



Flagstaff Pulliam Airport  
Drainage Master Plan

# Existing Conditions Assessment

October 4, 2022



# Airport Drainage Master Plan Goals

- Provide a **comprehensive guide** to **stormwater management** associated with future development and buildout of the airport properties
- Surface stormwater drainage includes **collection, conveyance, quantity** and **quality design** objective and environment environmental protections in support of regional stormwater management goals and strategies



# Airport Drainage Master Plan Components

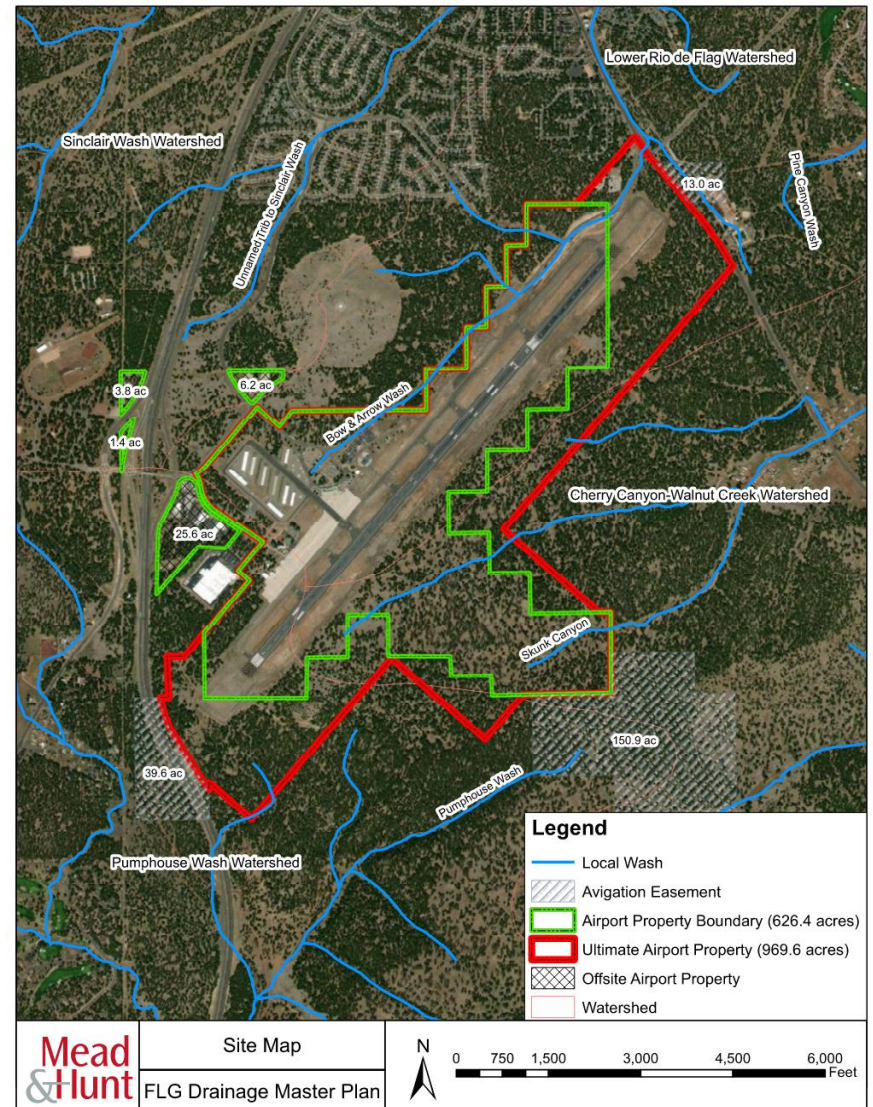
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- Existing Conditions Airport Drainage Assessment (**Complete**)
- Proposed Conditions Airport Drainage Assessment (**Next Steps**)
  - Short-term airport improvements (0-5 years)
  - Intermediate and Long-term airport improvements (6-20 years)
    - Estimated completion early 2023
- Develop Proposed Airport Drainage Improvements (**Next Steps**)
  - Concept-level recommended alternatives with cost estimates to address existing flooding concerns and impacts of short-term projects
  - High-level recommendations to address impacts of intermediate and long-range projects
    - Estimated completion mid 2023

# Existing Conditions Assessment

## Contents

- Overview of Relevant Past Airport Drainage Studies
- Design Codes/References
- Data Sources
- Hydrologic and Hydraulic Modeling Methods
- Calibration and Verification
- Flood Depth Maps
- Next Steps



# Overview of Relevant Past Airport Drainage Studies

- FEMA Flood Insurance Study for City of Flagstaff (FEMA, 1996)
- Runway 3-21 Extension and Safety Area Drainage Study (Kimley-Horn, 2007)
- Zuni Drive-Cochise Drive to Coconino Forest Property Drainage Study (Kimley-Horn, 2016)
- Pulliam Airport Overflow Parking Drainage Study (J.E. Fuller, 2021)
- Surface Water Hydrology and Flood Recurrence in the Flagstaff, Arizona Area, 2008-2019 Study (City of Flagstaff, 2021)



CITY OF FLAGSTAFF,  
ARIZONA  
COCONINO COUNTY



REVISED: AUGUST 2, 1996  
Federal Emergency Management Agency  
COMMUNITY NUMBER: 040028

Final Drainage Report

Flagstaff Pulliam Airport

Prepared by  
 Kimley-Horn  
and Associates, Inc.  
February 15, 2007  
10101001  
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Surface Water Hydrology and Flood Recurrence in the Flagstaff,  
Arizona Area, 2008-2019



# Key Design Codes and References

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- City

- City of Flagstaff, *Stormwater Management Design Manual*, March 2009.
- City of Flagstaff, *Low Impact Development Guidance Manual for Site Design and Implementation*, January 2009.

- County

- Coconino County, *Drainage Design Criteria Manual*, August 2020.
- Flood Control District of Maricopa County, *Drainage Policies and Standards for Maricopa County Supplemental Technical Document: FLO-2D Verification Report*, May 2016.
- Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Arizona: Hydraulics*, December 2018.

- State

- Arizona Department of Transportation, *Highway Drainage Design Manual Volume 2: Hydrology*, January 2014.

- Federal

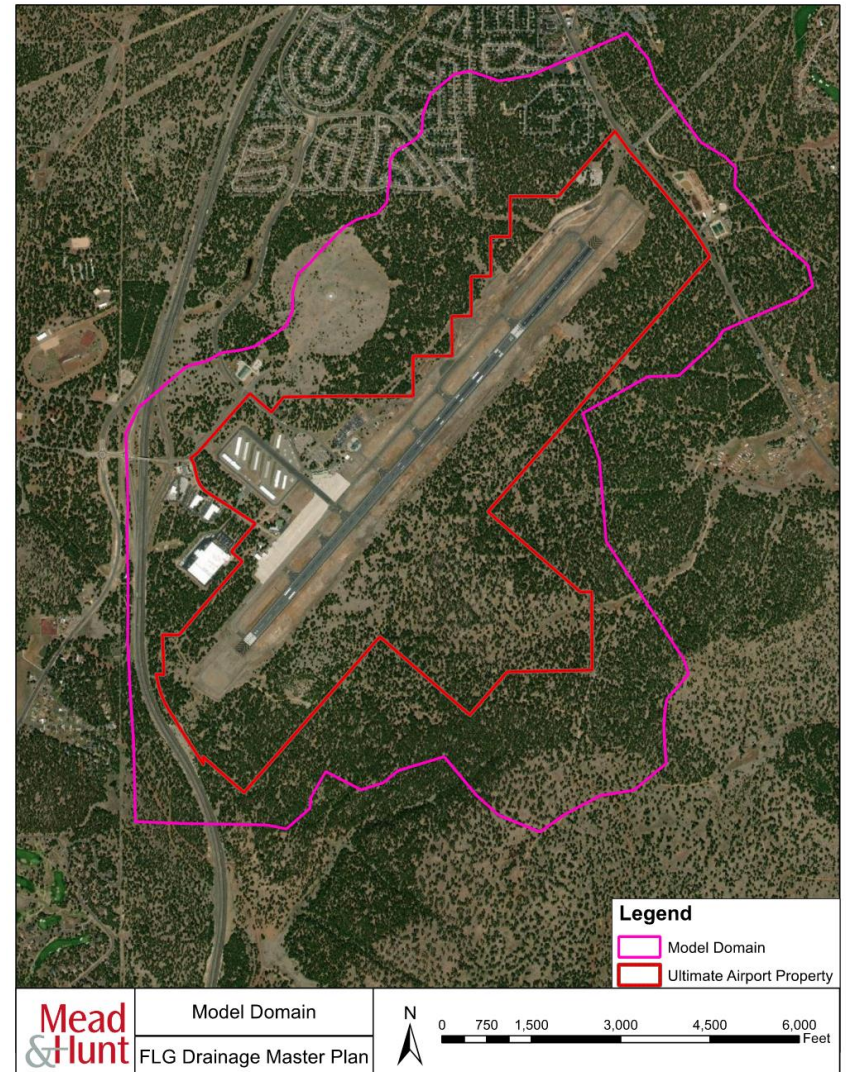
- FAA AC 150/5320-5D, *Airport Drainage Design*, August 2013.
- FAA AC 150/5200-33C, *Hazardous Wildlife Attractants on or Near Airports*, February 2020.

