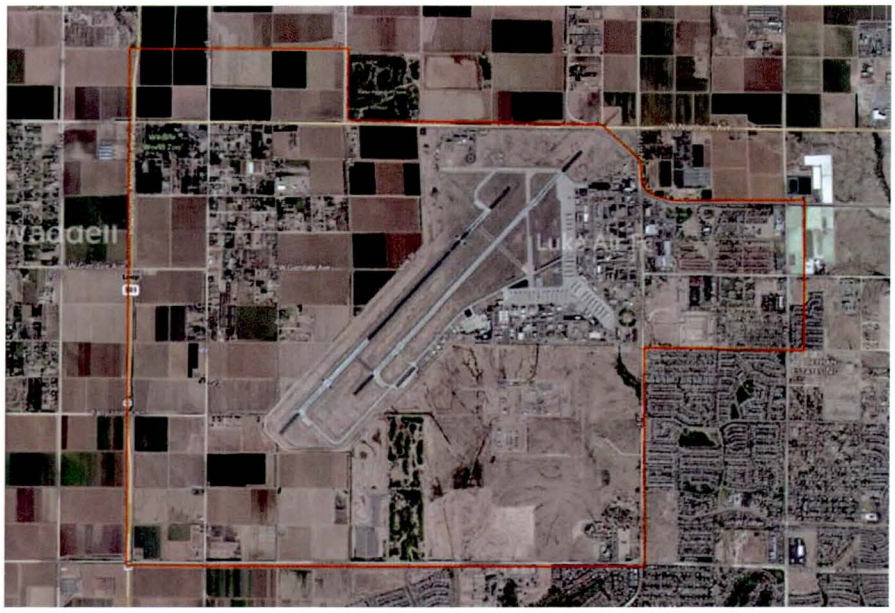
US Army Corps
of Engineers

Los Angeles District
Hydrology and Hydraulics Branch

LUKE AFB FLOOD CONTROL INVESTIGATION

Prepared For:
Luke Air Force Base
Maricopa County, Arizona
Project Number: NUEX120203
Project Order Number: F2U3082272J001



Prepared By:
US Army Corps of Engineers,
Los Angeles District, Engineering Division
Los Angeles, California
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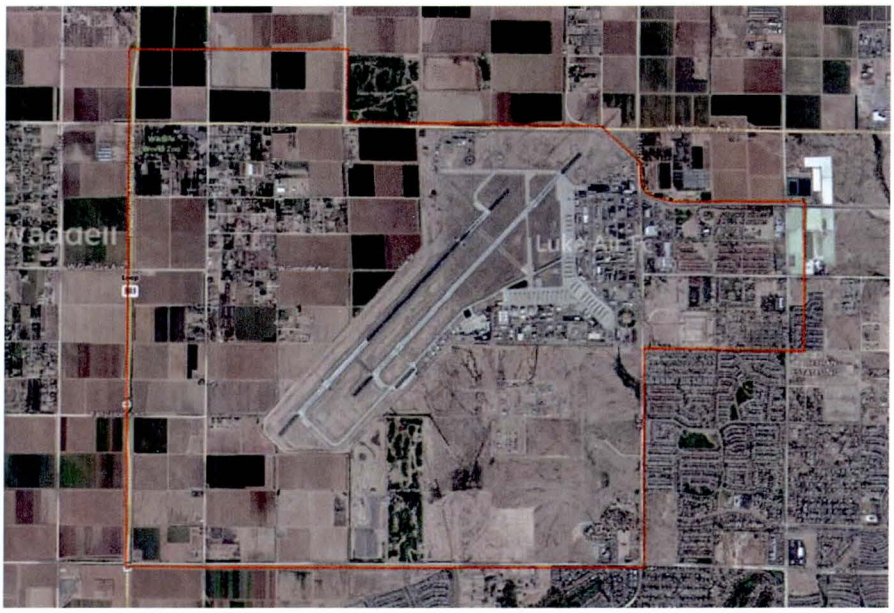

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PREFACE

The hydrologic and hydraulic investigation reported herein was authorized by Luke Air Force Base on 24 September 2012. The study was conducted by personnel of the Hydrology and Hydraulics Branch, Engineering Division, Los Angeles District, South Pacific Division, US Army Corps of Engineers during the period September 2012 to June 2013. All studies were conducted under the direction of Mr. Rene Vermeeren, Chief, Hydrology and Hydraulics Branch. The hydrologic and hydraulic analyses were conducted by Messrs. Kerry Casey, Adam Bier, and Joseph Goldstein, under the supervision of Mr. Cuong Ly, Chief, Hydrology and GIS Section. The report was prepared by Mr. Adam Bier, Hydraulic Engineer. The report was reviewed as part of District Quality Control (DQC) by Mr. Rene Vermeeren; Mr. Cuong Ly; Mr. Van Crisostomo, Chief, Hydraulic Section; and Mr. Kerry Casey, Senior Hydraulic Engineer. The report was reviewed as part of Agency Technical Review (ATR) by Messrs. Mike Lin and Stephen Graff of the Sacramento District, South Pacific Division, US Army Corps of Engineers and Messrs Pedro Melo Rodriguez, Anthony Beuche, and Richard Waskowsky of the Flood Control District of Maricopa County.

Prior to completion of hydrologic and hydraulic modeling, Messrs Ly, Casey, and Bier visited the project site to inspect the existing conditions of the storm drain system. Messrs. Anthony Beuche, Thomas Loomis, Scott Vogel, Richard Waskowsky, Pedro Melo Rodriguez, of the Flood Control District of Maricopa County; Mr. Joe Derungs, Project Manager, Project Management Division, Los Angeles District; and Mr. Alan Thomas, Environmental Programs Manager, CES Project POC, Luke Air Force Base, were members of the study team.

Mr. Richard Leifield is the Engineering Division Chief for Los Angeles District, US Army Corps of Engineers.

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LIST OF ACRONYMS

ADMPU – Area Drainage Master Plan Update

ADOT – Arizona Department of Transportation

AFB – Air Force Base

ASCII – American Standard Code for Information Interchange

ATR – Agency Technical Review

CFS – Cubic Feet per Second

COE – U.S. Army Corps of Engineers, Los Angeles District

District – Flood Control District of Maricopa County

DQC – District Quality Control

EPA – Environmental Protection Agency

GDS – Grid Developer System (FLO-2D Interface)

GIS – Geographic Information System

HARN – High Accuracy Reference Network

HEC – Hydrologic Engineering Center

HEC-RAS - Hydrologic Engineering Center River Analysis System

NAD - North American Datum

NAVD 88 – North American Vertical Datum of 1988

PDT – Project Delivery Team

PMP – Project Management Plan

PVC – Polyvinyl Chloride

SR – State Route

SWMM – Storm Water Management Model

TIN – Triangulated Irregular Network

USACE – U.S. Army Corps of Engineers

MODEL PARAMETERS

ARF – Area Reduction Factor

DTHETA – Average Soil Moisture Coefficient

IA – Initial Abstraction

RTIMP – Percent Impervious Area

SOILD – Maximum Depth for Infiltration

TOL – Depression Storage

VC – Percent Vegetative Covered Area

WRF – Width Reduction Factor

XKSAT – Hydraulic Conductivity of Soil

EXECUTIVE SUMMARY

This report documents the hydrologic and hydraulic analysis performed as part of the Luke AFB Flood Control Investigation (Project Number: NUEX120203). Analysis was conducted by the U.S. Army Corps of Engineers, Los Angeles District (COE) to investigate the hydrologic and hydraulic existing condition and flooding impacts at Luke Air Force Base (Luke AFB). Staff from the Flood Control District of Maricopa County (District) was included in the Project Delivery Team (PDT) along with Luke AFB staff. The District has extensive knowledge of this region and was included in the ATR process.

The Luke AFB Flood Control Investigation project goals are to identify flooding of aircraft parking ramps and structures on the base.

The purpose of this report is to document the existing conditions of the storm drain system at Luke AFB for future design documents and the eventual construction of flood control features to mitigate flooding of aircraft parking ramps and structures and to provide the hydrologic and hydraulic analysis of the existing condition at Luke AFB.

The study area is approximately 12 square miles and is generally bounded by Northern Parkway, Northern Avenue, and Dysart Drain to the north; State Route (SR) Loop 303 to the west; Camelback Road to the south; and Litchfield Road and Dysart Road to the east. Existing drainage facilities include Bullard Wash and Dale Creek Wash which drain from Luke AFB to the south. The Camelback West Channel Tributary conveys flows from the west of the airfield south to a drainage facility along Camelback Road. Flows from the north are diverted away from the base via the Northern Parkway Drainage Improvements and Dysart Drain. Flows from the West are diverted from the base by SR Loop 303.

An existing conditions Storm Drain Analysis was completed. EPA-SWMM was used to identify critical storm drain lines in the vicinity of the airfield parking ramps and three additional storm drain lines on base. The six critical storm drain lines have obstructions to proper flow including adverse slopes and inconsistent pipe sizes along the storm drain line.

Hydrologic and hydraulic modeling was completed using FLO-2D and EPA-SWMM at the request of Luke AFB and the District. An analysis involving multiple flood frequency events was considered; however, Luke AFB requested the analysis use the 100-year flood event. FLO-2D was used to delineate a floodplain for this event. Four critical areas were identified. Floodplain delineation and flood depths are shown on Plates 15-20.

The aircraft parking ramps appear to have some low spots which allow surface water to pond. This could be a result of poor grading or settlement. The aircraft parking ramp area should be investigated further in the next phase of the analysis to determine what measures can be taken to upgrade the storm drain line capacities to alleviate flooding.

1.0 GENERAL DESCRIPTION OF STUDY

1.1 Study Objectives

This study was authorized by Project Order (Number: F2U3082272J001). The U.S. Army Corps of Engineers, Los Angeles District (COE) is currently investigating the hydrologic and hydraulic existing condition and flooding impacts at Luke Air Force Base (Luke AFB). The hydrologic and hydraulic investigation reported herein was conducted for Luke Air Force Base.

The focus of this project is to evaluate the Existing Conditions Storm Drain System and conduct a floodplain Hydrologic and Hydraulic Analysis. An environmental baseline report documenting existing environmental conditions for incorporation into future project NEPA documentation was originally part of the PMP, but it was deleted from the scope of work.

The Luke AFB Flood Control Investigation project goals are to identify areas of flooding around aircraft parking ramps and structures on base.

The existing condition storm drain analysis was performed using the Environmental Protection Agency (EPA) Storm Water Management Model (SWMM). The existing condition hydrologic and hydraulic analysis for surface flows was performed using FLO-2D modeling software. See Appendix 1 for the PMP for this study.

1.2 Deliverables

A Topographic Survey Report was provided by Aerotech Mapping and consisted of survey data files and metadata. See Section 2.1 for discussion regarding the topographic survey.

The Storm Drain System Existing Conditions Analysis is provided in this report and includes a general description of the existing conditions storm drain system features and verification of elevations. An evaluation of the existing condition of key storm drains with video scoping was originally part of the scope of work; however, this task was replaced by additional field verification and the use of EPA-SWMM to investigate the existing condition of storm drain profiles. Field verification of inlet and invert elevations of key drainage system components was completed. Further discussion can be found in Section 2.2. An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis because the data for specific pump capacity was not available. However, two pumps that used default parameters assuming an ideal pump curve were included in the EPA-SWMM model as an estimate until better data is obtained.

The Existing Conditions Hydrologic and Hydraulic Analysis includes documentation of methods, assumptions, and results from the hydrologic and hydraulic modeling efforts. The Luke AFB watershed is defined by the Loop 303 Freeway to the west, Northern Parkway and Dysart Drain to the north, Camelback Road to the south, and Litchfield Road and Dysart Drain to the east. Watershed limits for Luke AFB are discussed further in Section 3.1. A FLO-2D model with

25-foot grid resolution was developed for the Luke AFB watershed to model a 100-year flood event. Hydrologic Engineering Center River Analysis System (HEC-RAS) was used to model hydraulic structures to determine the capacity of culverts within the base drainage area. Open channels were included in the FLO-2D model. The scope of work called for a HEC-HMS model to evaluate the hydrology on Luke AFB; however, at the request of Luke AFB and the District, the Hydrologic analysis was completed using FLO-2D and EPA-SWMM.

