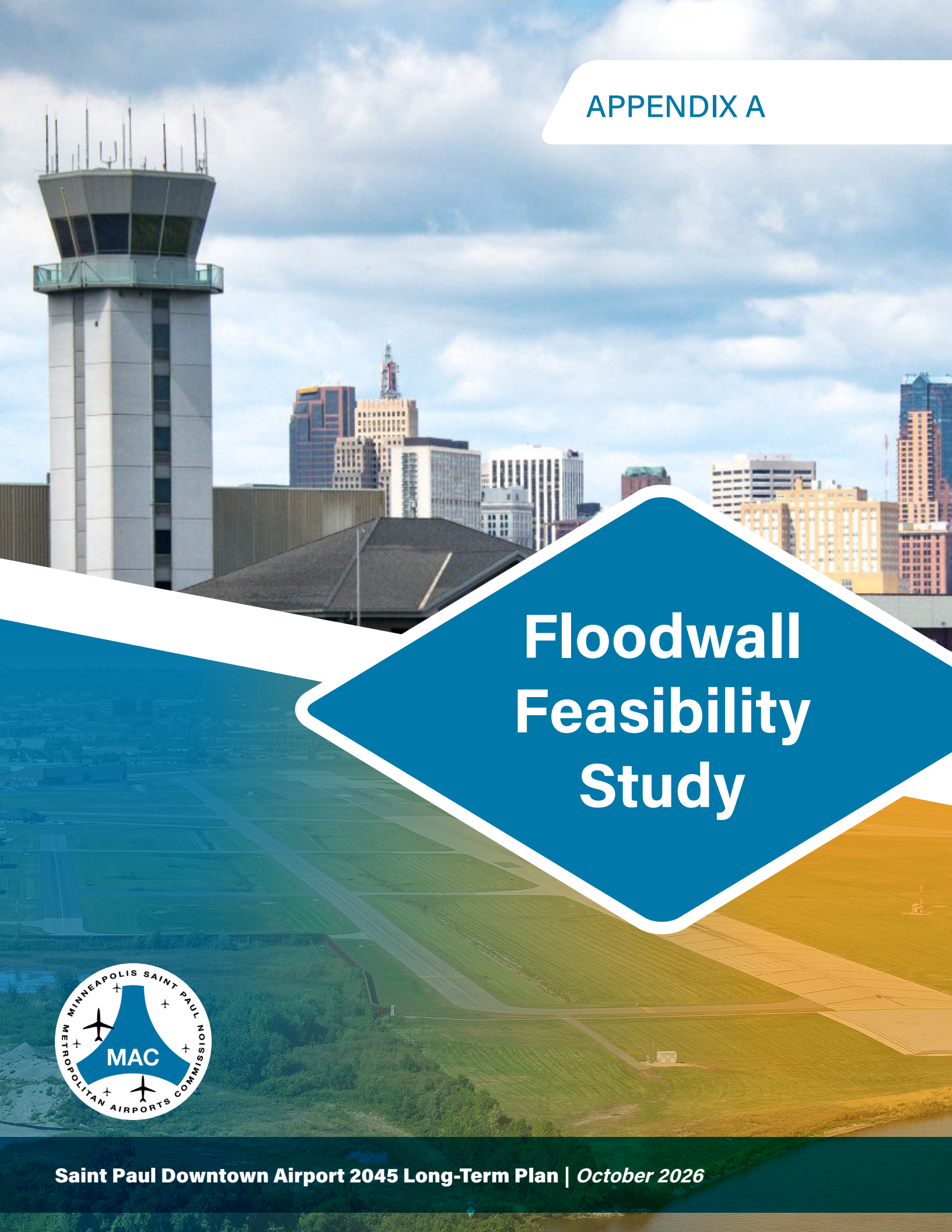


APPENDIX A

Floodwall Feasibility Study

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Appendix A: Floodwall Feasibility Study

1.1. Background

The Saint Paul Downtown Airport (STP) is located adjacent to the Mississippi River, just south of downtown Saint Paul, Minnesota. STP opened in 1926 and has been an important part of the economy of Saint Paul and the Twin Cities Metro Area. The Airport is located almost entirely within a FEMA flood zone AE (defined as an area with 1% chance of flooding any given year) with portions of the operations located within a FEMA floodway of the Mississippi River. The Airport has a history of flooding due to its proximity to the Mississippi River. Prior to the construction of the perimeter dike, the Airport has had to shut down operations on five (5) separate occasions totaling 210 days of operation. See **Table 1** for flooding. Closure of the Airport causes significant impacts to airport tenants, the city, local businesses, and the regional aviation ecosystem.

Table 1 - Past Airfield Closure due to Flooding

Flood Year	Estimated Flood Frequency (Years)	Duration of Airfield Closure (Days)
1965	190	31
1969	120	31
1993	20	35
1997	56	35
2001	75	78

Source:
Metropolitan Airports Commission (MAC).
Kimley-Horn, 2024.

In the early 2000s, the Metropolitan Airports Commission (MAC) developed a comprehensive flood protection system for the Airport. The flood protection system was designed to protect STP from the 1% annual-chance flooding event of the Mississippi River and was designed and constructed in phases between 2000 and 2009. The Final Perimeter Dike was completed in 2009 and was the latest flood protection system implemented.

1.1.1. Purpose of the Floodwall Feasibility Study

The MAC retained Kimley-Horn to evaluate the effectiveness and limitations of the existing flood protection system at STP and to assess potential floodwall modifications that could support future airfield development. While the existing perimeter dike and deployable floodwall system provides protection against the 1% annual-chance flood event, operational constraints, deployment complexity, and long-term development limitations prompted the need for a focused feasibility evaluation.

The primary objectives of this study are to:

- Document existing flood protection infrastructure and flood fight procedures;
- Evaluate hydraulic performance of existing conditions using updated modeling techniques;
- Identify and analyze potential floodwall alignment and configuration alternatives; and
- Assess how flood protection strategies influence future airfield development under both constrained and unconstrained floodplain scenarios.

The findings of this study are intended to inform MAC's long-term planning decisions at STP, including floodwall modifications that balance flood risk management, operational resiliency, regulatory compliance, and future development flexibility.

