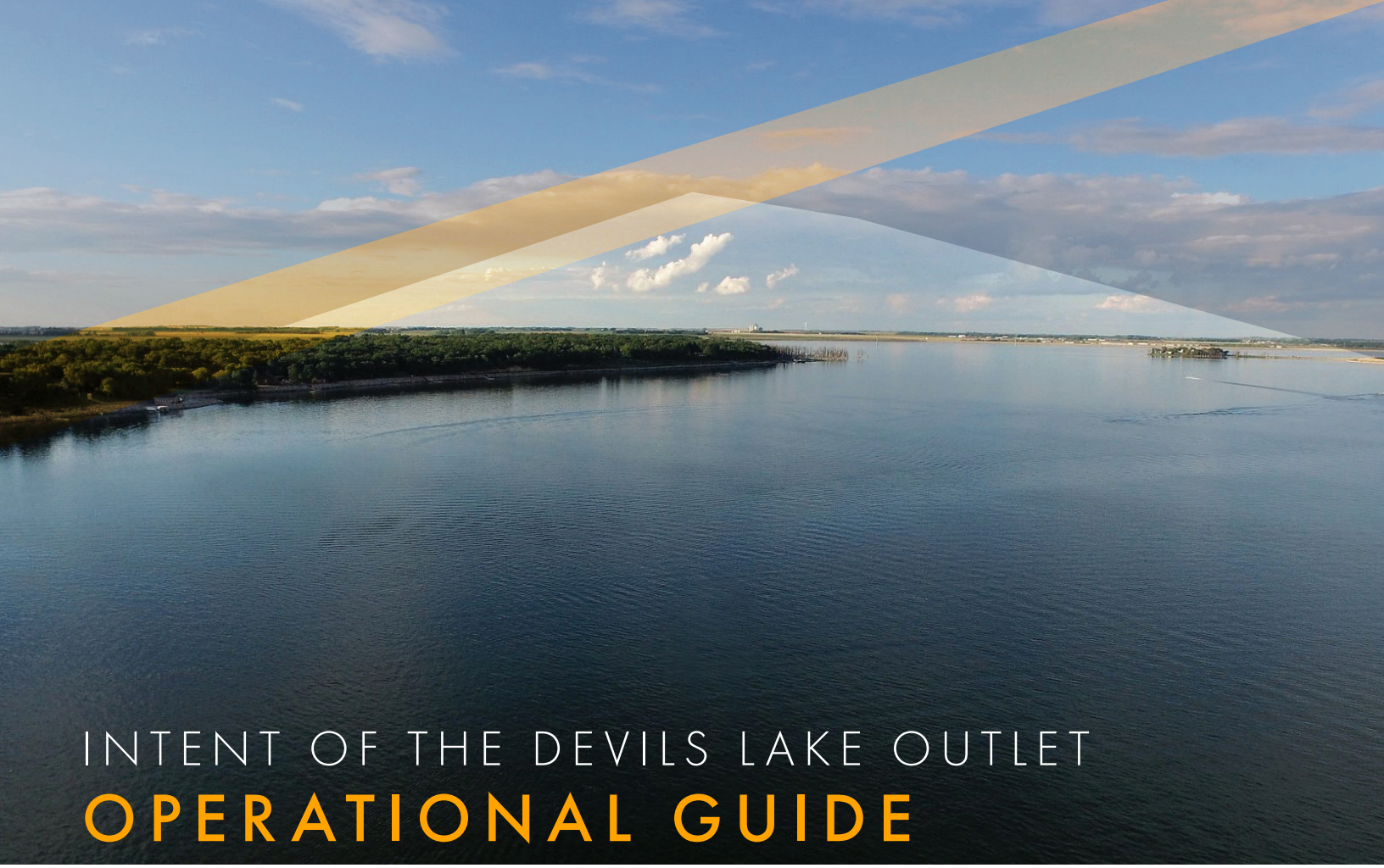


INTENT OF THE DEVILS LAKE OUTLET
OPERATIONAL GUIDE

This guide is intended to serve three major purposes:

- Serve as a reference for the background and operational capabilities of both outlets
- State the limitations which dictate how the outlets are managed
- Discuss the factors that are considered regarding outlet operational strategy

