APPENDIX L

Hydrology and Stormwater Pond Analysis

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Hydrology and Stormwater Pond Analysis

Liesch Associates, Inc.

June 1, 2012

Minneapolis-St. Paul International Airport 2020 Improvements Environmental Assessment/ Environmental Assessment Worksheet

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INTRODUCTION

This technical report addresses potential impacts to downstream receiving waters from increased impervious surface land cover associated with the Minneapolis-St. Paul International Airport (MSP) 2020 Improvement Plan Alternatives and 2030 traffic/roadway plan (addressed at the end of this appendix). The methodology selected by Liesch Associates, Inc. (Liesch) utilized existing monitoring data to establish baseline treatment efficiencies and incorporated modeling data to quantify increases in pollutant loading and peak discharges from each proposed alternative.

1 Land Cover by Alternative

Three alternatives have been proposed for the MSP 2020 Improvement Plan. Each alternative requires slightly different land use, and thereby slightly different land cover. Due to the effect on surface water runoff, the net increase in impervious surface is highlighted below along with a description of each alternative.

- No Action Alternative (NAA): Represents no proposed action or change in land cover. In this analysis the NAA is equivalent to existing conditions.
- Airlines Remain Alternative: Represents the proposed actions required to accommodate for additional travelers while keeping the airlines assigned to the terminals in which they are currently located. *Net impervious area increases 6.5 acres (0.4%).*
- Airlines Relocate Alternative: Represents the proposed actions required to accommodate for additional travelers along with relocating select airlines to opposite terminals. *Net impervious area increases 28.4 acres (1.5%).*

A more detailed description of the change in land cover within each of the stormwater retention pond drainage areas is presented in **Table 1.1 Drainage Area Land Cover by Alternative**. The table shows the net increases in both directly connected and indirectly connected impervious area. Directly connected impervious land cover includes pavements, roofs and other hard surfaces that are directly connected to the storm sewer piping network (i.e. runoff does not flow through grass surfaces prior to entering storm sewer piping). It was utilized in peak runoff rate modeling. The italicized numbers represent the net increase in impervious area.

The existing/NAA areas were generated from satellite photography. The Airlines Remain and Airlines Relocate alternatives were modified from the existing areas with data provided by TKDA (airside) and Kimely-Horn (landside). **Attachment 1 - Airlines Relocate Add'l Impervious** shows the locations of proposed airside land cover change from pervious to directly connected impervious for the Pond 1 Drainage Area.

Table 1.1

Drainage Area Land Cover by Alternative

	Pond 1 (acres)	**Pond 2 (acres)**	**Pond 3/4 (acres)**	**Mn/DOT Almaz Pond (acres)**
No Action Alternative				
- Direct Impervious	459	432	205	305
- Indirect Impervious	261	149	72	0
- Total Impervious	720	581	277	305
- Pervious	470	225	175	83
- Total	**1190**	**806**	**452**	**388**
Airlines Remain	*+ 2.7*	*- 0.2*	*+ 0.3*	*+ 0.0*
- Direct Impervious	461.7	431.8	205.3	305
- Indirect Impervious	261	149	72	0
- Total Impervious	722.7	580.8	277.3	305
- Pervious	467.3	225.2	174.7	83
- Total	**1190**	**806**	**452**	**388**
Airlines Relocate	*+ 27.5*	*- 0.2*	*+ 0.0*	*+ 0.0*
- Direct Impervious	493.1	431.8	205	305
- Indirect Impervious	254.4	149	72	0
- Total Impervious	747.5	580.8	277	305
- Pervious	442.5	225.2	175	83
- Total	**1190**	**806**	**452**	**388**

Source: Liesch Associates, MSP Existing Land Cover / TKDA, 2020 MSP Airside Development / Kimley-Horn, 2020 MSP Landside Development.

