US Army Corps of Engineers
Detroit District

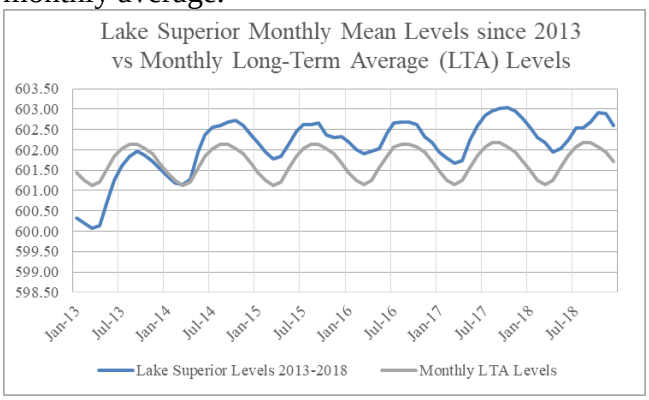
Great Lakes Update

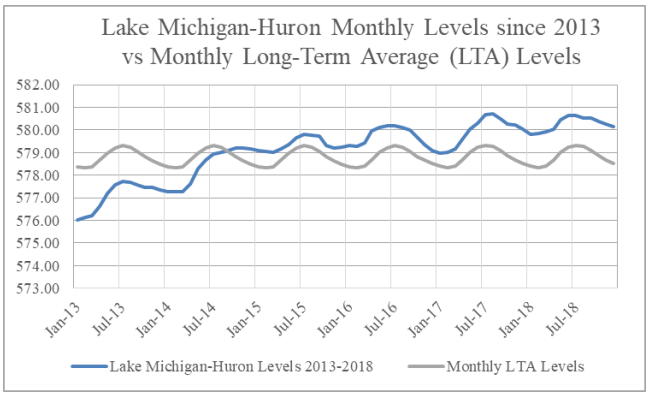
Volume 202: 2018 Annual Summary

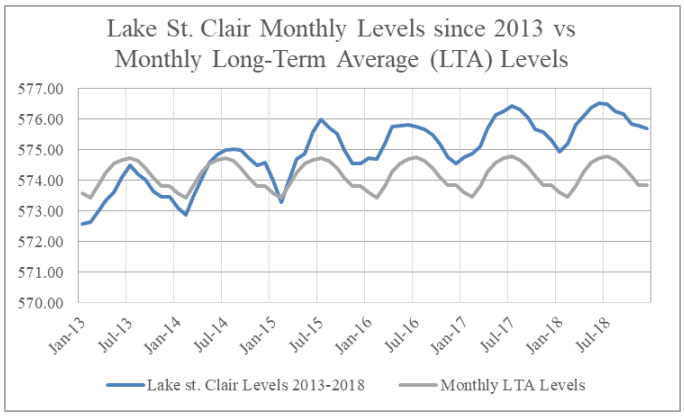
Background

The U.S. Army Corps of Engineers (USACE) monitors and forecasts the water levels of each of the Great Lakes. This report is primarily focused on summarizing the hydrologic conditions of the Great Lakes basin in 2018.

Lakes Superior, Michigan-Huron, St. Clair, and Erie remained above their average water levels in 2018, and all have been above average their monthly average levels since at least November 2015. Lake Ontario was above its monthly average levels in 2018 except for the three-month stretch of August to October when it approximated its monthly average.







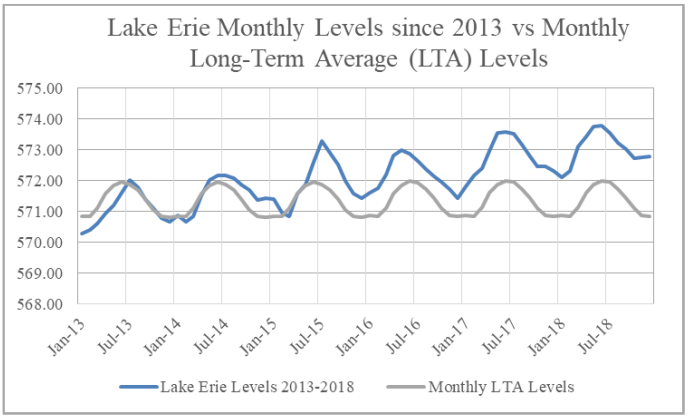


Figure 1: Plots showing above average water levels on the 4 upper lakes since 2015 (2018 water levels are provisional)