# Data Sources

COMPONENT	SOURCE
BUILDINGS	City of Flagstaff GIS database, supplemented by aerial imagery
STORM DRAINS	Field Survey, supplemented by City of Flagstaff GIS database
CULVERTS	Field Survey, supplemented by City of Flagstaff GIS database
LAND USE	Delineated using field topographic survey and aerial imagery
RAINFALL	NOAA Atlas 14 Database
TOPOGRAPHY	Project LiDAR, supplemented by City of Flagstaff LiDAR
SOILS	Arizona Department of Transportation GIS database

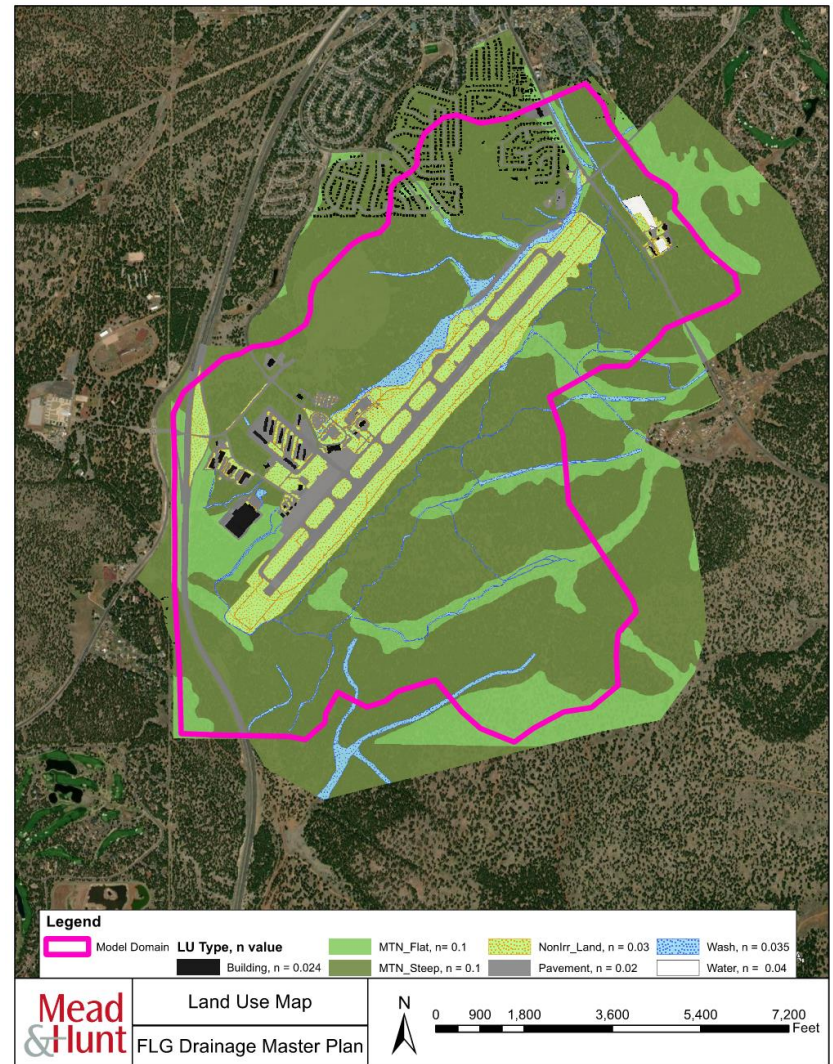
# Hydrologic and Hydraulic Modeling Methods

- Analysis Airport drainage using FLO-2D, a combined hydrologic and hydraulic model that simulates rainfall, runoff, and flood routing in two dimensions over a system of square grid elements
  - 20-foot grid size
- Model Domain: 236,384 grid cells (3.39 square miles)



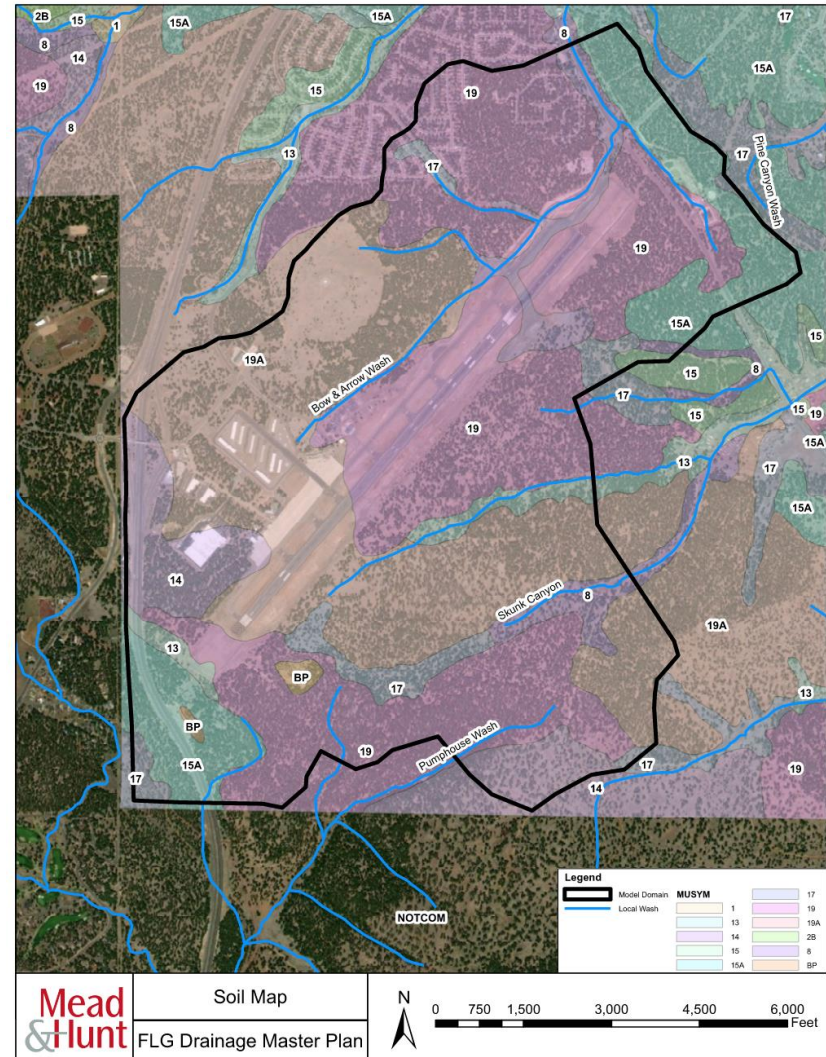
# Hydrologic and Hydraulic Modeling Methods (cont.)

- Land use delineation
- Broken into categories that align with City, County, and ADOT modeling guidance
  - Building
  - Pavement
  - Mountain (flat, steep)
  - Non-irrigated land
  - Wash
  - Water



# Hydrologic and Hydraulic Modeling Methods (cont.)

- Soils map
  - Numbers correspond to Arizona Department of Transportation (ADOT) soil types
  - Different infiltration capabilities for each soil type



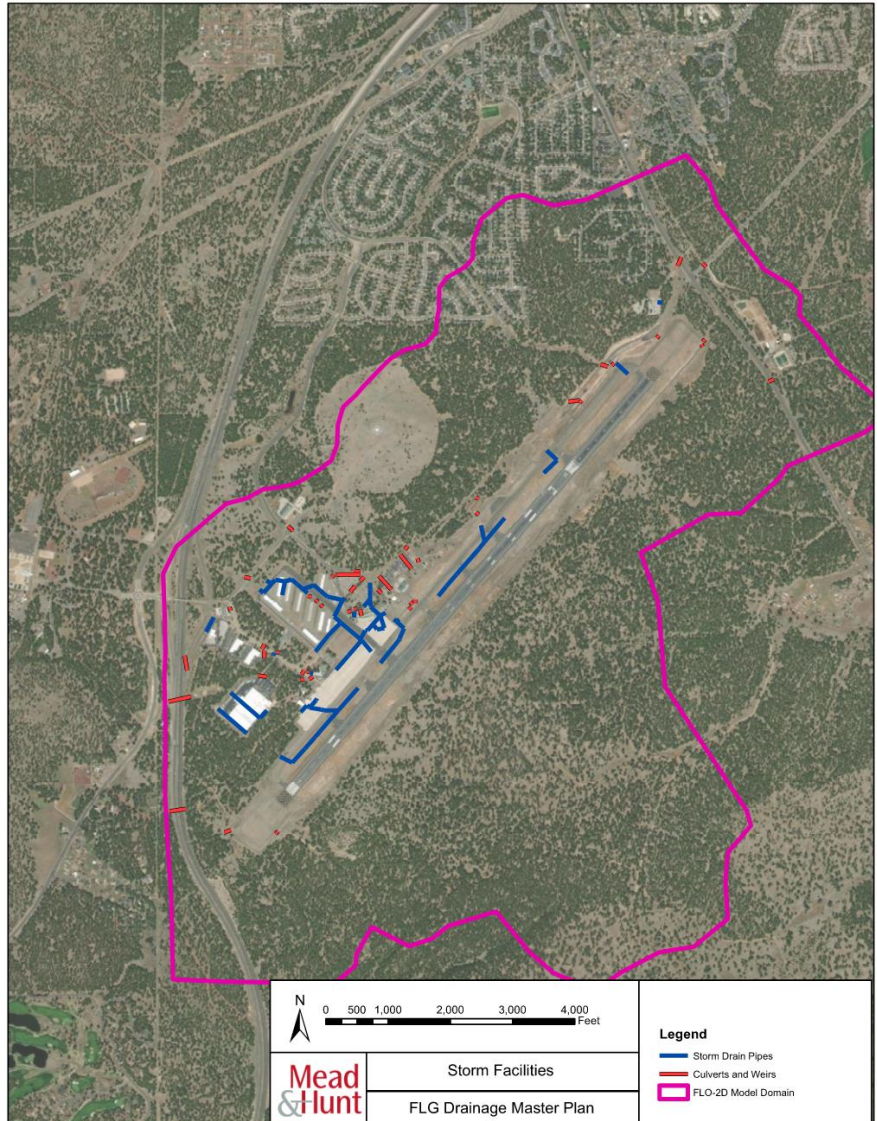
# Hydrologic and Hydraulic Modeling Methods (cont.)

- Rainfall

RETURN PERIOD (years)	DURATION (hours)	RAINFALL DEPTH (inches)
2	6	1.21
5	6	1.50
10	6	1.76
25	6	2.12
50	6	2.43
100	6	2.75