Each action alternative also has net new impervious area from roadway improvements outside the pond drainage areas. These increases are almost entirely from the Post Road and Highway 5 improvements. They total 3.7 acres for Airlines Remain Alternative and 1.1 acres for Airlines Relocate Alternative.

Combining the net new impervious area for the MSP drainage areas with net new impervious areas outside the MSP drainage areas yields the total net new impervious areas. These are 6.5 acres for the Airlines Remain Alternative (2.8 acres to MSP ponds, and 3.7 acres in other outside areas). For the Airlines Relocate Alternative, the net new impervious area is 28.4 acres

(27.3 acres to MSP ponds, and 1.1 acres in other outside areas). These projects and their associated increases in net impervious area will comply with the SWPPP and meet construction NPDES and Lower Minnesota River Watershed District permit requirements.

2 Existing Wet Detention Pond Treatment – NPDES Monitoring Data

Surface water discharges at MSP are governed by an individual National Pollution Discharge Elimination System/State Disposal System (NPDES/SDS) permit. To comply with this permit, monitoring data is collected. Typically, this data includes daily discharge rates and weekly total suspended solids (TSS) concentrations. The storm water treatment system at MSP is comprised of grass filtration associated with indirectly connected impervious surfaces, and wet detention ponds with high flow bypasses.

To establish baseline treatment efficiencies of the storm water treatment systems, FLUX (a software program developed by the Army Corps of Engineers) was utilized to analyze the existing monitoring data. The software is intended to interpret continuous flow data and periodic sampling data and provide pollutant loading rates through a statistical weight of evidence method.

The results of the FLUX analysis from January 2005 to July 2010 is presented in **Table 2.1 NPDES Monitoring Results Analyzed by FLUX, TSS.** Due to extended construction dewatering in the Pond 1 Drainage Area, the results from Pond 1 do not include data prior to September 2006. The intent of this data is to provide pond treatment efficiencies during normal operation.

Table 2.1

NPDES Monitoring Data Analyzed by FLUX, TSS

	Pond 1	Pond 2	Pond 3/4
Pond Discharge Loading, lbs/yr	11,819	26,984	17,691
Bypass1 Discharge Loading, lbs/yr	15,408	21,480	0
Bypass2 Discharge Loading, lbs/yr	6,894	N/A	37
Total Discharge Loading, lbs/yr	***34,121***	***48,464***	***17,728***
Daily Mean Flow Rate (FLUX), ft^3/s	1.51	1.23	0.78
NURP Urban Runoff TSS Concentration, mg/L	180-548	180-548	180-548
NURP Urban Runoff TSS Min. Loading (180 mg/L), lbs/yr	***535,242***	***436,123***	***277,533***
SLAMM Land Cover Loading, lbs/yr	794,054	494,054	323,784
Average Sand Loading, lbs/yr	8,677,927	5,524,932	3,572,285
Treatment Estimate w/ Most Conserv. NURP Loading	***93.63%***	***88.89%***	***93.61%***

Source: Liesch Associates, FLUX Analysis / NURP Urban Runoff Program / Dr. Robert Pitt, SLAMM Software.

Two data sources are presented for comparison to the total discharge loading computed by FLUX. The first source is from the National Urban Runoff Program (NURP), which lists typical TSS loading range of 180 to 548 mg/L for urban runoff. Conservatively, the lowest range was utilized to compute the total NURP loading. The second source was the TSS output loading from SLAMM, a program developed by Dr. Robert Pitt. The software accepted inputs for directly connected impervious area, indirectly connected impervious area, and pervious area. Additionally, to help frame the estimated TSS loadings, the average sand loading utilized for deicing is also listed by drainage area.

From the above analysis, the existing TSS removal efficiencies of the storm water treatment systems are well above 80% (viewed as acceptable TSS treatment efficiency).

