Appendix M – Deicer Management System Evaluation

TECHNICAL MEMORANDUM

TO:	Brent Perry, LFUCAB
FROM:	Gresham Smith
DATE:	June 15, 2024
SUBJECT:	**BLUE GRASS AIRPORT MASTER PLAN DEICER MANAGEMENT SYSTEM EVALUATION** Gresham Smith Project No. 45593.01

This memo presents findings from an assessment of future deicer management system needs at Blue Grass Airport as driven by the Preferred Alternative of the 2024 Blue Grass Airport Master Plan. It describes the functionality and capacity of the deicer management system under both existing and future conditions as well as siting conflicts associated with the Preferred Alternative and considerations for addressing those future conflicts.

Project Summary

LEX Aircraft Deicer Management System

Blue Grass Airport (LEX) is a public use airport owned and operated by the Lexington-Fayette Urban County Airport Board (LFUCAB), located approximately four miles west of Lexington, KY. Currently, the airport has one primary terminal with a ramp where all major aircraft park for cargo or passenger loading.

During winter months, both aircraft and pavement deicers and anti-icers (deicers, hereafter) are applied on the terminal ramp. Stormwater runoff containing deicers is managed in the LEX deicer management system. The LEX deicer management system includes the following components:

- Terminal ramp paved areas where deicers are applied.
- Inlets and stormwater conveyance piping to route stormwater runoff containing deicers away from the terminal ramp (sometimes called "glycol storm system"). This piping is used to convey both deicer-impacted stormwater and stormwater without deicers outside of deicing conditions.
- Deicer monitoring station where concentrations of deicer-related parameters in stormwater flows are measured, with automated routing of low deicer concentration runoff to surface waters or diversion of high concentration runoff to a detention structure called the "glycol detention pond".
- Temporary storage of the spent deicer and associated stormwater in the glycol detention pond for either further dilution from stormwater flows or discharge to the sanitary sewer.
- Sanitary sewage pump station that routes sewage plus high deicer concentration stormwater from the glycol detention pond to the sanitary sewer for eventual treatment in the local municipal wastewater treatment plant.

The existing LEX deicer management system includes approximately 33 acres of pervious and impervious area on and around the terminal ramp on which stormwater runoff is collected and conveyed toward Outfall 002 (**Figure 1**, magenta line). In winter months, airlines and FBOs apply deicers and anti-icers to aircraft within a marked deicer application zone on the ramp pavement adjacent to the main terminal (**Figure 1**, orange line). LFUCAB also applies pavement deicers within this drainage area and on the primary runway and associated taxiways. The subdrainage area includes the aircraft deicer application zone, two storage ponds to the west of the terminal originally intended for snow storage, and the deicing chemical storage area on the southeast portion of the ramp. Areas on and around the terminal ramp not draining to the deicer management system drain to other locations within the stormwater drainage system.

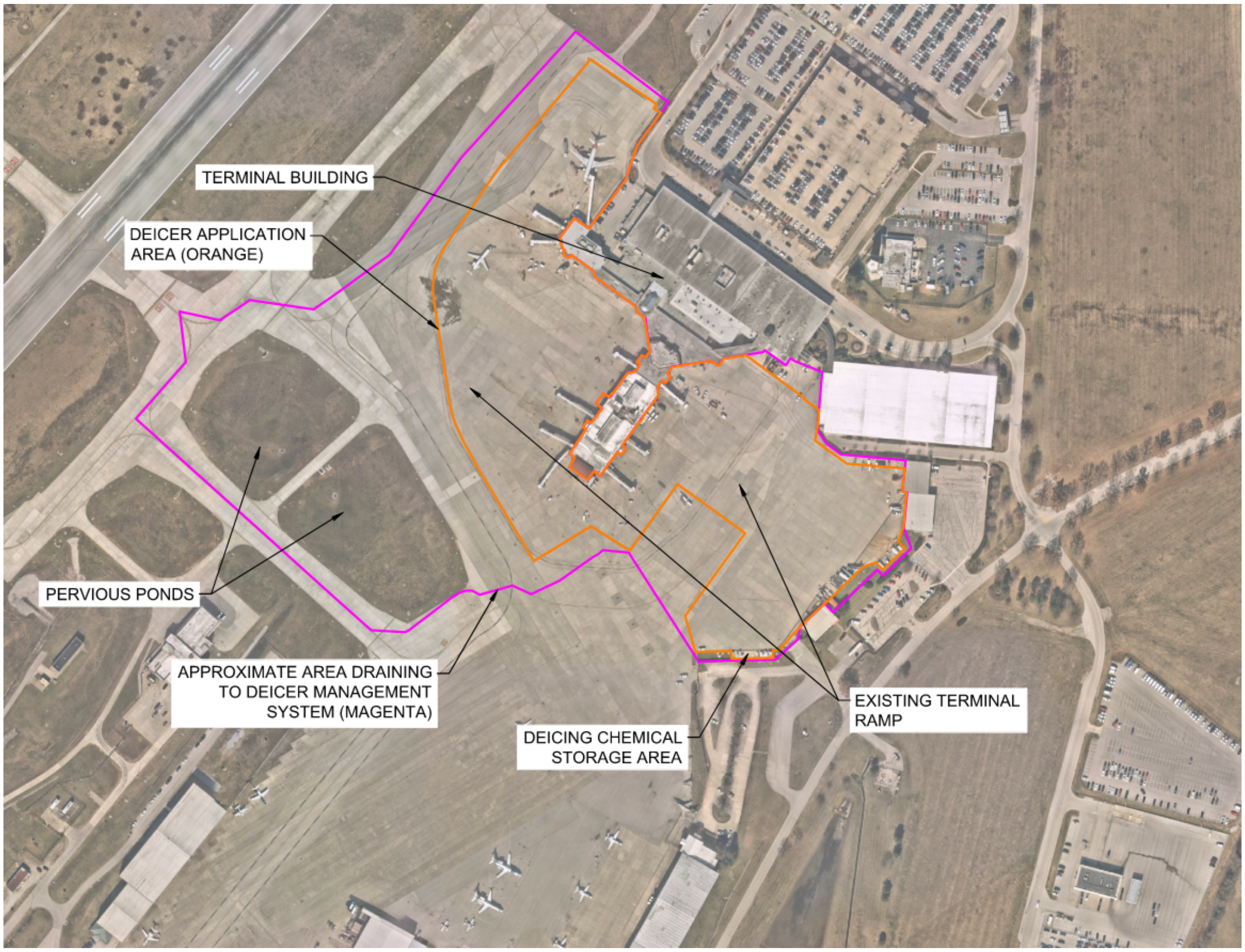


Figure 1: Existing Terminal Ramp and Deicer Application Area

Figure 2 presents a layout of the stormwater conveyance network for this subdrainage area. Blue lines represent pipelines that only convey stormwater runoff not expected to contain aircraft deicers. Red lines represent pipelines that convey stormwater runoff likely to contain aircraft and pavement deicers during and after winter deicing activities. The red lines are also used to convey non-deicing stormwater outside of deicing conditions.