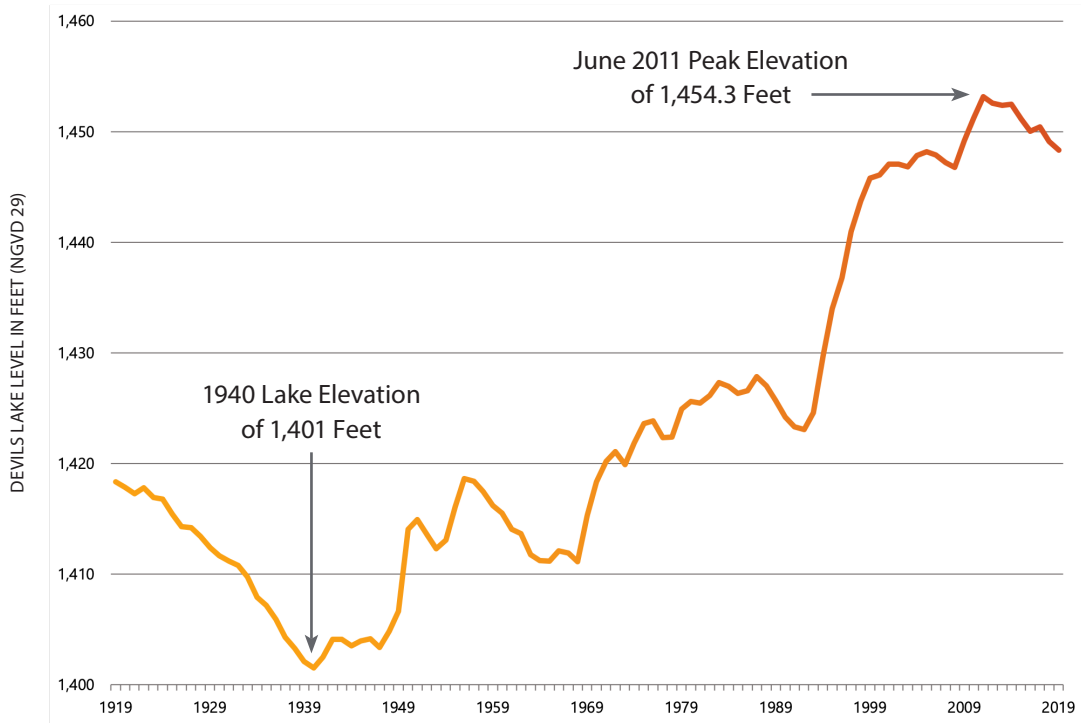
EXECUTIVE SUMMARY

The Devils Lake Outlets and the Tolna Coulee Control Structure are flood mitigation projects in northeastern North Dakota which were developed to alleviate the effects of the devastating flooding which has impacted the region over the past quarter century. The two outlets convey up to 600 cubic feet per second of water from Devils Lake to the Sheyenne River while the Tolna Coulee Control Structure serves as a safeguard against a potentially catastrophic uncontrolled overflow.

In recent years, the Devils Lake water surface elevation has declined as a result of near-average moisture conditions combined with outlet operations. This has resulted in an ongoing discussion over the intent of continued outlet operation as many citizens have come to benefit from the high lake level. In contrast, continued outlet operation provides maximum flood relief to citizens of the Devils Lake Basin while also creating the largest amount of buffer from potentially damaging future lake rise. This guide has been developed to help inform the public and policymakers of the important role that these infrastructure projects play in the Devils Lake Basin and beyond.

WATER SURFACE ELEVATION

DEVILS LAKE, NORTH DAKOTA



*Surface areas above elevation 1446.5 feet include Devils Lake & Stump Lake combined.

Figure 1 | Devils Lake water surface elevation (data courtesy of USGS 05056500)

BACKGROUND

The Devils Lake Basin (Basin) in northeastern North Dakota is a 3,840 square-mile subbasin of the Red River of the North Basin. Devils Lake and Stump Lake are the two major waterbodies that collect runoff from the Basin, and their lake levels fluctuate naturally, over long periods of time, in response to the precipitation, evaporation, and surface runoff that occurs. In times of water scarcity, evaporation will exceed precipitation and runoff and the lake levels will decline. Over time, the waterbodies within the Basin become disconnected and may eventually dry up. This was the case throughout the early 1900's, and in 1940, Devils Lake was nearly dry with a water surface elevation near 1,401 feet (figure 1).

More recently, a period of distinctly wetter-than-average conditions caused the lake to rise to levels that had not been experienced in modern history. In 2011, the lake experienced a record inflow of over 595,000 acre-feet (ac-ft) and the lake rose to the modern-day record elevation of 1,454.3 feet. For comparison, the average annual inflow was estimated to be 33,800 ac-ft from 1950-1992, and 244,200 ac-ft for the wet period of 1993-2006 (Vecchia, 2008).