3 DetPOND Analysis of TSS Treatment by Alternative

To quantify the reduction in treatment efficiency associated with the proposed alternatives, a DetPOND model was generated for each wet detention pond reflecting the land cover for each alternative. The DetPOND software was created by Dr. Robert Pitt and the first pond designed for MSP (Pond 1) was modeled by Dr. Pitt himself. Subsequent designs for MSP Pond 2 and the Mn/DOT Almaz Pond followed the same design practices. All ponds except Pond 3/4 are designed to accept a set maximum flow rate and then bypass the remaining runoff via a high flow bypass during large storm events.

The DetPOND analysis relies on a continuous range of rainfall data to predict TSS treatment efficiencies. This method is believed to be more appropriate in sizing ponds because it focuses on treating the entire volume of runoff (mostly from smaller storms, less than 1/2 inch), as opposed to more infrequent large storm events. All the MSP ponds were designed using a rainfall range at MSP from 1952 to 1989 with 3,997 separate rainfall events. Two model runs are completed for each analysis, one to determine the treatment efficiency of the pond, and the other to determine the volume of water bypassing the ponds from large storm events. The two results are then combined to calculate the net TSS treatment efficiency of the pond. Further discussion of the overall analysis method of the MSP ponds and bypasses can be found in the second example of the DetPOND Users Guide - *The Design and Use of Detention Facilities for Storm Water Management Using DetPOND.*

The results of each pond/alternative analysis are presented below in **Table 3.1 DetPOND Results by Alternative**. The italicized numbers represent the change in directly connected impervious from Table 1.1.

Table 3.1

DetPOND Results by Alternative

	Pond 1 (percent)	Pond 2 (percent)	Pond 3/4 (percent)	Mn/DOT Almaz Pond (percent)
No Action Alternative				
- TSS Control Efficiency	83.90	89.13	89.92	87.31
- Water Volume Treated	82.70	95.10	100.00	96.90
- ***Δ Net TSS Treatment Efficiency***	69.39	84.76	89.92	84.60
Airlines Remain	*+ 2.7 AC*	*- 0.2 AC*	*+ 0.3 AC*	*+ 0.0 AC*
- TSS Control Efficiency	83.87	89.13	89.92	87.31
- Water Volume Treated	82.60	95.10	100.00	96.90
- Net TSS Treatment Efficiency	69.28	84.76	89.92	84.60
- Δ Net TSS Treatment Efficiency	***- 0.11***	***+ 0.00***	***+ 0.00***	***+ 0.0***
Airlines Relocate	*+ 27.5 AC*	*- 0.2 AC*	*+ 0.0 AC*	*+ 0.0 AC*
- TSS Control Efficiency	83.56	89.13	89.92	87.31
- Water Volume Treated	81.60	95.10	100.00	96.90
- Net TSS Treatment Efficiency	68.18	84.76	89.92	84.60
- Δ Net TSS Treatment Efficiency	***- 1.21***	***+ 0.00***	***+ 0.00***	***+ 0.0***

Source: Liesch Associates, 2020 DetPOND Analysis.

Due to negligible increases in directly connected impervious with the proposed alternatives, Pond 2, Pond 3/4 and Mn/DOT Almaz Pond would experience virtually no change in net TSS treatment efficiency. Additionally for Pond 1, even in the Airlines Relocate Alternative, the change in net TSS treatment efficiency remains relatively small at just over 1%. (For context, 1.2% of Pond 1 TSS discharge is approximately 400 lbs/year, or 0.4% of all MSP discharges to the Minnesota River.) For all ponds, especially Pond 1, the TSS treatment efficiency is less than the calculated TSS treatment efficiency generated from the existing monitoring data. This difference is believed to be a result of limitations associated with flow routing in the model, which does not allow the bypass flow to bypass the pond, thereby lowering pond treatment. Since this loss of treatment efficiency is already accounted for manually, the effect of the bypasses are being overrepresented.