1.3 Study Area

Luke AFB is located in the City of Glendale in Maricopa County, Arizona approximately 15 miles west of the City of Phoenix. McMicken Dam is approximately 8 miles northwest of the study area. Watercourses in the vicinity area include Beardsley Canal (5 miles to the west), Trilby Wash (10 miles to the northwest), Agua Fria River (3 miles to the east), and the Gila River (10 miles to the south). See Plate 1 for vicinity map. The study area is approximately 12 square miles and is bordered by Northern Parkway, Northern Avenue, and Dysart Drain to the north; State Route Loop 303 to the west; Camelback Road to the south; and Litchfield Road and Dysart Road to the east. See Plate 2 for a topography map which shows Luke AFB and the study area. The study area is in the Agua Fria River watershed and includes portions of the following jurisdictions: City of Glendale, Luke AFB, City of Litchfield Park, City of Goodyear, and unincorporated Maricopa County.

1.4 Previous Studies

The *Loop 303/White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona report* (Loop 303 Hydrologic Report) dated September 2009 was the main source for the hydrologic conditions for Luke AFB. This report provided the hydrology information used in the analysis, including information on existing drainage facilities and capital improvement projects in the vicinity of Luke AFB. See Section 3.0 for discussion regarding the existing hydrologic data.

1.5 Coordination

Bi-weekly coordination meetings were held involving COE, District, and Luke AFB personnel. The coordination meetings allowed for discussion of project related issues including schedule, goals, and deliverables. Draft FLO-2D and EPA-SWMM models were shared with the District during the modeling process to allow for concurrence on modeling procedures, assumptions, and results. The District was consulted regarding the FLO-2D and EPA-SWMM modeling as well as being involved in the review process. The District will be working on the next phase of the study.

2.0 DATA COLLECTION

2.1 Topographic Survey

Aerial photography and mapping collected in March 2008 by the Flood Control District of Maricopa County (District) was used by Aerotech Mapping to create survey data with a 2-foot contour interval. All shapefiles and mapping products use NAD 1983 HARN State Plane Arizona Central (International Feet) as the horizontal datum. NAVD 88 was used for the vertical datum. Additionally, the District created a TIN file from the Aerotech Mapping survey data.

2.2 Field Investigation

An initial meeting and field investigation was held 6-8 November 2012 involving COE staff, Luke AFB, and the District. The purpose of the meeting and site visit was to observe the existing hydrologic and hydraulic condition at Luke AFB. The goal was to evaluate the existing storm drain system and get an understanding of the size and capacity of the storm drains.

A follow up site visit was held 11-13 December 2012. The purpose of the site visit was to survey existing storm drain inlets and culverts (structures). The COE survey team surveyed elevations for 43 storm inlets, 10 storm drain outlets/outfalls, 33 culverts, and wall heights at the Camelback Road culvert. Locations of features surveyed and elevations will be provided electronically. The structures were surveyed to obtain a representative sample of the total number of structures in the study area.

2.3 Geographic Information System (GIS)

Luke AFB provided a geodatabase that provided information on culverts, conduits, inlets, outlets/outfalls, junctions, pipe fittings, pump stations, open drainage lines, storm drain lines, and detention basins. The data provided by Luke AFB was used unless a survey point was available from the COE survey from 11-13 December 2012.

Some of the elevations for the GIS data points appeared to be consistent with the TIN described below. A select set of inlets were field surveyed, which verified that adverse slopes do occur in the system. The GIS data was used as provided by Luke AFB, but it is recommended that the remainder of the inverts and culverts be re-surveyed to verify the data.

The District provided the 2-foot contour TIN surface compiled from the Aerotech Mapping survey data. They also provided the 2-foot ASCII file that was used to interpolate the elevations for each grid cell in FLO-2D. The following shapefiles were provided to aid in the GIS and FLO-2D modeling efforts.

- LUKEAFB_SFC.SHP – Provides terrain type, initial abstraction, percent impervious, percent vegetative cover, overland Manning's n-value, and initial saturation condition for the study area.

- LAFB_Walls2008.shp – Provides location of the various walls in and around the base, including the boundary security walls. Only the major walls were modeled in FLO-2D. Major walls include security boundary walls, walls surrounding parking areas, and walls surrounding buildings and yards.
- Jersey_Barriers.shp – Provides the location of the Jersey Barriers located around the aircraft parking ramps. Only the major Jersey Barriers were included in the shapefile (i.e. the barriers surrounding the parking ramps).
- SoilSSURGO2012AprNRCS.shp – Provides soil parameters for the study area including soil description, initial saturation and rock outcrop percentage.

Additionally, Luke AFB provided measurements and photographs of 39 storm inlets through a survey completed from 15-16 April 2013. Inlet dimensions are an input in FLO-2D when using the EPA-SWMM component. The measurements included length, width, and height of the inlet. In addition to the 39 measured inlets, another 90 inlet dimensions were verified based on similar inlet design as those measured directly.

3.0 EXISTING HYDROLOGIC DATA

3.1 Loop 303 Hydrologic Report

According to the Loop 303 Hydrologic Report, the watershed in the Luke AFB area generally slopes to the south-southeast towards the Agua Fria River to the east and the Gila River to the south. Luke AFB is part of the Agua Fria River Watershed which has a drainage area of approximately 238 square miles. The watershed in the area around Luke AFB has been historically either undeveloped or used for agricultural uses, but recent development has led to more residential communities.

3.2 Existing Storm Water Conveyance Features

Major existing drainage structures and improvements are located in the vicinity of Luke AFB. Dysart Drain and Dysart Detention Basin capture flows from the north. Camelback West Channel Tributary runs along the west side of Reems Road and lies to the west of the Luke AFB. Dale Creek Wash, Northern Litchfield Conveyance Channel, and Southern Litchfield Conveyance Channel convey flows southeast away from Litchfield Road and the south entrance gate. See Plate 3 for the Existing Facilities Map.

Additionally, the Loop 303 Hydrologic Report identified improvement projects in the vicinity of Luke AFB, including the Loop 303 Freeway and SR 303L Channel as well as the Northern Parkway Drainage Improvements. According to the District, the Northern Parkway, the Loop 303, and their associated drainage improvements are currently under construction (June 2013). Each roadway project includes a corresponding drainage project with facilities that will intercept, detain, and convey the 100-year peak flow. As a result, the Loop 303 Freeway and Northern Parkway and their drainage facilities are included as Existing Conditions as part of this report. The Northern Parkway Drainage Improvements run along Northern Parkway to the north of the study area diverting flows entering from the north. The Loop 303 Channel runs along the Loop 303 Freeway along the western border of the study area diverting flows from entering from the west.

Based on the inclusion of the SR 303L Channel diverting flows from the west, the Northern Parkway Drainage Improvements and Dysart Drain diverting flows from the north, the study area is set as the contributing watershed for the analysis presented in this report. The study includes only flows generated from the rainfall within the study area and does not include potential overland flows from the Loop 303 and Northern Parkway drainage improvements from the west and north, respectively. See Section 5.3.2 for further discussion regarding rainfall and inflows.

The Loop 303 Hydrologic Report presents additional planned improvement projects in the vicinity of Luke AFB including the following: drainage improvements along Kachina and Lalomi which would drain flows north to Dysart Drain, drainage improvements along Litchfield Road which would drain south to existing Dale Creek Wash, and an extension of Bullard Wash

which would convey flows from Super Sabre Street diverting flows to the south to the existing Bullard Wash. These facilities are part of the Capital Improvement Plan (CIP) and are not assumed existing in the analysis presented in this report. See Plate 4 for the planned improvement projects in the vicinity of Luke AFB according to the Loop 303 Hydrologic Report. Some of the future detention basins shown adjacent to the Loop 303 and Northern Parkway are either under construction or will be constructed with roadway projects. The Loop 303 is an ADOT project and the final locations and configurations of the basins may not correspond directly to what is depicted on the on Plate 4.

Plate 5 shows the existing conditions drainage facilities with the drainage path lines for the study area. The drainage path lines were provided by the Loop 303 Hydrologic Report GIS data. The drainage path lines show the general drainage patterns with the study area.

3.3 Subsidence

According to the Loop 303 Hydrologic Report, Luke AFB is subject to subsidence. The land subsidence is generally due to compaction of the alluvium caused by lowering of the water table. The report stated that between a period between the 1950's and 1980's that significant subsidence was reported near Olive Road and Reems Road which is approximately 2 miles north of the airfield, whereas very little subsidence was experienced near Camelback Road and Litchfield Road which is approximately 2 miles south of the airfield. Subsidence in the base area may have adversely affected the existing sub surface storm drain system. According to the District, Dysart Drain adjacent to the north boundary of the base was improved in 1994 to address adverse slope caused by subsidence.

4.0 EXISTING STORM WATER DRAINAGE SYSTEM

4.1 Existing Storm Water Conveyance System

The Loop 303 Hydrologic Report from September 2009 presented information on existing storm water conveyance features in the study area. The results presented in this section were obtained from the HEC-1 model completed as part of the September 2009 Hydrologic Report.

4.1.1 Dysart Drain

Dysart Drain, located along the northern boundary of the study area, receives flow from the north and conveys it east to the Agua Fria River. The design capacity of Dysart Drain is 448 cfs at Bullard Avenue and 2287 cfs at Dysart Road. According to the Loop 303 Hydrologic Report, the existing conditions flows are 267 cfs and 1062 cfs for the 100-year event, respectively, at those locations along Dysart Drain. The Dysart Detention Basin (Falcon Dunes Golf Course) was designed to store 408.9 acre-feet, while the existing conditions reported 147 acre-feet storage. The flow into Falcon Dunes is designed to be 596 cfs.

4.1.2 Bullard Wash

Bullard Wash originates at Luke AFB and flows south to the Gila River. Bullard Wash has an upstream watershed limit of Dysart Drain. Bullard Wash is not channelized from Luke AFB to Camelback Road. Bullard Wash becomes channelized south of Camelback Road. The existing culvert under Camelback Road at Bullard Wash was designed to have capacity for the 100-year peak flow. The culvert consists of six box culverts that are 10 feet wide and 8 feet high. The Loop 303 Hydrologic Study reported Bullard Wash flows to be 2867 cfs at Camelback Road.

4.1.3 Loop 303

The Loop 303 drainage facilities capture flows from the west and convey flows south of the base. The design flows reported in the Loop 303 Hydrologic Report are subject to change as the final design was not complete. The report showed Loop 303 system design flow to be 2082 cfs at Northern Avenue and 2588 cfs at Camelback Road with existing conditions flows to be 932 cfs and 2276 cfs at those locations, respectively. According to the District, the final design of the Loop 303 drainage improvements has been completed and construction of those improvements is underway (June 2013).

4.1.4 Dale Creek Wash

Dale Creek Wash originates near the south gate of Luke AFB and travels southeast through residential area to the Litchfield Detention Basin. From the Loop 303 Hydrologic Report, the existing condition flow from Dale Creek Wash is 936 cfs into the Litchfield Detention Basin.

4.2 Existing Storm Water Drainage System Components

Luke AFB provided a geodatabase of the various existing storm drain system features. See Plates 6 to 8 for maps showing the locations of the various storm drain features such as: detention basins, storm drain lines (closed conduits), open drain lines, storm drain inlets, storm drain junctions (manholes), storm drain fittings, culverts, pump stations, and storm drain discharge outlets. See Section 5.0 for discussion on the features included in the FLO-2D and EPA-SWMM models. Detailed performance information can be found in the swmm.RPT file from the FLO-2D output.

4.2.1 Detention Basins

Detention Basin depth and surface area were measured using aerial photography and field investigations. Five detention basins were identified on Luke AFB and basin names were assigned based on location. The two main detention basins (Airfield North and Airfield South) are located west of Litchfield Road near the aircraft parking ramp area. Airfield North has an approximate depth of 4 feet and storage capacity of 26.8 acre-feet. Airfield South has an approximate depth of 4 feet and capacity of 15.6 acre feet. A 36 inch conduit connects the two basins. See Plates 6 to 8. Another detention basin (Thunderbird Basin) is located near the eastern boundary of the base north of Thunderbird Street in a residential area. This basin has an approximate depth of 2.5 feet and storage capacity of 8.3 acre-feet. Lastly, two detention basins (Kachina North and Kachina South) are located along the northern end of Kachina. Kachina North has an approximate depth of 3.5 feet and storage capacity of 1.8 acre-feet. Kachina South has an approximate depth of 3.5 feet and capacity of 6.0 acre-feet.

4.2.2 Storm Drainage Lines (open and closed)

Luke AFB has approximately 630 closed conduit main storm drainage lines. There are approximately 70 service storm drainage lines that were not included in the analysis. The majority of the closed conduits are circular reinforced concrete pipe (93 percent). Other materials used for the conduits include PVC (5 percent) and corrugated metal (2 percent). The conduit sizes vary from 6 to 72 inches. See Plates 6 to 8 for closed conduit storm drain line locations.