# Hydrologic and Hydraulic Modeling Methods (cont.)

- Storm Drains and Hydraulic Structures



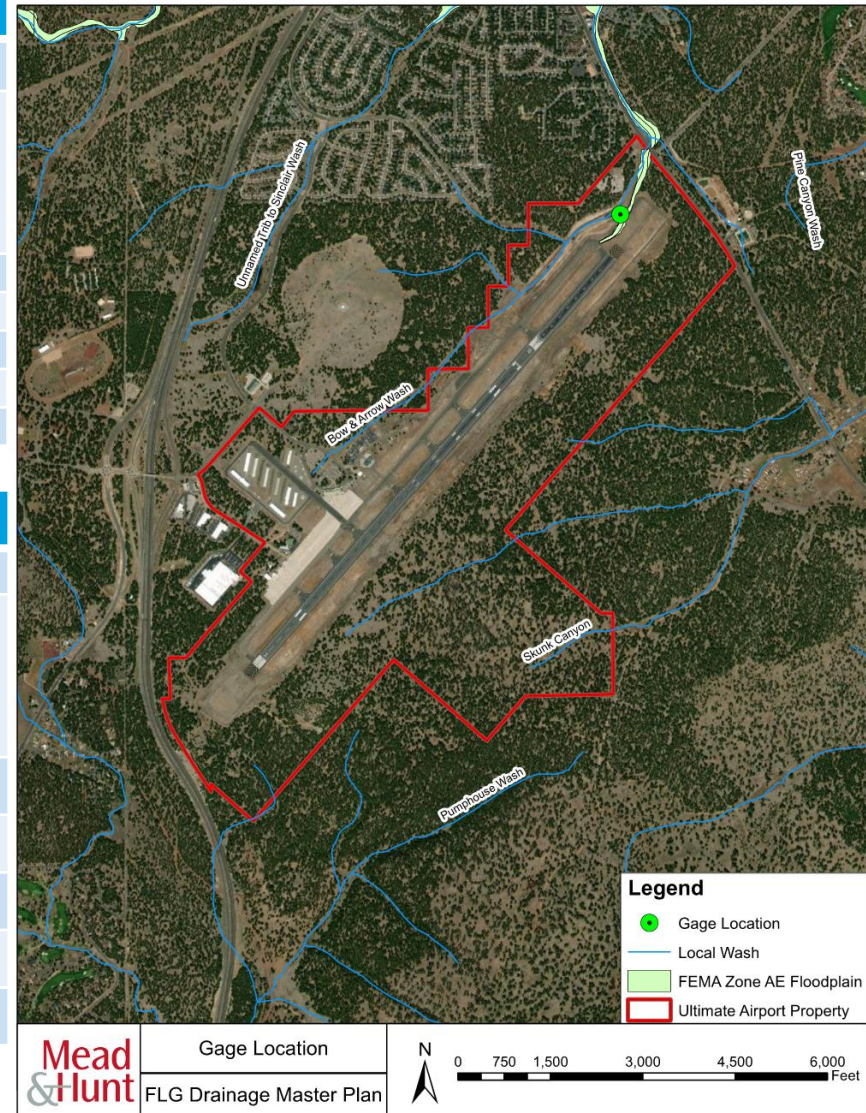
# Calibration and Verification

**CALIBRATION SUMMARY TABLE**

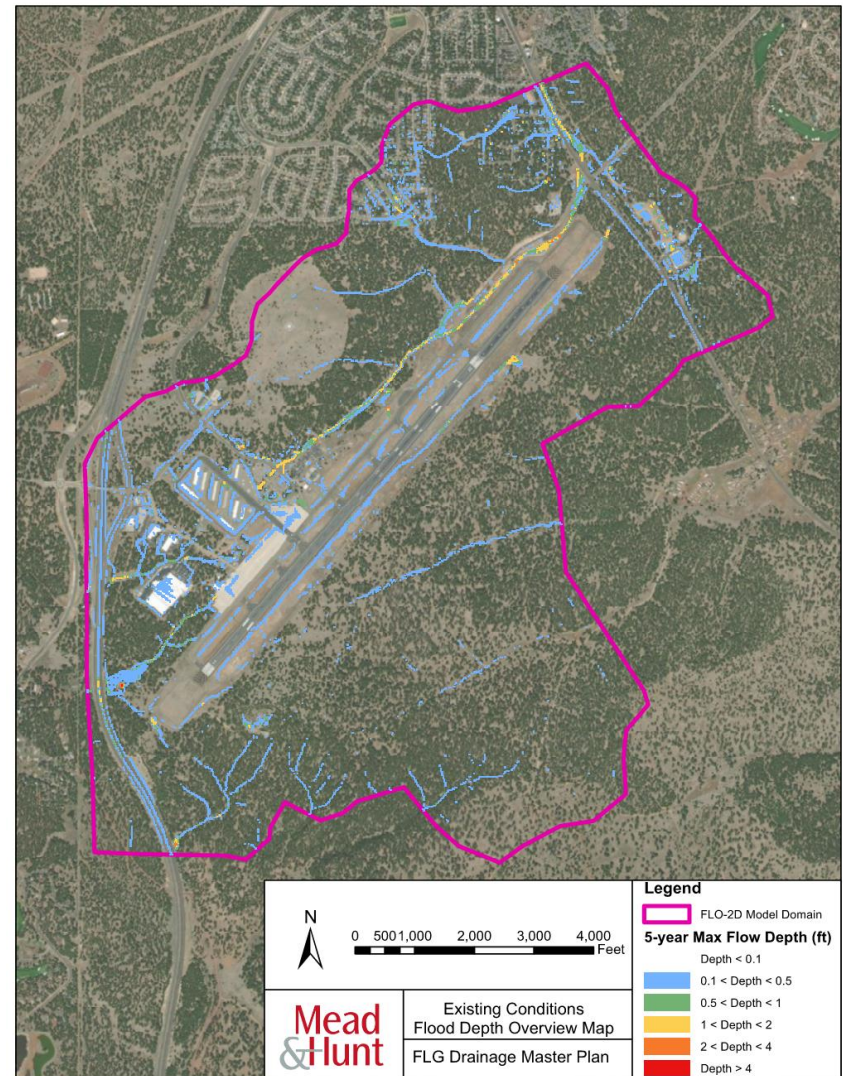
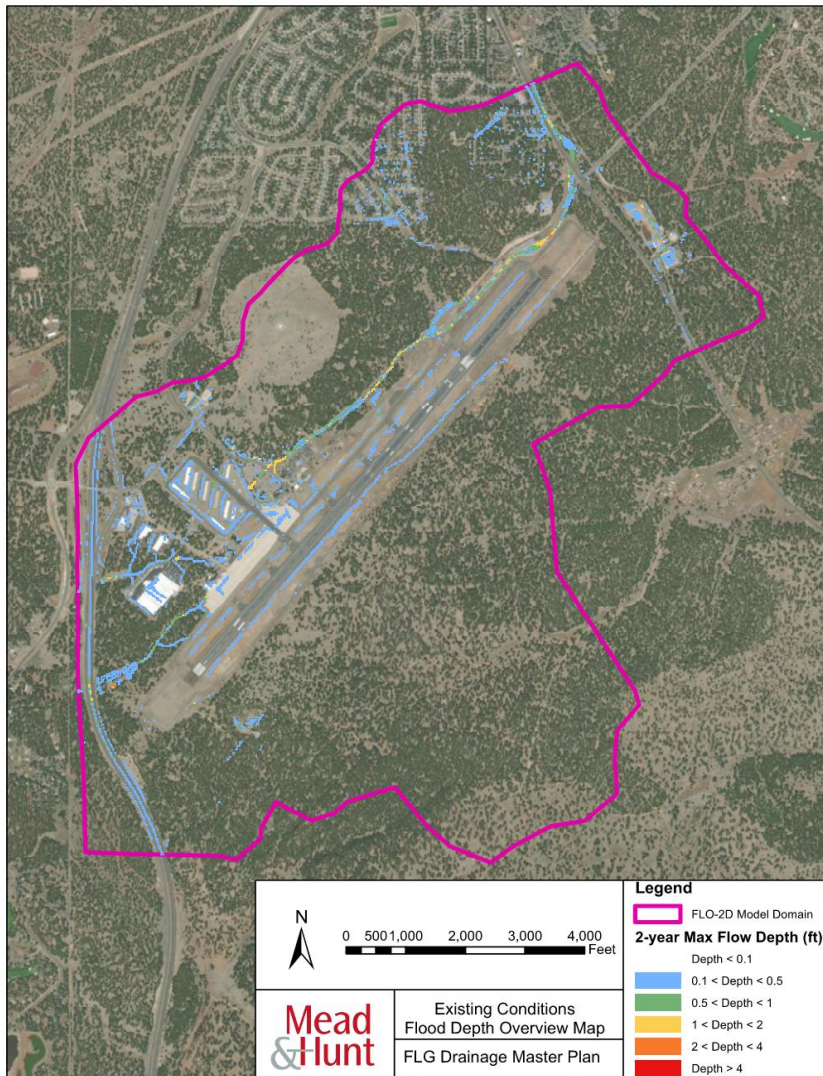
RETURN PERIOD	PEAK DISCHARGE (CFS)			
	Flagstaff Gage Bulletin 17B	FLO-2D with 4-inch Limiting Infiltration Depth	FLO-2D with 5-inch Limiting Infiltration Depth	FLO-2D with 6-inch Limiting Infiltration Depth
2-year	11.7	19.9	14.5	12.3
5-year	37.7	48.8	36.7	33.4
10-year	63.9	91.2	67.3	61.1
50-year	143.8	179.7	145.1	133.0
100-year	184.0	224.1	183.2	167.7