The existing TSS treatment efficiencies are believed to be the best estimate of the current treatment of the wet detention ponds. The DetPOND model is believed to be effective in presenting the change in treatment efficiencies from increased impervious areas. Applying the modeled net changes (0.0 to 1.2%) to the measured treatment efficiencies yields results well above 80% TSS removal. Specifically for Pond 1 – Airlines Relocate Alternative, the predicted TSS treatment efficiency will be 92.42% (93.63% from existing monitoring data minus 1.21% from the change in land cover). **Table 3.2 Estimated TSS Treatment Efficiencies** presents this data for the storm water treatment systems at MSP, which includes grass filtration from indirectly connected impervious and three MSP ponds.

Table 3.2

Estimated TSS Treatment Efficiencies

	Pond 1 (percent)	Pond 2 (percent)	Pond 3/4 (percent)	Mn/DOT Almaz Pond (percent)
TSS Treatment Estimate from FLUX	93.63	88.89	93.61	N/A
Airlines Remain				
- Δ Net TSS Treatment Efficiency from DetPOND	- 0.11	+ 0.00	+ 0.00	+ 0.00
- Estimated TSS Treatment Efficiency	***93.52***	***88.89***	***93.61***	***N/A***
Airlines Relocate				
- Δ Net TSS Treatment Efficiency from DetPOND	- 1.21	+ 0.00	+ 0.00	+ 0.00
- Estimated TSS Treatment Efficiency	***92.42***	***88.89***	***93.61***	***N/A***

4 XPSWMM Analysis of Peak Flows by Alternative

Due to negligible changes in directly connected impervious for all alternatives in Pond 2, Pond 3/4 and Mn/DOT Almaz Pond, changes in peak flows were only analyzed for Pond 1. To quantify the change in peak flows associated with the proposed alternatives, two XPSWMM models were created for Pond 1 to represent the existing NAA and the alternative with the larger change, the Airlines Relocate Alternative. The overall peak flows for the system were analyzed with the 100 year rainfall event, and the results from several key locations are noted in **Table 4.1 XPSWMM Peak Flow Results for MSP Pond 1 – 100 Year Event.**

Table 4.1

XPSWMM Peak Flow Results for MSP Pond 1 – 100 Year Event

	No Action Alternative (cubic feet/second)	Airlines Relocate Alternative (cubic feet/second)
Flow From Pond 1 Drainage Area	1699	1713
- Flow to 494 Bypass	586	589
- Flow to Pond 1	1143	1150
+ In/Out of Pond 1	234	234
+ Flow Bypassing Pond 1	913	917
Hwy 5 Outfall Discharge (w/ P2 & Mn/DOT)	3349	3355

Source: Liesch Associates, 2020 Pond 1 XPSWMM Analysis.

Results from the peak flow analysis for Pond 1 indicate the increase in directly connected impervious associated with the worst-case Airlines Relocate Alternative to be 6 CFS (0.2%) at the Highway 5 Outfall Discharge.

Another analysis was completed to estimate the effect the increase in directly connected impervious would have on storm water conveyance in the local vicinity of the modifications. The analysis utilized the 10 year storm with both a 1 hour Huff 2Q Point distribution and a 24 hour SCS Type II distribution. For each distribution, the XPSWMM models verified that the existing storm sewer system was capable of conveying the storm water runoff without flooding outside the available ponding areas. This remained true within the local vicinity and downstream of the proposed modifications. However, special precaution should be taken to ensure appropriate local storm water conveyance is available during design and construction of any modification to the land cover or storm sewer system.