Luke AFB has approximately 170 open drainage lines that help divert the flows throughout the base property. Approximately 30 percent are paved ditches while 70 percent are unpaved (natural bottom) ditches. See Plates 6 to 8 for open drainage line locations.

4.2.3 Storm Drain Inlets

Luke AFB has approximately 510 storm drain inlets in the storm drain system. Approximately 435 of the inlets were modeled as part of the EPA-SWMM model. According to the Luke AFB geodatabase, approximately 20 percent of the inlets are classified as being curb inlets while 80 percent are drop inlets. Invert elevations were provided for the majority of the inlets. See Plates 6

to 8 for inlet locations. Of the 435 inlet invert elevations obtained from the Luke AFB GIS geodatabase, 43 of those were surveyed by the COE. The invert elevations surveyed by the COE were used in lieu of the elevations provided by Luke AFB for the respective inlets.

4.2.4 Storm Drain Junctions and Fittings

Luke AFB has approximately 75 storm drain fittings and 115 storm drain junctions (manholes) in the storm drain system. Invert elevations were provided for the majority of the junctions. Invert elevations were not available for the fittings, so straight-line interpolation was used between known upstream and downstream invert elevations from storm drain junctions. The maximum depth of the manholes was calculated as the difference between the ground elevation and invert elevation. See Plates 6 to 8 for junction and fitting locations.

4.2.5 Culverts

There are approximately 80 individual culverts located throughout the study area. Approximately 30 culverts run along the northern side of Super Sabre Street, and approximately 30 culverts are located along the northern border of the base near Dysart Drain. There are another 20 culverts at various locations around the base including one between the two detention basins in the aircraft parking ramp area. See Plates 6 to 8 for culvert locations.

4.2.6 Pump Stations

A pump station is located near the baseball sports complex, north of the running track and west of Litchfield Road. According to elevation differences between upstream and downstream storm inlets, the pump station pumps the flows approximately 12 feet vertically. According to the Luke AFB geodatabase, an additional pump exists inside a storm drain junction north of Spad Street. See Plates 6 to 8 for pump station locations.

4.2.7 Storm Drain Discharge Outlets

Luke AFB has approximately 32 storm drain outlets, discharging to open drain lines, Dysart Drain, and concrete catch basins. The two concrete catch basins are located along Super Sabre Street at locations where multiple storm drain lines (open and closed) converge. The concrete catch basins convey flow to culverts that run beneath Super Sabre Street. See Plates 6 to 8 for storm drain discharge outlet locations.

5.0 FLOODPLAIN ANALYSIS USING FLO-2D AND EPA-SWMM

5.1 Modeling Procedure

FLO-2D and EPA-SWMM were used to perform the hydrologic and hydraulic analysis as requested by Luke AFB and the District. The FLO-2D Pro model has been integrated with the EPA-SWMM version 5.0 to simulate the exchange of surface water flow (FLO-2D) with a storm drain system (EPA-SWMM). The two models run simultaneously; whereas, FLO-2D calculates all hydraulic and hydrologic surface water flow routing while EPA-SWMM only solves the conduit hydraulics and routing of the storm drain network. The FLO-2D model computes the storm drain inflow discharge based on the predicted grid element headwater depth and exchanges this discharge with the EPA-SWMM model to compute the storm drain system pipe hydraulics and the potential return of flows to the surface through downstream manholes, outlets, and storm drains. The return flow is routed based on FLO-2D surface hydraulic and hydrologic calculations.

5.2 FLO-2D Introduction

FLO-2D is a two-dimensional flood routing model that can be a valuable tool for delineating floodplains and determining flood depths. FLO-2D GDS Pro (Build Model 13.02.04) was used to create and process the surface water components. This software was requested by Luke AFB and the District. According to the FLO-2D website, FLO-2D is a flood routing model that simulates channel flow, unconfined overland flow, and street flow over complex topography. FLO-2D uses the continuity and momentum equations. The flood simulation for Luke AFB included the following additional components: rainfall, infiltration, buildings, levees, and hydraulic structures. The rainfall and infiltration components along with Manning's n-values and ground elevations were determined spatially by a grid cell system. Additionally, FLO-2D has the capability to model subsurface flow including storm drains and culverts using the EPA-SWMM interface. FLO-2D is a USACE approved model for surface water hydraulic applications and was selected to analyze the flooding at Luke AFB.

Considering the Luke AFB study area of approximately 12 square miles, the quality of the 2-foot contour interval TIN survey data, and computer processing time, a 25-foot by 25-foot grid cell size was selected for the FLO-2D model, which resulted in 551,096 grid cells.

5.3 FLO-2D Hydrologic Components

5.3.1 Infiltration and Abstraction

The Green-Ampt method was used to simulate infiltration using FLO-2D GDS Pro. Soil and land use shapefiles were used to compute Green-Ampt infiltration parameters spatially using a grid cell system. The shapefile "LukeAFB_SFC.SHP" was used to obtain land use parameters, including land use descriptions, initial abstraction (IA), percent impervious area (RTIMP),

percent vegetative cover area (VC), and initial saturation condition. The initial abstraction (interception) is filled prior to simulating infiltration. IA values were obtained from the District. Table 2 from *the FLO-2D Pro Reference Manual* and Table 4.2 from the *Drainage Design Manual for Maricopa County* were used to verify the IA, RTIMP, and VC variables. See Table 1 for the land use classifications used in the Green-Amp calculation. The shapefile "SoilSSURGO2010AprNRCS.SHP" was used for the soil parameters which include soil description, hydraulic conductivity (XKSAT), rock outcrop percentage, and effective impervious area. Infiltration is not calculated for buildings, streets, and impervious surfaces in the model; however, rainfall is assumed to occur over the entire grid element even if the element is completely blocked out (ARF = 1.0).

In the INFIL.DAT, global values were set regarding porosity (0.0) and maximum depth for infiltration "SOILD" (0.2083 feet). The maximum depth for infiltration (SOILD in the INFIL.DAT file) is assumed to be 0.2083 feet (2.5 inches). The District used the existing HEC-1 model from the *Loop 303/White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona* report to calculate the maximum depth of infiltration. Using a 100-year, 6-hour rainfall of 2.40 inches with a pattern 1 distribution, and the HEC-1 model was run to calculate the total loss for basin B51 (in the 2008 model). The total loss for basin B51 was found to be 0.99 inches. To calculate the maximum penetration depth of infiltrated water, IA is subtracted from the total loss, which is then divided by the average soil moisture deficit (DTHETA).

$$Maximum\ Depth\ of\ Infiltration = (Total\ Loss - IA)/DTHETA$$

From the INFIL.DAT, the average IA is approximately 0.25 inches and the average DTHETA is 0.3. So the estimated maximum penetration depth of infiltrated water is approximately 2.5 inches. Based on the HEC-1 model, the total loss for basins B51, B53, B41, and B44 were calculated to be 0.99, 1.16, 1.49, and 1.64 inches respectively. Using the 0.99 total loss value limits the maximum infiltration to a more conservative value. In FLO-2D, the Green-Ampt infiltration ceases when the wetting front reaches the limiting soil depth "SOILD".

According to the Hydrologic Engineering Center (HEC), this method of calculating the equivalent infiltration depth assumes saturation. In reality, the wetting front will move deeper into the soil and the space immediately above the wetting front will not be saturated. So while the procedure will give a reasonable depth of infiltration, a very detailed infiltration simulation would be required to determine the depth of the wetting front and the water content profile between that point and the soil surface.

In FLO-2D, TOL (in the TOLER.DAT file) represents the minimum water depth necessary to initiate sharing of volume between grids. Depression storage (TOL) is an initial loss from the potential surface flow. According to the District, it functions as a surface detention and should be set to a value less than 0.03 feet. The District has been using a value of 0.004 feet (equivalent to 0.048 inches), based on the smallest value of IA in Table 6.5 in the *Drainage Policies and*

Standards for Maricopa County, Arizona. The initial abstraction (IA) calculated by the GDS when assigning infiltration data to each grid cell represents the total initial abstraction (which includes the TOL value of 0.048 inches). However, the IA in the INFIL.DAT file should not include the TOL value since FLO-2D adds it when running a simulation. Consequently, the IA value initially assigned by the GDS should be adjusted such that the TOL plus IA equals the total initial abstraction.

The soil moisture deficit parameter DTHETA represents the volumetric soil moisture deficit (soil moisture deficit times the porosity) as described from the Drainage Design Manual for Maricopa County. According to FLO-2D, the global value for porosity should be set to 0.0 when DTHETA represents the volumetric soil moisture deficit. According to the manual, "if the soil is effectively saturated at the start of rainfall, then DTHETA equals zero; if the soil is devoid of moisture at the start of rainfall, then DTHETA equals the effective porosity of the soil." Three conditions have been defined for use in Maricopa County based on antecedent moisture condition that could be expected at the start of design rainfall. The three conditions are dry, normal, and saturated. The District recommended that a "normal" value be used for initial saturation for all classifications (other than those associated with water). DTHETA "normal" should be used for soil that is usually in a state of moderate soil moisture.

5.3.2 Rainfall and Inflow

FLO-2D requires either an inflow flood hydrograph or precipitation. For this analysis, a precipitation event was selected to uniformly distribute rainfall over the grid system. The *Hydrology Drainage Design Manual for Maricopa County* dated 10 February 2011 was used to calculate the rainfall for Luke AFB. The design storm is a 6-hour local storm with 100-year frequency. The drainage area is approximately 12 square miles. Using Figure A.58 of the Hydrology Manual, the point rainfall depth is estimated to be 2.40 inches (T002N, R001W). The District recommended using a Pattern 1 distribution without any depth area reduction when performing hydrologic analysis using FLO-2D. See Table 2 for the 6-hour local storm with 100-year frequency Rainfall Distribution table.

In the RAIN.DAT file, the IRANBUILDING was set to 1, which enables the model to add the rainfall to the surface water of the grid element with an ARF value. It assumes that the buildings have a gutter system that discharges water to the ground, contributing to the rainfall runoff.

Inflow flood hydrographs were not used in the modeling effort. Dysart Drain, which runs along the northern boundary of Luke AFB from the Falcon Dunes Golf Course to Dysart Road, is designed to convey the 100-year storm event. Additionally, according to the *Loop 303/White Tanks ADMPU Area Hydrologic Analysis*, the Falcon Dunes Golf Course acts as a detention basin which guides runoff to Dysart Drain. Potential flows from the north along Northern Parkway between Loop 303 and N. Reems Road will be diverted from the project area. Furthermore, Loop 303, a freeway development, lies on the western boundary of the study area.

According to the District, each roadway project (Loop 303 and Northern Parkway) includes a corresponding drainage project with facilities that will intercept, detain, and convey the 100-year peak flows. Since the Northern Parkway is currently under construction and ADOT identifies 2014 as the completion date of the Loop 303, base improvements will be designed based upon those roadways being in place as discussed in Section 3.2. The submittal to FEMA for re-delineation of the floodplain will not occur before both roadway projects are completed.

5.4 FLO-2D Geometric Components

5.4.1 Elevations

Elevations were interpolated from a 2-foot ASCII file that was created from the TIN. The Grid Developer System (GDS) was used to overlay the grid on the ASCII elevation points, which interpolated and assigned elevation to each grid element. Elevations were spatially varied and assigned to individual grid elements throughout the computational domain.

5.4.2 Streets

Since the grid appears to adequately capture the general street geometry and the Manning's n-values for the individual grid elements reflect the RTIMP, the streets are not included in the FLO-2D model as a STREETS.DAT file. Furthermore, some streets have widths greater than the grid cell width of 25 feet. FLO-2D requires the street width to be less than the grid element and requires the overall floodplain surface area of the element after the streets are removed to be at least 5 percent of the original surface area.

5.4.3 Buildings (Area Reduction Factors)

Initially, area reduction factors (ARFs) and width reduction factors (WRFs) were automatically assigned from the polygon shapefile "Buildings.shp". Buildings were incorporated into the FLO-2D model to help detail the predicted area of inundation from the overland flow. The building footprints were exported from the "LukeAFB_SFC.shp" which was provided by the District. The building footprints were drawn using the 2008 aerial photography and verifications were made using more recent Google imagery.

WRFs were initially computed by FLO-2D but were removed from the model because WRFs can cause rainfall to be trapped on buildings when values of 1.0 (for WRFs) are used according to the District. WRFs can partially or completely obstruct flow paths when utilized. Only ARFs are included in the ARF.DAT.

ARFs and WRFs are coefficients that modify the individual grid element surface area storage and flow width. According to FLO-2D, ARFs can be used to reduce the flood volume storage on grid elements due to buildings. ARFs are specified as a percentage of the total grid surface area (from 0.05 to 1.0). For example, if a grid element is covered by 50 percent of a building, the ARF value will be 0.50.