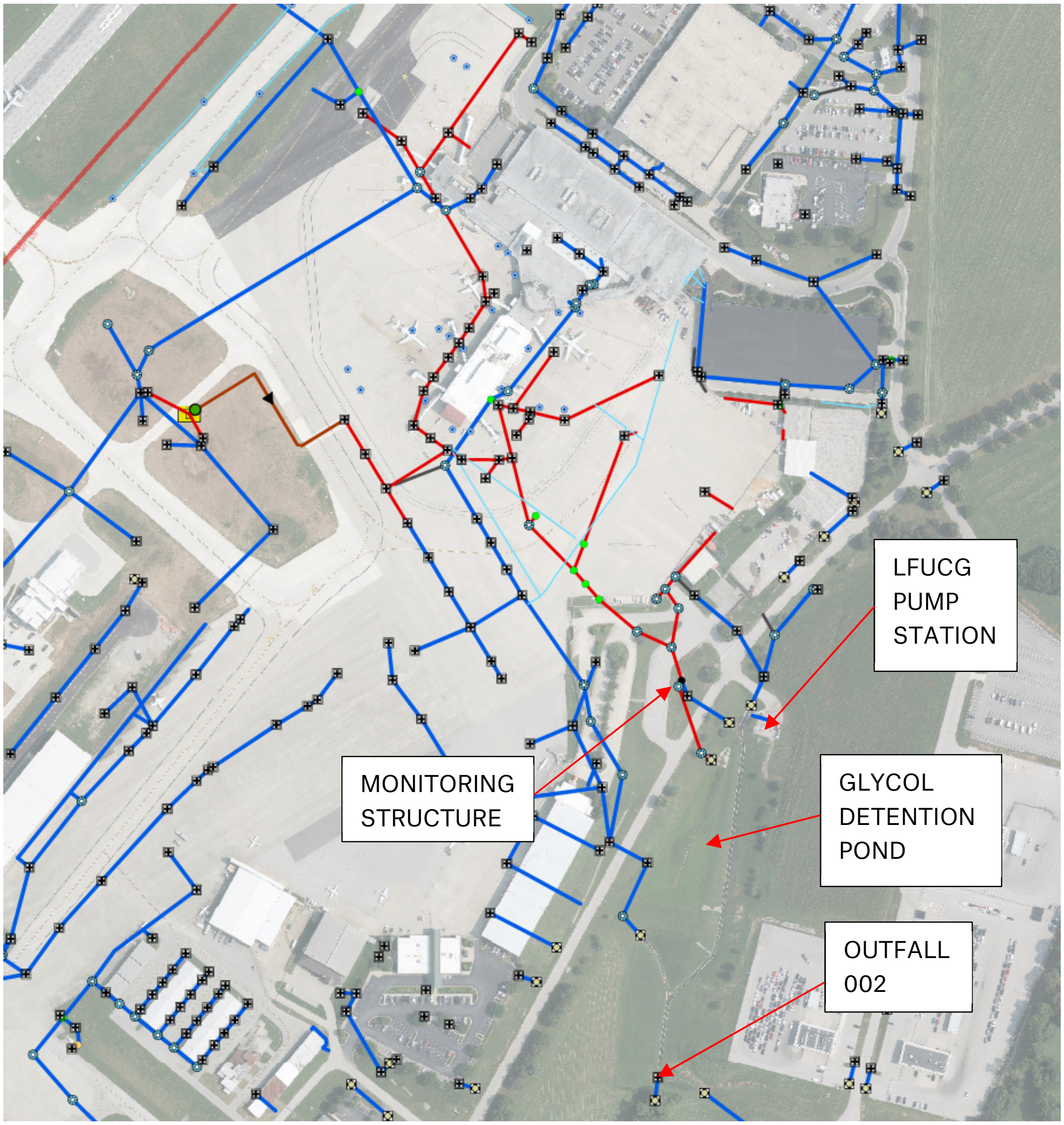


Figure 2: Existing Stormwater Conveyance and Deicer Management Infrastructure

As shown in Figure 2, the conveyance piping from the deicer application zone converges to a single point at a monitoring structure located off of the southeast side of the existing ramp. At the monitoring structure, flow is sampled and tested near-continuously for Total Organic Carbon (TOC) concentration. Flows with TOC concentrations higher than a diversion concentration setpoint are routed to the glycol detention pond. Flows with TOC concentrations lower than the diversion setpoint are routed through open stormwater channels and discharged to surface waters at Outfall 002.

The TOC diversion set point is based on effluent limits and other conditions in the LEX Kentucky Pollutant Discharge Elimination System (KPDES) permit No. KY0101851. The current permit does not contain numeric limits for propylene glycol (PG, the primary constituent in aircraft deicers) or other deicer-related parameters for discharges from Outfall 002. However, the permit does contain a stipulation that PG detected in the stormwater effluent for two or more reporting periods within a deicing season (November 1 to April 30) will result in a permit violation. To address the ambiguity and practical management challenges of the permit requirement related to PG, several years ago LFUCAB conducted a stream water quality based waste load allocation study to determine the assimilative capacity of the receiving streams downstream of Outfall 002.

At the completion of that wasteload allocation assessment, LFUCAB coordinated with the Kentucky Division of Water (KDOW) on the findings from the wasteload allocation study. After reaching a verbal agreement with KDOW on KPDES permit modifications driven by the study, LFUCAB anticipated a modification to the KPDES permit but KDOW hasn't acted on issuing a modified permit. In January 2023, LFUCAB submitted a KPDES permit renewal application to support the normal term 5-year permit renewal. LFUCAB anticipated that the new KDPES permit issued by KDOW will include numeric limits for TOC, with removal of the conditions related to monitoring and reporting of PG. KDOW has not yet responded to the permit renewal application with an updated KPDES permit. However, based on the verbal agreement with KDOW associated with the wasteload allocation study discussions, LFUCAB modified its deicer management operational protocols to only use readings from the online TOC monitor to manage flow routing from the deicer application area, with no analyses performed for propylene glycol.

The change in protocols involved using a diversion set point of 400 mg/L TOC (assimilative capacity from wasteload allocation study was 870 mg/L of TOC). If the TOC concentration at the monitoring structure exceeds 400 mg/L, the stormwater runoff from the deicer application area is diverted to the glycol detention pond. The glycol detention pond is an unlined, open-air pond bordered on the west by Airport Road and on the east by open stormwater channels (see **Figure 3**). At the level of the detention pond emergency overflow, it has a capacity of 1.17 MG. The glycol detention pond includes one valved discharge pipe to control flows to open channels conveying pond contents to Outfall 002 and one valved discharge pipe to control flows to the Lexington-Fayette Urban County Government (LFUCG) Sanitary Pump Station adjacent to the glycol detention pond. Both valves are closed when no discharges from the pond are occurring. The valve to the pump station is manually opened when discharge to the sanitary sewer is desired. The LFUCG Pump Station conveys wastewater to the sanitary sewer system and wastewater treatment plant managed by the LFUCG. On occasion if stormwater stored in the glycol detention pond becomes sufficiently dilute from incoming stormwater flows, operators may open the pond discharge valve to discharge glycol pond contents to Outfall 002.

Discharge to the sanitary sewer system is authorized through an Industrial User Permit issued by the LFUCG to LFUCAB. The Industrial User Permit includes the following:

- Numeric discharge concentration limits for metals and pH, but no limits for deicing-related parameters.
- Allowable mass loading rates for Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), and Ammonia Nitrogen (NH_3-N) that can be discharged without application of an "extra strength" (surcharge) fee.
- Flow rate monitoring requirement for LFUCAB.
- Optional monitoring requirements for LFUCAB for BOD_5, NH_3-N, TSS, and flow, among other non-deicing related parameters

- Indication that LFUCG collects and tests samples.
- Applicable rates for fees per 100 ft^3 discharged plus additional high strength discharge fees for BOD_5 (> 250 ppm), NH_3-N (> 25 ppm), and TSS (> 150 ppm) on a per pound discharged basis.

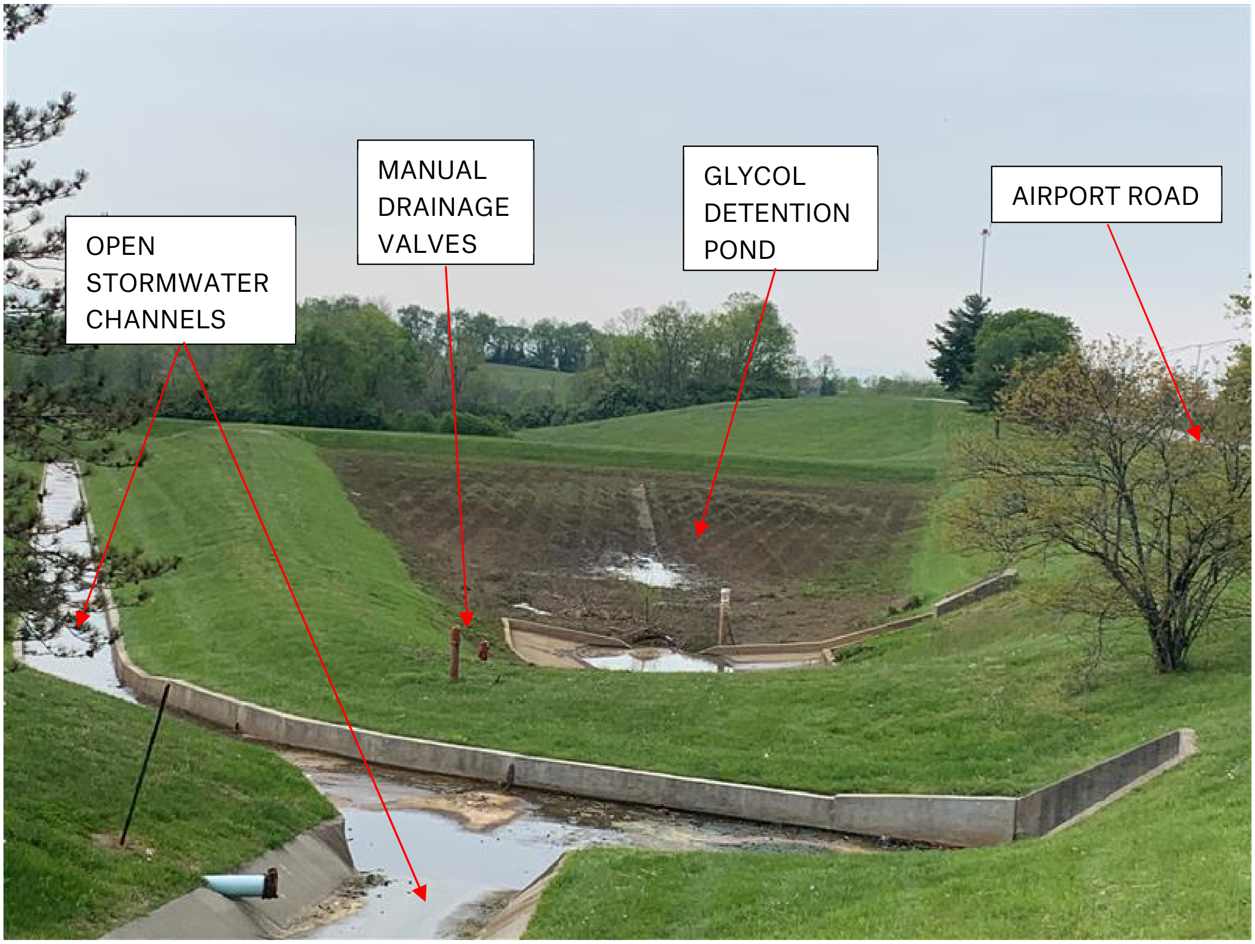


Figure 3: Glycol Detention Pond and Open Stormwater Channels

LEX Master Plan Future Development Alternative

The LEX Airport Master Plan identifies a Preferred Alternative for modifications to the airport layout to support future operations and growth. The proposed modifications for the Preferred Alternative will impact both the overall stormwater drainage system and the deicer management system (see **Figure 4**). While there are many modifications to the airport layout per the Preferred Alternative, factors that will directly affect the deicer management system include the following.