5 Estimated 2030 Traffic/Roadway Plan Impacts – Stormwater

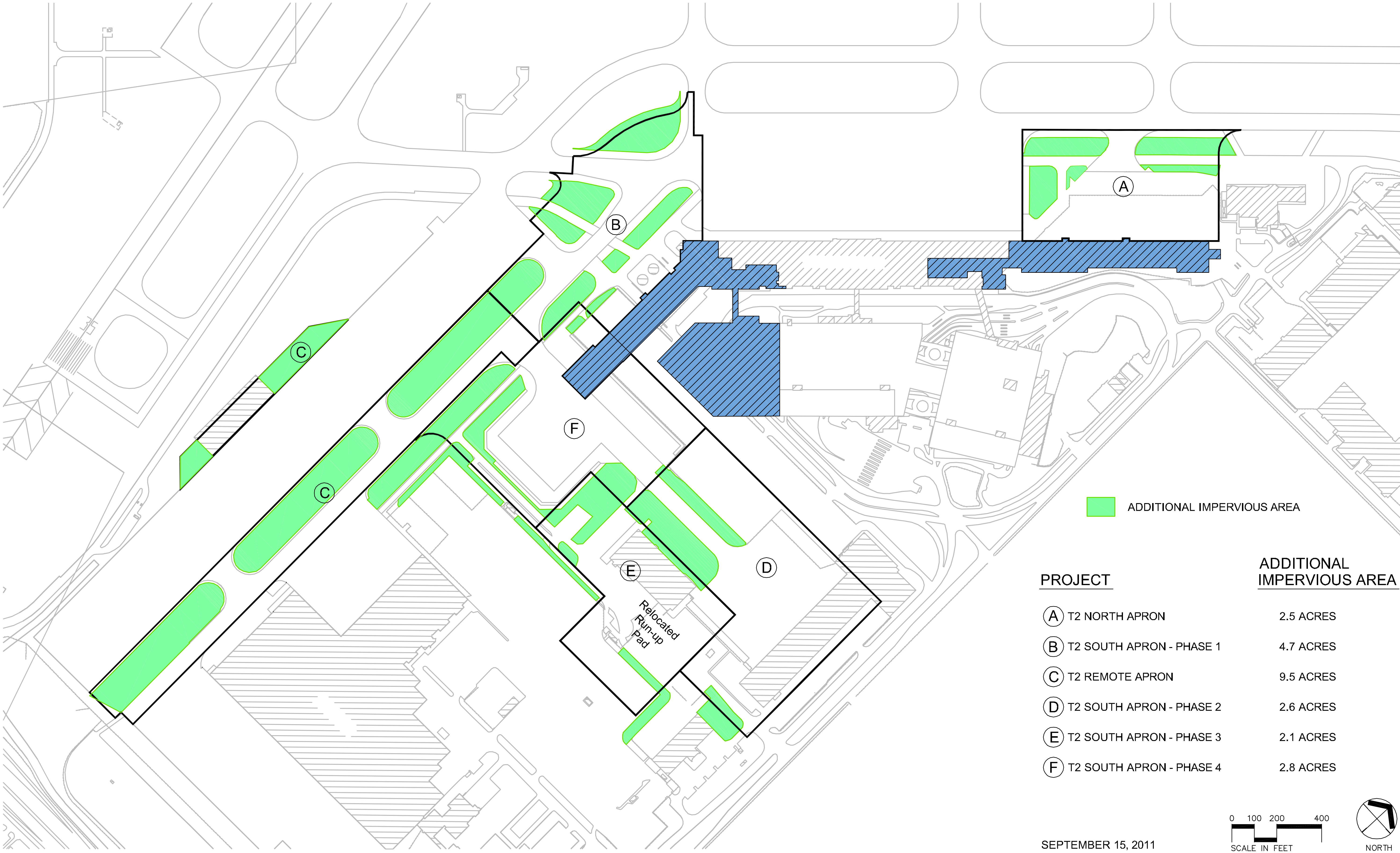
In addition to addressing potential impacts to downstream receiving waters from 2020 Improvement Plan Alternatives, impacts associated with the 2030 Traffic/Roadway plan were also estimated. The Mn/DOT Almaz Pond drainage area was the only area with greater increases in net impervious surfaces than in the 2020 Improvement Plan Alternatives. For the 2030 plan, the net impervious area increases 5.2 acres from the NAA along with a 1.3 acre increase in pervious area. The increase of both impervious and pervious area is a result of a 6.5 acre increase in total Mn/DOT Almaz Pond drainage area from the transfer of a portion of the MSP Pond 1 drainage area to Mn/DOT roadway (land use change from MSP parking lot and open area to roadway). **Attachment 2 - 2030 Plan – Drainage Area Change** shows the proposed drainage area change.