1.1.2. Description of Existing System

While STP has benefited from the perimeter dike system constructed between 2000 and 2009, the effectiveness of the system depends on a combination of permanent and deployable elements, coordinated operational procedures, and timely decision-making during flood events. To provide context for subsequent modeling and alternatives analysis, the following sections describe the components of the existing flood protection system and how the system is operated during a flood fight.

The complete Flood Protection System is made up of the perimeter flood barrier, storm sewer, subdrain, stormwater detention, slide gates, and pump stations (see sub-appendix A1 for map of the Flood Protection System). The perimeter flood barrier is comprised of three main parts, Earthen Levees, Sheet Pile Walls, and Deployable Floodwalls. Subdrain systems are in place to capture under seepage and promote drainage to onsite detention areas and pump stations. Slide gates are located at the main storm sewer discharge points around the airfield. Three pump stations are installed onsite, which aid in drainage during flood events when the floodwall is in place and when the slide gates are closed.

Four earthen levees are located along the perimeter of the Airport. The first is a 320-foot section near the southeast end of Bayfield Street. The second (and longest) levee is about 1,050 feet long and located on the airfield between Runways 31 and 32. The third levee is about 60 feet long and located at the northwest corner of the property and ties into the Pioneer Press property on the north side of the Airport terminal parking lot. The fourth levee is about 500 feet long and located along Eaton Street at the Airport Road intersection. A railroad runs through this levee and a closable flood gate is located at this crossing.

Most of the flood protection system consists of sheet pile walls that offer protection above ground from flooding and below ground from groundwater flow. Sheet pile walls were installed on average 31 feet deep and extend approximately 8.5 feet above grade. The Eaton Street sheet pile walls extend about 20 feet below grade and 5 feet above grade. The earthen levees sections are the only parts of the flood protection system that do not have sheet pile below grade.

Deployable floodwalls are located between all locations not protected by earthen levees or permanent sheet pile walls. The deployable floodwalls consist of metal stop logs that are assembled on top of an in-place concrete I-wall or an in-place concrete half wall. All deployable floodwall locations have sheet pile installed on average 31 feet below grade to help the floodwall from overturning and prevent water infiltration under the flood protection system. Full height deployable floodwalls use 12 stop logs to reach a full height of 8.5 feet above grade. The deployable floodwalls are utilized along Runways 27, 31, and

32, as well as locations along Bayfield Street and near the terminal building. When the full height deployable floodwall is erected, the overtopping river stage is 25.5 feet measured from the Robert Street Bridge Gage, corresponding to an elevation of about 708.5 feet at the low point in the perimeter dike. Deployable floodwalls may be deployed at half height, if the river crest is not anticipated to reach the top of the wall.

1.1.3. Flood Fight Protocol

The decision to deploy the flood protection system must be made at least two weeks before the river stage is forecasted to exceed "Major Stage" 17.0 feet. It is assumed that in many cases this decision will have to be made with incomplete or conflicting information about the expected flood levels. The two-week lead time is needed to prepare for the flood, this includes the time it takes to install the wall (~3 days) and reconfigure the airfield for temporary operations (~3 days). See **Table 2** for a summary of the river stage action levels.

Table 2 - STP Flood Protection System Action Levels

Robert Street Bridge River Gage		River Elevation at MAC Administration Building		Action (*Italicized*) / Comments
River Stage (ft.)	Elevation (NAVD88)	Admin. Gage	Elevation (NAVD88)	
0.0	683.77	-	682.77	Robert Street Bridge Gage Datum reference (NAVD88)
6.8	690.60	-	689.60	*Close all slide gates and activate pump stations*
10.0	693.77	-	692.77	NWS-designated "Action stage" for a flood event
12.8	696.60	-	695.60	*Close Taxiway E when river is 1 ft below lowest taxiway pavement centerline elevation (696.40 NAVD88 minus 1 ft and adjusted for river gradient to Robert Street Bridge Gage)*
14.0	697.77	-	696.77	NWS-designated "flood stage" for a flood event
15.0	698.77	-	697.77	NWS-designated "moderate stage" for a flood event
16.6	700.37	-	699.37	10% flood event (10-year flood event)
17.0	700.77	-0.2	699.77	NWS-designated "major stage" for a flood event
22.1	705.87	4.9	704.87	2% flood event (50-year flood event)
24.1	707.87	6.9	706.87	1% flood event (100-year flood event). This is the design flood elevation for the STP Flood Protection System (at which point approx. 1.46 ft of freeboard remains for the Full-Height Deployable Floodwall at the system low point near the intersection of runway 09/27 and Taxiway E).
25.5	709.33	8.3	708.33	STP Flood Protection System low point elevation (708.1 NAVD88)
26.0	709.77	8.8	708.77	NWS Record Stage Event (April 1965)
28.7	712.47	11.5	711.47	0.2% Flood event (500-year flood event)

Source:
Metropolitan Airports Commission (MAC).
Kimley-Horn, 2024.

The flood protection system involves several time-dependent steps for deploying the flood wall. A crucial decision point at the two-week mark allows for flood wall construction and airfield operations adjustments to occur before the Mississippi River reaches major flood stage. Below is a summary of these time-dependent steps.

- Make a final decision to commence the flood fight (Two weeks prior to major flood stage).
- Rent two hydraulic lifts (Lulls) to aid in wall assembly.
- Order the Flood Fighter to erect the deployable floodwall.
- Order the Flood Fighter to reconfigure the airfield.
- Schedule the required airport closures to allow the reconfiguration of the runways.
- Begin erecting the deployable floodwall and monitor the progress of the work.
- Order additional flood fight materials such as sandbags, plastic, tape, etc.
- Notify the railroad entity of the intention to engage the railroad closure gate at the intersection of Airport Road and Eaton Street.
- Notify the Federal Aviation Administration (FAA), tenants, Xcel Energy, City of Saint Paul Regional Water Services, City of Saint Paul Sewer Department, railroad authorities, and the National Weather Service (NWS) of the intent to commence the flood fight.
- Order the portable pump or obtain firm commitment of its availability.
- Order or obtain firm commitment for one 480-V, three-phase, 30 kW mobile generator. Verify site access requirements for generator installation and fueling, and receptacle configuration. Order one receptacle of the required configuration.
- Three days before river stage is forecasted to be above “Major Stage” 17.0, engage the railroad closure gate at the intersection of Airport Road and Eaton Street.