**VERIFICATION SUMMARY TABLE**

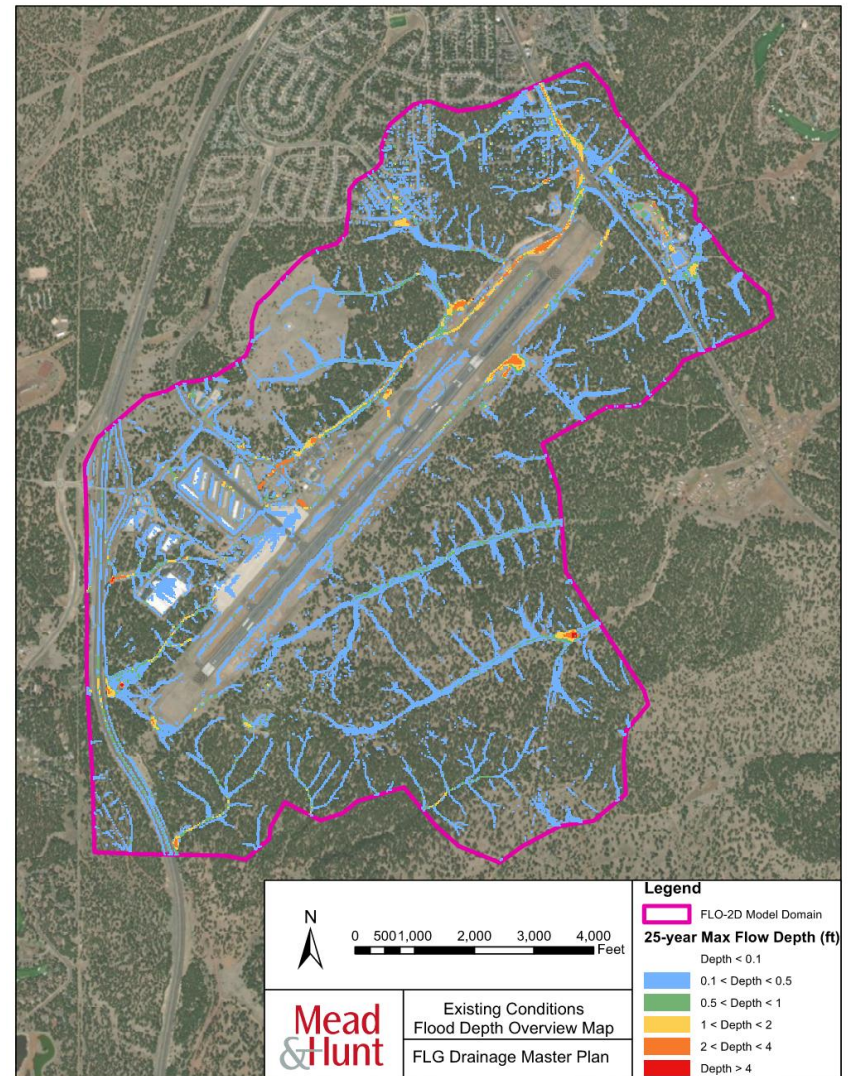
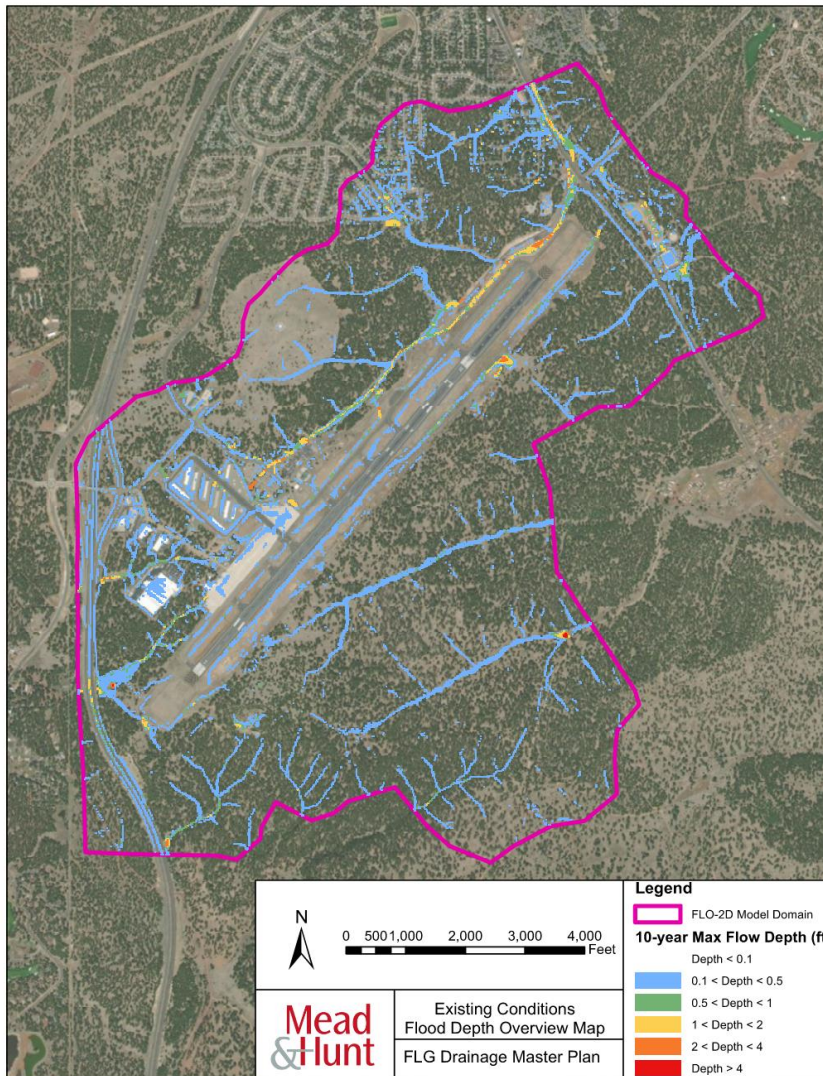
RETURN PERIOD	PEAK DISCHARGE (CFS)			
	Flagstaff Gage Bulletin 17B Study	FLO-2D with 5-inch Limiting Infiltration Depth	Zuni Drive Calibrated HEC-HMS Study	1996 FEMA FIS Report
2-yr	11.7	14.5	6.6	--
5-yr	37.7	36.7	26.2	--
10-yr	63.9	67.3	50.7	--
50-yr	143.8	145.1	--	--
100-yr	184.0	183.2	206.2	146.0



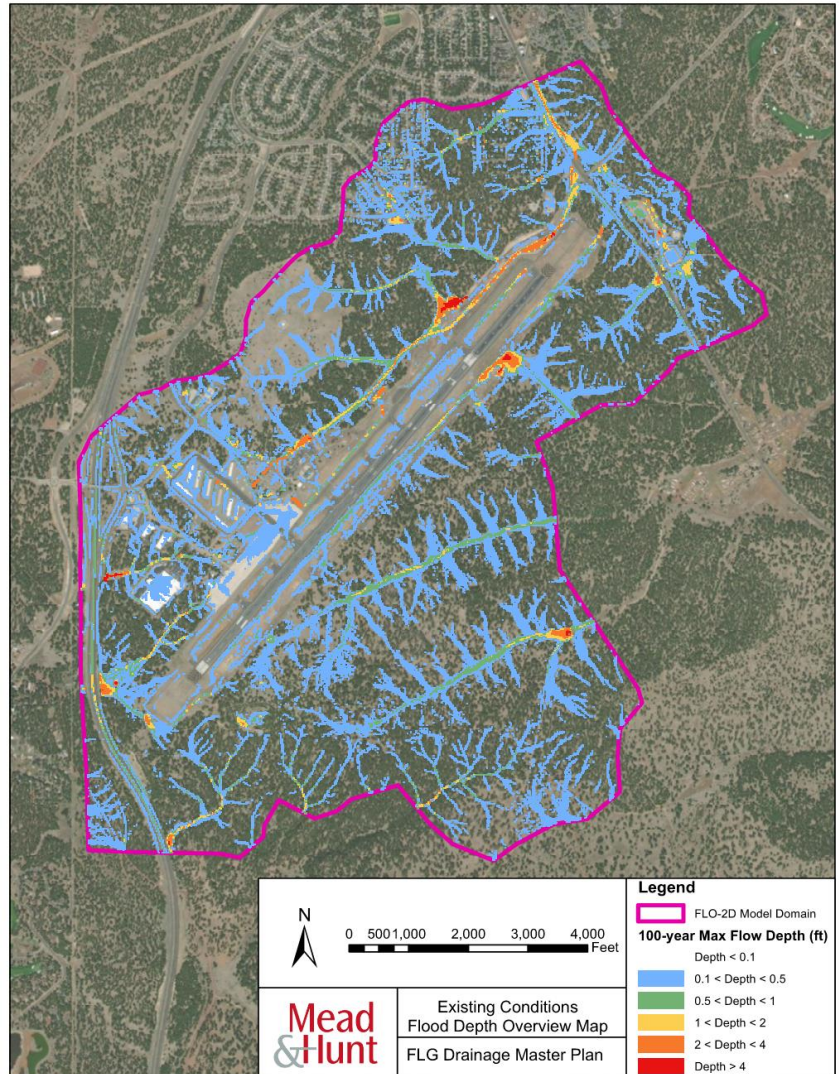
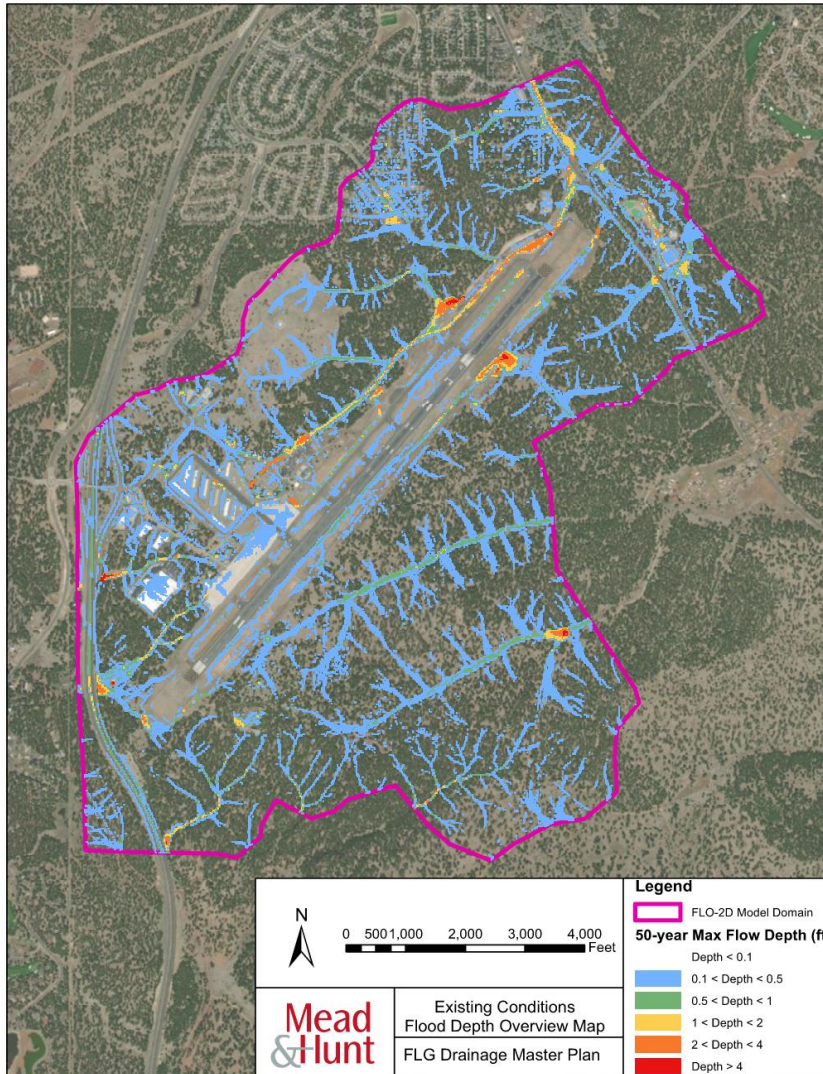
# Flood Depth Overview Map – 2-year and 5-year Storms