TSS treatment efficiency as estimated by DetPOND is reduced from 84.60% to 84.30% (-0.30%) from the increased drainage area and increased impervious surface. Specifically, the TSS Control Efficiency was reduced from 87.31 % to 87.18% and the Water Volume Treated was reduced from 96.90 % to 96.70%. This TSS treatment efficiency is greater than 80% which is consistent with the MPCA General NPDES Permit for Construction Activity Part III – C Permanent Stormwater Management Item 5 that requires Alternative Methods to achieve approximately 80% TSS removal on an annual average basis. Furthermore, monitoring results from MSP Pond 1 and 2 (shown above in Section 2) suggest that actual treatment efficiency for the Mn/DOT Almaz Pond is much greater than the DetPOND Calculations. Mn/DOT Almaz Pond along with MSP Pond 1 and 2 share a similar pond design. Additionally, all projects will meet construction NPDES and Lower Minnesota River Watershed District permit requirements. Currently the applicable requirements for these impacts call for ½” runoff over the new impervious surfaces to be treated via infiltration best management practice(s) to address volume control. **Attachment 3 - Post 2020 Roadway Improvements & Conceptual Volume Control BMP Site** presents a conceptual site for this infiltration practice along with a rough grading design.

Changes in the Mn/DOT Almaz Pond drainage area are not significant enough to show measureable increases in peak flow to the large scale XPSWMM model. However, the transfer of additional impervious and pervious surface to the Mn/DOT drainage area from the MSP Pond 1 drainage area should consider impacts to local stormwater conveyance during preliminary and final design of the roadway improvement project.

Attachment 1:

Airlines Relocate Add’l Impervious



PROJECT	ADDITIONAL IMPERVIOUS AREA
(A) T2 NORTH APRON	2.5 ACRES
(B) T2 SOUTH APRON - PHASE 1	4.7 ACRES
(C) T2 REMOTE APRON	9.5 ACRES
(D) T2 SOUTH APRON - PHASE 2	2.6 ACRES
(E) T2 SOUTH APRON - PHASE 3	2.1 ACRES
(F) T2 SOUTH APRON - PHASE 4	2.8 ACRES

SEPTEMBER 15, 2011

CURRENT: Dec 15, 2011 – 10:50am
DIR: K:\MAC\14860\air\drainage\relocate–impervious2.dwg

NO.	DATE	BY	DESCRIPTION OF REVISIONS

DESIGNED
DRAWN
CHECKED

I HEREBY CERTIFY THAT THIS PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA

NAME
DATE
LIC. NO. ####

TKDA
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Metropolitan Airports Commission
GENERAL OFFICES
6040 - 28TH AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55450

ALTERNATIVE 2 - AIRLINES RELOCATE ADD'L IMPERVIOUS
2020 MSP DEVELOPMENT

PROJ. NO. 14777
MSP
DRAWING NO. RELOC

Attachment 2:

2030 Plan – Drainage Area Change

0 190 380 Feet

Drainage Area to be Transferred - MSP Pond 1 to Mn/DOT Almaz Pond

2030 Plan - Proposed Pavement

Existing MSP Pond 1 Drainage Area

Source: MS Virtual Earth
Projection: NAD83 UTM Zone15N

N

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Mpls-St. Paul International Airport	Jul 12
2030 Plan - Drainage Area Change	Figure L2