Additionally, in the RAIN.DAT, the setting IRAINBUILDING is set to 1 to allow the rainfall on the buildings to contribute to the surface water on a grid element. Rainfall runoff is increased as the rainfall on the building rooftop is added to the surface flow on the grid cell, which is a conservative assumption that buildings have a gutter system that discharges the water to the ground. The ARF values are considered to be in addition to the impervious surface assigned infiltration value. Building locations in the main base area are shown in Plate 9.

5.4.4 Levees (Walls and Jersey Barriers)

The area of inundation can be affected by Jersey barriers and walls. These are modeled as levees in FLO-2D. The FLO-2D levee component confines flow on the floodplain surface by blocking one or more of the eight flow directions. The Jersey barriers were assumed to have a height of 2.5 feet and the walls on the base were assumed to have a height of 6 feet.

Aerial photography from 2008 was initially used to aid in modeling the location of Jersey barriers and walls. Google imagery was used to verify the wall and Jersey barrier locations. The shapefile "Jersey_Barriers.shp" was provided by the District which shows the locations of the major Jersey barriers at Luke AFB. The shapefile "LAFB_Walls2008" was provided by the District. Based on the imagery sources stated above a new shapefile "LAFB_Walls_ USACE.shp" was created to include additional walls found on base. Additionally, walls surrounding trash dumpsters and air conditioners as well as other small segments located around the base (which are included in the shapefile "LAFB_Walls2008.shp") were not included in the LEVEE.DAT file. Levees and Jersey barrier locations are shown in Plate 9.

5.4.5 Hydraulic Structures

There are approximately 40 culvert locations within the project study area, consisting of approximately 80 individual culverts. The culverts vary in size, shape, and material but typically are constructed of either reinforced concrete or corrugated metal. Twenty seven culvert locations were judged to significantly impact the hydraulic results and were incorporated in the FLO-2D model as hydraulic structures. The culvert descriptions and locations are listed in Tables 3 and 4. The culvert locations are shown on Plates 10 to 14. HEC-RAS 4.1.0 was used to develop rating curves (depth vs. discharge) for each culvert location. The rating curves have a maximum flow that corresponds with the capacity of the hydraulic structure. The curves were then inputted into FLO-2D after selecting an inflow and an outflow grid cell. The HEC-RAS culvert cross-sections were developed based on the Luke AFB TIN provided by the District and culvert invert elevations and pictures from the survey performed by the COE on 11-13 December 2012.

For each culvert location, four cross-sections were created. One cross-section located sufficiently upstream and one sufficiently downstream of the culvert so that flow is not affected by the structure. The other two cross-sections are located a short distance downstream and upstream from the culvert to represent the natural ground of the floodplain directly adjacent to the hydraulic structure. Manning's roughness coefficients typically ranged from 0.012 to 0.04

(finished concrete to dense brush and small trees). Trash racks (where applicable) were assumed to reduce the flow area by 50%. For example a 6 ft x 4 ft box culvert with a trash rack was modeled as a 4 ft x 3 ft box culvert. Culverts with trash racks are noted in Table 3 and 4. The culverts were not assumed to have any volume storage or sediment loads, and were run using a mixed flow regime.

5.5 FLO-2D Model Components

5.5.1 Roughness Coefficients (Manning's n-values)

The roughness coefficients (Manning's n-values) represent overland flow and were spatially varied for each grid cell. The n-values were assigned using the 2008 aerial photography and were verified using Table 1 from the *FLO-2D PRO Reference Manual*. The Manning's n-values are as follows:

- 0.06 – Urban High Vegetation, Agricultural
- 0.05 – Urban Low Vegetation
- 0.03 – Unpaved Roads, Shade Structures, Urban Bare Ground, and Wash Bottom
- 0.02 – Asphalt, Concrete, Buildings

Using GDS, n-values were assigned to each grid cell based on the shapefile "LukeAFB_SFC.shp" provided by the District. The grid was overlaid on the shapefile, and GDS interpolated and assigned an n-value to each grid element. Due to the n-value interpolation, some grid cells were assigned an n-value different than those listed above. For example, a grid cell that had 50 percent asphalt and 50 percent unpaved road would result in an n-value of 0.025.

5.5.2 Floodplain Cross-Sections

Floodplain cross-sections were used in the FLO-2D model to calculate a hydrograph and hydraulic results for the flow across the cross-section. Cross-sections were placed throughout the study area at locations including upstream and downstream from major hydraulic structures, along major drainage paths, and across some areas with major flooding. Additionally, cross-sections were placed in areas where potential improvements may be necessary or where the floodplain appeared to significantly impact existing structures. Cross-sections were modeled by selecting a continuous straight line of grid cells perpendicular to the flow direction. Floodplain cross-sections were not required for hydraulic computations; they were used in the model to check the flow data at locations upstream and downstream from hydraulic structures and at the four critical areas discussed in Section 5.9. See Table 5 for floodplain cross-section information as well as the approximate maximum discharge for each cross-section for a 12-hour simulation of a 6-hour 100-year design event. See Plates 10-14 for floodplain cross-section locations.

5.5.3 Outflow

The FLO-2D grid system represents an impermeable border from which no flow will escape, which can cause flow to pond against the boundary unless outflow nodes are assigned. Outflow elements discharge any flow off the grid system without effecting the water surface elevation and approximate normal depth flow conditions from upstream elements. Outflow nodes were placed around the perimeter of the grid boundary along the western (Loop 303), southern (Camelback Road), and eastern (Litchfield Road and Dysart Road) edges. Additionally outflow elements were placed on the upstream end of the Camelback Road culvert (grid cells 547859, 547860, and 547861).

5.6 EPA-SWMM Modeling

EPA-SWMM 5.0 was used to model the storm drain system for Luke AFB. This software was requested by Luke AFB and the District. SWMM is a dynamic rainfall-runoff simulation model used for a single rainfall event or a long-term simulation of runoff quantity and quality usually from urban areas. Subcatchment areas receive rainfall and transport runoff to storm drain inlets. The runoff is transported through a series of storm drain conduits, channels, storage devices, and pumps. SWMM tracks the quantity of runoff created within each subcatchment and calculates the flow rate, flow depth, and other hydraulic parameters. SWMM has been incorporated into FLO-2D to calculate subsurface flow in combination with FLO-2D's surface flow. Further discussion of the relationship will be discussed in Section 5.10.

5.7 EPA-SWMM Model Assumptions

The Luke AFB EPA-SWMM model is titled SWMM.inp per instructions from FLO-2D. The following are modeling assumptions that were used for the SWMM model. Darcy-Weisbach was selected as the force main equation. A 6-hour local storm with 100-year frequency was chosen for the rainfall event. See Section 5.3.2 for more information regarding rainfall. The following time steps were assumed: routing step – 1 second, report step – 3 minute, wet step – 5 minutes, dry step – 1 hour. In addition, drop inlets were modeled as Type 3 inlets and curb inlets were modeled as Type 2 inlets. See Section 5.10 for further discussion regarding Type 2 and 3 inlets. See Appendix 2 for more detailed EPA-SWMM modeling assumptions.

5.8 EPA-SWMM Components

5.8.1 Junctions

Junctions in EPA-SWMM include inlets, pipe fittings, and pipe junctions. In the EPA-SWMM model, inlets are represented by "J" (e.g. J1-1) and fittings and junctions are represented by "F" (e.g. F1-10). Inlets have sub catchments attached while junctions and fittings do not. Entered data includes invert elevation, maximum depth (height of inlet), and description. Invert elevations were available for inlets and junctions from either the Luke GIS geodatabase or the

COE survey. The invert elevations of the fittings were determined by straight-line interpolation from the known upstream and downstream invert elevations of inverts and/or junctions.

5.8.2 Conduits

Conduits in the EPA-SWMM model are represented by "C" (e.g. C1-1). Entered data includes conduit length, conduit depth (diameter), outlet offset, shape, and roughness. Table 4.1 from the District's draft Hydraulics manual dated April 2010 was used to assign Manning's n-values for closed conduits. Reinforced concrete and PVC pipes were modeled with a Manning's n-value of 0.013; corrugated metal pipes were modeled with a Manning's n-value of 0.024.

5.8.3 Sub-catchments

Sub-catchments are represented by "S" (e.g. S1-1). Entered data includes rain gage and inlet where sub-catchment drains. The other inputs for each sub-catchment in the EPA-SWMM model are not necessary for the FLO-2D model including area, width, percent slope, percent impervious, etc. Note that the area and width values entered may not be representative of the sub-catchment but can be the default value since FLO-2D does not require these inputs.

5.8.4 Outfalls

Outfalls were used at the end of storm drain lines and discharge water back onto the FLO-2D grid. They are represented by "Out" (e.g. OUT01). Outfall invert elevations were obtained from the Luke AFB geodatabase.

5.9 Critical Storm Drain Locations

EPA-SWMM was used to plot the profiles for the existing storm drains around Luke AFB. An investigation of the various storm drain profiles was completed to identify areas where the storm drain system can be improved to help alleviate surface flooding. Three storm drain lines in the aircraft parking ramp area were identified as possible systems to be improved. Storm drain lines elsewhere on Luke AFB may also cause flooding problems; however, an emphasis was placed on the storm drains that directly affect the aircraft parking ramps for this analysis. See Plates 7 and 8 for an aerial showing the storm drain system in the aircraft parking ramp area which highlights the six storm drain lines discussed below. According to the 12-hour simulation for the 6-hour local storm event with 100-year frequency, multiple inlets along the following storm drain lines are surcharged which causes flooding. The SWMM.rpt output file provides detailed performance information for each conduit and inlet for each storm drain line.

Figure 1 shows the storm drain system that travels north to south along the Jersey barriers along the aircraft parking ramp to the east of the detention basins. See Figure 1 for a map and profile. The system begins with 15-inch and 18-inch pipes for approximately 2,700 feet from J1-1 to J1-11. Junction 1-11 has the lowest elevation along the profile with an elevation of 1067.71. The storm drain expands to 36 –inches as the pipes system has an adverse slope from J1-11 to J1-18,

which could allow the flows in this reach to backup in the pipe system. For the 6-hour local storm with 100-year frequency, seventeen inlets from J1-1 to OUT01 from the EPA-SWMM model show flooding due to surcharging in the storm drain system. The maximum rate of flow from the inlets along this storm drain line is 61.6 cfs at inlet J1-11, and the duration of flooding is approximately 5.3 hours for a 12-hour simulation.

Figure 2 shows the storm drain system that travels north to south across the aircraft parking ramps. See Figure 2 for a map and profile. The system begins with 24-inch conduit from J2-1 to J2-3, where the conduit is 12-inches before transitioning to 36-inch pipe from J2-4 to the outlet. Additionally the pipe has an adverse slope between J2-3 and J2-9, which could potentially allow flows to back up in the storm drain. For the 6-hour local storm with 100-year frequency, fourteen inlets from J2-1 to OUT02 from the EPA-SWMM model show flooding due to surcharging in the storm drain system. The maximum rate of flow from the inlets along this storm drain line is 19.7 cfs at inlet J2-3, and the duration of flooding is approximately 1.9 hours for a 12-hour simulation.

Figure 3 shows the storm drain system that travels across the aircraft parking ramp north of 145th Lane. See Figure 3 for a map and profile. The system begins with 24-inch and 36-inch conduits from J5-1 to J5-3 as the storm drain travels across the aircraft parking ramp. The storm drain system contracts to a 24-inch pipe at J5-3 before being pumped up to a 36-inch pipe at F5-6. The storm drain continues with a 36-in conduit until the outlet. This storm drain could potentially cause problems in drainage due to the varying pipe sizes and pump location. For the 6-hour local storm with 100-year frequency, eleven inlets from J5-1 to OUT05 from the EPA-SWMM model show flooding due to surcharging in the storm drain system. The maximum rate of flow from the inlets along this storm drain line is 19.0 cfs at inlet J5-2, and the duration of flooding is approximately 2.9 hours for a 12-hour simulation at inlet J5-3.