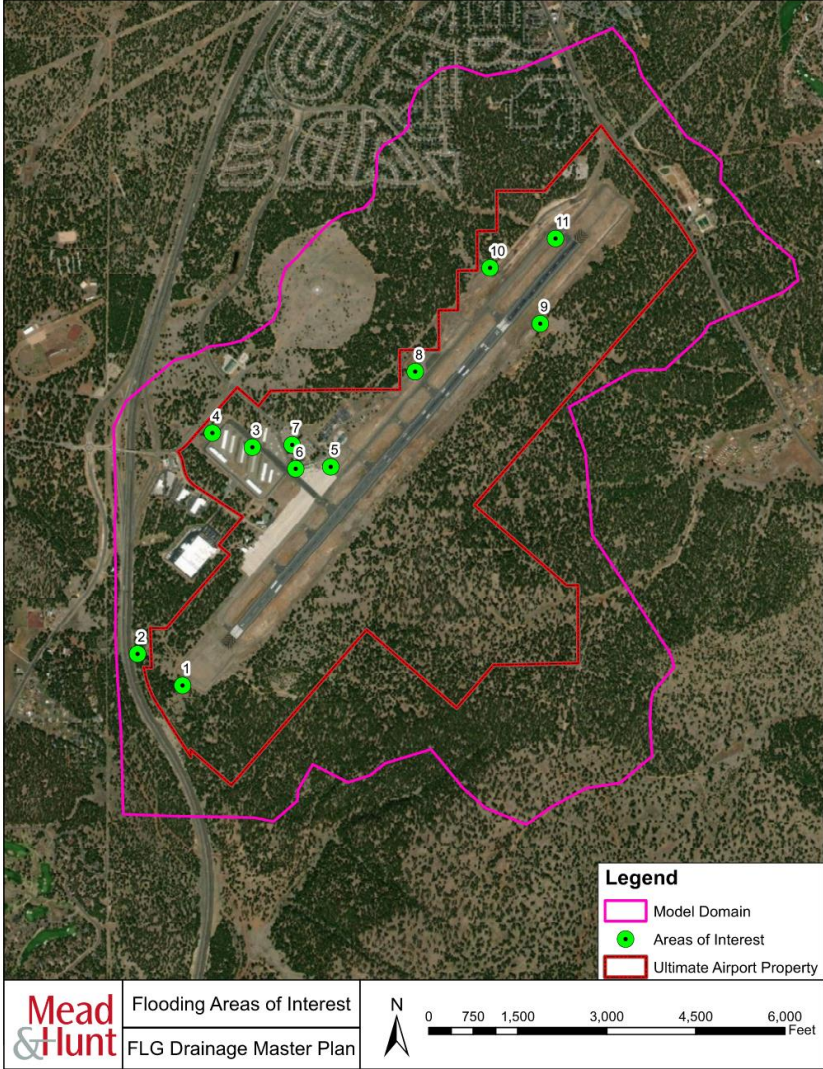
# Flood Depth Overview Map – 10-year and 25-year Storms



# Flood Depth Overview Map – 50-year and 100-year Storms

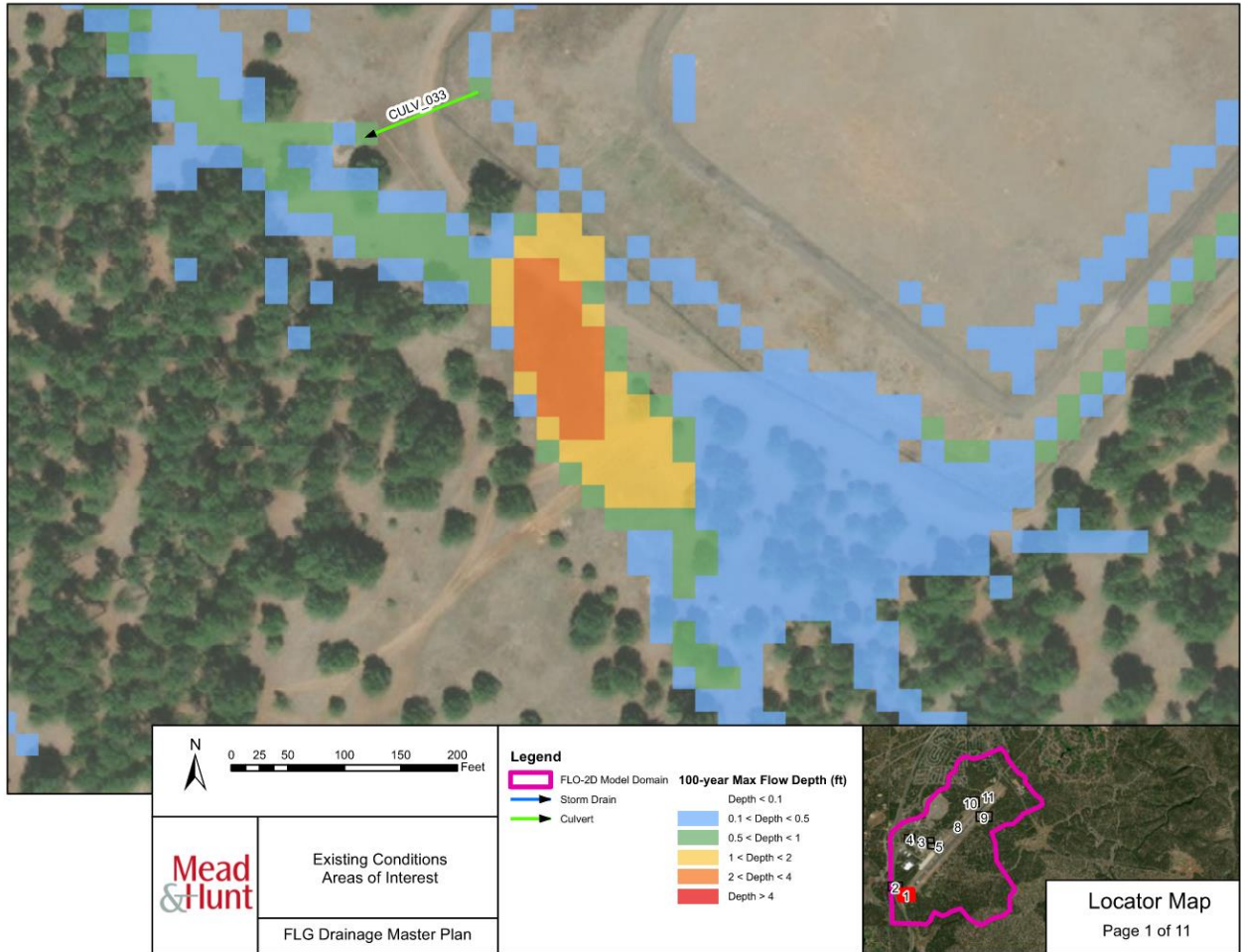


# Flooding Areas of Interest



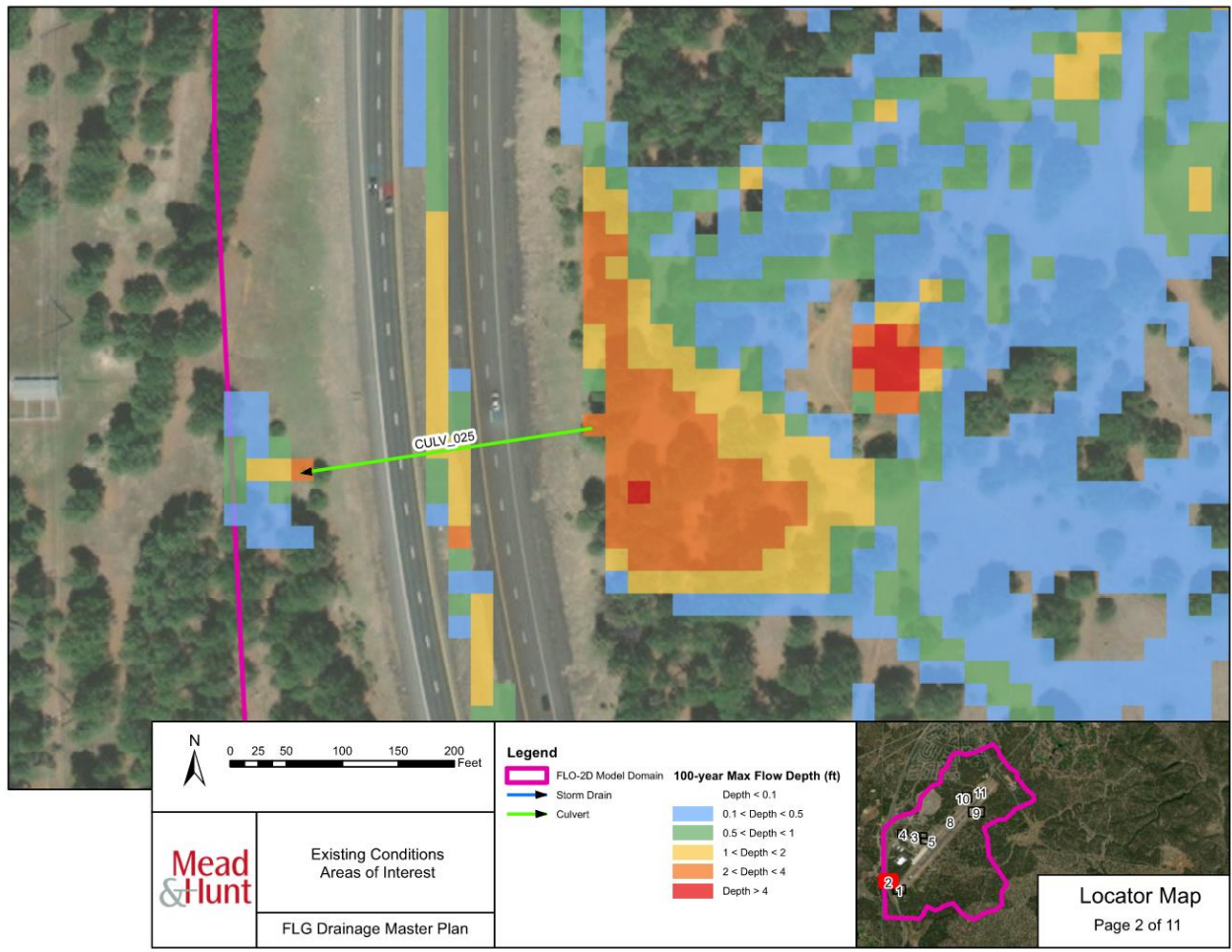
# Area 1 – 100-year Flooding

- Location:
  - At the bottom of the embankment southwest of the runway
- Max Ponding Depth:
  - 3.08'
- Concern:
  - Ponding may impact future slope stability.