Official water levels are based on monthly lake-wide means, and the period of record used for each of the lakes includes the years 1918 to 2017. These data have been coordinated between the United States and Canada. All 2018 water levels will be officially coordinated and added to the historical record in the spring of 2018. The elevations used are referenced to the International Great Lakes Datum of 1985. The water level of each lake is

averaged from a network of individual gages around each lake. Also of note is that Lake Michigan and Lake Huron are hydraulically treated as one lake due to their connection at the Straits of Mackinac.

The Great Lakes are very large and behave differently from smaller, inland lakes. In general, Great Lakes water levels do not rise and fall with individual storms. Significant water level fluctuations require multiple months, seasons, or years of wet or dry conditions.

Seasonal changes in weather patterns typically cause an annual pattern of rising and falling of Great Lakes water levels. Each of the Great Lakes typically exhibits a seasonal rise in the spring primarily caused by an increase in liquid precipitation, increased runoff due to melting of accumulated snow, and low evaporation rates. The typical seasonal decline of the water levels in the fall and winter is primarily caused by an increase in evaporation, a decrease in precipitation, and the accumulation of snowpack on the land area.

The Net Basin Supply (NBS) is an important quantity for understanding the amount of water which arrives to the lake. USACE uses the residual method to compute NBS, shown below in the summarizing equations:

WL: Water Level Change
I: Connecting Channel Inflow
O: Connecting Channel Outflow
D: Diversion into(+) or out(-) of lake
P: Precipitation falling on lake
R: Runoff draining to lake
E: Evaporation from lake surface

Water balance for each lake:

$$WL = I + D + P + R - E - O$$

Residual Method Net Basin Supply:

$$NBS = WL - I - D + O$$

Altogether, NBS represents the combined effects of precipitation over the lake, runoff to the lake, and evaporation off of the lake. NBS is the main driver of water levels, and is also discussed in more detail in the following sections for each lake.

Lake Superior

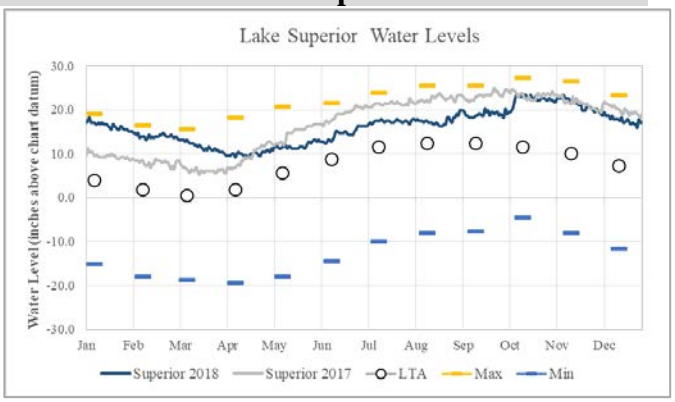


Figure 2: Lake Superior Water Levels

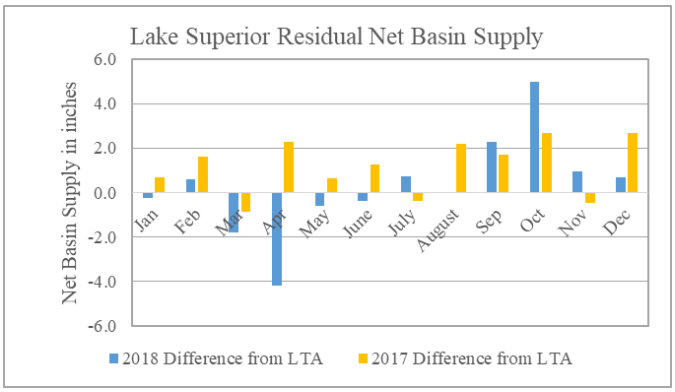


Figure 3: Lake Superior Residual Net Basin Supply, deviation from Long-Term Average