Figure 4 shows the storm drain system that flows to the east, beginning near the intersection of Mustang Street and Fighter Country Avenue before running along Phantom Street and terminating into the main north-south storm drain line that runs east of N 139th Avenue. See Figure 4 for a map and profile. See Plate 7 for a larger map of the storm drain system in the surrounding area. The system begins with 12-inch and 18-inch pipes from J14-1-A to F14-4, followed by a 24-inch pipe with an adverse slope from F14-4 to F14-5. The line transitions to 42-inch pipe at F16-11 and has an adverse slope from F16-11 to F16-13 before transitioning to a 48-inch pipe from F16-14 to F16-16. This storm drain could potentially cause problems in drainage due to the varying pipe sizes and adverse slopes. For the 6-hour local storm with 100-year frequency, four inlets from J14-1-A to F9-25 from the EPA-SWMM model show flooding due to surcharging in the storm drain system. The maximum rate of flow from the inlets along this storm drain line is 19.8 cfs at inlet J14-2-A, and the duration of flooding is approximately 1.8 hours for a 12-hour simulation.

Figure 5 shows the storm drain system that travels north from near the intersection of Thunderbird Street and 138th Avenue to Dysart Drain. See Figure 5 for a map and profile. See Plate 8 for a larger map of the storm drain system in the surrounding area. The storm drain line begins with 8-inch pipes before progressively transitioning to 18-inch, 24-inch and 30-inch pipes before discharging outflow in Dysart Drain. The system has an adverse slope from J37-9 to J37-10 with an invert elevation difference of approximately 5 feet over 375 feet of pipe. This storm drain could potentially cause problems in drainage due to the conduit adverse slope. For the 6-hour local storm with 100-year frequency, eleven inlets from J37-1 to OUT37 from the EPA-SWMM model show flooding due to surcharging in the storm drain system. The maximum rate of flow from the inlets along this storm drain line is 8.5 cfs at inlet J37-4, and the duration of flooding is approximately 1.2 hours for a 12-hour simulation at inlet 37-2.

Figure 6 shows the storm drain system that travels north from near the intersection of Commisary Road and Thunderbird Street to Dysart Drain. See Figure 6 for a map and profile. See Plate 8 for a larger map of the storm drain system in the surrounding area. The storm drain line begins with 18-inch pipe at J36-1 before transitioning to 24-inch pipe at J36-2. The storm drain line has an adverse slope from J36-2 to J36-6 with an invert elevation difference of approximately 3.5 feet over 700-feet of pipe. This storm drain could potentially cause problems in drainage due to the conduit adverse slope. For the 6-hour local storm with 100-year frequency, nine inlets from J36-1 to OUT36 from the EPA-SWMM model show flooding due to surcharging in the storm drain system. The maximum rate of flow from the inlets along this storm drain line is 29.8 cfs at inlet J36-1, and the duration of flooding is approximately 5.6 hours for a 12-hour simulation.

5.10 Storm Drain System (EPA-SWMM – FLO-2D Interface)

The FLO-2D Pro model has been integrated with the EPA-SWMM version 5.0 to simulate the exchange of surface water flow (FLO-2D) with a storm drain system (EPA-SWMM). According to the *FLO-2D Pro Model and EPA_SWMM Model Integration Manual*, the two models run simultaneously, with FLO-2D as the main interface. FLO-2D calculates all hydraulic and hydrologic surface water flow routing while EPA-SWMM only solves the conduit hydraulics and routing of the storm drain network. The FLO-2D model computes the storm drain inflow discharge based on the predicted grid element headwater depth and exchanges this discharge with the EPA-SWMM model to compute the storm drain system pipe discharge and the potential return to the surface through downstream manholes, outlets, and storm drains. The return flow is routed based on FLO-2D hydraulic and hydrologic calculations.

The model integration allows for the FLO-2D model to compute all the surface water hydrology and hydraulics including rainfall runoff, infiltration, and overland flow routing. Because FLO-2D handles the rainfall calculations, the EPA-SWMM model does not require rainfall information. The SWMM modeling effort included inputting storm drain inlet and outlet locations and data, conduit geometry and location, and outfall data. The inlets and outlets exchange water between

the EPA-SWMM storm drain system and the surface water in FLO-2D. Water can flow in either direction based on the head difference between inlets/outlets. Outfalls discharge the storm water out of the EPA-SWMM model system. See Sections 5.6 to 5.7 and Appendix 2 for further discussion regarding the EPA-SWMM modeling assumptions for inlets, sub-catchments, conduits, and outfalls.

To integrate the EPA-SWMM model with FLO-2D, the user is required to input storm drain inlet geometry data which gets saved in the SWMMFLO.DAT file. Luke AFB provided measurements and photographs of 39 storm inlets through a survey completed from 15-16 April, 2013. In addition to the 39 measured inlets, another 90 inlet dimensions were verified based on similar inlet design as those measured directly. The remaining 300 inlets were estimated based on Google imagery. The Luke AFB geodatabase provided inlet information, including whether an inlet is a curb or drop inlet. According to the *FLO-2D Pro Model and EPA-SWMM Model Integration* manual, FLO-2D has three types of storm drain inlets, two of which were used in the Luke AFB modeling and are described below.

Curb inlets are modeled as Type 2 inlets which are described as "curb opening inlet with sag." Required input information includes the following: weir coefficient, curb opening length, curb opening height, and curb opening width. For type 2 inlets, the weir coefficient was assumed to be 2.3. For the curb inlets with estimated dimensions, the height was estimated to be 5 inches or 0.416 ft for a six inch curb. The length and width dimensions vary for each inlet.

Drop inlets are modeled as Type 3 inlets which are described as "grate (gutter) inlet with or without sag." Required input information includes the following: weir coefficient, grate perimeter (not including the curb side), grate open area, and grate sag height. The weir coefficient was assumed to be 3.0 based on the FLO-2D SWMM manual instructions. The grate perimeter was calculated by summing the length and twice the width. The area was calculated by multiplying the length and width for rectangular inlets and by multiplying the radius squared by pi for circular inlets. The drop inlets were assumed to be at grade, so the grate sag height was assumed to be 0 feet. Additionally, for both inlet types, the orifice flow coefficient is 0.67.

Some EPA-SWMM model data and functions have been modified to enable the flow exchange with the FLO-2D model, including the following:

- After calculating the total area of each drop inlet, the area was reduced to 80 percent of the total area for the SWMMFLO.DAT to account for the area of inlet obstructed by the metal bars of the inlet grate. Since Luke AFB has a variety of grate types and a complete inlet survey has not been completed, COE and District personnel decided to globally assume 80 percent open area for water to flow through for each inlet. Furthermore, to account for the reduction in available area for water to flow into curb inlets, the inlet width was reduced by 80 percent.

- The EPA-SWMM model includes a rain gage which functions only as a switch which allows each sub-catchment area in the EPA-SWMM model to receive runoff information from FLO-2D to calculate the storm drain inflow discharge.
- Sub-catchment areas are assigned to the curb and drop inlets that receive flow as part of the storm drain system. They are used in FLO-2D to differentiate between the inlets that receive flow and the junctions and fittings which do not.
- Junctions function as inlets (when connected to a sub-catchment) or as a connection between pipes (fittings and manhole junctions). The fittings and junctions do not receive inflow and are not connected to sub-catchments. The required input data includes invert elevation and maximum manhole or invert depth.
- Conduits route inflow to the downstream junction/manhole in the storm drain system. The slope of the conduit is calculated based on the upstream and downstream invert elevations. The required input data includes geometry, maximum depth (pipe diameter for circular conduits), length, and roughness.

See Appendix 2 for further discussion regarding the EPA-SWMM modeling assumptions for inlets, sub-catchments, conduits, and outfalls. See Appendix 3 for the inlet measurement data that was used to complete the SWMMFLO.DAT.

5.11 FLO-2D and SWMM Output

The output for the FLO-2D and EPA-SWMM model is provided in electronic format. The EPA-SWMM model output is provided as "SWMM.rpt". The FLO-2D output is provided electronically in various ".OUT" text files, including SUMMARY.OUT. Other important output files include those for levees, hydraulic structures, floodplain cross-sections, Manning's n-values, infiltration, and flood depths.

5.12 Results

This section provides a description of the Existing conditions floodplain for the 6-hour duration storm with a 100-year frequency. The floodplain was generated using FLO-2D Pro, build model 13.02.04. See Plate 15 for the overall study area floodplain, and see Plates 16 to 20 for detailed floodplains on Luke AFB. There are four major flooded areas on base where improvements to the drainage systems would be beneficial. The plates display floodplains with flood depths greater than 0.10 feet.

Historical flood depths were not available to calibrate the floodplain produced in this analysis; however, the FEMA 100-year floodplain was used for comparison. Furthermore, Alan Thomas from Luke AFB, upon viewing the initial floodplain map, provided reasonable verification that the flooded areas represent areas where flooding has been observed.

For the 12-hour simulation of the 6-hour local storm with 100-year frequency, the rainfall volume from a 2.4 inch rain event is 1574.96 acre-feet. Approximately 294 acre-feet of flow

enters the storm drain system, 141 acre-feet of flow exits the storm drain system, and 153 acre-feet of flow remains in the storm drain system for a 12-hour simulation. Approximately 135 acre-feet of flow is infiltrated into the soil, another 905 acre-feet is stored on the floodplain, and 385 acre-feet of flow exits the study area for a 12-hour simulation. The maximum inundated area is 7,756.09 acres.

For the 24-hour simulation of the 6-hour local storm with 100-year frequency, the rainfall volume from a 2.4 inch rain event is 1574.96 acre-feet. Approximately 508 acre-feet of flow enters the storm drain system, 327 acre-feet of flow exits the storm drain system, and 181 acre-feet of flow remains in the storm drain system for a 24-hour simulation. Approximately 135 acre-feet of flow is infiltrated into the soil, another 645 acre-feet is stored on the floodplain, and 615 acre-feet of flow exits the study area for a 24-hour simulation. The maximum inundated area is 7,756.09 acres.

The first major flooded area occurs along the aircraft parking ramp east of the detention basins as the overland flow travels south. Plate 16 shows the maximum depth recorded for the simulation. The floodplain in this region runs along the Jersey barriers which run along the eastern side of the aircraft parking ramp. The floodplain begins to expand approximately where Falcon Street meets the aircraft parking ramp area heading south. It expands to approximately 700 feet wide with a maximum flow depth of 2 feet in the aircraft parking ramp area. The flooding in this area begins approximately four hours into the six hour storm, and flood depths remain significant (greater than 0.5 feet) for approximately 12 hours. The two detention basins near the airfield show flood depths as large as 5.0 feet. Both detention basins have an approximate depth of 4.0 feet.

The second major flooded area occurs along the aircraft parking ramp south of the detention basins as the overland flow travels west. See Plate 17. The floodplain in this region runs along the Jersey barriers which run along the southern side of the aircraft parking ramp, south of the detention basins. The floodplain also runs along the access road on the south side of the Jersey barriers where it floods several buildings. The floodplain in this area has a maximum depth of 2 feet and a maximum floodplain width of 700 feet. The flooding in this area begins approximately four hours into the six hour storm, and flood depths remain significant (greater than 0.5 feet) for approximately 12 hours.

The third major flooded area is bounded by Litchfield Road to the east, Phantom Street to the South, the aircraft parking ramp to the west, and Mitchell Street to the north. See Plate 18. The floodplain in this region runs along the streets travelling east-west and north-south between the aircraft parking ramps and Litchfield Road. The north-south streets with the worst flooding are Fighter Country Avenue, Jerstad Lane Homer Drive, Bong Lane, and N 139th Drive. The flooding along Fighter Country Avenue extends from north of Mitchell Street to Phantom Street. The maximum flood depth is 1.5 feet as the flooding inundates the street and affects a few buildings near the intersection with Mustang Street. The flooding along Jerstad Lane extends

from north of Mitchell Street to Fighter Country Avenue. The maximum flood depth is 1.5 feet as the flooding inundates the street and affects a few buildings near the intersection with Mustang Street. The flooding along Bong Lane from north of Mitchell Street to Phantom Street has a maximum flood depth of 1.5 feet as the flooding inundates the street and affects a few buildings near the intersection with Eagle Street. The flooding along N 139th Drive extends from south of Thunderbird Street to south of Phantom Street. The maximum flood depth is 1.5 feet. Additionally, flooding occurs between Bong Lane and Litchfield Road, as the floodplain expands to approximately 500 feet wide with a maximum depth of 1.5.

The east-west streets with the worst flooding are Mustang Street, Falcon Street, Eagle Street, and Mitchell Street. The flooding along Mustang Street extends from the aircraft parking ramp to N 139th Drive. The maximum flood depth is 1.5 feet in this region. The flooding along Falcon Street extends from Fighter Country Avenue to Bong Lane. The maximum flood depth is 1.5 feet in this region. The flooding along Eagle Street extends from Jerstad Lane to Bong Lane. The maximum flood depth is 1.5 feet in this region. The flooding along Mitchell Street extends from the aircraft parking ramp to approximately 350 feet east of Bong Lane. The maximum flood depth is 1.5 feet in this region. The flooding in this area begins approximately four hours into the six hour storm, and flood depths remain significant (greater than 0.5 feet) for approximately 8 hours.