# Area 2 – 100-year Flooding

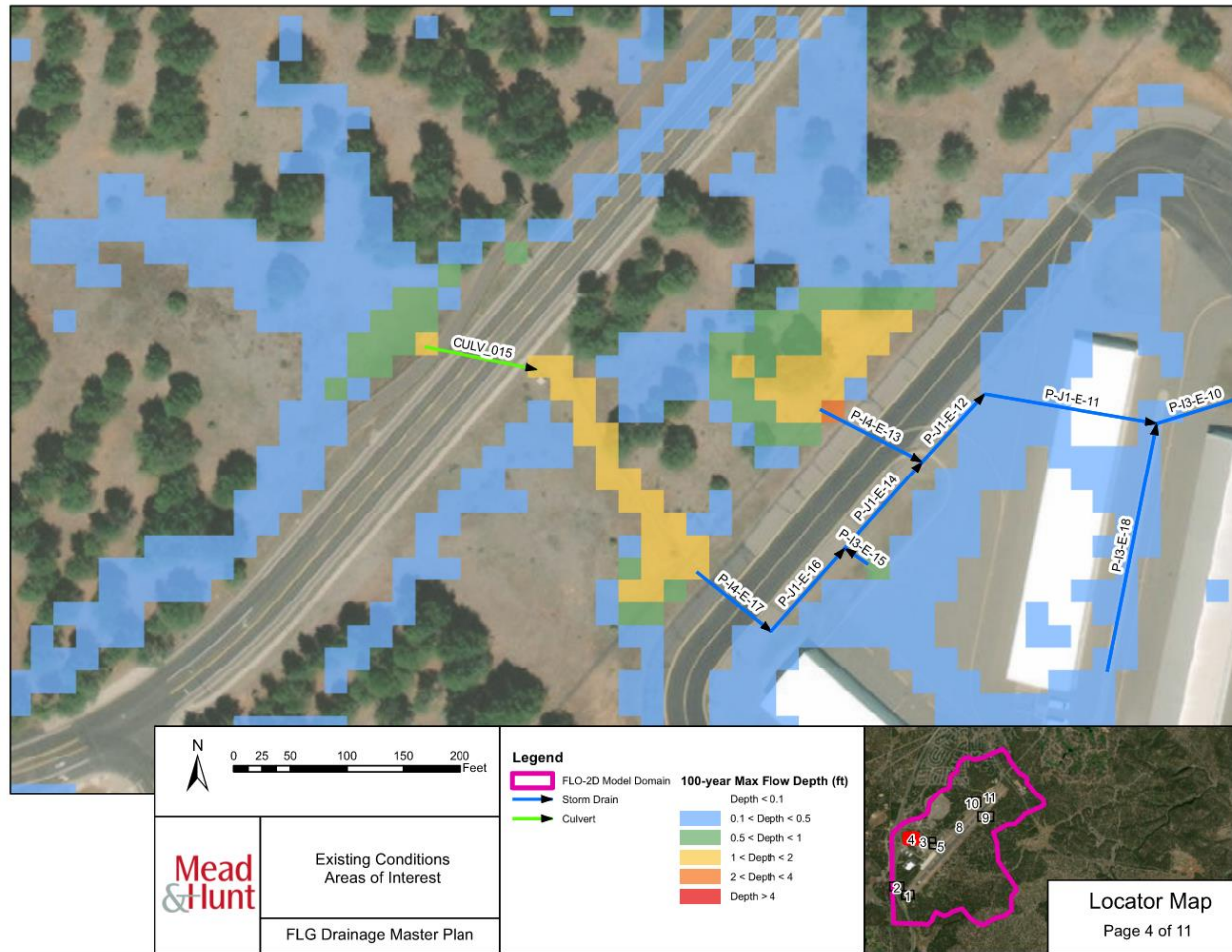
- Location:
  - West of the southern end of the Airfield, upstream of the culvert running under Highway 17.
- Max Ponding Depth:
  - 4.20'
- Concern:
  - A low point east of the culvert traps stormwater and does not drain to the culvert. Potential wildlife attractant.





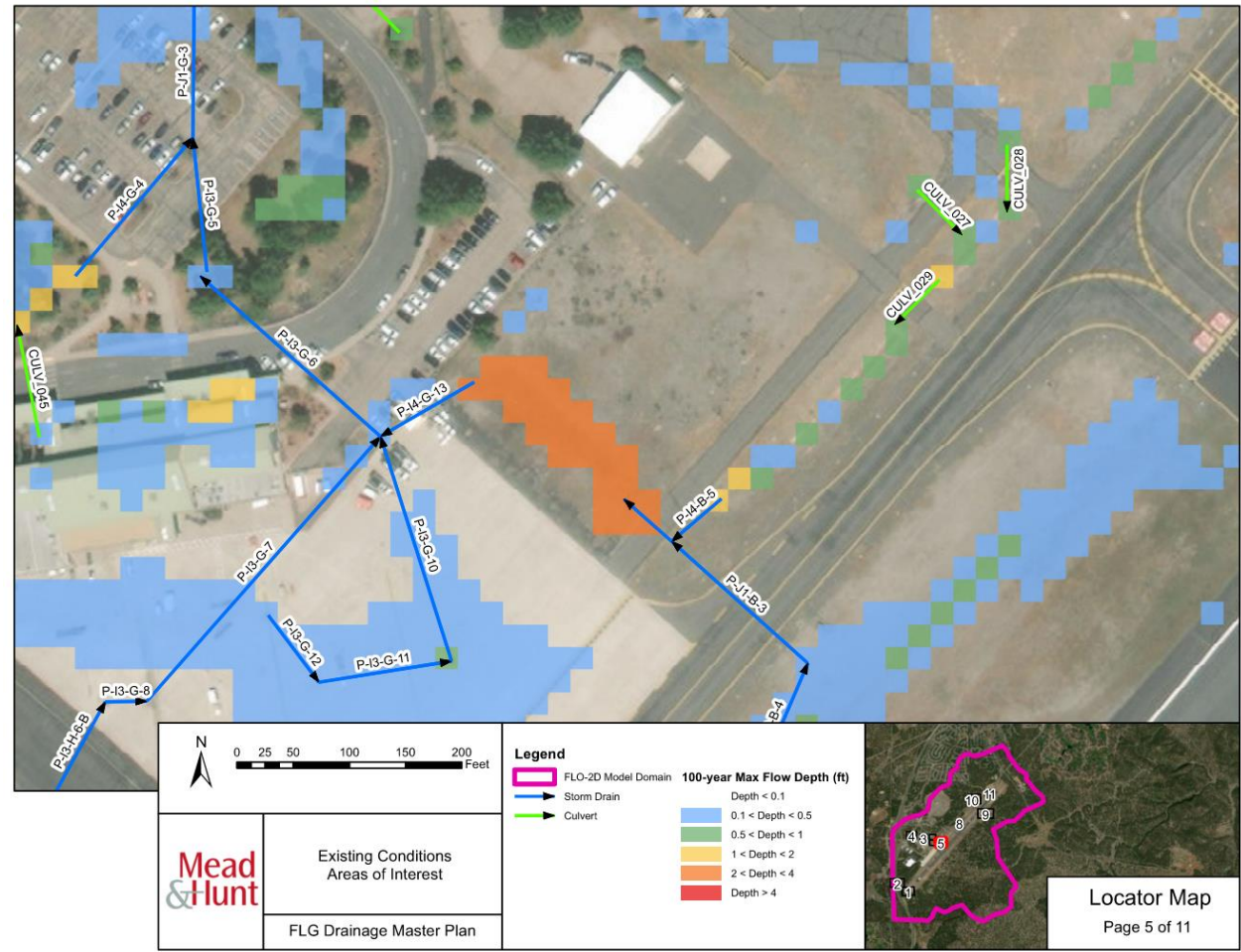
# Area 4 – 100-year Flooding

- Location:
  - Upstream of the storm drain inlets capturing runoff from J.W. Powell Boulevard west of Taxiway W.
- Max Ponding Depth:
  - 2.34'
- Concern:
  - Has potential to be a wildlife attractant or spill onto Taxiway W if the pipe inlets become clogged with debris.



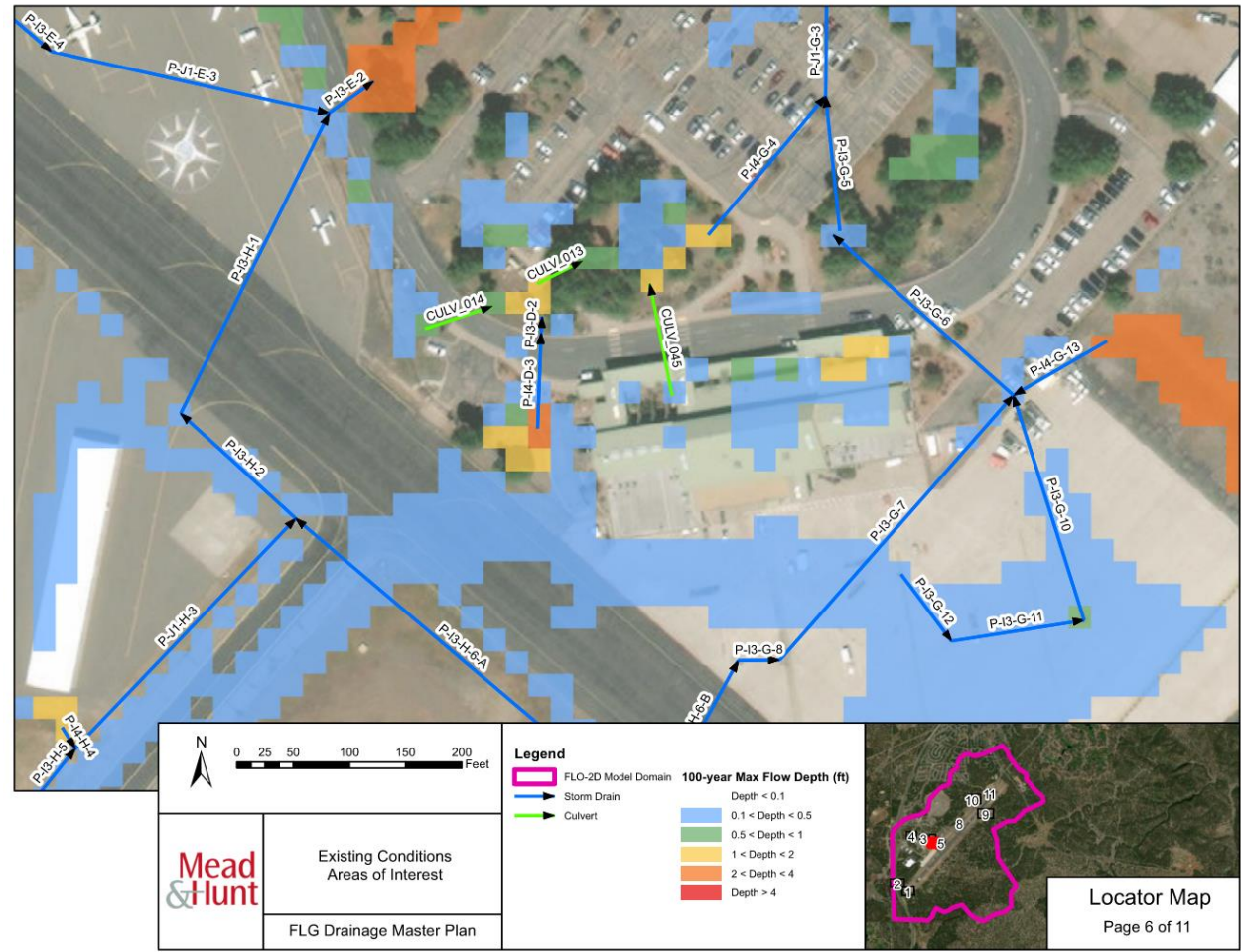
# Area 5 – 100-year Flooding

- Location:
  - Within the retention basin east of the Airport Terminal Building.
- Max Ponding Depth:
  - 3.55'
- Concern:
  - The inlet pipes draining from the Airfield into this basin are relatively flat, so ponding in this basin could lead to backups onto the Airfield. Additionally, this ponding could serve as a wildlife attractant next to the runway.