- Proposed terminal footprint impacts:
  - Modified extents of the deicer application and collection areas.
  - Conflicts with existing stormwater infrastructure on the terminal ramp.
- Proposed terminal ramp modification impacts:
  - Change in the deicer application area drainage characteristics.

- Net increase of 4 acres of area draining to the deicer management system.
- Net increase of 5 acres of impervious area and a decrease of 1 acre of pervious area.
  - Conflicts with existing snow storage ponds receiving drainage from the terminal ramp.
  - Conflicts of planned future infrastructure with current monitoring station and the glycol detention pond infrastructure.
- Impacts from increases in future flight operations:
  - Increased volumes of applied aircraft deicer and anti-icer.
  - Likely increased volumes of stormwater runoff impacted by deicers.

The Preferred Alternative modifications to the terminal footprint and terminal ramp area served as the basis for assessing potentially needed future changes to the LEX deicer management system, including potential changes in the future spent deicer stormwater (i.e., glycol detention pond) storage requirements.

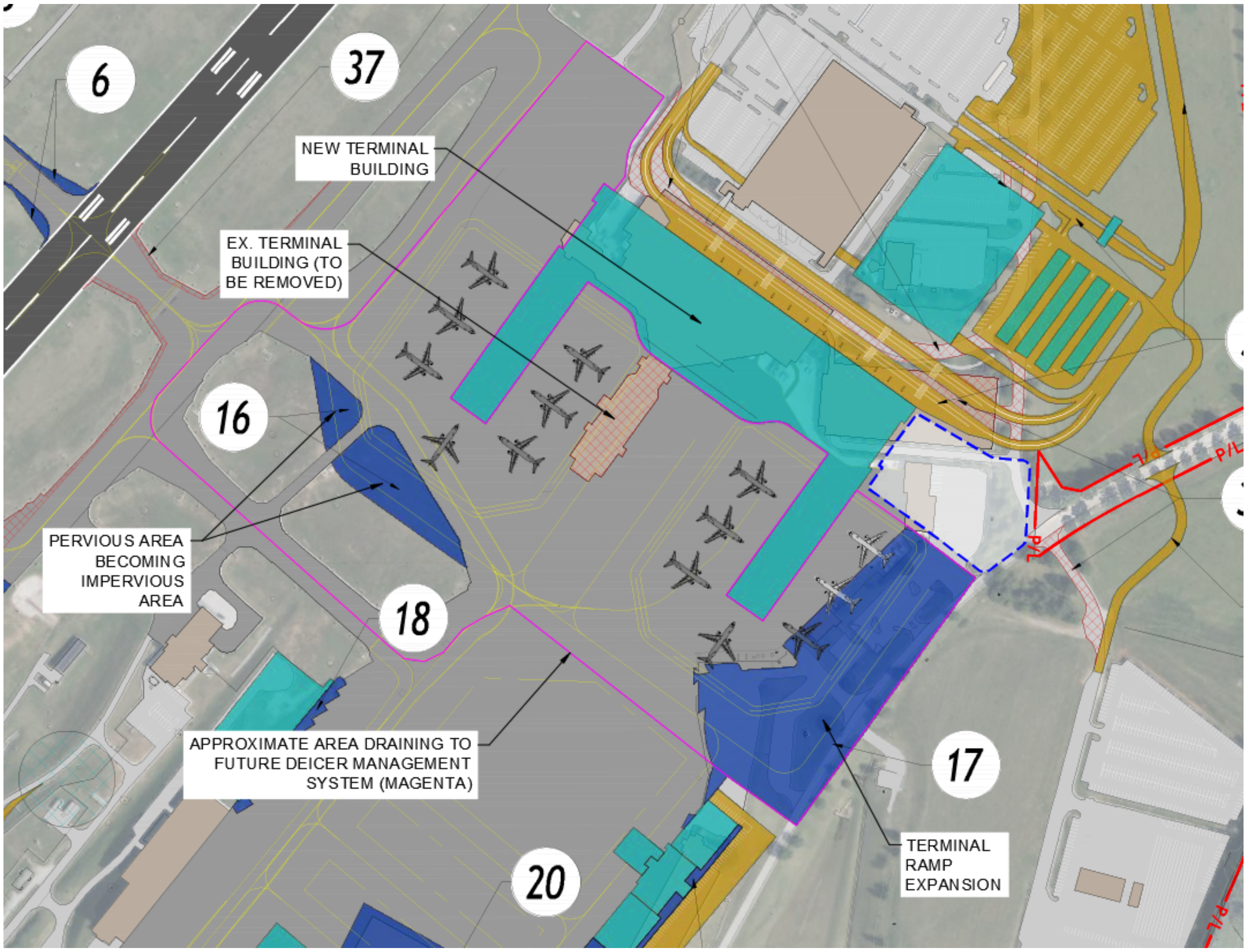


Figure 4: Proposed Modifications to Terminal and Terminal Ramp Under the Preferred Alternative (Image from 2024 LEX Airport Master Plan)

Deicer Management System Modifications Assessment Methodology

To support the LEX Airport Master Plan development, Gresham Smith was tasked with providing recommendations for modifications to the deicer management system infrastructure and operational protocols to accommodate impacts from the future development defined by the Preferred Alternative. The supporting analysis included the following steps:

- Model existing deicer application, stormwater runoff monitoring, diversion, storage, and discharge systems for current flight and deicing operations to quantify storage capacity requirements for a range of weather conditions.
- Model deicer application, stormwater runoff monitoring, diversion, storage, and discharge systems for proposed future flight and deicing operations to quantify storage capacity requirements for a range of weather conditions, based on the Master Plan Preferred Alternative.
- Quantify the changes in volumetric capacity required for future spent deicer storage compared to the existing storage capacity.
- Assess potential changes in the layouts of conveyance piping, monitoring station, and spent deicer storage.

To simulate the deicing operations and estimate spent deicer storage volume requirements at LEX under existing and future conditions, Gresham Smith utilized its proprietary GlyCAST™ model. The GlyCAST™ model is a continuous hourly deicing and stormwater flow routing model driven by historical weather data and situation specific deicing and flight operations over many deicing seasons. Through simulation of deicer concentrations and stormwater runoff flow rates at specific points within the LEX deicer management system, the model was used to estimate the spent deicer storage volume necessary to capture all high concentration flows above the selected TOC diversion set point for a range of deicing seasons.

The following resources were used to develop the LEX GlyCAST™ model. All information except for the weather data was provided by the LFUCAB environmental team.

- 51 years of historical weather data from 1971-2022 from the Automated Surface Observing System (ASOS).
- Flight schedule information from the month of February 2023 to develop a representative daily flight schedule for simulating deicing operations (see **Figure 5** for reference).
- CAD basemaps of the existing airport topography.
- Drainage maps with stormwater drainage area delineations for the existing deicer management system.
- Stage gauge survey for the glycol detention pond's volume at different elevations.
- Operational management protocols of the existing deicer management storm system.
- KPDES and Industrial User Permits for the discharge of stormwater and sanitary waste, respectively,
- Sanitary discharge volumes and fees for 2012 through 2021 for discharges from the spent deicer storage pond to the LFUCG Pump Station routing flows to the sanitary sewer.
- Deicer application data for the 2009-2010 deicing season from various air carriers.

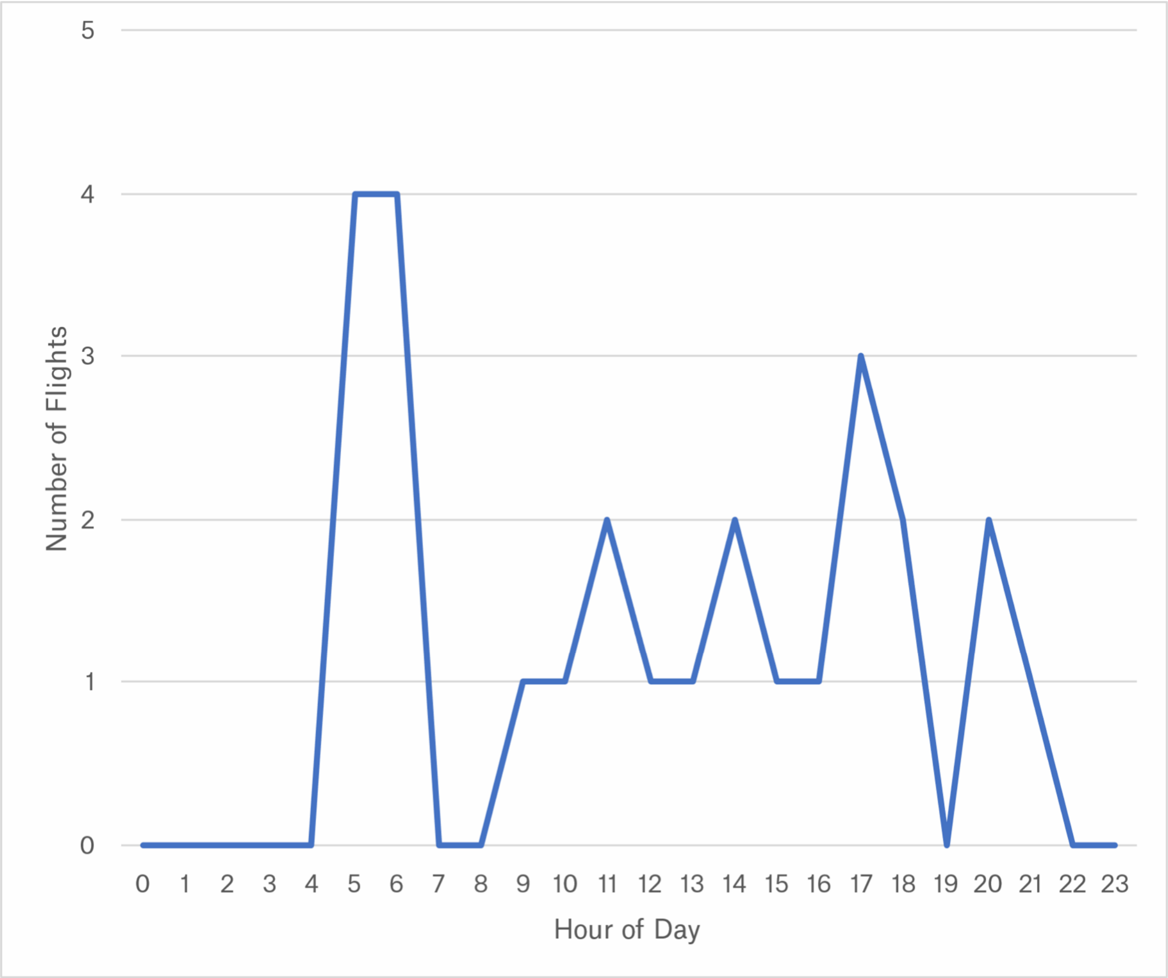


Figure 5: Representative Daily Departure Flight Schedule Used for Existing Conditions Simulations