The fourth major flooded area is occurs east of Litchfield Road, along Thunderbird Street between Litchfield Road and Kachina. See Plate 19. Flooding is prevalent along most streets in this region, with the greatest flooding occurring along Thunderbird Street between Commissary Road and Kachina. The maximum flood depths in this area are 2.0 feet and the average floodplain width is approximately 700 feet. Additionally, flooding occurs north of Thunderbird Street between Litchfield Road and Commissary Road. The flooding affects several buildings in this region with a maximum flood depth of 1.5 feet. The flooding in this area begins approximately four hours into the six hour storm, and flood depths remain significant (greater than 0.5 feet) for approximately 12 hours. Kachina North detention basin shows flood depths as large as 3.5 feet and Kachina South detention basin shows flood depths as large as 3.0 feet. Both detention basins have an approximate depth of 3.5 feet.

Lastly, a major flooded area was identified along the channel that runs west to east at the northern boundary of the Falcon Golf Club. See Plate 20. A breakout occurs at the northwest corner of the Falcon Golf Club from the drainage channel that diverts flows from the airfield. The breakout flows have a maximum discharge of approximately 135 cfs at this location, which leads to flood depths between 5.0 and 8.8 in the northern portion of the Falcon Golf Club.

6.0 CONCLUSION AND RECOMMENDATIONS

Luke AFB is concerned about flooding on base, especially in the aircraft parking ramp area where flooding has been observed. The aircraft parking ramp area was identified as a critical area where flooding is likely to occur. The storm drain profile analysis revealed that three storm drain lines in this area have inconsistencies related to capacity as well as adverse slopes. Additionally, three other storm drain lines on base were identified as potentially having an adverse affect on drainage. Storm Drain Profiles 1 to 6, discussed in Section 5.9, show larger conduits followed by smaller conduits which would cause the storm drains to back-up and flood the surface. The profiles also show that some portions of the storm drain systems have adverse slopes which could cause flow problems in the pipe. Furthermore, the FLO-2D analysis showed major flooding in the aircraft parking ramp area which is discussed in Section 5.12 and shown in Plates 16 and 17. The aircraft parking ramps appear to have some low spots which allow surface water to pond. This could be a result of poor grading or settlement. The aircraft parking ramp area should be investigated further in the next phase of the analysis to determine what measures can be taken to upgrade the storm drain capacities and to alleviate flooding. In addition, the storm drain line capacities can be increased by 1) replacing the smaller portions of the storm drain and/or 2) reconstructing the adverse slope locations within the lines.

7.0 REFERENCES

a) *FLO-2D Pro Model and EPA SWMM Model Integration*, FLO-2D Software Inc, 2012.
b) GDS Manual PRO, FLO-2D-Software Inc., 2012.
c) FLO-2D Reference Manual, FLO-2D Software Inc., 2012.
d) FLO-2D Data Input Manual, FLO-2D Software Inc., 2012.
e) Flood Control District of Maricopa County, *Loop 303/White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona Final Report*, September 2009.
f) Flood Control District of Maricopa County, *HEC-1 Model - Loop 303/White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona*, September 2009.
g) Flood Control District of Maricopa County, *Drainage Design Manual for Maricopa County, Arizona – Hydrology*, February 2011.

TABLES

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

TABLES

Table 1: Land Use Classifications

Class ID	Class Type	Initial Abstraction (IA)	Percent Impervious (RTIMP)	Vegetative Cover (VC)	Initial Saturation
		(inches)	(percent)	(percent)	
3	Urban High Vegetation	0.1	0	100	normal
5	Urban Low Vegetation	0.1	0	60	normal
9	Urban Bare Ground	0.2	0	0	normal
12	Wash Bottom	0.1	0	0	normal
13	Concrete	0.05	98	0	normal
14	Asphalt	0.05	95	0	normal
15	Buildings	0.05	95	0	normal
16	Shade Structures	0.05	98	0	normal
17	Water	0	100	0	saturated
18	Swimming Pools	0	100	0	saturated
21	Unpaved Road	0.1	50	0	normal
22	Agricultural	0.5	0	85	normal

Table 2: Rainfall Distribution

Time (hrs)	Pattern 1 Distribution	Cumulative Rainfall (inches)
0.00	0.000	0.000
0.25	0.008	0.019
0.50	0.016	0.038
0.75	0.025	0.060
1.00	0.033	0.079
1.25	0.041	0.098
1.50	0.050	0.120
1.75	0.058	0.139
2.00	0.066	0.158
2.25	0.074	0.178
2.50	0.087	0.209
2.75	0.099	0.238
3.00	0.118	0.283
3.25	0.138	0.331
3.50	0.216	0.518
3.75	0.377	0.905
4.00	0.834	2.002
4.25	0.911	2.186
4.50	0.931	2.234
4.75	0.950	2.280
5.00	0.962	2.309
5.25	0.972	2.333
5.50	0.983	2.359
5.75	0.991	2.378
6.00	1.000	2.400
Notes:		
1. Total rainfall is 2.4 inches at Luke AFB according to Figure A.58 from the *Drainage Design Manual for Maricopa County*		
2. A Pattern 1 distribution was used		

Table 3: Hydraulic Structures (Culvert Descriptions)

Structure ID	Culvert Entrance Description	Location	# Culverts	Culvert Size	Culvert Size Source	Culvert Shape	Culvert Material	Culvert Length (feet)
1	Headwall with Flared Wing Walls	Travels south beneath Super Sabre Street approximately 200ft west of Super Sabre St entrance gate	2	5 Ft W 4.25 Ft H	COE Survey	Box	RC	85
2*	Flared Wing Walls and Trash Racks	Travels N-S beneath Super Sabre Street approximately 630ft west of N 143rd Dr and 230ft east of Shubin Lane.	2	6 Ft W 4 Ft H	COE Survey	Box	RC	93
3	Projected Out From Fill	Travels N-S beneath Super Sabre Street approximately 840ft west of 146th Dr along Super Sabre St	1	60-in	COE Survey	Circular	CM	815
4	Mitered to Conform to Slope	Travels N-S, connecting the two detention basins near the airfield	1	36-in	COE Survey	Circular	RC	240
5	Square Edge Entrance with Headwall	Travels W-E, draining an open ditch, north of Lightning St., underneath a parking lot and into Dysart Drain.	4	30-in	Luke GIS	Circular	RC	565
6	Square Edge Entrance with Headwall	Travels southwest beneath Strike Eagle Street near N Ammo Rd.	2	40-in	COE Survey	Circular	RC	63
7*	Square Edge Entrance with Headwall, Trash Racks	Travels southwest beneath N Ammo Rd just north of Tiger St	3	6 Ft W 4 Ft H	COE Survey	Box	RC	55
8**	Projected Out From Fill	Travels south beneath Strike Eagle Street approximately 550 feet west of N. Ammo Road	3	96-in	COE Survey	Circular	CM	45
9	Projected Out From Fill	Travels southwest beneath Strike Eagle Street approximately 45 feet east of Super Sabre Street	1	84 in	COE Survey	Circular	CM	60
10	Headwall with Flared Wing Walls	Travels southwest beneath Access Road alongside Super Sabre Street approximately 690 feet south of Strike Eagle Street	1	60-in	COE Survey	Circular	RC	25
11	Headwall with Flared Wing Walls	Travels west beneath 143rd Dr on the north side of Super Sabre St	1	24-in	COE Survey	Circular	CM	268
12	Square Edge Entrance with Headwall	Travels west beneath driveway on the north side of Super Sabre St, about 620 feet east of 143rd Dr.	2	18- in	COE Survey	Circular	RC	90
13	Square Edge Entrance with Headwall	Travels west beneath 142nd drive alongside Super Sabre Street	1	18-in	COE Survey	Circular	RC	53
14	Square Edge Entrance with Headwall	Travels south beneath driveway on the west side of 142nd, approximately 100 feet north of Super Sabre St	1	12-in	COE Survey	Circular	RC	86

Table 3: Hydraulic Structures (Culvert Descriptions) - Continued

Structure ID	Culvert Entrance Description	Location	# Culverts	Culvert Size	Culvert Size Source	Culvert Shape	Culvert Material	Culvert Length (feet)
15	Square Edge Entrance with Headwall	Travels west beneath Johnson Drive, north of Super Sabre Street	1	18-in	COE Survey	Circular	RC	51
16	18 in CMP Mitered to Conform to Slope, 2 x 12 in RCP with Square Edge Headwall	Travels west beneath driveway, West of 146th, along Super Sabre Street	3	1 x 18 in 2 x 12 in	COE Survey	Circular	CM	45
17	Mitered to Conform to Slope	Travels west beneath 146th along Super Sabre Street	1	36-in	COE Survey	Circular	CM	55
18	Mitered to Conform to Slope	Travels west beneath driveway along Super Sabre Street (200 feet east of Ammo Road)	1	36-in	COE Survey	Circular	CM	28
19	Mitered to Conform to Slope	Travels west beneath driveway along Super Sabre Street (350 feet east of Ammo Road)	1	18-in	COE Survey	Circular	CM	40
20	Mitered to Conform to Slope	Travels west beneath Tovrea Drive (450 ft north of Super Sabre Street)	1	18-in	Luke GIS	Circular	CM	54
21	Mitered to Conform to Slope	Travels west beneath driveway (450 ft north of Super Sabre Street between 145th and 146th Drive)	1	18-in	Luke GIS	Circular	CM	20
22	Mitered to Conform to Slope	Travels west beneath 145th Drive just north of Super Sabre Street	1	18-in	COE Survey	Circular	CM	72
23	Projected Out From Fill	Travels west beneath driveway along Super Sabre Street 450 ft east of 143rd Drive	2	18-in	COE Survey	Circular	CM	43
24	Square Edge Entrance with Headwall	Travels west beneath North Ammo Drive just south of Tiger Street	2	24-in	Luke GIS	Circular	RC	50
25	Square Edge Entrance with Headwall	Travels north beneath berm near intersection of Ammo Drive and Tiger Street	2	24-in	Luke GIS	Circular	RC	22
26	Square Edge Entrance with Headwall	Travels west beneath Torvea Street North of Tiger Street	1	72-in W 36 in H	Luke GIS	Semi-Circular	CM	54
27	Square Edge Entrance with Headwall	Travels west beneath Torvea Street South of Texan Street	1	4 Ft W 2 Ft H	Luke GIS	Box	RC	41

Notes:

See Plates 10-14 for Hydraulic Structure Locations

CM - Corrugated Metal

RC - Reinforced Concrete

*Indicates Trash Rack; Culvert area decreased by 50%

**3 x 96-inch culverts blocked by sediment, culverts modeled as 96-inch with 50% sediment. Invert of pipe assumed 4 ft lower than TIN elevations

Culvert Length Measured using GIS

Table 4: Hydraulic Structures (Elevations)

Structure ID	Location	# Culverts	FLO-2D Grid Element Number		Invert Elevation (NAVD 88)		Elevation Source	Approx. Max Discharge[1] (cfs)
			Inlet	Outlet	Inlet	Outlet		
1	Travels south beneath Super Sabre Street approximately 200ft west of Super Sabre St entrance gate	2	313401	318266	1076.87 1076.87	1076.70 1076.70	Inlet: COE Outlet: TIN	36
2*	Travels N-S beneath Super Sabre Street approximately 630ft west of N 143rd Dr and 230ft east of Shubin Lane	2	311338	315230	1065.96 1065.87	1064.93 1065.25	Inlet: COE Outlet: Luke	330
3	Travels N-S beneath Super Sabre Street approximately 840ft west of 146th Dr along Super Sabre St	1	309294	315103	1062.68	1061.97	Inlet: COE Outlet: COE	175
4	Travels N-S, connecting the two detention basins near the airfield	1	199457	209191	1069.71	1069.61	Inlet: COE Outlet: COE	50
5	Travels W-E, draining an open ditch, north of Lightning St., underneath a parking lot and into Dysart Drain	4	96136	93215	1076.91 1077.20 1076.91 1076.87	1070.42 1070.37 1070.45 1070.50	Inlet: Luke Outlet: Luke	93
6	Travels southwest beneath Strike Eagle Street near N Ammo Rd.	2	363279	366245	1061.59 1061.56	1061.92 1061.45	Inlet: COE Outlet: COE	130
7*	Travels southwest beneath N Ammo Rd just north of Tiger St	3	395904	395901	1061.15 1061.11 1061.13	1060.69 1060.69 1060.69	Inlet: COE Outlet: TIN	325
8**	Travels south beneath Strike Eagle Street approximately 550 feet west of N. Ammo Road	3	363249	365475	1060.96 1060.96 1060.96	1060.75 1060.75 1060.75	Inlet: TIN Outlet: TIN	82
9	Travels southwest beneath Strike Eagle Street approximately 45 feet east of Super Sabre Street	1	332761	334243	1063.24	1062.6	Inlet: COE Outlet: COE	255
10	Travels southwest beneath Access Road alongside Super Sabre Street approximately 690 feet south of Strike Eagle Street	1	347582	349064	1063.39	1063.3	Inlet: TIN Outlet: TIN	140
11	Travels west beneath 143rd Dr on the north side of Super Sabre St	1	310393	311354	1074.52	1072.72	Inlet: Luke Outlet: COE	17
12	Travels west beneath driveway on the north side of Super Sabre St, about 620 feet east of 143rd Dr.	2	311392	311387	1077.18 1077.18	1077.15 1077.15	Inlet: TIN Outlet: TIN	16
13	Travels west beneath 142nd drive alongside Super Sabre Street	1	311411	311408	1078.22	1078.15	Inlet: TIN Outlet: TIN	9
14	Travels south beneath driveway on the west side of 142nd, approximately 100 feet north of Super Sabre St	1	306543	311408	1079.62	1078.72	Inlet: TIN Outlet: TIN	3
15	Travels west beneath Johnson Drive, north of Super Sabre Street	1	312412	312409	1078.66	1078.29	Inlet: COE Outlet: Luke	9