The estimated time it takes for the flood control system dismantling and storage is about 42 days. This includes all FAA reconfiguration of the airfield and dismantling, cleaning, and storing of the deployable floodwall. See sub-appendix A2 for detailed Flood Control System Deployment Schedule.

At the time of this writing, the floodwall has been deployed a total of eight (8) times since the project was completed.

1.1.4. Airfield Operations During Flood Fight

Commencing a flood fight results in reduced airfield operations. There are two airfield configurations that may be implemented during a flood fight. The first scenario includes the closure of Runways 09/27 and 13/31 and a reduced threshold of Runway 14/32 due to the deployable floodwall. The temporary threshold results in a runway length of 5,341 feet (6,491 feet in non-deployed conditions). In addition, Taxiway E is mostly inoperable since it falls on the river side of the perimeter dike. The second scenario assumes that runways 09/27 and 13/31 remain operational but at reduced thresholds.

Reconfiguring the airfield for temporary operations during a flood fight requires extensive communication and physical alterations. The procedures for reconfigurations are as follows:

- Notify FAA that a flood fight is commencing and to start moving equipment from areas outside of the flood protection system.
- Notify the tenants and update them with estimated schedules.
- Issue a NOTAM (Notice to Air Missions) for temporary closure of Runway 14/32 while the reconfiguration is taking place.

- Close Runway 14/32 so that the temporary threshold can be established. This must be accomplished before closing Runway 13/31. Establishment of the temporary threshold on the end of Runway 32 will include the following procedures:
    - Modifying pavement markings.
    - Turning the circuit selector switch to “FLOOD” condition for runway 14/32.
    - Turn off the PAPIs (Precision Approach Path Indicators) for the Runway 32 approach.
    - Conceal all Runway 14 distance-to-go signs.
- Issue NOTAM concerning Runway 14/32 temporary threshold and reopen Runway 14/32.
- Issue NOTAMs to close Runway 09/27 and 13/31 and associated taxiways.
- Turn the Taxiway E circuit selector switch to “FLOOD” condition to deactivate the lights along Taxiway E that will be closed during a flood fight.
- Deactivate the regulators for Runway 13/31 and 09/27 and verify ALSCMS (Airfield Lighting Control and Monitoring System) FLOOD indicator is activated.
- Turn off PAPIs for Runway 27 and Runway 13/31 approaches.
- Remove Runway 31 REILs (Runway End Indicator Lights).
- Remove airfield lights and signs on the river side of the flood protection system (must be done prior to deploying the floodwall).
- Calibrate the Taxiway E edge light circuit regulator and verify three discernible illumination levels.
- Inspect all known utility crossings of the flood protection system. Confirm that crossings are secured and sealed on both ends.
- After the deployable floodwall has been erected, install temporary obstruction lights near the end of Runway 32.

After the flood fight, the airfield must be reconfigured for normal operations. The reconfiguration process includes the reverse of all steps listed above. Additional steps are needed to ensure a safe return to normal operations. All pavement that was submerged during the flood fight must be tested to confirm that it will support aircraft and MAC maintenance equipment. All airfield lighting systems and safety systems that were displaced in the configuration must be tested again after the flood fight.

1.2. Modeling

The effectiveness of the existing flood protection system and potential floodwall modifications cannot be evaluated solely through observational or historical data. Accordingly, a hydraulic modeling analysis was performed to quantify flood behavior adjacent to the airfield, evaluate existing conditions, and assess the impacts of proposed floodwall alternatives on river stages and floodway encroachments.

This study utilizes existing Federal Emergency Management Agency (FEMA) hydraulic models as a baseline, identifies discrepancies between available datasets, and refines the models to better reflect current conditions at STP. The calibrated model framework is then used to evaluate floodwall alignment alternatives and their implications for flood risk management and future airfield development.

The hydraulic model is based on the HEC-RAS models used for the 2007 Letter of Map Revision (LOMR) for the STP, which includes the compensatory excavation project for the perimeter dike. This model includes approximately 8,890 feet (1.68 mi) of the Mississippi River starting at the 3M Hangar located along Bayfield Street and ending at the Saint Paul Police Department Impound. The effective model had two geometries named “Existing” and “Proposed”. The existing model geometry corresponds

to the conditions before the channel excavation occurred. The proposed geometry has revised floodways and incorporates the new channel geometry from the excavation of the Mississippi shoreline at STP. No changes were made to the received geometries. It is important to note that the Water Surface Elevations (WSE) in the model received do not exactly match the WSE as found in the current Flood Insurance Study (FIS) Report for Ramsey County, (27123CV000B, Revised September 16, 2015).

As part of establishing a reliable analytical baseline, the received hydraulic models were reviewed for consistency with current FIS data and prior LOMRs. See the section below for information on the inconsistencies between the FIS report and the received model.

1.2.1. Model Discrepancies

The received model results, accompanied by the LOMR for STP, dated February 2, 2007, and the results found in the September 16, 2015, FIS report are not consistent. The main differences include cross section naming and WSE results.

Cross Section Naming:

The LOMR documentation states that cross sections 86 and 89 of the STP model and cross section E and F of the FIS model should be the same. **In reality, cross section 86 and 89 of the STP Model correspond to cross section D and E in the FIS report**. After further review, there was a cross section in a previous FIS report named “D” that was deleted in the most recent FIS report and all cross sections that came after “D” were renamed.

Results Differences:

The results shown in the FIS Report for cross sections D and E are not identical to the results in the received model. The water surface elevation for the base flood are approximately 0.2 feet lower in the model received than they are in the FIS Report. This discrepancy is due to the vertical datums used. The most current FIS report notes that all elevations were converted to the NAVD 88 Datum. The model uses the NGVD 29 Datum. In Saint Paul, the conversion is NGVD 29 = NAVD 88 – 0.16.