Critical assumptions associated with the existing conditions deicing model include:

- 51 deicing seasons were modeled based on historical weather data from 1971-2022.
- Only regularly scheduled air carrier operations were simulated. No general aviation (GA), military, or cargo operations were included.
- Daily flight totals, as well as hourly timing for departures and arrivals, were based on average daily operations from the February 2023 monthly flight information.
- 26 total daily flight operations were simulated for a mix of airplane design group (ADG) II and III aircraft.
- The area collected as part of the deicer management system as delineated from topographical information provided by LFUCAB consists of approximately 33 acres of pervious and impervious surfaces.
- Per operational protocols, the glycol detention pond was modeled to retain stormwater flows until it reached 60% capacity, at which point the glycol detention pond discharges to the sanitary sewer until it empties. The glycol detention pond was assumed to continue to receive stormwater flows

while is it actively draining. This model protocol mimics current glycol detention pond operations and provides a conservative volumetric basis for possible scenarios where the pond may not be completely drained preceding a storm event.

- It was assumed that the LFUCG Pump Station is capable of emptying the maximum volume of the glycol detention pond within 24 hours, resulting in a pond discharge rate of approximately 900 gpm.
- The concentration at which the TOC monitoring structure diverts flows to the glycol detention pond in the model was set to 360 mg/L TOC, which provides a 10% buffer from the actual currently applied diversion concentration of 400 mg/L TOC.

After developing a base model for the existing conditions based on the information above, a future conditions model version was developed to represent anticipated stormwater runoff and deicing conditions based on the Preferred Alternative from the Airport Master Plan. Information from the Airport Master Plan used in the future conditions model includes:

- Future ramp pavement extents for the Preferred Alternative.
- Pervious and impervious area extents for the Preferred Alternative.
- Master Plan Operations Forecast (Appendix A of Section 3 of the Master Plan) for flight schedule projections to 2041.

Critical assumptions associated with the future conditions model are as follows:

- The critical aircraft for the primary runway under future conditions will continue to be an ADG III aircraft.
- The future conditions daily flight schedule was generated by scaling the existing conditions daily schedule by the ratio of future to existing air carrier operations projected by the Recommended Master Plan Forecast. See **Figure 6** for the projected future daily flight schedule.
- It was assumed that the entire future primary terminal ramp would be routed to the deicer management system.

Other than the assumptions listed above, all of the model inputs for the future model were consistent with the existing conditions model.

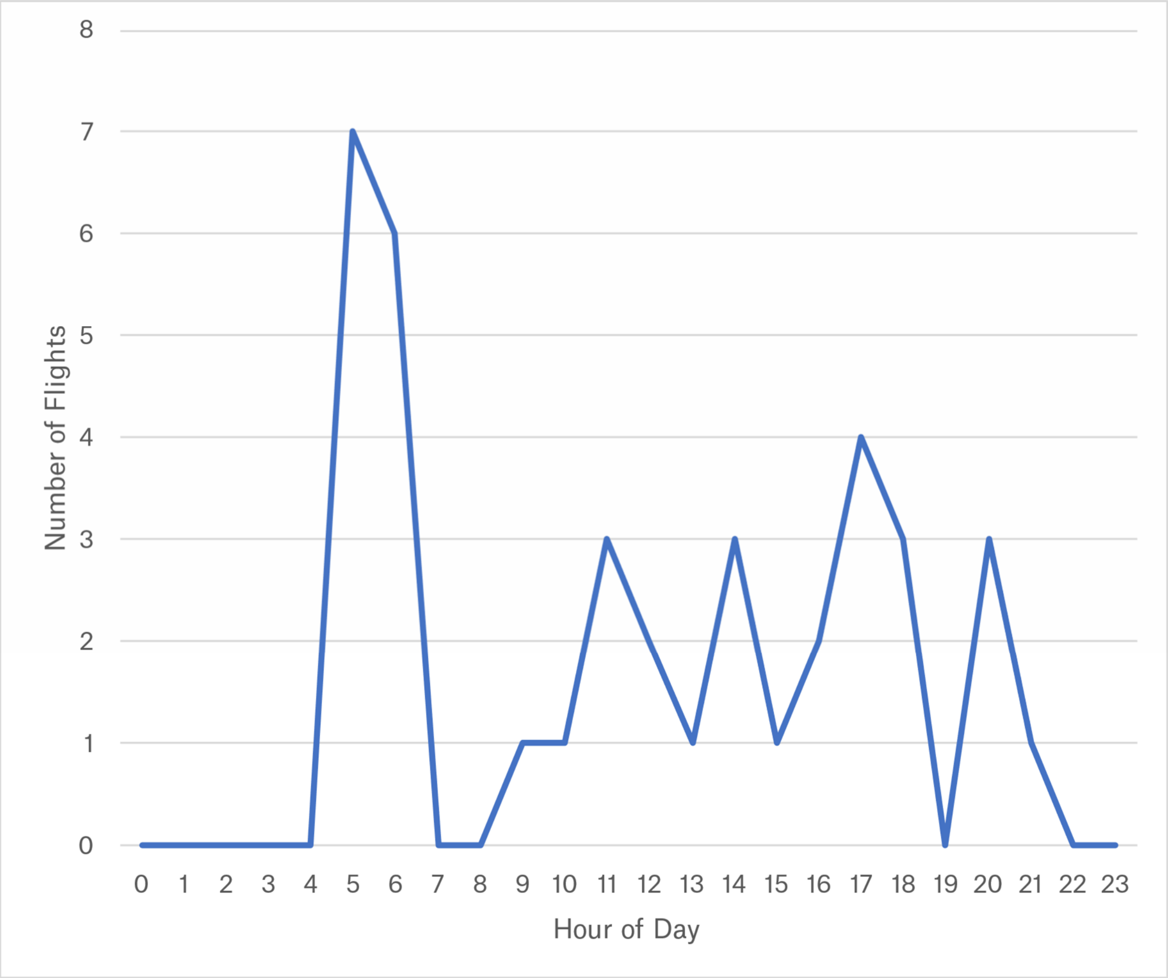


Figure 6: Representative Daily Departure Flight Schedule for Future Conditions

Results of Glycol Detention Capacity Analysis

Existing Conditions

Per the existing conditions model results, the existing deicer management system and glycol detention pond proved capable of effectively handling stormwater runoff for the range of seasons covered. Based on the model simulations, the glycol detention pond total capacity (at emergency overflow) was not exceeded for any of the simulated deicing seasons. Approximately 14% of the simulated seasons exceeded 75% of the glycol detention pond's total capacity (0.88 MG out of 1.17 MG) with the highest required volume during the most extreme deicing season (1.15 MG) being nearly at the glycol detention pond's capacity (1.17 MG). In general, the assumed rate at which LFUCAB can empty the glycol detention pond by discharging through the LFUCG Pump Station consistently outpaced the influent stormwater flows under conditions when the glycol detention pond approached its storage capacity. See **Figure 7** for a summary of the maximum modeled storage volumes for all 51 deicing seasons.