The West End and East End Devils Lake Outlets (figure 2) are flood mitigation projects which were initiated in response to the dramatic lake rise that began in 1993. The West End Outlet started operation in 2005 when the lake elevation was 1,448.8 feet. Initially, the maximum discharge capacity was 100 cubic feet per second (cfs) and the outlet operated intermittently for several years while the water quality impacts to the Sheyenne River were evaluated. In 2009, the West End Outlet began to discharge steadily, and in 2010, the discharge capacity was increased to 250 cfs.

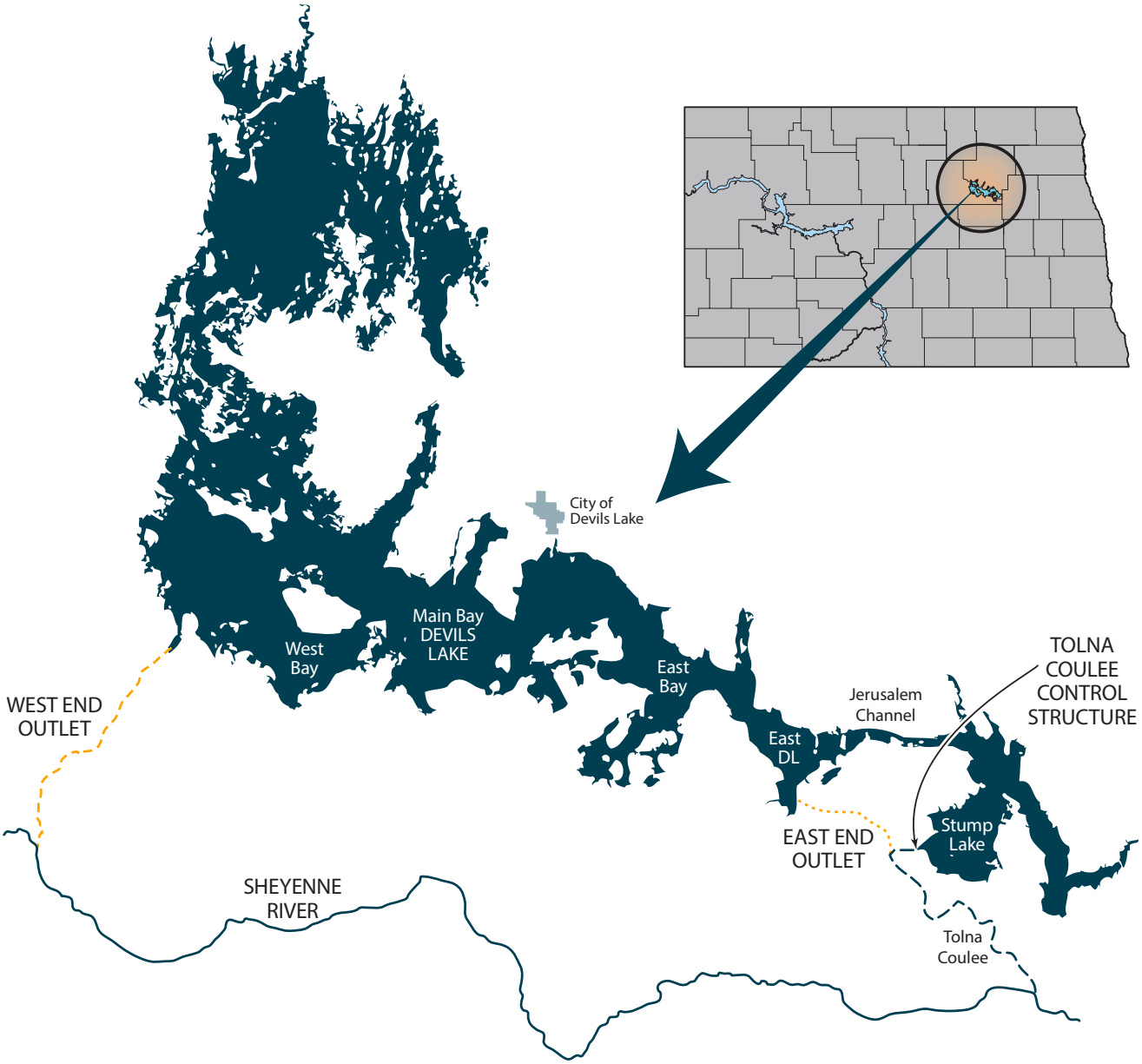


Figure 2 | Map of the Devils Lake Outlets

Despite the effort to discharge floodwater and prevent additional lake rise by placing a designation of statewide significance on all drainage projects in the Basin, the water continued to rise. After record spring inflows in 2009 and 2011, there was significant concern that the lake would continue to rise to the overflow elevation of 1458 feet, potentially resulting in an uncontrolled overflow of the lake to the Sheyenne River through the Tolna Coulee.