Table 4: Hydraulic Structures (Elevations) - Continued

Structure ID	Location	# Culverts	FLO-2D Grid Element Number		Invert Elevation (NAVD 88)		Elevation Source	Approx. Max Discharge[1] (cfs)
			Inlet	Outlet	Inlet	Outlet		
16	Travels west beneath driveway, West of 146th, along Super Sabre Street	3	309313	309311	1065.64 1066.68 1066.68	1065.51 1066.21 1066.21	Inlet: TIN Outlet: TIN	20
17	Travels west beneath 146th along Super Sabre Street	1	309329	309326	1065.9	1065.46	Inlet: COE Outlet: COE	30
18	Travels west beneath driveway along Super Sabre Street (200 feet east of Ammo Road)	1	310314	310312	1067.19	1067.08	Inlet: COE Outlet: COE	25
19	Travels west beneath driveway along Super Sabre Street (350 feet east of Ammo Road)	1	310320	310318	1067.38	1067.12	Inlet: COE Outlet: COE	9
20	Travels west beneath Tovrea Drive (450 ft north of Super Sabre Street)	1	291838	293782	1068.84	1068.25	Inlet: TIN Outlet: TIN	9
21	Travels west beneath driveway (450 ft north of Super Sabre Street between 145th and 146th Drive)	1	294749	294747	1067.91	1068.02	Inlet: TIN Outlet: TIN	8
22	Travels west beneath 145th Drive just north of Super Sabre Street	1	310338	310335	1071.81	1069.56	Inlet: TIN Outlet: COE	2
23	Travels west beneath driveway along Super Sabre Street 450 ft east of 143rd Drive	2	311382	311380	1076.92	1076.55	Inlet: TIN Outlet: TIN	17
24	Travels west beneath North Ammo Drive just south of Tiger Street	2	399609	399606	1062.36 1062.37	1061.44 1061.50	Inlet: Luke Outlet: Luke	85
25	Travels north beneath berm near intersection of Ammo Drive and Tiger Street	2	401091	399609	1062.82 1062.95	1062.65 1062.71	Inlet: Luke Outlet: Luke	35
26	Travels west beneath Torvea Street North of Tiger Street	1	394454	394451	1067.82	1067.59	Inlet: Luke Outlet: Luke	27
27	Travels west beneath Tovrea Street South of Texan Street	1	385562	385559	1068.81	1068.54	Inlet: Luke Outlet: Luke	15

Notes:

See Plates 10-14 for Hydraulic Structure Locations

Elev. Source: COE = Data from COE spot survey, completed Dec 2012; Luke = Data from Luke AFB GIS Geodatabase; TIN = Data from Luke TIN surface

* Indicates Trash Rack; Culvert area decreased by 50%

**3 x 96-inch culverts blocked by sediment, culverts modeled as 96-inch with 50% sediment (Invert of pipe assumed 4 ft lower than TIN elevations)

1. Approximate Maximum Discharge (cfs) through hydraulic structure during FLO-2D 12-hour simulation of the 6-hour local storm with 100-year frequency

Table 5: Floodplain Cross-Sections

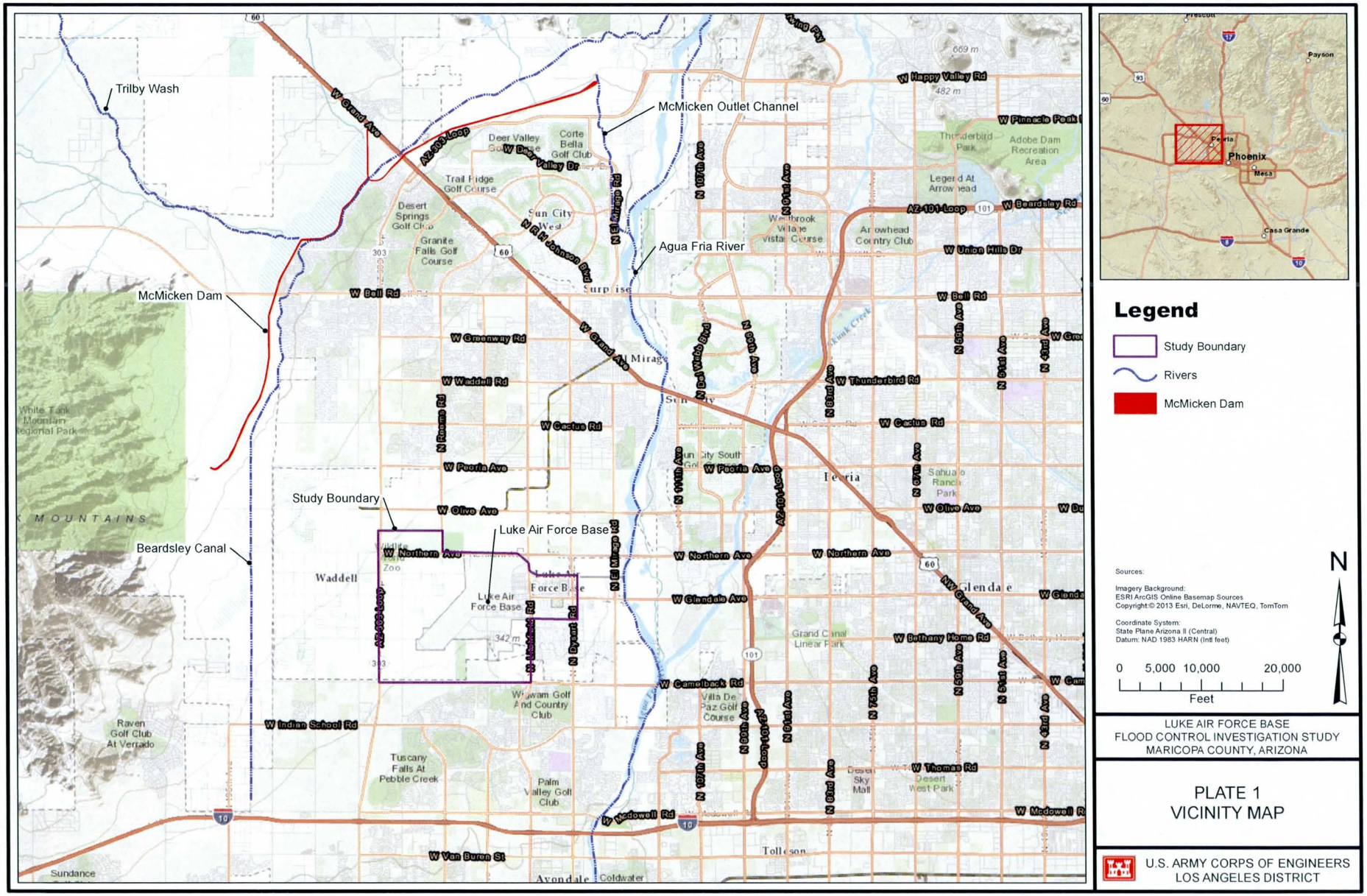
Cross Section	Reference Plate	Location / Description	Flow Direction	# Elements in Cross-section	Grid Cell	Approx. Max Discharge[3] (cfs)
1	14	Upstream from HS-5	East	7	97607	100
2	14	Across Thunderbird Street near Commisary Road	West	14	173381	25
3	14	Across parking lot between Commisary Road and N 138th Ave, north of Thunderbird Street	Northwest	19	163621	35
4	14	Across parking lot between Commisary Road and N 138th Ave, north of Thunderbird Street	Northwest	8	142222	20
5	14	Across airfield parking ramp (Major Flooded Area 1)	South	14	179053	55
6	14	Across airfield parking ramp (Major Flooded Area 1)	South	16	200457	55
7	14	Across airfield parking ramp (Major Flooded Area 1)	South	18	214078	80
8	14	Across airfield parking ramp (Major Flooded Area 1)	South	30	225750	40
9	14	Across airfield parking ramp (Major Flooded Area 1)	South	27	236455	45
10	14	Upstream from HS-8 (Airfield North Detention Basin)	Southeast	13	204315	465
11	14	Downstream from HS-8 (Airfield South Detention Basin)	South	9	210159	220
12	11	Across airfield parking ramp (Major Flooded Area 2)	West	10	262654	5
13	10	Airfield drainage path west of runway	Southwest	21	269247	335
14	10	Airfield drainage path west of runway	Southwest	20	301326	380
15	10	Airfield drainage path west of runway	Southwest	18	356310	270
16	10	Airfield drainage path east of runway	Northeast	9	406814	550
17	13	Airfield drainage path before Falcon Golf Course breakout	East	9	386856	585
18	13	Falcon Golf Club breakout	South	14	393528	135
19	13	Airfield drainage path after Falcon Golf Course breakout	East	4	389112	75
20	13	Airfield drainage path east of Falcon Golf Course	Southeast	5	409901	70
21	11	Upstream from HS-16	West	4	310294	40
22	11	Upstream from HS-3	South	9	308315	210
23	11	Downstream from HS-3	Southwest	4	314128	75
24	13	Upstream from HS-9	Southwest	3	331277	45
25	13	Downstream from HS-9	Southwest	3	334241	35
26	13	Upstream from HS-10	Southwest	3	345357	30
27	13	Across drainage along Super Sabre St before Golf Course	Southeast	4	386120	95
28	13	Upstream from HS-8	South	40	361747	60
29	13	Downstream from HS-8	South	40	369909	75
30	12	Upstream from HS-2	West	5	308422	130

Table 5: Floodplain Cross-Sections (continued)

Cross Section	Reference Plate	Location / Description	Flow Direction	# Elements in Cross-section	Grid Cell	Approx. Max Discharge[3] (cfs)
31	12	Downstream from HS-2	South	8	318145	110
32	13	Upstream from HS-6	West	5	359577	255
33	13	Downstream from HS-6	South	6	369210	205
34	13	Upstream from HS-7	South	5	390718	170
35	13	Downstream from HS-7	Southwest	7	397374	145
36	10	Bullard Wash (2600 ft upstream from Camelback Road)	Southwest	5	473652	325
37	10	Bullard Wash (1400 ft upstream from Camelback Road)	South	9	509258	320
38	10	Bullard Wash (300 ft upstream from Camelback Road)	South	12	540427	320
39	10	Bullard Wash (50 ft upstream from Camelback Road)	South	8	547114	345
40	12	Upstream from HS-1	Southwest	5	309509	15
41	12	Downstream From HS-1	South	6	320166	20
42	12	Drainage upstream from N. Litchfield Conveyance Channel	Southeast	21	362714	130
43	10	Dale Creek Wash	South	9	315392	20

Notes:

1. See Plates 10-14 for Floodplain Cross-Section Locations.
2. Grid Cell indicates first grid cell listed on FPSEC.DAT
3. Maximum discharge across floodplain cross-section according to FLO-2D 12-hour simulation of 6-hour storm, 100-year frequency