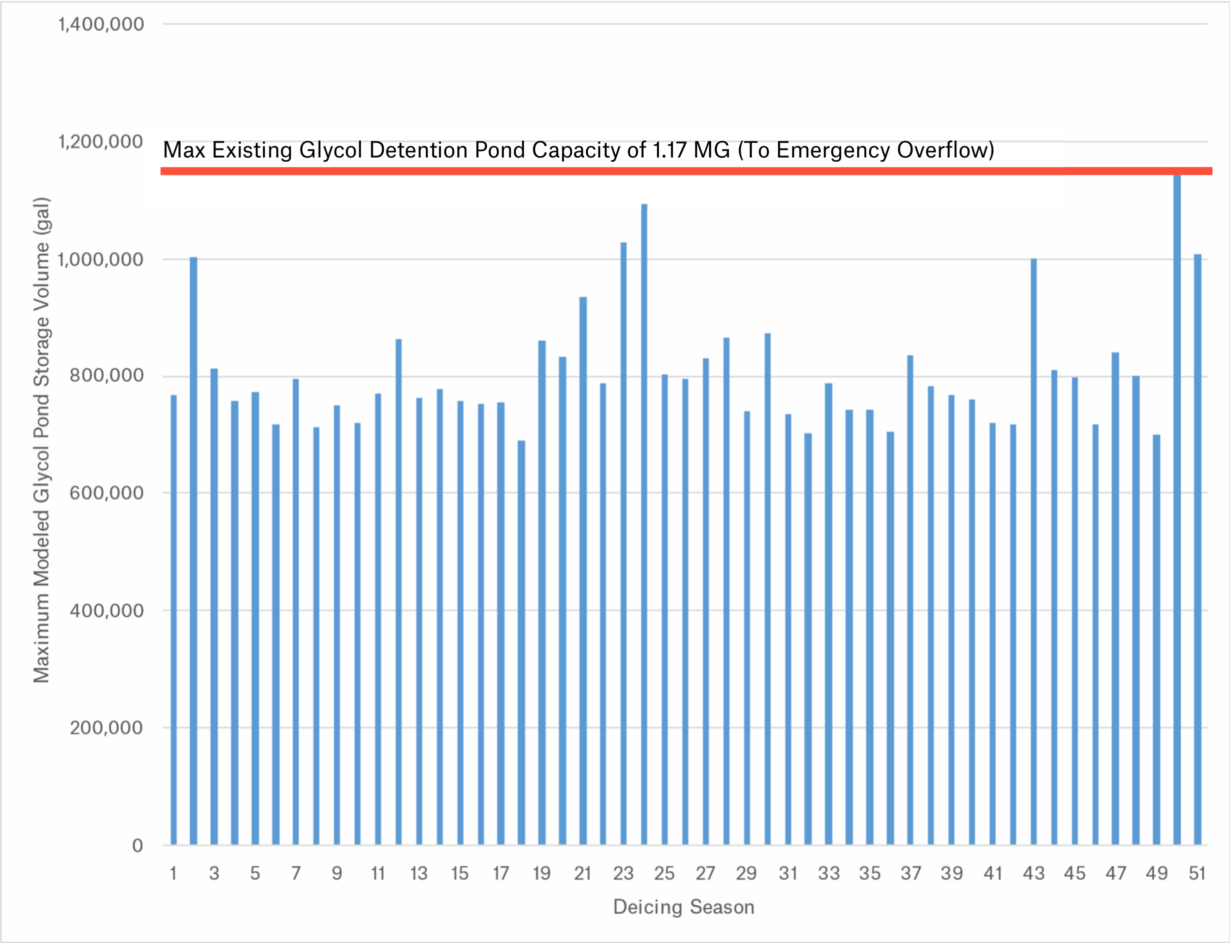


Figure 7: Maximum Modeled Glycol Detention Pond Storage Volumes for Existing Conditions

The findings from the model analysis proved consistent with information provided by the LFUCAB environmental management team, who reported occasional situations where the glycol detention pond would approach its maximum capacity but no instances of pond overflows.

Future Conditions

Based on the simulation results for the future conditions model, the maximum required spent deicer storage capacity for the Preferred Alternatives increased by approximately 15% compared to existing conditions. The maximum simulated storage capacity over all 51 seasons was 1.32 MG, an increase of approximately 0.17 MG from the required maximum capacity simulated for existing conditions. The increase in required detention capacity is attributable to increased drainage area and increases in deicer application quantities. The glycol detention pond discharge rate continued to outpace incoming stormwater flows. See **Figure 8** for a summary of the maximum modeled storage volumes required for all 51 deicing seasons.

Glycol Detention Pond Discharge Rate to LFUCG

Discharges from the glycol detention pond are not subject to any limitations in flow rate, maximum daily flow volume, maximum deicer-related pollutant concentrations, or deicer-related pollutant mass loading rates. As a result, the glycol detention pond discharge rate is controlled completely by operational decisions to open the pond discharge valve to the LFUCG Sanitary Pump Station and the available flow rate capacity in the pump station. The available pump station flow capacity is affected to some degree by the glycol detention pond level and likely to a greater degree by the volume of sanitary sewage that must be pumped at any given time.

As stated earlier, the LFUCG Pump Station available flow capacity rate of 900 gpm was used in the baseline analysis based on historical observations. For the sensitivity analyses, the available pump capacity was decreased by approximately 50% to 450 gpm. In future conditions, assuming that the existing LFUCG Pump Station is still used, the available pump capacity for discharge from the glycol detention pond could be decreased if sanitary flow rates from the facility increase. The sensitivity analyses results indicated a 9% increase in required glycol detention capacity to 1.43 MG when pump station discharge rates were decreased by 50%.

An increase in pump station flow rate of 50% was also assessed, which resulted in an 8% decrease in required glycol detention capacity.

Percent Detention Capacity Trigger for Glycol Detention Pond Discharges

As mentioned in the model simulation assumptions, stormwater flows were retained in the glycol detention pond until the pond reached 60% of its available capacity, at which point the pond would be drained at the maximum LFUCG Pump Station discharge rate until it was empty. A sensitivity test with the threshold percentage of 0% was performed to determine how much detention capacity would be required if the glycol detention pond was drained as soon as it accumulated any flow. The maximum storage capacity required under a 0% threshold for discharge was modeled to be 0.69 MG, an approximately 48% decrease in required storage capacity from the base future scenario of 1.32 MG. In summary, if the glycol detention pond was drained prior to any precipitation event and any flow routed to the pond was immediately drained at the maximum LFUCG Pump Station discharge rate, the maximum amount of storage that would be required per the model is approximately 0.7 MG. The significant reduction in simulated required storage volume suggests that the required storage capacity is sensitive to the threshold capacity at which pond discharge is initiated. If the glycol detention pond is completely emptied prior to any precipitation event, it may significantly reduce the amount of required storage capacity to contain contaminated stormwater flows.

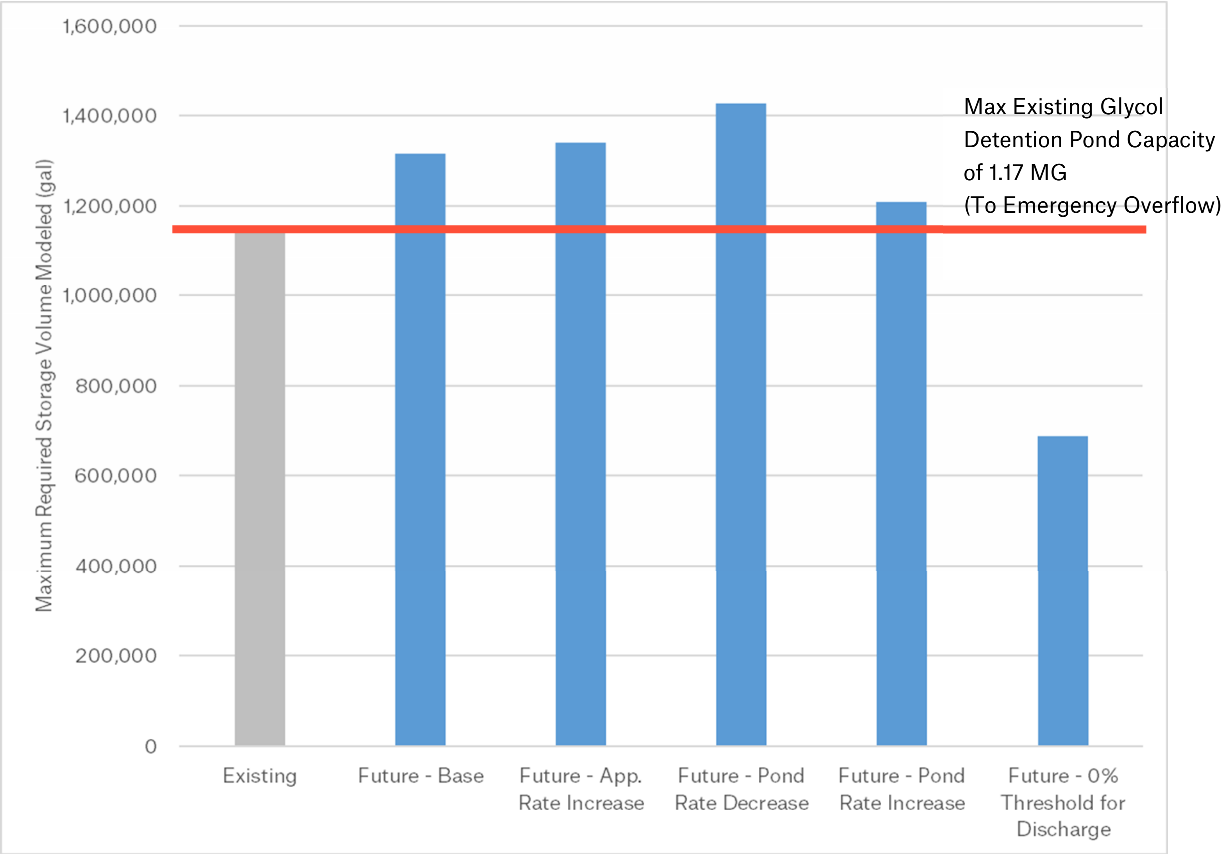
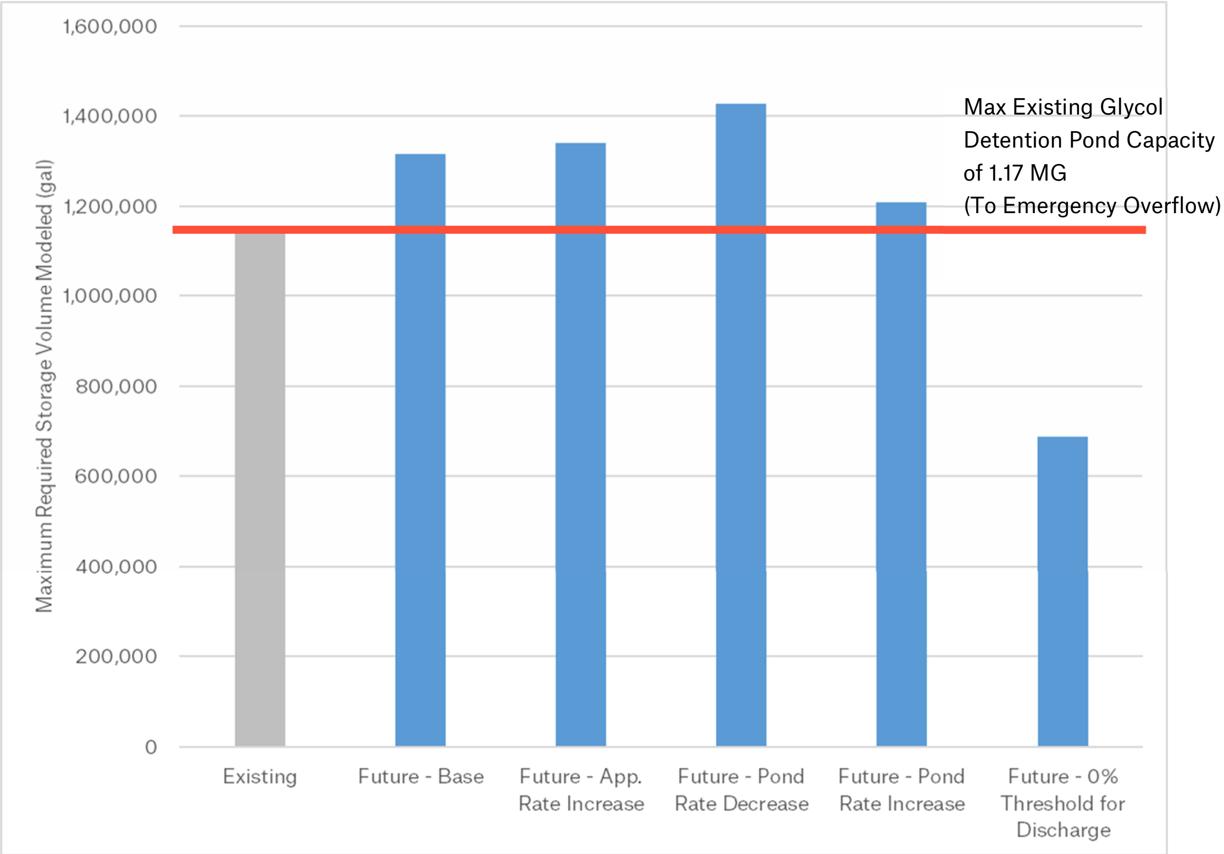