In an effort to keep pace with the rising floodwater, construction was completed on the Devils Lake East End Outlet in 2012. The East End Outlet provides up to 350 cfs of discharge capacity and works in conjunction with the West End Outlet to lower the Devils Lake water surface elevation.

TOLNA COULEE CONTROL STRUCTURE

In addition to the two outlets, the Tolna Coulee Control Structure (Control Structure) serves as a third piece of flood mitigation infrastructure which is designed to serve the Devils Lake, Sheyenne, and Red River Basins in the event that the lake rises to the overflow elevation. It was constructed by the U.S. Army Corps of Engineers in 2012 and is owned and operated by the North Dakota State Water Commission (SWC).

As stated in the *Standing Instructions to the Project Manager for Water Control; Tolna Coulee Control Structure* (USACE, 2012): "The purpose of the project is to prevent a catastrophic release of flow through the Tolna Coulee in the event of an overflow from Stump Lake while allowing Devils Lake water levels to fall to the level they would have without the project" (p. 1).

In other words, the Control Structure is not designed to artificially hold excess water on Devils Lake and it will not alter erosion of the high point in Tolna Coulee in the event of an overflow. The high point of the Tolna Coulee is approximately one third of a mile downstream from the Control Structure and it has an elevation of 1458 feet. If the lake rises to that elevation, and if the coulee does erode during an overflow event, the stop logs in the Control Structure will be removed in accordance with the rules in the standing instructions. The final result is that the natural coulee features, not the Control Structure, will ultimately control the overflow elevation. More detail on the background and purpose of the Control Structure is available in the U.S. Army Corps of Engineers standing instruction document.

"The purpose of the Tolna Coulee Control Structure is to prevent a catastrophic release of flow through the Tolna Coulee in the event of an overflow from Stump Lake while allowing Devils Lake water levels to fall to the level they would have without the project."

DEVILS LAKE OUTLET DETAILS

	WEST END OUTLET	EAST END OUTLET
First Year Of Operation	2005	2012
Rated Discharge Capacity	250 cfs	350 cfs
Total Discharge (through 2019 season)	704,800 acre-feet	518,100 acre-feet
Total Motor Horsepower	13,000 (2 pump stations)	7,000
Outlet Length	13.7 Miles	5.5 miles
Conveyance Method	Open Canal & Buried Pipe	Buried Pipe
Minimum Lake Elevation At Intake	1445.0 feet	1446.0 feet
Sulfate At Intake (2012 Average)	567 mg/L	1,010 mg/L
Sulfate At Intake (2019 Average)	646 mg/L	1,026 mg/L

Table 1 | Devils Lake Outlet Details

OUTLET DETAILS

The West End Outlet conveys water from the Round Lake portion of the West Bay of Devils Lake to the Sheyenne River. The East End Outlet conveys water from East Devils Lake to the Tolna Coulee which enters the Sheyenne River near Pekin, ND. The combined maximum discharge capacity is 600 cfs, and the two outlets operate simultaneously to balance the downstream water quality and quantity.

The outlets begin discharging after the peak spring flow has passed so they do not contribute to spring flooding. The outlets typically operate continuously throughout the warm weather months with the exception of temporary shut downs for maintenance, inspection, or when large rainfall events reduce downstream channel capacity. In the fall, the outlets are winterized when continued freezing temperatures are forecasted. Table 1 above highlights some of the primary outlet details.

MINIMUM INTAKE ELEVATIONS

The West End Outlet was designed for a minimum lake elevation of 1445.0 feet. For the outlet to operate down to that lake level, additional excavation in two abandoned road beds would likely be required to allow continued flow to the pump station. Also, the maximum discharge capacity may be limited based on the amount of flow that could be drawn to the intake.