Cross section D in the FIS Report shows a Base Flood Elevation (BFE) of 706.3 and cross section 86 of the model received shows a BFE of 706.11, a difference in 0.19 feet (0.03 feet when accounting for the vertical datum conversion). Cross section E in the FIS report shows a BFE of 706.6 and cross section 89 of the received model shows a BFE of 706.43, a difference in 0.17 feet (0.01 feet when accounting for the vertical datum conversion). The discrepancies in the model results and the current FIS report are likely due to rounding, since the FIS report rounds to one (1) decimal place. Similar discrepancies are present in the floodway elevation results.

Following identification of these inconsistencies, an effective model was established to align geometry, elevations, and nomenclature with the current regulatory framework while preserving the approved floodplain representation.

1.2.2. Effective Model

The Effective Model includes two plans, two geometry files, and one flow file. Plan “Existing” uses the “Existing” geometry file and represents the conditions at STP prior to compensatory excavation. The “Existing” Plan was renamed “OLD_Existing” and the “Existing” geometry was renamed “OLD_Existing” for this study. Plan “Proposed” uses the “Proposed” geometry and represents the condition at STP after the compensatory excavation was completed. The “Proposed” Plan was renamed “Effective” and the “Proposed” geometry was renamed “Effective” for this study. Both geometries include fourteen (14) cross sections that border the Airport. The “Effective” geometry encroachment areas match what is shown in the FIS Report for floodway widths, however the perimeter dike are not included in the cross section geometry.

1.2.3. Existing Conditions Modifications

To evaluate how the constructed flood protection system performs under current conditions, the effective model geometry was modified to incorporate as-built floodwall and levee elements. An additional cross section 84.7 was also added between cross sections 84.5 and 85 to improve modeling accuracy at the end of the runway. The elevations of the perimeter dike are found in record drawings signed and dated December 4, 2009. Exact locations of the dike within the cross section were estimated with the use of LiDAR, as-built plans and aerial imagery. All model calculation settings and flows remained unchanged for this study.

The corrected effective geometry uses ineffective flow areas in HEC-RAS to simulate the impact of the perimeter dike using elevations found in the record drawings. Permanent sheet pile walls with an elevation of 708.83 (NGVD 29) were added in cross sections 91, 90, 89.8, 89, and 88.3 as ineffective flow areas. Earthen levees with an elevation of 709.25 (NGVD 29) were added in cross sections 88 and 87 as ineffective flow areas. For the deployable section of the wall, it was assumed that the floodwall was not deployed in existing conditions. However, ineffective flow areas were added to represent the pond/backwater area on the southwest side of Runway 32, cross sections 86, 85.4 85, 84.7 and 84.5 reflect this change. The ineffective flow area for cross section 84 was raised 2 feet to improve modeling accuracy based on the effective elevation data. Cross sections 83.6 and 83 were not changed.

1.2.4. Existing Conditions Model Results

The existing conditions model, as shown in **Table 3**, will be used as a baseline to compare with proposed conditions of various alternatives. The 100-year flow was analyzed to simulate the airfield inundation and the protection level of the floodwall.

Table 3 - Existing Conditions Hydraulic Model Results

Cross Section	Effective 100 Year WSE (1929 NGVD)	Existing Conditions 100 Year WSE (1929 NGVD)	Top of Barrier Elevation (1929 NGVD)
91	706.47	706.51	708.83
90	706.46	706.50	708.83
98.8	706.43	706.47	708.83
89	706.43	706.43	708.83
89.3	706.37	706.33	708.83
88	706.31	706.28	709.25
87	706.25	706.19	709.25
86	706.11	706.08	Not deployed
85.4	706.04	706.01	Not deployed
85	706.00	705.95	Not deployed
84.7 (New Cross Section)	NA	705.91	Not deployed
84.5	705.91	705.88	Not deployed
84	706.00	705.98	NA
83.6	705.84	705.84	NA
83	705.83	705.83	NA

Source:
Metropolitan Airports Commission (MAC).
Kimley-Horn, 2024.

1.2.5. Proposed Conditions

Using the refined existing conditions model as a baseline, a series of floodwall alignment and configuration alternatives were developed to address identified limitations of the current system, reduce operational constraints, and improve compatibility with future airfield development objectives.

Alternatives Analysis:

Alternative Set A

The first set of alternatives analyzed involved moving the alignment of the deployable floodwall to the west near the intersection of Runways 27 and 31 and then southeast to follow the boundary of the existing ROFA of Runway 32. This will be referred to as “pulling back” the alignment in this location which occurred at cross sections 88.3, 88 and 87. The first alternative followed the existing floodwall alignment around the end of Runway 32, and the second alternative followed the existing ROFA boundary resulting in extension of the runway and floodwall into the Mississippi River. In the second alternative, a rise of a tenth of a foot was caused upstream from constriction of the river at the end of the runway. In the first alternative approximately a hundredth of a foot of rise was shown, this is due to the expanded western overbank area of the river causing water to slow down in the model and increase the water surface elevations in this area. The expanded western overbank areas are a result of the floodwall alignment shifting to the west.