Figure 9: Comparison of Maximum Required Storage Volumes for Various Conditions

Summary of Findings from Spent Deicer Detention Volume Analysis

1. The existing glycol detention pond has a maximum capacity of 1.17 MG at the glycol detention pond's emergency overflow. For existing conditions, the glycol detention pond appears to have sufficient capacity to detain stormwater with spent deicer for a wide range of deicing conditions without overtopping. No short-term changes in the pond are needed.
2. For future conditions, a glycol detention capacity of at least 1.34 MG is required to prevent emergency overflows to Outfall 002, with as much as 1.43 MG being required if sanitary sewer discharges to the LFUCG Pump Station increases in the future, thereby decreasing the available flow capacity for pumping spent deicer-impacted stormwater to the sanitary sewer.
3. For planning purposes at this master planning level, it is conservatively recommended that a 1.5 MG storage structure be considered. This volume will be sufficient to contain stormwater-impacted deicer for a wide range of weather and operational conditions, while also providing sufficient room for space above the emergency overflow level.
4. Required spent deicer-impacted stormwater detention capacity could decrease if the stored stormwater is discharged to the sanitary sewer as soon as it accumulates in detention, rather than retaining the stored stormwater until the detention structure reaches 50 to 60% of capacity as is the current practice.



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Preferred Alternative Impacts on Deicer Management Component Siting

The extent of the proposed terminal and terminal ramp modifications in the Preferred Alternative has a direct impact on the existing deicer management system infrastructure and on the siting of future deicer management system infrastructure. The proposed pavement extents in the Preferred Alternative, combined with offsets for safety areas, AOA fencing, access roads, and the grading to connect the ramp extents to existing grade, will directly conflict with the existing deicer management system components as shown in **Figure 10**. In particular:

- The deicer application area will change in the Preferred Alternative, meaning that a new/modified storm sewer network will be needed in the application area to prevent that drainage from mixing with ordinary stormwater flows.
- To construct the terminal building and modified ramp area, it is likely that at least some of the existing stormwater piping and structures, including the piping associated with routing of spent deicer stormwater, will need to be modified and/or replaced.
- The existing monitoring structure and TOC sampling shelter are located directly within the proposed terminal ramp pavement extents and will likely need to be replaced.
- Because the pavement extents of the terminal ramp are much farther east than the current pavement and considering the difference in grade between that pavement and the surrounding areas, an embankment needed to support the extended pavement would likely extend into the existing glycol detention pond area (see cyan line on Figure 10).
- The new embankment may also affect the LFUCG Sanitary Pump Station.

These impacts are further discussed on the following page.

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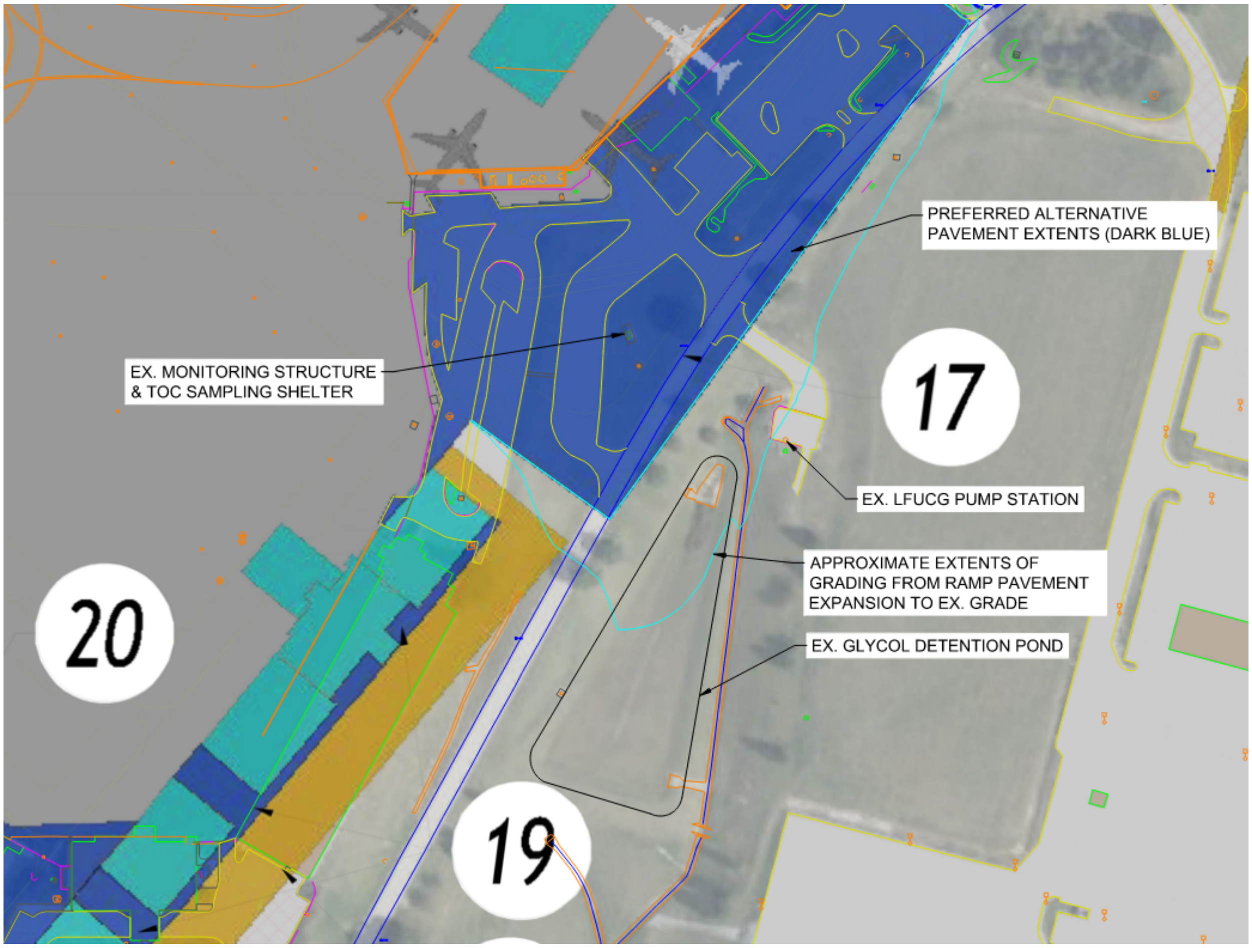

Figure 10: Impacts of Terminal Ramp Expansion Under Airport Master Plan Preferred Alternative

Ramp Stormwater and Spent Deicer Drainage System

The proposed expansion of the terminal ramp and reconstruction of the terminal building will likely require significant updates to the existing stormwater drainage system. New stormwater piping and structures will need to be provided to accommodate new pavement extents. Roof drainage from the new terminal building will need to be connected to the existing clean stormwater system. There will also likely be updates to ramp grading and associated stormwater inlets that drain to either the stormwater or deicer management system piping depending on which areas of the terminal ramp are designated as deicer application areas. During future planning and design phases for a new terminal and terminal ramp modifications, both non-deicing stormwater drainage and deicer application area drainage impacts need to be carefully considered and planned in conjunction with ramp layout planning.