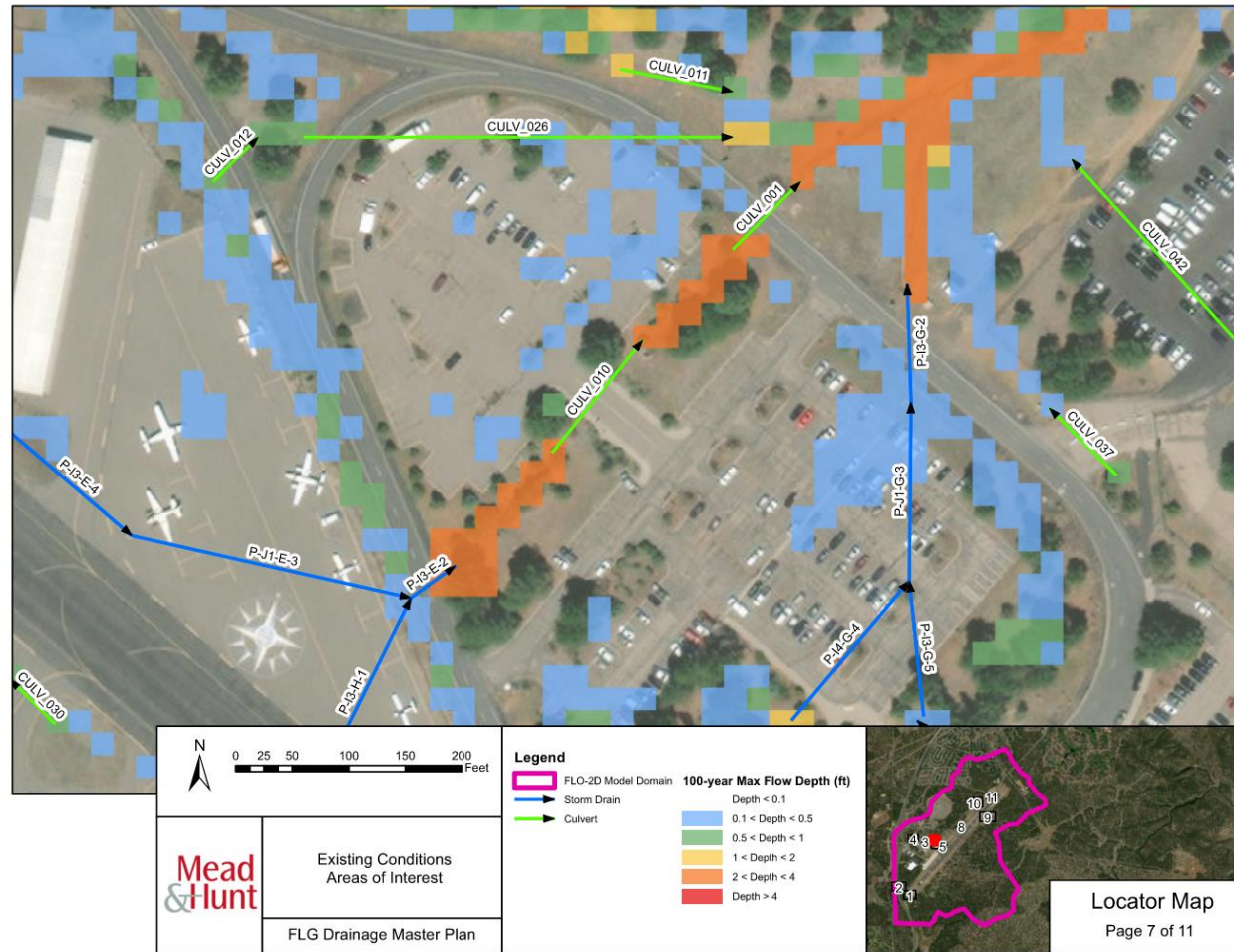
# Area 6 – 100-year Flooding

- Location:
  - Storm drain inlet west of the Terminal Building and south of Pulliam Drive.
- Max Ponding Depth:
  - 2.74'
- Concern:
  - This could lead to spillover onto Pulliam Drive.



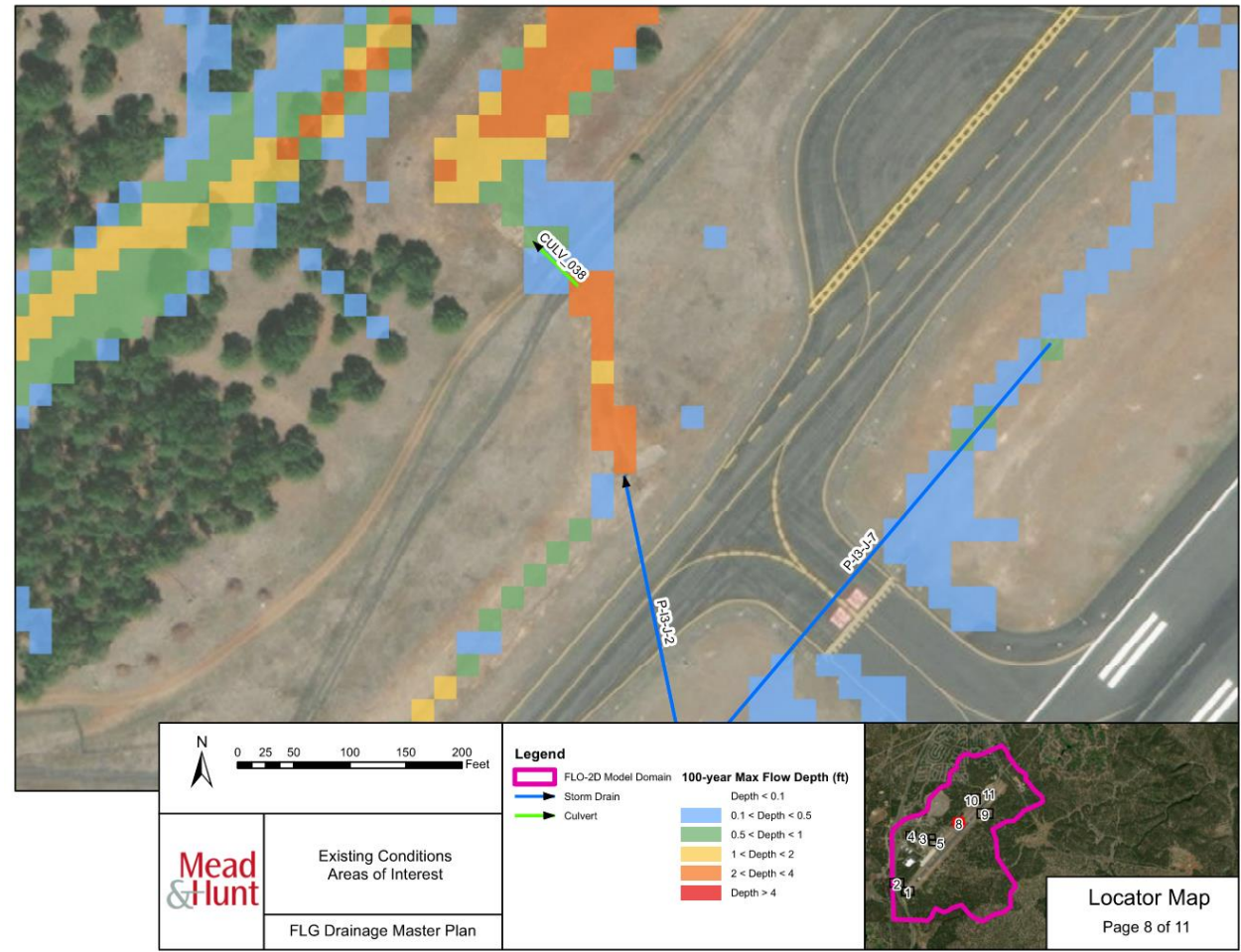
# Area 7 – 100-year Flooding

- Location:
  - Within the parking lot infield north of the Terminal Building.
- Max Ponding Depth:
  - 3.87'
- Concern:
  - These infield flowpaths are relatively flat and may spill onto the parking lot in the event of culvert clogging.