Figure 2 shows the 2018 water levels of Lake Superior compared with the 2017 levels and the monthly long-term average (LTA) levels. A similar figure is shown for each lake in the following sections. Each lake's data has been plotted relative to chart datum (a.k.a. low water datum), which represents the value at zero. Chart datum for Lake Superior is 601.1 feet. The solid blue line in Figure 2 represents the daily 2018

water levels and the solid gray line shows the 2017 levels. The LTA levels for each month are shown by the circles. Figure 3 shows monthly residual NBS, and the NBS shown is relative to the monthly LTA NBS.

In January and February 2018, Lake Superior was just two inches below its recorded high level for those two months. Lake Superior started the year seven inches above its 2017 water levels, but by May was two inches below its 2017 level. The net basin supply to the lake was substantially below average in March and April, as the lake only received about 35% of the precipitation it usually receives in those 2 months and runoff in April 2018 was only half its April average. The NBS continued to be slightly below average in May and June, and Lake Superior remained 4 to 5 inches below 2017 levels from June to September.

Lake Superior's seasonal rise of 11 inches took place from April to October, when it reached its peak monthly average level of 602.92 feet. This rise was less than the 17 inch-rise in 2017, but nearly equal to the lake's historical average seasonal rise of 12 inches. In addition, it's typical from September to October for Lake Superior to begin its seasonal decline, but in 2018, the lake rose 3 inches in October. The lake received nearly 150% of its average precipitation in October, leading to an NBS that was over 4 times its average October NBS. The period of higher than average NBS between September and November resulted in Lake Superior levels being just 1 to 3 inches below its 2017 Levels in October, November, and December. Lastly, 2018 was a particularly dry year overall in the Lake Superior basin, as the lake only received 88% of its annual average precipitation.

By the end of 2018, Lake Superior had been above its monthly LTA levels every month since May 2014, a period of 56 months. The lake has not experienced such a prolonged stretch of above average levels since the mid-1980s. Over the final 3 months of 2018, Lake Superior monthly average levels were 10 to 11 inches above LTA and five to six inches below its monthly record high water levels

Lake Michigan-Huron

Lake Michigan-Huron's level was 15 to 20 inches above its monthly LTA for every month in 2018. The lake's 2018 levels are shown in Figure 4. Figure 5 shows monthly residual net basin supply relative to its monthly LTA NBS. The water level of Lake Michigan-Huron has been above average every month since November 2014, a streak of 50 consecutive months. For the first two months of 2018, the lake was about 10 inches above its 2017 levels, catapulted by above average net basin supply. Its mean monthly level in February of 579.86 feet was its highest level in February since 1997.

By July 2018, however, the lake's level was at its 2017 level, and was two inches below its August 2017 level the following month. This relative decline can be attributed to the lake's lackluster seasonal rise of 10 inches. Lake Michigan-Huron began its seasonal rise in January, one month earlier than it typically does, but its 2018 seasonal rise was less than half of its 2017 seasonal rise of 21 inches, and was even below its historical average seasonal rise of 12 inches.

The lake hovered around its 2017 levels in the remaining 5 months of the year. Figure 5 illustrates there was no discernible monthly or seasonal pattern in the Lake Michigan-Huron's monthly NBS during 2018. The lake's NBS was substantially above normal in five months in 2018, while it was considerably below average in only two months last year. The water supplies to the lake were well above average in December 2018, leading to a water level of 580.15 feet. This was the highest December water level since the record

high December level in 1986, and the lake's seventh highest recorded December water level.