Deicer Management Monitoring and Diversion System

During the planning and design phase for the terminal ramp expansion, it is recommended that LFUCAB include plans for a new monitoring and diversion structure for the deicer management system, as the proposed pavement for the terminal ramp expansion extends over both the existing monitoring structure and TOC sampling shelter. The existing monitoring structure (see **Figure 11**) is a large, 26' x 11' x 14' buried concrete structure that is likely incapable of being relocated and will either need to be demolished or abandoned in place. It is recommended that the existing TOC sampling shelter and associated equipment also be replaced with a new shelter and new, updated TOC sampling equipment to replace the aging equipment from the original 1996 design.

Figure 11: Existing Monitoring Structure and TOC Sampling Shelter

The exact location of the new monitoring structure and TOC sampling shelter will need to be determined during future design. However, both the monitoring structure and TOC sampling shelter will need to be located downstream of the existing structures while coordinating closely with the location of future detention for the deicer management system. Locating the new monitoring structure and TOC sampling shelter outside of the AOA fence, similar to the existing location of the structures, would allow for more convenient ease of access for operators and vendors if repairs or replacement parts are needed. Existing deicer management system drainage piping will need to be adjusted in relation to the location of the monitoring structure. If possible, it is most cost effective to locate the diversion structure so that it will maintain the gravity drainage of the existing deicer management system into the components of the future deicer management system.

<u>Deicer Management System Spent-Deicer Impacted Storwmater Detention</u>

The existing glycol detention pond will likely need to be replaced if the Preferred Alternative is implemented. The replacement is driven by a variety of factors including:

- The existing pond is reasonably likely to be impacted by the significant extension of the terminal ramp to the east.

- The effective storage capacity for spent deicer under future conditions will need to increase from current capacity of 1.17 MG to as much as 1.43 MG depending on operational decisions.
- The existing glycol detention pond is an earthen detention basin with no impervious liner. It is therefore susceptible to leaking and allows the opportunity for captured contaminated stormwater to infiltrate into the groundwater if the contaminated stormwater remains in the pond for an extended period of time.
- The existing glycol detention pond is uncovered and can act as a waterfowl attractant.
- Captured stormwater containing deicers that remains within the open glycol detention pond for an extended period poses a risk of foul odors, which could become a more significant nuisance with the ramp and associated buildings situated closer to the pond in the Preferred Alternative.

LFUCG Pump Station

As illustrated in Figure 8, it is possible that the LFUCG Pump Station location could be in conflict with the grading required to construct the terminal ramp expansion under the Preferred Alternative. If the grading extents from the ramp down to existing grade at the LFUCG Pump Station do overlap, it is possible that the pump station riser can be extended and associated equipment can be raised up to the new proposed grade.

The LFUCG Pump Station capacity should also be evaluated in future planning and design to account for both future sanitary sewage demand and the optimal rate for draining the spent deicer storage structure. As outlined in the *Model Results Conclusions* section, the ability of the LFUCAB to manage captured flows within the deicer management storm system primarily hinges upon the available pump capacity at the LFUCG Pump Station for contaminated stormwater flows from the glycol detention pond. The LFUCG Pump Station receives flows from all sources of sanitary waste across the airport. Demand from other sources of sanitary waste will likely increase per future conditions as passenger traffic increases at the airport; therefore, it would be advisable to determine if enough remaining capacity will be available to provide the same pump rates for draining captured spent deicer flows as under existing conditions while receiving future conditions demands from other sanitary sources. New pumps with higher pumping capacities or a new pump station may be required to meet increased demands.

Alternatives for Future Deicer Management Infrastructure

The major infrastructure components for future deicer management infrastructure include:

- New or modified stormwater conveyance piping.
- New diversion structure / TOC monitoring structure located at a point downstream of all branches of the deicer application area collection system and the spent deicer storage structure.
- New 1.5 MG spent deicer detention structure.
- Potential for new or modified LFUCG Sanitary Pump Station.

Alternatives for key infrastructure elements are discussed below.

Stormwater Conveyance

Currently, the existing deicer management system operates entirely by gravity from the storm drains on the ramp to the LFUCG Pump Station. Ideally, maintaining gravity drainage would be the most economic option, as it prevents the requirement of an additional pump station. Maintaining gravity drainage requires working within the elevation difference between the existing monitoring structure (elev. 942') and the inlet to the LFUCG Pump Station (elev. 925.85') for all of the new deicer management system components. The elevation difference of about 16 feet will need to include slopes of gravity drainage pipes, water depth for storage, and any freeboard required for a storage alternative.

It is presumed that some of the existing stormwater and deicer management system piping on the existing ramp can be retained, but it is likely that substantial amounts of the piping will need to be rerouted/replaced to construct the terminal building with sufficient foundations and without having underlying piping. Similarly, if new ramp pavement will be constructed, the new pavement will require new drainage infrastructure.

The layout of the revised stormwater drainage configuration will need to consider the extent and isolation of the deicer application area as well as the need to connect to existing stormwater drainage structures on the exterior of the new development.

New Diversion Structure / TOC Monitoring Station

It is not likely that that new extended portions of the terminal ramp could be constructed around the existing diversion structure and monitoring station. Assuming that a new location is needed for the diversion structure and TOC monitoring station, several factors should be considered:

- Need for new sample collection within the drainage piping.
- Access to power and control system infrastructure.
- Driving access to the structure for operators and environmental compliance staff.

Spent Deicer Detention Structure and Discharge System

There are several potential detention structure solutions available as alternatives to the existing glycol detention pond. Three potential alternatives are outlined in **Table 1** below.

Table 1: Summary of Deicer Management System Detention Alternatives

Storage Method	Description	Pros	Cons
Type II or III Precast Wire Wound Concrete Tank or Precast Vault	Buried or partially buried concrete vault constructed from precast sections assembled on site	• More economic than cast-in-place structure • Shorter construction timeframe • Modular design allows for customizable layout • History of successful use at other airports	• Limited depth of bury • May require internal spray-on lining or corrosion inhibitor in concrete mix to prevent corrosion of concrete by degrading deicers during warm weather conditions
Cast-in-Place Concrete Storage Vault/Tank	Buried or semi-buried cast-in-place concrete vault	• Allows for wide range of depth of bury • Greater degree of water-proofing • With proper design, space at grade above vault can be utilized for parking or other uses	• Most expensive option • May require internal spray-on lining or corrosion inhibitor in concrete mix to prevent corrosion of concrete by degrading deicers during warm weather conditions
Pre-Engineered Modular Stormwater Storage Structures	Buried storage structures sold by various manufacturers	• Fastest construction • Allows for other development on surface	• Less potential to be truly watertight • Lower effective volume per area
Covered Detention Basin	Lined detention basin with floating cover	• Anticipated lowest capital cost • Typically lowest required excavation • Liner is resistant to corrosion by degrading deicers	• Requires largest footprint • Area occupied is aboveground and cannot be utilized for other purposes • Maintenance difficulty with liners and covers

It is recommended that all conveyance structures associated with the detention structure be enclosed pipes or box culverts. In the current system's open channels, aircraft and pavement deicers exposed to sunlight encourage the growth of biofilm, a complex comprised of bacteria and extra-polymeric substances. Biofilm growth has been observed within the open stormwater channels, as illustrated in **Figure 14**. Excessive biofilm growth in discharge channels can lead to biofilm growth in receiving streams. In the past, KDOW has required lower effluent limits for Kentucky airports for BOD_5 when biofilms are frequently present in the receiving streams.

Figure 14: Biofilm Growth in Open Stormwater Channel Downstream of Monitoring Structure

In order to reduce the likelihood of biofilm growth, it is recommended that the LFUCAB consider replacing the existing open stormwater channels with buried drainage pipe and storm grates to manage stormwater flows. Buried piping would prevent the stormwater containing trace amounts of deicers from having unnecessary exposure to sunlight while within the storm system, inhibiting the growth of biofilms. Utilizing buried piping also has the secondary benefit of partially containing odors that may arise from degrading deicers as they are conveyed by the storm system.

<u>Siting Options for Future Deicer Management Infrastructure</u>

The most important siting decision is the location of the spent deicer detention structure. The siting options for this structure depend on the type of structure and size. **Table 2** outlines some of the alternative locations.

Table 2: Outline of Potential Locations for Proposed Future Deicer Management System Detention Structures

Location	Pros	Cons
Within the existing glycol detention pond extents	• Elevation at grade is within operating range between existing monitoring structure and LFUCG Pump Station, limiting need for excessive cut or fill of site	• Constrained site extents
East of the LFUCG Pump Station	• Open field with large amount of space available • Currently no planned development	• Elevation at grade is at least 15' higher than berm of existing glycol detention pond • May require extensive excavation and depth of bury • May require pump station to lift flows to storage alternatives closer to grade if gravity flow cannot be maintained
South of existing glycol detention pond	• Location utilizes area that would not likely be utilized for other facility development	• Elevation south of the existing glycol detention pond declines rapidly • May require extensive fill • May require utilization of a pump station to lift flows from lower grade up to LFUCG Pump Station if gravity flow cannot be maintained

Figure 12 illustrates a potential alternative siting option assuming a 1.5 MG precast concrete storage vault located south of the existing glycol detention pond.