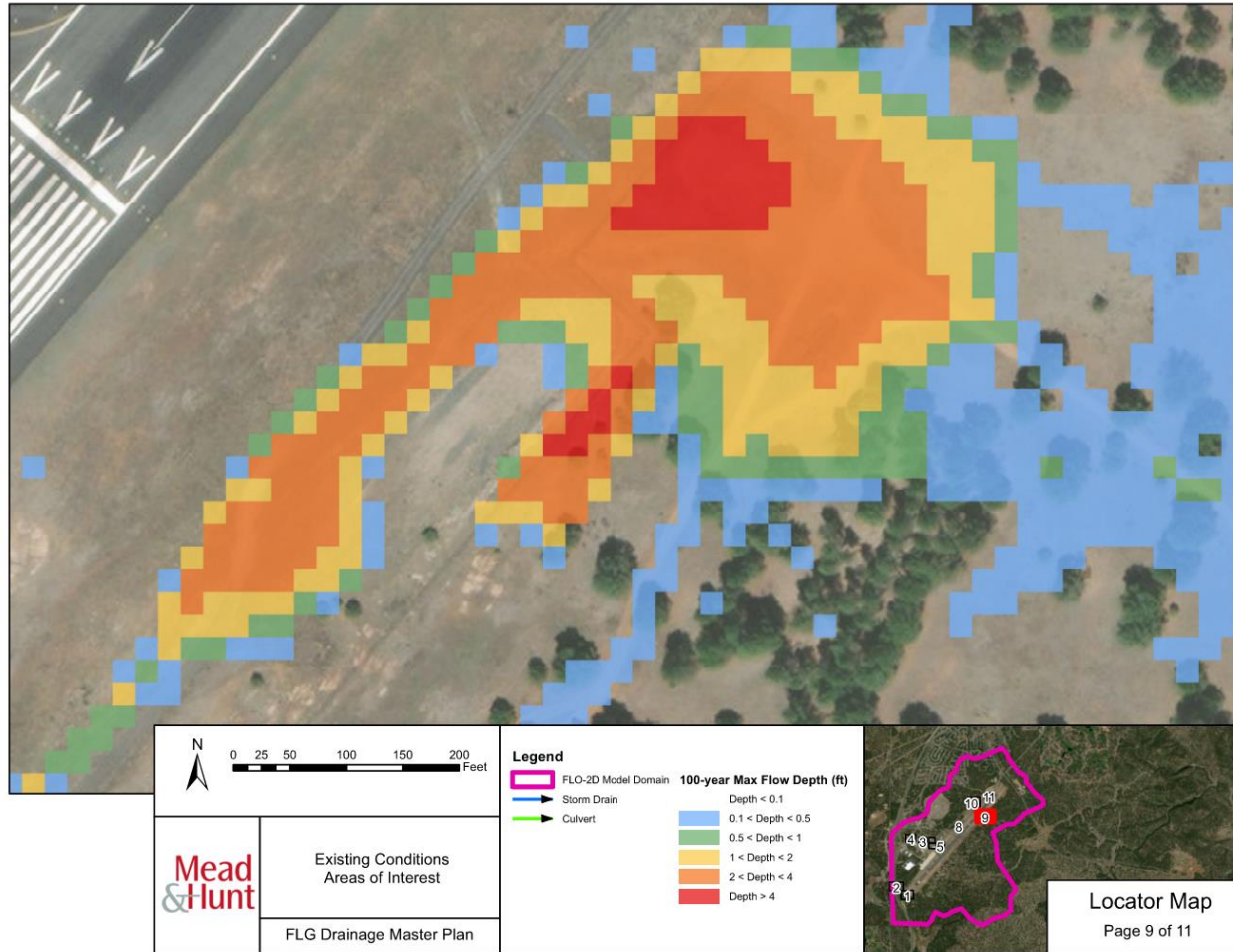
# Area 8 – 100-year Flooding

- Location:
  - West of Taxiway A3, upstream of the culvert underneath the access roadway draining to the existing detention basin to the west.
- Max Ponding Depth:
  - 3.52'
- Concern:
  - This could indicate inadequate culvert capacity leading to roadway overtopping.



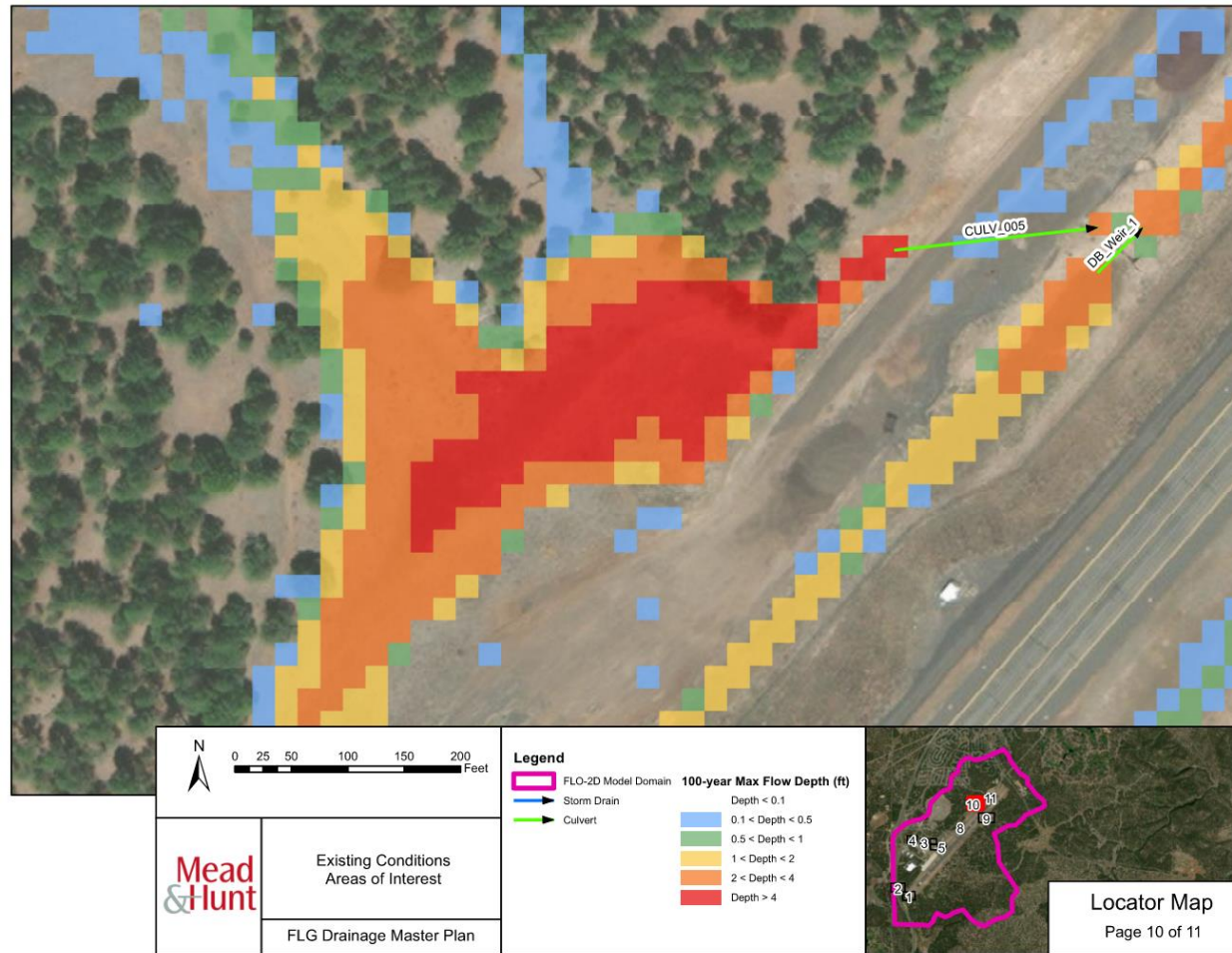
# Area 9 – 100-year Flooding

- Location:
  - A low point approximately 500 feet east of Taxiway A2.
- Max Ponding Depth:
  - 4.84'
- Concern:
  - This could serve as a wildlife attractant or lead to embankment stability concerns over time and could benefit from grading modifications to facilitate proper drainage.



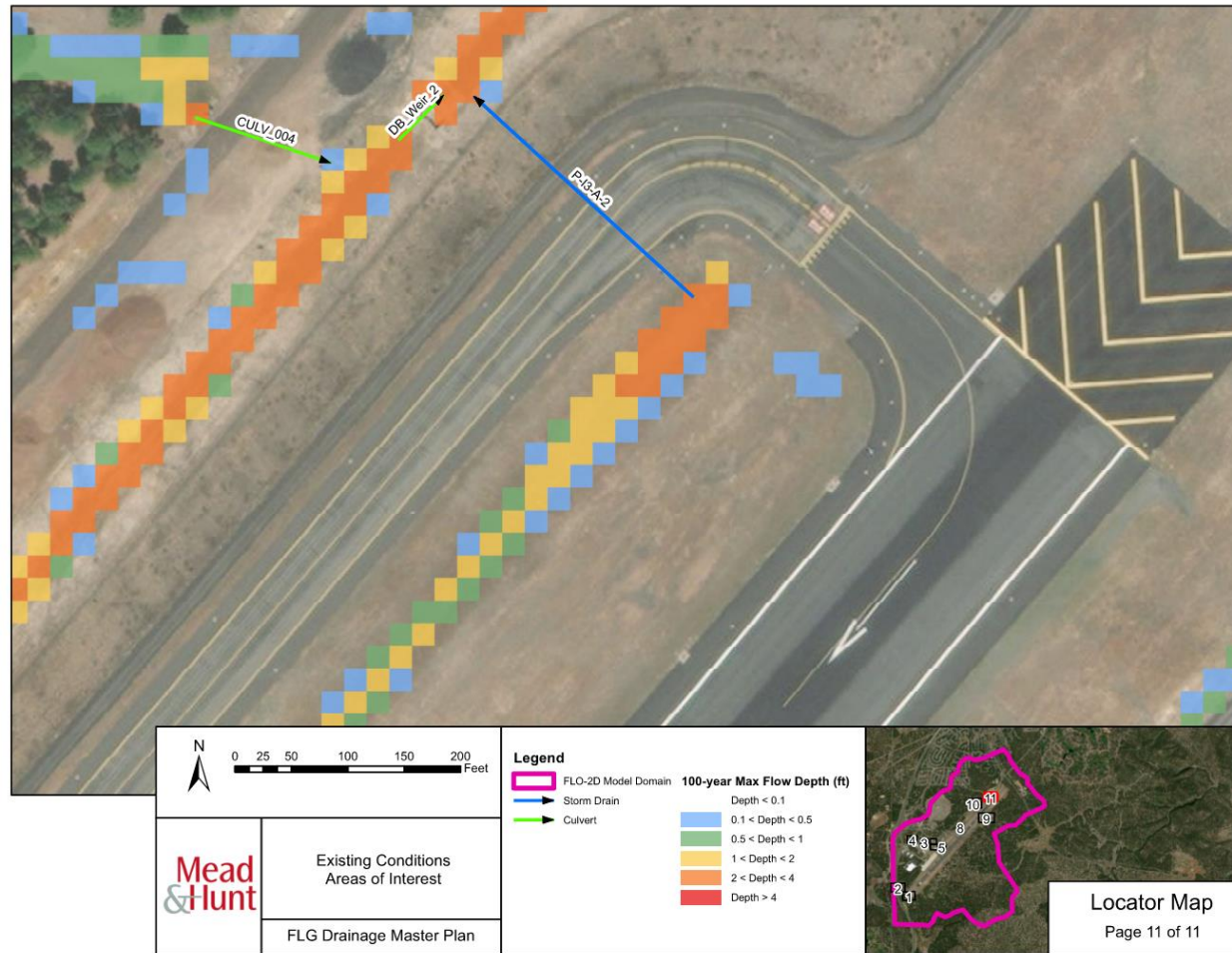
# Area 10 – 100-year Flooding

- Location:
  - Upstream of the culvert feeding into Bow and Arrow Wash approximately 700 feet north of Taxiway A2.
- Max Ponding Depth:
  - 7.27'
- Concern:
  - This could lead to overtopping of the perimeter road.



# Area 11 – 100-year Flooding

- Location:
  - In the infield south of Taxiway A1.
- Max Ponding Depth:
  - 3.83'
- Concern:
  - This could pose a wildlife hazard or lead, cause ponding on the Airfield pavement, or lead to slope stability issues.



# Next Steps for Airport Drainage Master Plan

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- Proposed Conditions Airport Drainage Assessment
  - Short-term airport improvements (0-5 years)
  - Intermediate and Long-term airport improvements (6-20 years)
- Develop Proposed Airport Drainage Improvements
  - Concept-level recommended alternatives with cost estimates to address existing flooding concerns and impacts of short-term projects
  - High-level recommendations to address impacts of intermediate and long-range projects
- Final Airport Drainage Master Plan



**Thank you.**