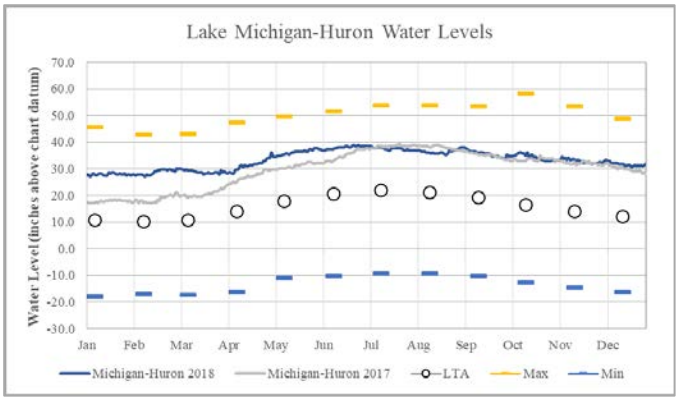


Figure 4: Lake Michigan-Huron Water Levels

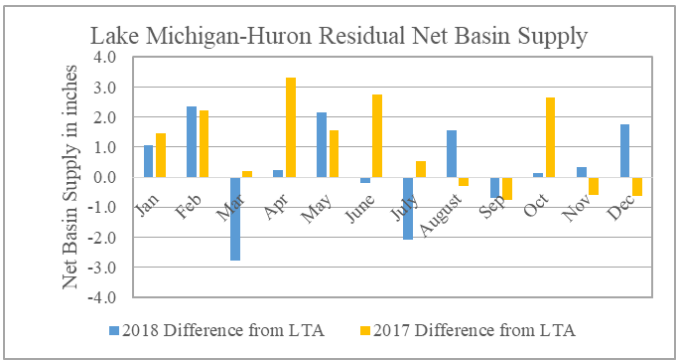


Figure 5: Lake Michigan-Huron Residual Net Basin Supply, difference from Long-Term Average

Lake St. Clair

Figure 6 shows the water levels of Lake St. Clair in 2018 compared to 2017 and the LTA levels. Lake St. Clair has been above its monthly LTA every month since March of 2015. Its peak level in 2018 of 576.51 feet, achieved in June, was its highest level since August of 1997. In May, the lake was within 6 inches of its maximum recorded May level.

For the first half of 2018, the level of Lake St. Clair was above the previous year's levels. In July and August, 2018 levels approximated their levels of a year ago, while in the remaining four months, the level of Lake St. Clair ranged from two to four inches above 2017 levels. Lake St. Clair's seasonal rise in 2018 began in January, and lasted until June. It typically starts its seasonal rise in February. Lake St. Clair's 2018 rise was 19 inches, higher than the previous year's rise of 17 inches, and higher than its historical average rise of 16 inches.

The lake's above average rise was buoyed by above average NBS in March, April, and June. Net basin supplies to Lake St. Clair were greatly above average in September, October, and November, leading to a flatter seasonal decline in the fall than average. The lake's average decline from September to December is nine inches, but in 2018 it only fell six inches.