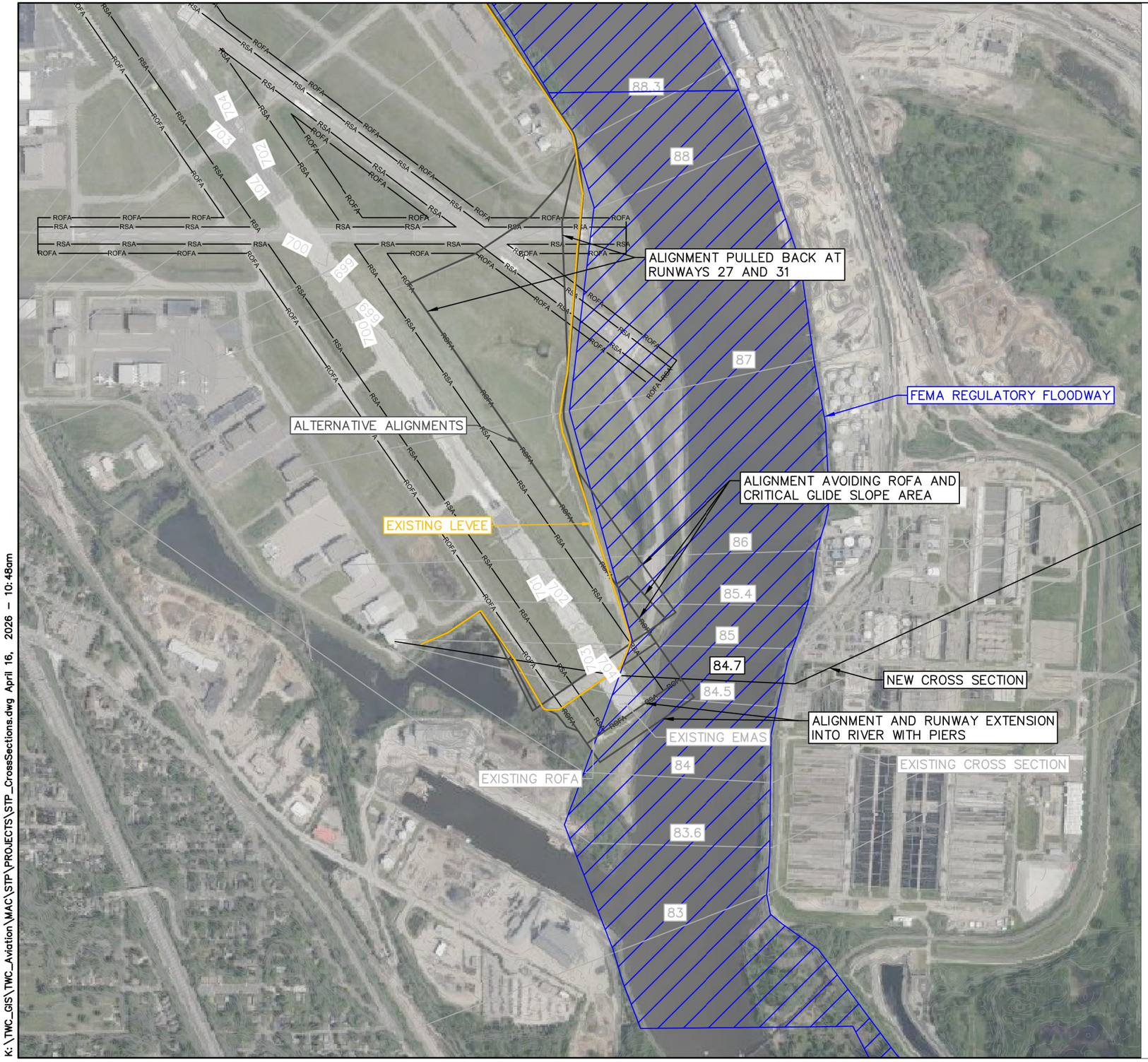
Alternative Set B

The next set of alternatives analyzed were a combination of the first two (Set A) alternatives with varying runway extensions/shortenings and alignment “pull back” distances at Runways 27 and 31. In the extension alternatives, piers were modeled in the river at the end of the runway to better represent impact in the floodway. The extension alternatives again showed a tenth of a foot of rise upstream. The impact to the floodplain was decreased as the floodwall alignment/runway length shortened. As the alignment was “pulled back” at Runways 27 and 31, there was an increase in the water surface elevations in this area. Therefore, keeping the alignment closest to the existing alignment at this location was ideal. This same effect occurred at the end of the runway when it was shortened too much causing a rise at that location.

Alternative Set C

The final set (Set C) of alternatives analyzed were floodwalls that followed the existing alignment along the river then turned southwest across the runway northwest of the existing EMAS. This alternative followed the existing ROFA boundary as close as possible. The first alternative followed the existing ROFA alignment through the critical glide slope area and the second alternative routed the floodwall around the critical glide slope area. Both alternatives showed a rise in the floodplain in the hundredths of feet. The second alternative (avoided the critical glide slope area) shifted the floodwall east towards the river causing a larger rise upstream.

The alternative alignments are shown in **Figure 1**.



Existing Conditions Hydraulic Model Results

Cross Section	Effective 100-Year WSE (1929 NGVD)	Existing Conditions 100-Year WSE (1929 NGVD)	Top of Barrier Elevation (1929 NGVD)
91	706.47	706.51	708.83
90	706.46	706.50	708.83
98.8	706.43	706.47	708.83
89	706.43	706.43	708.83
89.3	706.37	706.33	708.83
88	706.31	706.28	709.25
87	706.25	706.19	709.25
86	706.11	706.08	Not deployed
85.4	706.04	706.01	Not deployed
85	706.00	705.95	Not deployed
84.7 (New Cross Section)	NA	705.91	Not deployed
84.5	705.91	705.88	Not deployed
84	706.00	705.98	NA
83.6	705.84	705.84	NA
83	705.83	705.83	NA