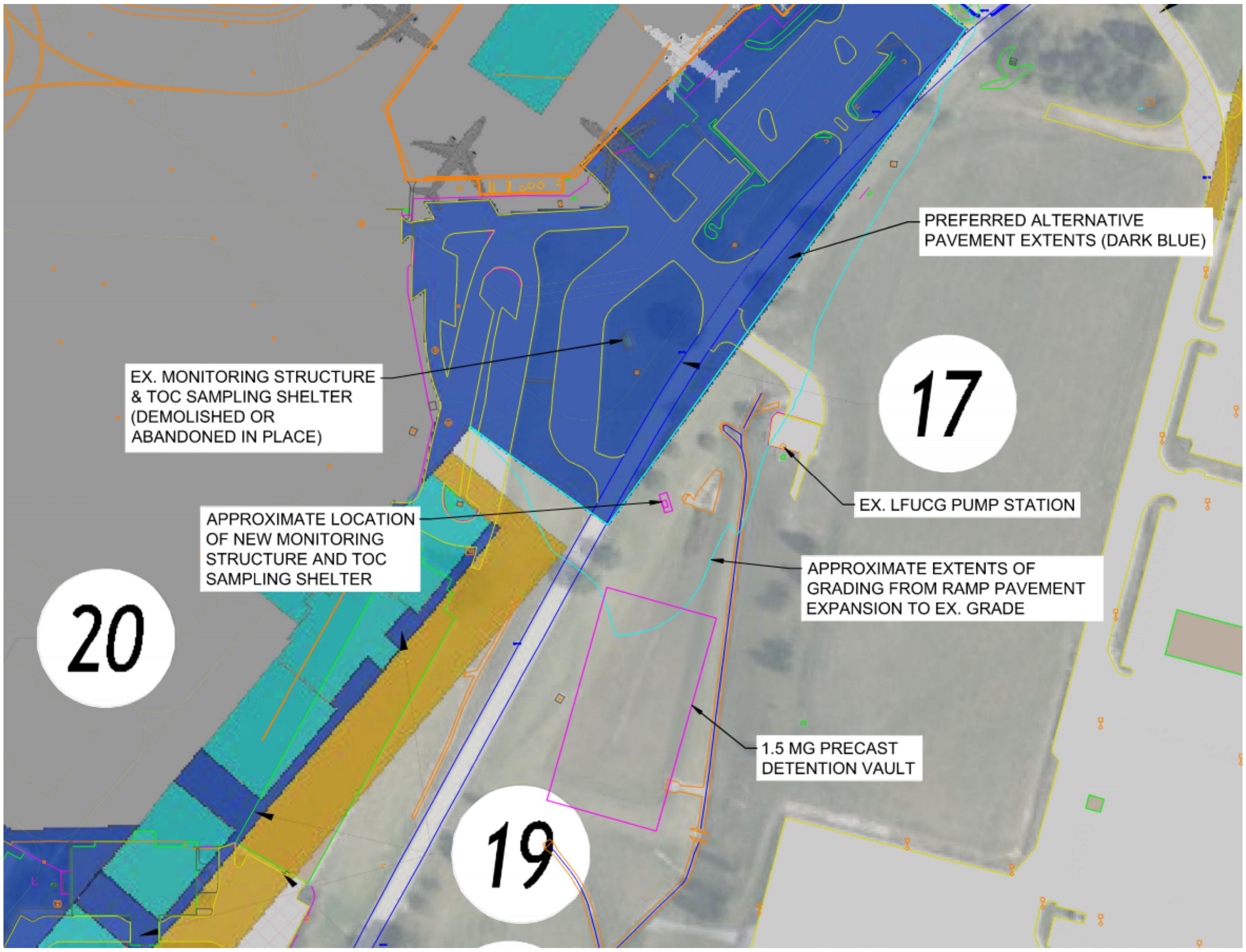

Figure 12: Proposed Future Layout for Deicer Management System Detention Structure Improvements

The 1.5 MG precast concrete vault is located primarily within the extents of the existing glycol detention pond. The inner height of the vault is approximately 6′, with 5′ of active storage height and 1′ of freeboard. The top of the vault was assumed to be approximately equal to the height of the existing glycol detention pond's berm, meaning that a minimum amount of excavation would be required to site the vault. By constraining the vault's elevations to be similar to the existing glycol detention pond's elevations, a similar hydraulic profile to the existing deicer management system is maintained for the future system. As outlined in Table 1, a precast vault is more economical than a cast-in place vault, and the modular design of the precast system could allow the vault shape to be further refined to reduce excavation. The elevation profile is also suitable to maintain gravity drainage so that an additional pump station is not needed. See **Figure 13** for an example of a precast concrete vault.

Figure 13: Example of Precast Concrete Detention Vault Assembly (Image Courtesy of StormTrap® Website)

The main concerns with the layout pictured in Figure 10 are waterproofing and concrete corrosion. Since the precast vault is assembled by joining precast concrete sections together, care will need to be taken to ensure that the vault sections are assembled as true water-tight seals. Concrete corrosion occurs when deicers within stormwater degrade, especially under warm weather conditions. One of the by-products of deicer degradation is an acid that reduces the pH of the captured stormwater. Over time, the low pH of the stormwater can cause the concrete of the vault in contact with the stormwater to degrade, potentially affecting the rebar or other reinforcement. Degradation of the concrete can lead to leaks and potentially affect the structural integrity of the unit. Several methods are available to reduce this risk including spray-lining for the interior of the vault and by adding a corrosion inhibitor to the concrete mix. Another method of managing concrete corrosion is to discharge captured stormwater flows soon after they are collected, reducing the likelihood that deicers would have a chance to degrade and lower the pH of the stormwater while also minimizing low pH stormwater contact time with the concrete.

Future Deicer Management Controls / Operational Considerations

Currently, stormwater flows captured in the glycol detention pond are managed manually, including visually inspecting the pond and manually adjusting the discharge valve adjacent to the glycol detention pond to enable drainage of the pond's contents (see Figure 2). LFUCAB may want to consider usage of level sensors and automated discharge valves in the detention structure with remote access to allow improved monitoring and management of flows within the deicer management system detention remotely. Remote control access will also allow for quicker response times during periods of high stormwater flows or for automatic control of discharge from the deicer management system detention based on specified parameters.

Implementation Timing/Phasing

Implementation for the recommended updates to the deicer management system largely depends on a combination of the overall implementation schedule for the Preferred Alternative of the Airport Master Plan and any updates that may be deemed priority by the LFUCAB to avoid potential future compliance conflicts. **Table 3** below outlines implementation considerations for each of the recommendations listed in the previous section of this report.

Table 3: Implementation Considerations for Recommended Updates

Item	Implementation Considerations
LFUCG Pump Station	• Necessity of pump upgrades depends on whether the future sanitary sewage demand reduces the available capacity for draining the glycol detention pond or future glycol detention alternative. • Pump station riser and associated equipment may need to be raised depending on future grade from ramp expansion.
Deicer Management System Piping and Monitoring Structure	• Revised stormwater conveyance alignments need to be considered in early ramp expansion planning, for both deicing and non-deicing conditions. • Deicer management system updates from the monitoring structure and downstream could potentially be implemented prior to the ramp expansion, but tentative, updated future designs for the terminal ramp expansion could lead to redundant deicer management system adjustments during future ramp expansion. • Coordination of the implementation of new ramp deicing areas and drainage with maintaining existing deicing operations will be a challenge. Should deicing activities be temporarily moved to areas other than the current deicer application during construction, those areas may not drain to the monitoring system and glycol detention pond.
Deicer Management System Detention	• Conflicts may arise with further refinement of the ramp expansion in the future, depending on ramp extents and grading. Careful consideration should be placed on location of detention structure modifications with respect to the Preferred Alternative of the Airport Master Plan. A location less likely to be impacted by the future ramp expansion would potentially allow for earlier implementation of a new glycol detention alternative. • Preliminary planning, modeling activities, and coordination with vendors for selection of a new detention alternative should begin 6 – 12 months prior to the start of design.

Spent Deicer Detention Structure Discharge	• Potential to prioritize updates to convert open channels to buried piping prior to ramp expansion to alleviate known issues • Conflicts may arise with updates required during ramp expansion, leading to redundant renovations • Conflicts may arise with modifications to deicer management system detention structures, depending on location and area required. Updates to open stormwater channels may be beneficial to perform along with deicer management system detention structure modifications, since the existing glycol detention pond and open stormwater channels are adjacent.

Summary of Findings and Recommendations

Findings and recommendations from this assessment of the impacts of the 2024 LEX Master Plan Preferred Alternative on the LEX deicer management system are summarized below. Note that the presented alternatives are high-level concepts and will require further analysis for siting and feasibility during future design and planning.

1. The existing deicer management system has sufficient capacity and capabilities to manage stormwater runoff containing deicers from current flight operations and deicing activities, although the design and condition of the glycol detention pond and associated discharge channels does pose some risk for leaking, odors, and biofilm growth.
2. The increase in drainage area, flight operations, and associated deicing activities associated with the Preferred Alternative will increase the volume of stormwater impacted by deicer that must be collected to achieve compliance with expected future KPDES permit limits.
3. The increase in volume of deicer-impacted stormwater to collect under future conditions will ultimately require an increase in storage volume of approximately 28% to a total of 1.5 MG.
4. The Master Plan Preferred Alternative includes a significant extension of the terminal ramp to the east that will conflict with some existing deicer management infrastructure.
5. Deicer management infrastructure that will need to be relocated or more likely replaced include:
    a. Stormwater drainage piping associated with collection of runoff from a likely modified deicer application area.
    b. New diversion structure/TOC monitoring station.
    c. New spent deicer storage structure
    d. New discharge piping/culverts from the deicer storage structure to both Outfall 002 and the LFUCG Sanitary Pump Station.
    e. Modification or replacement of the LFUCG Sanitary Pump Station.
    f. Potential improvements to monitoring and controls.
6. The land areas adjacent to the extended terminal ramp area and existing glycol detention pond should be sufficient to site the above new and modified infrastructure.