The East End Outlet was designed for a minimum lake elevation of 1446.0 feet. This elevation was selected primarily because the natural cutoff elevation of flow between Devils Lake and Stump Lake through the Jerusalem Channel is 1446.5 feet. At the minimum intake level, the two lake systems would be fully separated.

DISCHARGE QUANTITY AND QUALITY LIMITATIONS

The outlets do not operate when downstream gage stations are above flood stage or when the discharge could be expected to raise a downstream gage to flood stage. Additionally, through past outlet operation, it has been determined that minor overland flooding begins to occur along the Sheyenne River near Cooperstown at flow above approximately 800 cfs. The system of USGS gages in the Devils Lake and Sheyenne River basins is monitored and outlet discharge is adjusted to prevent flooding to the greatest extent possible. However, current conditions are always considered when planning outlet operation and emergency conditions may cause modification to the typical water quantity limitations.

The rules that govern the downstream water quality limitations are codified in *North Dakota Administrative Code Chapter 33.1-16-02.1, Standards of Quality for Waters of the State*. The primary rule that limits the maximum outlet discharge is the

site-specific sulfate standard of 750 milligrams per liter in the Upper Sheyenne River. The ambient streamflow and discharge from both outlets are carefully monitored through a water quality sampling program. Twenty sites ranging from above the West End Outlet insertion point to the Red River at Pembina are regularly sampled and outlet discharge is adjusted to prevent exceedances of the water quality standards. From 2012 to 2019, an average of over 530 water quality samples per year were collected from those twenty sites to thoroughly monitor outlet discharge.

DISCHARGE HISTORY

2019 was the fourteenth year of operation for the West End Outlet and the eighth for the East End Outlet. Figure 3 below shows the annual outlet discharge for each outlet from 2007 through 2019. The annual total outlet discharge peaked at 171,235 ac-ft in 2015 and has steadily decreased since. As the lake level has declined, the sulfate concentration has gradually increased at both of the outlet intakes and the discharge has been reduced to prevent exceedances of the downstream water quality standards. Additionally, in 2019, the pumping season was significantly shorter than average because of high streamflow on the Sheyenne River in the late spring and early fall.

OPERATIONAL PLANNING AND MANAGEMENT

The overall operational decisions regarding the Devils Lake Outlets are made by the Governor and SWC, subject to the legislatively appropriated operational funding. To inform the operational decisions, the Devils Lake Outlet Management Advisory Committee (Committee) was established under *North Dakota Century Code Chapter 61-36*. The Committee is a diverse seventeen-member group which consists of stakeholders with a wide variety of experience from the Devils Lake, Sheyenne,