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Kimley»Horn

STP AIRPORT

FIGURE 1: ALTERNATIVE FLOOD WALL ALIGNMENTS

4/17/2026

NORTH

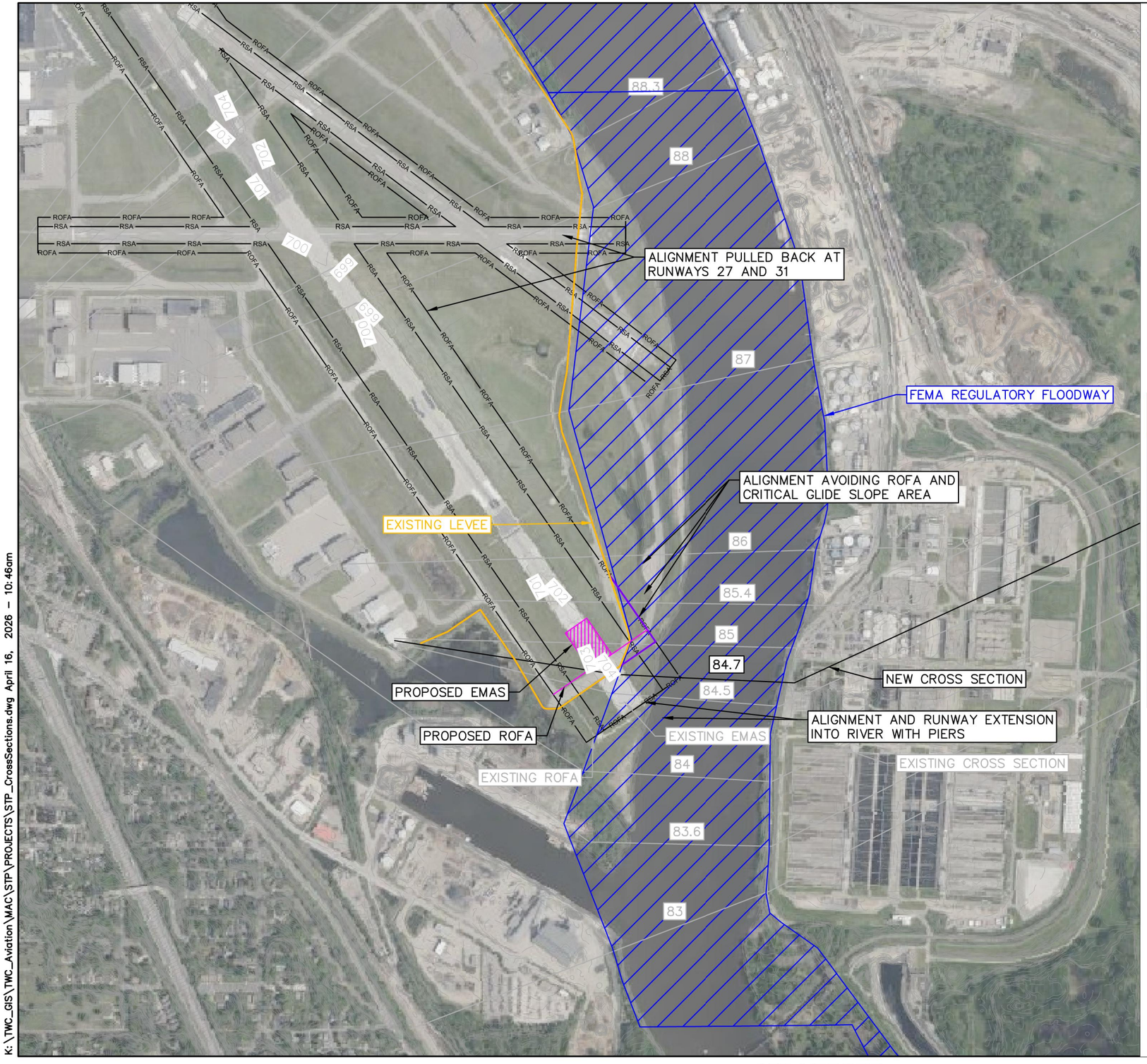
0 750 1500

HORIZONTAL SCALE IN FEET

Preferred Alternatives:

Taking into consideration the above alternatives analysis, two preferred alternatives were determined for proposed conditions. Alternative 1 is a deployable floodwall that follows the existing alignment, then follows the proposed ROFA boundary, before cutting across Runway 32 northwest of the existing EMAS and wrapping around the runway east of the pond. This alignment does not intersect either the proposed ROFA or RSA zones. Alternative 2 follows the same alignment as Alternative 1, with the runway end raised 8 feet and a permanent floodwall constructed. The preferred proposed conditions alignment is shown in **Figure 2**.

The Proposed Conditions geometry and ineffective flow areas are adjusted for the new alignment at cross sections 85.4, 85, 84.7 and 84.5. Due to similar floodplain impacts from the preferred alternatives, one geometry and plan were used to represent both alternatives as they have the same alignment.



Existing Conditions Hydraulic Model Results

Cross Section	Effective 100-Year WSE (1929 NGVD)	Existing Conditions 100-Year WSE (1929 NGVD)	Top of Barrier Elevation (1929 NGVD)
91	706.47	706.51	708.83
90	706.46	706.50	708.83
98.8	706.43	706.47	708.83
89	706.43	706.43	708.83
89.3	706.37	706.33	708.83
88	706.31	706.28	709.25
87	706.25	706.19	709.25
86	706.11	706.08	Not deployed
85.4	706.04	706.01	Not deployed
85	706.00	705.95	Not deployed
84.7 (New Cross Section)	NA	705.91	Not deployed
84.5	705.91	705.88	Not deployed
84	706.00	705.98	NA
83.6	705.84	705.84	NA
83	705.83	705.83	NA

Proposed Conditions Hydraulic Model Results

Cross Section	Existing Conditions 100-Year WSE (1929 NGVD)	Proposed Conditions 100-Year WSE (1929 NGVD)	Permanent Floodwall Proposed Top of Barrier Elevation (1929 NGVD)
91	706.51	706.52	708.83
90	706.50	706.51	708.83
98.8	706.47	706.48	708.83
89	706.43	706.44	708.83
89.3	706.33	706.34	708.83
88	706.28	706.29	709.25
87	706.19	706.20	709.25
86	706.08	706.08	713.00
85.4	706.01	705.99	713.00
85	705.95	705.93	713.00
84.7 (New Cross Section)	705.91	705.90	713.00
84.5	705.88	705.87	713.00
84	705.98	705.98	NA
83.6	705.84	705.84	NA
83	705.83	705.83	NA

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Kimley»Horn

STP AIRPORT

FIGURE 2: PREFERRED FLOOD WALL ALIGNMENT

4/17/2026

NORTH

0 750 1500

HORIZONTAL SCALE IN FEET

1.2.6. Proposed Conditions Model Results

The Proposed conditions 100-year flow was analyzed and compared with the existing conditions model. **Table 4** includes the floodplain analysis. A hundredth of a foot rise is shown upstream of the proposed modifications. Additional detailed modeling during final design is recommended.

Table 4 - Proposed Conditions Hydraulic Model Results

Cross Section	Existing Conditions 100 Year WSE (1929 NGVD)	Proposed Conditions 100 Year WSE (1929 NGVD)	Permanent Floodwall Proposed Top of Barrier Elevation (1929 NGVD)
91	706.51	706.52	708.83
90	706.50	706.51	708.83
98.8	706.47	706.48	708.83
89	706.43	706.44	708.83
89.3	706.33	706.34	708.83
88	706.28	706.29	709.25
87	706.19	706.20	709.25
86	706.08	706.08	713.00
85.4	706.01	705.99	713.00
85	705.95	705.93	713.00
84.7 (New Cross Section)	705.91	705.90	713.00
84.5	705.88	705.87	713.00
84	705.98	705.98	NA
83.6	705.84	705.84	NA
83	705.83	705.83	NA

Source:
Metropolitan Airports Commission (MAC).
Kimley-Horn, 2024.