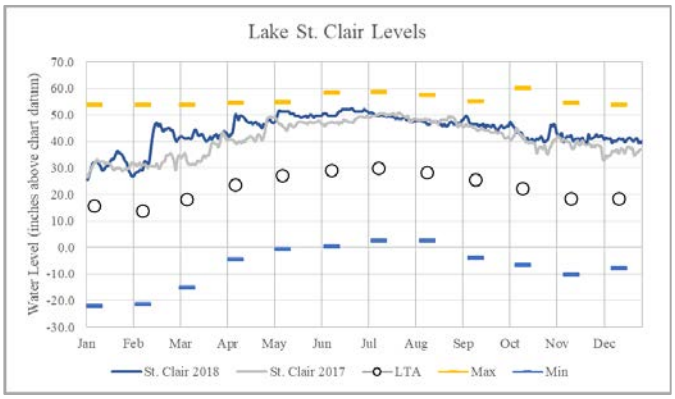


Figure 6: Lake St. Clair Water Levels

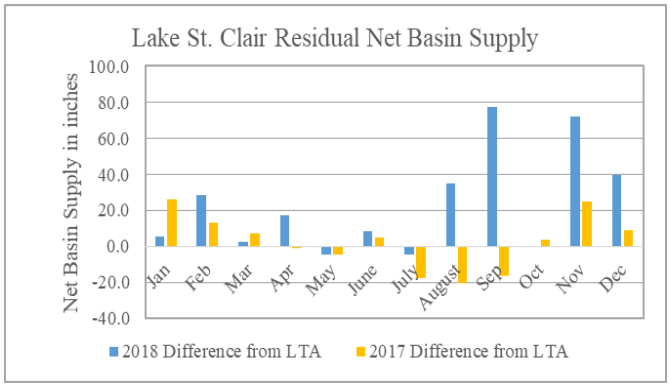


Figure 7: Lake St. Clair Net Basin Supplies

Lake Erie

2018 was another year of continued high water levels on Lake Erie, as displayed in Figure 8. The lake's level has been above its monthly LTA since June 2015, a period of 43 consecutive months. The lake's monthly mean level in June, 573.79 feet, was the highest level Lake Erie has achieved since July of 1997. In January, Lake Erie was 15 inches above its LTA level, and remained 18 to 24 inches above LTA for the rest of 2018.

The level of Lake Erie in 2018 was above the prior year's level during the first 6 months of 2018. In July and August, the lake's level was nearly equal to its 2017 level, but in the last 4 months of the year, it was three to six inches above 2017 levels.

The seasonal rise on Lake Erie in 2018 was 20 inches, less than the lake's previous 26-inch seasonal rise from December 2016 to June 2017, but notably larger than Lake Erie's average water level climb of 14 inches. 2018's robust seasonal rise can be attributed to the significant climb during February. The lake's mean monthly level rose 9.5 inches from February to March. The lake's February net basin supply was more than 2.5 times its average February NBS, as precipitation received by the lake was over 50 percent above average. Runoff was also above average that month.

Net basin supplies to Lake Erie were above average in 4 of the first 5 months of the year, but after that early part of the year, Lake Erie NBS was only above average in October and November. The lake's monthly NBS in 2018 is shown in Figure 9. Concerning annual precipitation, Lake Erie's 2018 precipitation was slightly above average, by about 0.5 inches. It was the only Great Lake to experience above average precipitation in 2018.

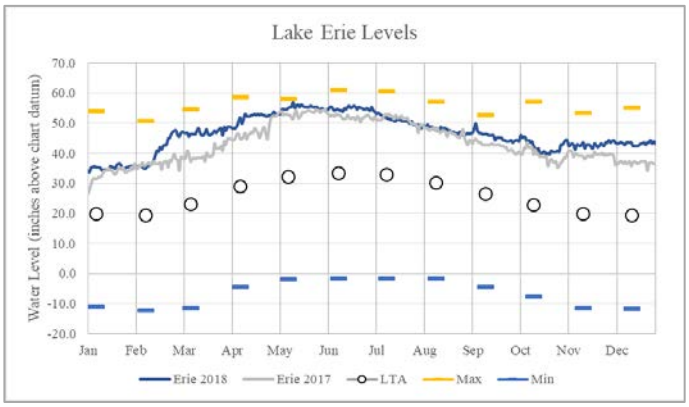


Figure 8: Lake Erie Water Levels

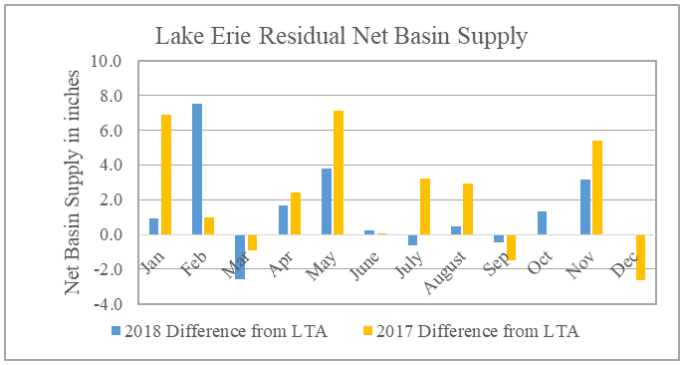


Figure 9: Lake Erie Residual Net Basin Supply, deviation from Long-Term Average

Lake Ontario

Figure 10 shows Lake Ontario water levels relative to the chart datum of 243.3 feet. The lake began 2018 eight inches above its January 2017 level. The lake's seasonal rise in 2018, including its ascent in December 2017, was 19 inches, considerably higher than Lake Ontario's average seasonal rise of 14 inches. The lake's Net Basin Supply, shown in Figure 11, was above average in four of the first five months of the year. In fact, March was the only month NBS to the lake was below average in 2018. Similar to 2017, the lake's level peaked in May, although it typically peaks in June.