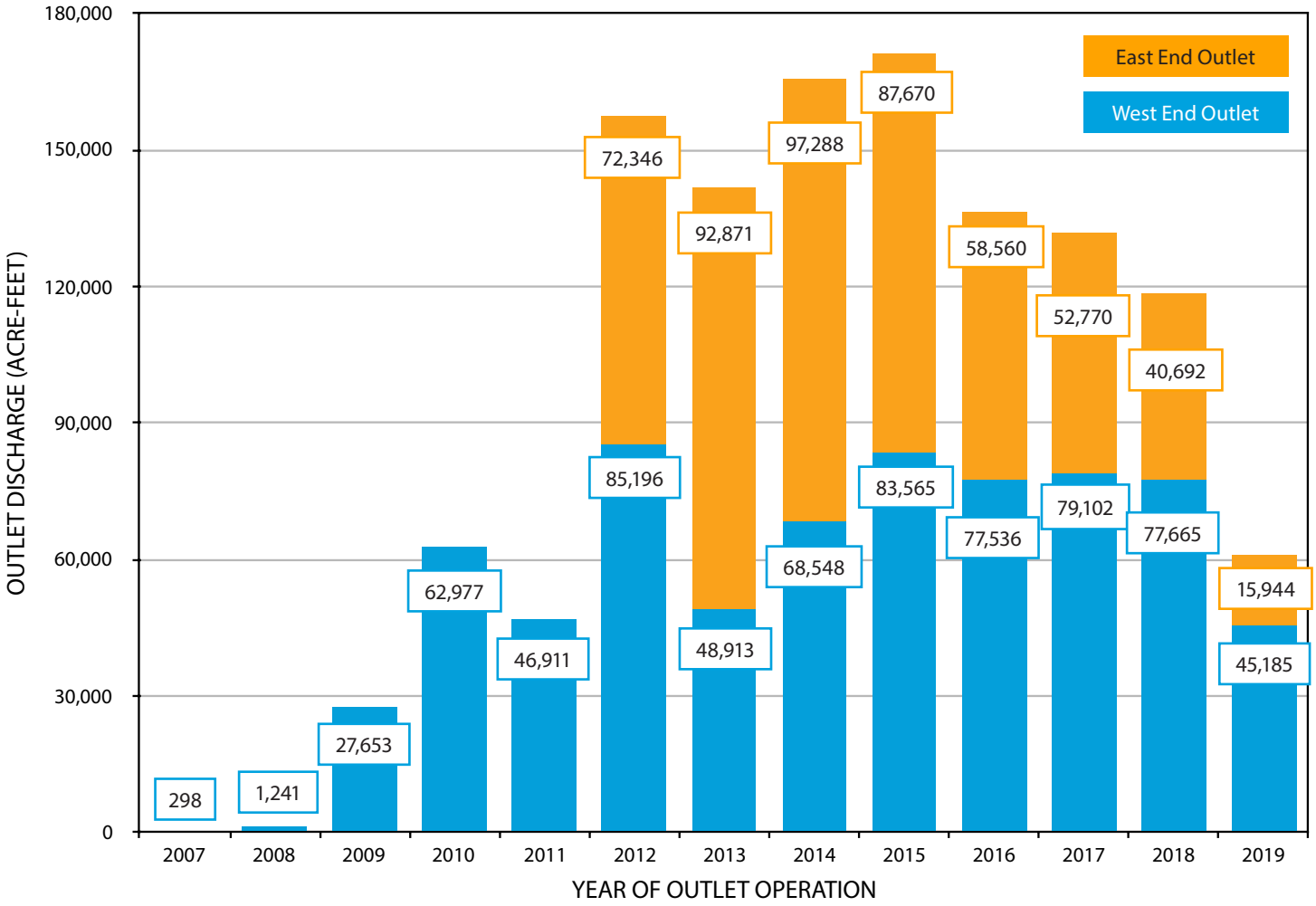


Figure 3 | Annual Outlet Discharge from 2007 through 2019.

and Red River Basins. Additionally, the State of Minnesota and the Province of Manitoba are both represented on the Committee and their input provides valuable perspective on the real and perceived impacts of outlet operation.

Over the past several years, the Committee has met each spring, when the yearly lake rise probability forecast was available, to develop an operational target recommendation. This recommendation effectively dictates how the outlets are operated for the season. Since 2016, the target lake elevation has been 1448.0 feet. Once the operational target has been approved by the Governor and SWC, day-to-day outlet operation, maintenance, and monitoring is managed by SWC staff. The SWC also partners with the Garrison Diversion Conservancy District and USGS for outlet maintenance and water quality sampling. In addition to daily management, SWC staff are also responsible for administering the Devils Lake Outlet Mitigation Program which provides cost-share funding for projects where impacts are directly attributable to outlet operation.

FUTURE OUTLET OPERATIONAL INTENT

As the lake level has declined, there has been an ongoing discussion about the lake elevation at which the discharge operation should be shut down. The high lake levels have provided a wide variety of recreational benefits and many in the Devils Lake Basin would prefer to keep the lake at the current elevation or higher. Additionally, the recent steady decline of the lake and near average moisture conditions has led to the question of whether or not the wet-period has begun to come to an end.

Alternatively, there are many who continue to be impacted by the current lake level and they argue that the outlets should be used to recover inundated agricultural land and to provide as much of a buffer as possible from potential future flooding. It is important to remember that the outlets are capable of reducing the Devils Lake water surface elevation by up to one foot in a full season of operation, and that the lake has risen over two feet during spring runoff several times in the past decade. Overall, the threat of future impactful flooding remains and the demonstrated potential for the lake to rise several feet each spring has resulted in continued support of outlet operation in an effort to provide continued flood relief and storage capacity for any potential future lake rise.

If the lake level continues to decline, the outlets will eventually be forced to cease operation after contributing to a monumental flood mitigation effort. However, if wet conditions persist, the outlets will continue to serve the region by tipping the scales in favor of lake level reduction.

REFERENCES CITED

U.S. Army Corps of Engineers, St. Paul District. (2012), *Standing Instructions to the Project Manager for Water Control; Tolna Coulee Control Structure.* State Water Commission Archive.

Vecchia, A.V. (2008), *Climate simulation and flood risk analysis for 2008–40 for Devils Lake, North Dakota:* U.S. Geological Survey Scientific Investigations Report 2008–5011, 28 p.

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