1.2.7. Floodway Modifications

The Effective FIS report shows that cross section D (corresponding to XC 86 in the effective model), has a surcharge of 0.2'. In Minnesota, 0.5' of surcharge from the natural channel is allowed when defining the floodway. The encroachment stations may be able to move in, so that the surcharge in this section of the river is closer to the allowable maximum of 0.5', however, increasing the floodway elevation on the Mississippi River in Downtown Saint Paul is most likely unfeasible due to the upstream structures impacted (including a federal levee system) and overall extents of impacts induced.

There have been discussions involving the Union Pacific Railroad bridge that crosses the river about 1,200 feet downstream of the property. Removal of this bridge does not appear to change the 100-year WSE at STP by a significant amount, nor would removal lead to further development opportunities onsite due to reduced flooding.

1.3. Airfield Development

Flood protection strategies at STP directly influence the extent and type of airfield development that can occur under applicable floodplain regulations. Accordingly, the following section evaluates future development scenarios under both constrained and unconstrained floodplain conditions, based on whether the existing floodwall system is maintained or substantially upgraded.

The future development at STP can be best described as following one of two scenarios: Constrained and Unconstrained. Constrained development would not change any FEMA Flood Zones onsite; much of the site would remain as a Zone AE (Within the base floodplain where base flood elevations are provided). All redevelopments would have to comply with the regulations associated with development in a floodplain for the City of Saint Paul, and FEMA. The second scenario would be Unconstrained, whereby development would require levee accreditation to change the flood zone to FEMA Zone X (Area with reduced flood risk due to levee). Any future redevelopment would be able to take place unconstrained by floodplain zoning regulations.

1.3.1. Constrained (Minor Floodwall Improvements)

With minor or no improvements to the floodwall, the FEMA flood risk classification would likely not change, and all development would have to adhere to Chapter 72 of the Saint Paul Code of Ordinances *Floodplain Management Overlay Districts,* which is described as follows:

1.3.1.1. Permitted Uses in a Floodway – Section 72.62

Airport service roads and runways are permitted with the Floodway district as long as they follow the standards in Section 72.62.

Standards for permitted uses in the floodway include:

- No increase in the 1% chance flood elevation and shall not involve structures, fill, obstruction, excavations, or storage of any materials or equipment.
- The service roads or runway shall have a low flood damage potential.
- The service roads or runways shall not adversely affect the hydraulic capacity of the channel or floodway.
- The service roads or runways shall not cause pollution of waters, as defined in Minnesota Statutes, Section 115.01, unless adequate safeguards, approved by the state pollution control agency, are provided.

1.3.1.2. Permitted Conditional Uses in a Floodway

Structures accessory to airport service roads and runways (hangars) are permitted with a conditional use permit if they follow the standards in Sec. 72.64.

Standards for conditional uses in the floodway include:

- No increase in the regional flood or cause an increase in flood damages in the river. The accessory structure (hangar) shall not adversely affect the hydraulic capacity of the channel or floodway.

- Fill shall be protected from erosion by vegetative cover, mulching, riprap or other acceptable method.
- Accessory structures shall not be designed for human habitation.
- Accessory structures shall be constructed and placed on the building site so as to offer the minimum obstruction to the flow of floodwaters:
    - Whenever possible, structures shall be constructed with the longitudinal axis parallel to the direction of flood flow; and
    - So far as practicable, structures shall be placed approximately on the same flood flow lines as those of adjoining structures.
- Accessory structures shall be elevated on fill or structurally dry floodproofed in accordance with the FP-1 or FP-2 floodproofing classification in the Minnesota State Building Code. As an alternative, an accessory structure may be floodproofed to the FP-3 or FP-4 floodproofing classification in the Minnesota State Building Code, provided the accessory structure constitutes a minimal investment, does not exceed five hundred (500) square feet in size, and for a detached garage, the detached garage must be used solely for parking of vehicles and limited storage. All floodproofed accessory structures must meet the following additional standards:
    - The structure must be adequately anchored to prevent flotation, collapse or lateral movement of the structure and shall be designed to equalize hydrostatic flood forces on exterior walls;
    - Any mechanical and utility equipment in a structure must be elevated to or above the regulatory flood protection elevation or properly floodproofed; and
    - To allow for the equalization of hydrostatic pressure, there must be a minimum of two "automatic" openings in the outside walls of the structure having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding. There must be openings on at least two sides of the structure and the bottom of all openings must be no higher than one foot above the lowest adjacent grade to the structure. Using human intervention to open a garage door prior to flooding will not satisfy this requirement for automatic openings.
- The storage or processing of materials that are, in time of flooding, flammable, explosive, or potentially injurious to human, animal, or plant life is prohibited. Storage of materials or equipment may be allowed if readily removable from the area within the time available after a flood warning and in accordance with a plan approved by the planning commission.

1.3.1.3. General Development in a Flood Fringe

For development in a flood fringe district, structures must be elevated on fill so that the lowest floor is at or above the Regulatory Flood Protection Elevation (RFPE). The finished fill elevation for such structures shall not be lower than one (1) foot below the RFPE and the fill must extend at least 15 feet beyond the outside limits of the structure. The storage of any materials or equipment shall be elevated on fill to the RFPE.

Standards for Conditional Uses in a Flood Fringe

Any structure in the flood fringe district that is not elevated on fill may be allowable as a conditional use. A conditional use permit must be issued by the planning commission if the structure adheres to the rules set forth in Section 72.73 of the Saint Paul Code of Ordinances. All areas of nonresidential structures including basements to be placed below the regulatory flood protection elevation shall be

structurally dry floodproofed in accordance with the FP-1 or FP-2 floodproofing classifications in the Minnesota State Building Code. This shall require making the structure watertight, with the walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

Floodproofing Measures

FP-1 classification – Any building or structure located in a Flood Hazard Area with no space below the BFE or in which all enclosed spaces below the BFE are classified W1 or W2 without employing any contingent closure, removal, protection, or other measure which requires human intervention for effectiveness in a flood event to obtain those classifications shall be known as a Completely Flood-Proofed Structure and classified FP1.