However, in 2018, the lake did not come close to approaching its record-high 2017 water level climb of 53 inches, a historic rise which culminated in the setting of new record-high monthly levels for May, June, and July. After the record-high water level climb, the lake experienced a steep 43-inch decline in mid-to-late 2017. This steep decline combined with the much lower seasonal rise in 2018 resulted in Lake Ontario being below its 2017 level by March 2018. It remained below 2017 levels for the rest of 2018. In fact, in the aforementioned three months in which record-high levels were set in 2017, the lake's 2018 levels were 21, 23, and 24 inches, respectively, lower than they were the year before.

Entering 2018, like the other Great Lakes, Lake Ontario's monthly levels had been above average in every month since at least late 2015. The 2018 seasonal decline of Lake Ontario, between May and October, was 23 inches, so Lake Ontario fell more than it rose in 2018. Although Lake Ontario was 11 inches above LTA in January, the lake's net decline in 2018 led to the lake matching its monthly LTA in August, September, and October of 2018.

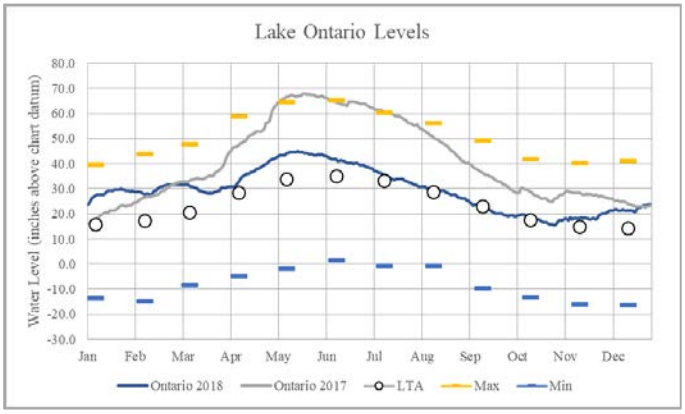


Figure 10: Lake Ontario Water Levels

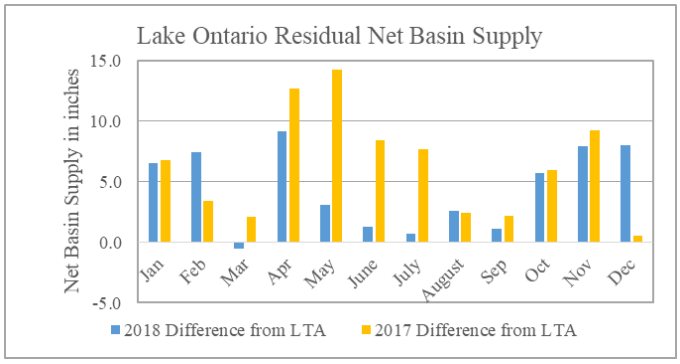


Figure 11: Lake Ontario Residual Net Basin Supply, deviation from Long-Term Average

New Soo Lock Updated Authorization by Federal Government

2018 proved to be a pivotal year in the Detroit District's decades-long effort to build a crucial new lock at its Soo Locks complex. The Soo Locks are a set of locks, situated on the St. Mary's River at Sault Ste. Marie, Michigan that allow vessels to transit the 21 foot elevation change between Lake Superior and Lake Michigan-Huron. These locks are operated and maintained by the U.S. Army Corps of Engineers, Detroit District. The locks are an invaluable link in the Great Lakes/St. Lawrence Seaway navigation system, which supports a shipping industry that generates $18.1 billion in business revenue and nearly 130,000 jobs in the United States.