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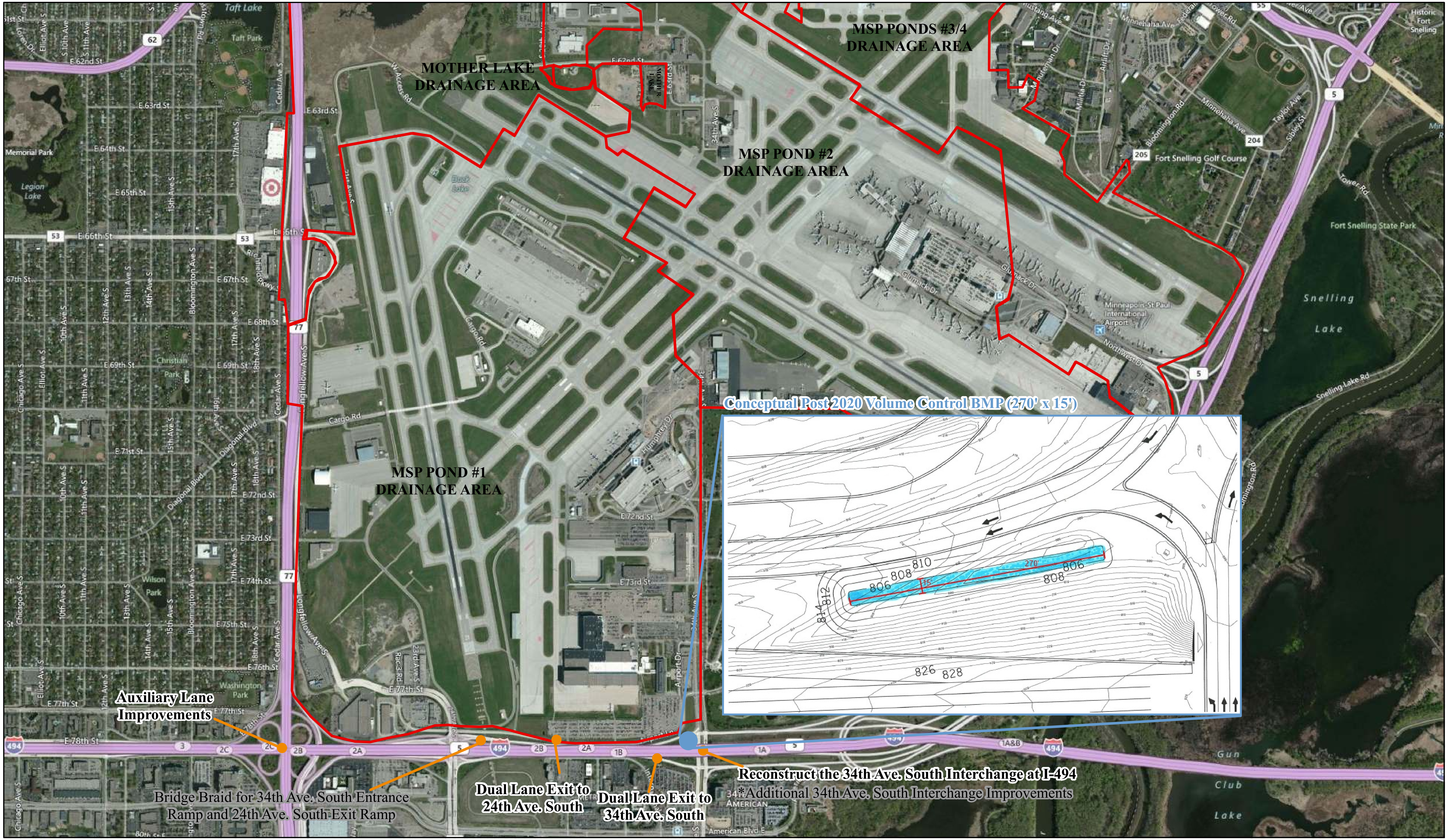
Attachment 3:

Post 2020 Roadway Improvements &
Conceptual Volume Control BMP Site



0 1,000 2,000 Feet

Almaz Pond
White 2020 Airlines Relocate
Gray Planned Post 2020

Source: MS Virtual Earth
Projection: NAD83 UTM Zone15N

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