FP-2 classification - Any Building or structure located in a Flood Hazard Area with any space below the BFE and in which all such spaces are classified W1 or W2, but for which at least one or more of the spaces employs any contingent closure, removal, protection, or other measure which requires human intervention for effectiveness in a flood event to obtain those classifications shall be classified FP2. FP2 would likely be the classification needed for aircraft hangars and other accessory structures.

W1 flood proofing class is classified as a space that remains completely dry during flooding to the BFE. Walls shall be impermeable to the passage of water and water vapor. Interior finishes are nearly unrestricted, except for high hazard type uses. Structural components shall have the capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy. W1 classification would likely be required for all habitable spaces or in any structure where the storage of materials constitutes a safety hazard.

W2 flood proofing class is classified as a space that remains essentially dry during flooding to the BFE. Walls shall be substantially impermeable to the passage of water but may pass some water vapor or seep slightly. Interior finishes are restricted when hazardous or vulnerable under these conditions. Structural components shall have the capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy. W2 classification is likely required for airplane hangars and other accessory buildings.

1.3.2. Non-Constrained (Major Floodwall Improvements)

1.3.2.1. Design Criteria for Levee Certification

For levee systems to be recognized (i.e., accredited) by FEMA, evidence supporting that the design and operation and maintenance systems meet the minimum requirements for accreditation under the Code of Federal Regulations 44 CFR 65.10, which provides reasonable assurance that protection from the base flood exists. FEMA accreditation criteria are described in **Table 5**.

Table 5 - FEMA Floodwall Accreditation Design Criteria

FEMA Design Criteria	
Freeboard	The minimum freeboard required is 3 feet above the Base Flood Elevation (BFE) all along the length of the levee, with an additional 1 foot within 100 feet of structures (such as bridges) or wherever flow is restricted, and an additional 0.5 foot at the upstream end of a levee.
Closures	All openings must be provided with closure devices that are structural parts of the system during operation and designed according to sound engineering practice.
Embankment Protection	Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of seepage path and subsequent instability.
Embankment and Foundation Stability	Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided must evaluate expected seepage during loading conditions associated with the base flood and must demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the U.S. Army Corps of Engineers (USACE) Engineer Manual 1110–2–1913, Design and Construction of Levees, (Chapter 6, Section II), may be used.
Settlement Analysis	Engineering analyses must be submitted to assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in USACE Engineer Manual 1110–1–1904, Soil Mechanics Design—Settlement Analysis, must be submitted.
Interior Drainage	An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than 1 foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters, as described in USACE Engineer Manual 1110-2-1914, Hydrologic Analysis of Interior Areas.

Source:
Federal Emergency Management Agency (FEMA).
Kimley-Horn, 2024.

1.3.2.2. Operational Criteria

For a levee system to be accredited, the operational criteria described in **Table 6** must be provided. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP.

Table 6 - FEMA Floodwall Accreditation Operational Criteria

FEMA Operational Criteria	
Flood Warning System	Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials that will be used to trigger emergency operation activities; and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.
Plan of Operation	A formal plan of operation including specific actions and assignments of responsibility by individual name or title.
Periodic Operation of Closures	Provisions for periodic operation, at not less than 1-year intervals of the closure structure for testing and training purposes

Source:
Federal Emergency Management Agency (FEMA).
Kimley-Horn, 2024.

1.3.2.3. Interior Drainage Plan

Interior drainage systems associated with levee systems typically include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood risk reduction purposes only if the following minimum criteria are included in the operation plan. **Table 7** includes Interior Drainage Criteria for indoor drainage.

Table 7 - FEMA Interior Drainage Criteria

FEMA Interior Drainage Criteria	
Flood Warning System	Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials that will be used to trigger emergency operation activities; and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.
Plan of Operation	A formal plan of operation including specific actions and assignments of responsibility by individual name or title.
Manual Backup	Provision for manual backup for the activation of automatic systems.
Periodic Inspection	Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than 1 year shall elapse between either the inspections or the operations.

Source:
Federal Emergency Management Agency (FEMA).
Kimley-Horn, 2024.

1.3.2.4. Maintenance Plan

For levee systems to be recognized as accredited by FEMA, the maintenance criteria must be as described herein.

- Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is sought or when the plan for a previously recognized system is revised in any manner.

- All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP which must assume ultimate responsibility for maintenance.
- This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, the plan shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

1.3.2.5. Certification

Data submitted to support that a given levee system complies with the structural requirements set forth in “Design Criteria” (Paragraphs 65.10(b)(1) through (7) of the regulations) must be certified by a Registered Professional Engineer. Certifications are subject to the definition given in Section 65.2 of the NFIP regulations. In lieu of these structural requirements, a federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection from the base flood.

- All data submitted needs to be certified by a professional Engineer or by a federal agency.
- Certified as-built levee plans need to be included in the submittal.

Development in a Reduced Flood Risk Due to Levee.

Development in a reduced flood zone follows the standards for development in a FEMA Zone X area. Very few limitations are present for development in a Zone X.

1.4. Next Steps

One of the goals of this report is to determine development opportunities at STP that are compliant with the City of Saint Paul floodplain standards and meet the needs of MAC’s long-term plan of STP. A deep understanding of what types of development are allowed, and the conditional uses is vital to the success of the Airport’s future development strategy.

Airport development concepts will be designed in the Long-Term Plan Alternatives Analysis to meet the regulatory floodplain requirements of Saint Paul and accommodate the future needs of the Airport. The floodplain development conditions are outlined in this section of the report and the development needs of STP will be presented in the Long-Term Plan Report. Continued coordination between the City of Saint Paul and MAC is recommended to determine allowable developments in the Mississippi River floodplain.

It is recommended that a 2D model is created for proposed conditions. A 1D-2D HEC-RAS model of the Mississippi River from the Minnesota Department of Natural Resources (MnDNR) can be obtained for this modeling effort. 2D modeling allows for more accurate representation of river flooding, interior drainage, and floodwall feasibility. Realignment of the floodwall will need to show a no-rise condition to meet regulatory conditions. A 2D model provides a higher level of detail and provides benefit to future development.