Only one of the locks, the Poe Lock, can handle the largest vessels that haul invaluable materials, such as the iron ore, from which is produced the high-strength steel used in the manufacture of automobiles and appliances. In 2017, 89% of the total tonnage that transited the Soo Locks Complex was restricted to the Poe Lock due to vessel size. Prolonged interruption in operations of the Poe Lock could have a devastating impact on the economy and even national security of the United States, which underscores the importance for constructing a New Soo Lock with the same dimensions as the Poe Lock.

In 1986, Congress authorized construction of a new Poe-sized lock that would be built on the site of the current 100-plus-year-old Sabin and Davis Locks. However, construction was not initiated until 2009 when funds were provided to construct coffer dams at the ends of the Sabin Lock and deepen the downstream approach channel.

Figure 12: Current Soo Locks with inactive Davis and Sabin Locks on the left

Figure 13: Conceptual Rendering of New Soo Lock replacing Davis and Sabin Locks

2018 seemed to be a turning point for the New Soo Lock's construction:

- In June 2018, the Detroit District released an economic study that estimated a new lock would yield annual benefits of $77.3 million and a benefit-cost ratio of 2.42. The report also provided an updated cost estimate for the new lock - $922.4 million.

- In October 2018 the President signed into law "America's Water Infrastructure Act of 2018," which authorized construction of the New Soo Lock at the current cost estimate of $922.4 million.

- In November 2018, funding in the amount of $32,388,000 was appropriated for the New Soo Lock in the fiscal year 2019 Work Plan. These funds were provided to completion the design and initiate construction of the deepening of the upstream approach channel.

- In December 2018, the State of Michigan and the U.S. Army Corps of Engineers, Detroit District, signed a memorandum of agreement allowing for the State of Michigan's contribution of $52 million for the New Soo Lock at the Soo Locks facility.

The State of Michigan's contribution will allow for construction of the entire Upstream Channel Deepening as well as design of the Upstream Approach Walls and partial design of the New Lock Chamber. It is estimated that Michigan's contribution, combined with the Corps' $32 million, will accelerate the total project's completion by one shipping season.

Award of a contract to begin upstream channel deepening is expected in the summer of 2019. With continued efficient funding, the next steps in the construction of the New Soo Lock, include:

- Complete construction of the Upstream Channel Deepening
- Complete design and award construction contract for the Upstream Approach Walls
- Continue design efforts on the New Soo Lock Chamber

With efficient funding, construction of the New Soo Lock would be complete within 7 to 10 years of the start of construction.

Learn more about the New Soo Lock project here: https://www.lre.usace.army.mil/About/Highlighted-Projects/New_Soo_Lock/

More Information

Update articles are included periodically in the *Monthly Bulletins* highlighting topics and explanations relevant to Great Lakes water levels. February's *Monthly Bulletin* typically includes an annual summary from the year before. Subsequent articles published this year will cover various topics of interest concerning the Great Lakes. Nearly all past Update Articles dating back to 1985 can be accessed here:

https://www.lre.usace.army.mil/Missions/Great-Lakes-Information/News-and-Information/Great-Lakes-Update-Articles/

The *Monthly Bulletin* is sent by postal mail. To be added to the postal mailing list, please send an email to hhpm@usace.army.mil or call 1-888-694-8313 and select option 1. Alternatively, the Monthly Bulletin can be viewed on our website. The home page is: http://www.lre.usace.army.mil. In addition to the *Monthly Bulletin*, the Detroit District issues the *Weekly Great Lakes Water Level Update* and the *Weekly Great Lakes Connecting Channels Water Levels and Depths*. Both products are updated each Thursday. Additionally, a one year *Great Lakes Water Level Outlook* is produced once every three months. All forecast products are located here:

http://www.lre.usace.army.mil/Missions/GreatLakesInformation/GreatLakesWaterLevels/WaterLevelForecast.aspx

The Detroit District also has a Facebook page which can be found here:

https://www.facebook.com/USACEDetroitDistrict/

Please email questions and comments to hhpm@usace.army.mil. To contact the District by phone call toll free 1-888-694-8313 and select option 1. The Detroit District's mailing address is:

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