Trilby Wash
McMicken Outlet Channel
McMicken Dam
Agua Fria River
Study Boundary
Luke Air Force Base
Beardsley Canal
Legend
Study Boundary
Rivers
McMicken Dam
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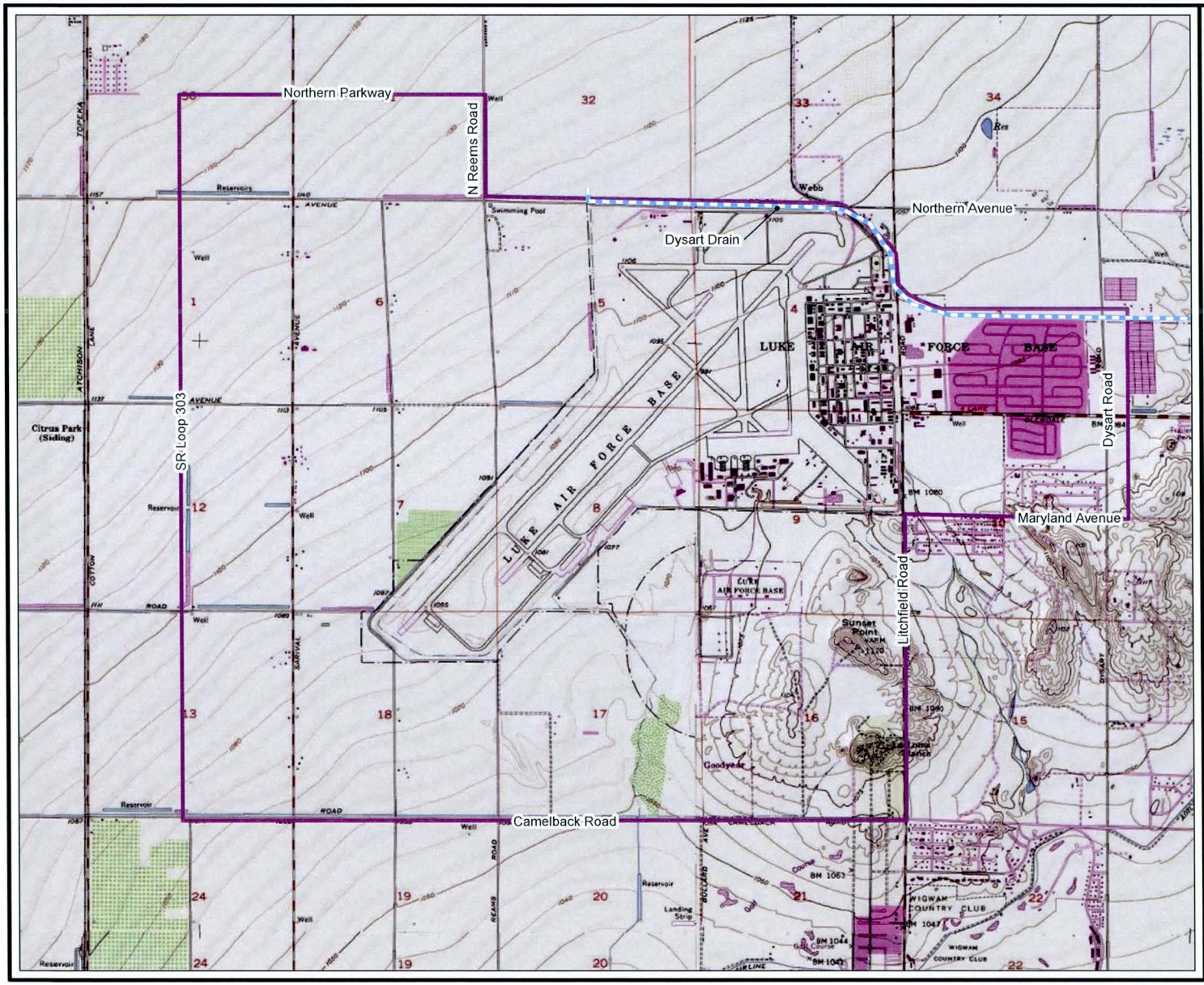
Feet
Sources:
Imagery Background:
ESRI ArcGIS Online Basemap Sources
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom
Coordinate System:
State Plane Arizona II (Central)
Datum: NAD 1983 HARN (Intl feet)
LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA
PLATE 1
VICINITY MAP
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Dysart Drain
- Study Boundary

Sources:

Imagery Background:
ESRI ArcGIS Online Basemap Sources
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Coordinate System:
State Plane Arizona II (Central)
Datum: NAD 1983 HARN (Intl feet)

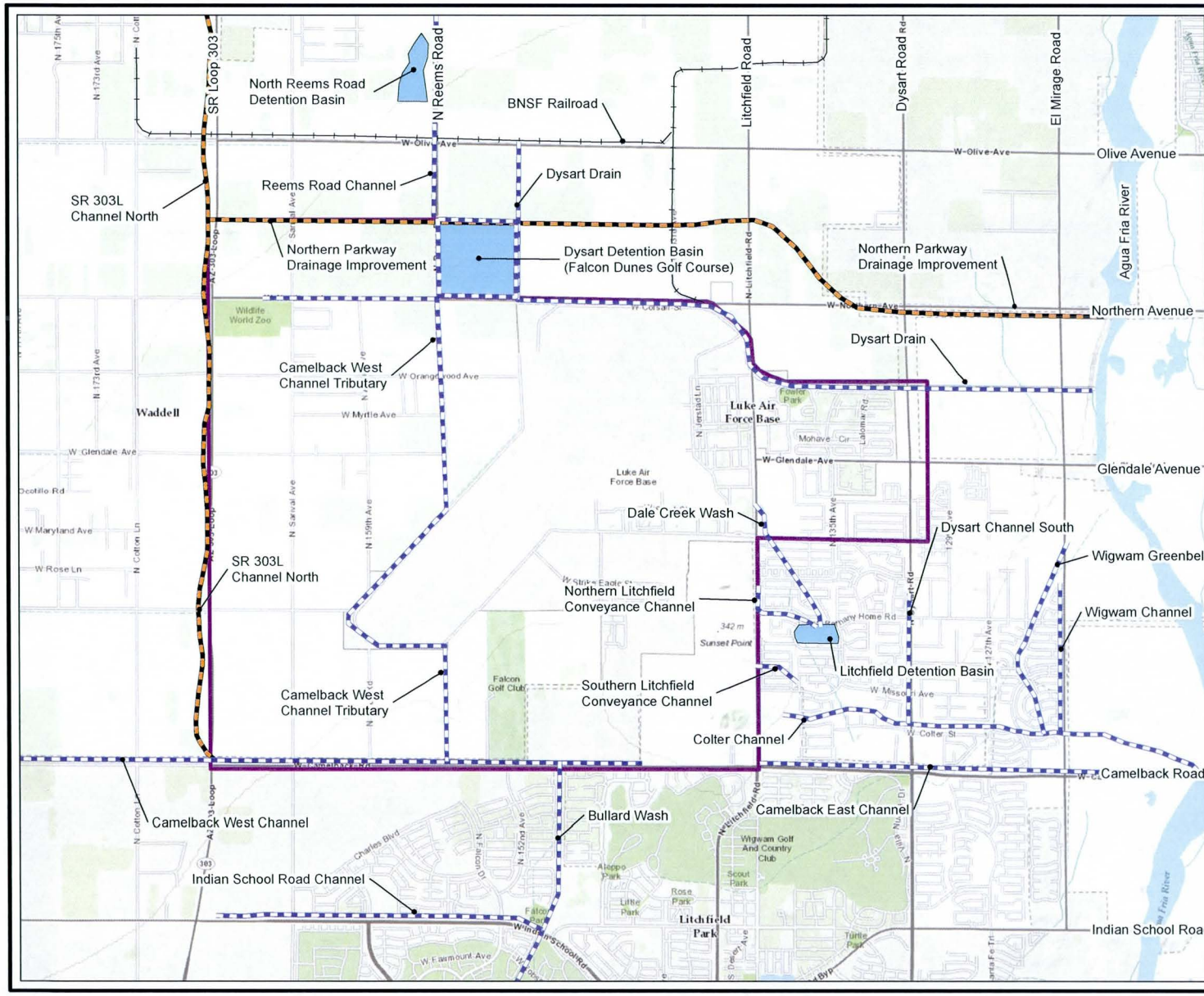
N

0 1,250 2,500 5,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 2
STUDY AREA
USGS TOPOGRAPHY MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Existing Drainage Facility
- Drainage Facility (2014)
- Railroads
- Existing Detention Basin
- Study Boundary

N

Notes:

Drainage Facilities shown are according to September 2009 report titled Loop 303/ White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona.

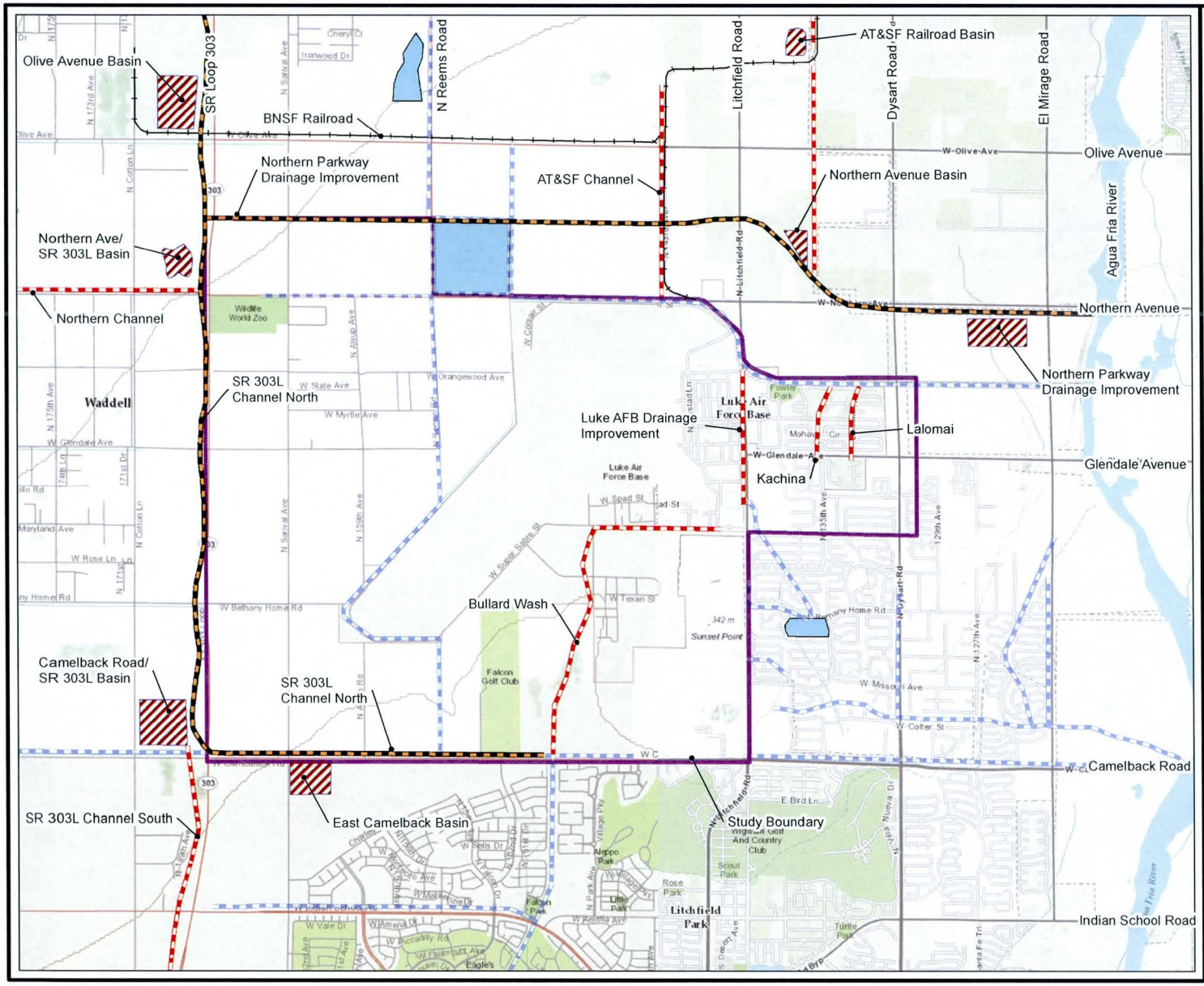
Northern Parkway Drainage Improvement and SR 303L Channel North are projected to be completed in 2014. These facilities are assumed to be Existing Condition for this analysis.

0 2,000 4,000 8,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 3
EXISTING FACILITIES MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Drainage Facility (2014)
- Future Drainage Facility
- Existing Drainage Facility
- Railroads
- Existing Detention Basin
- Future Detention Basin
- Study Boundary

N

Notes:
Drainage Facilities shown are according to September 2009 report titled Loop 303/ White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona.

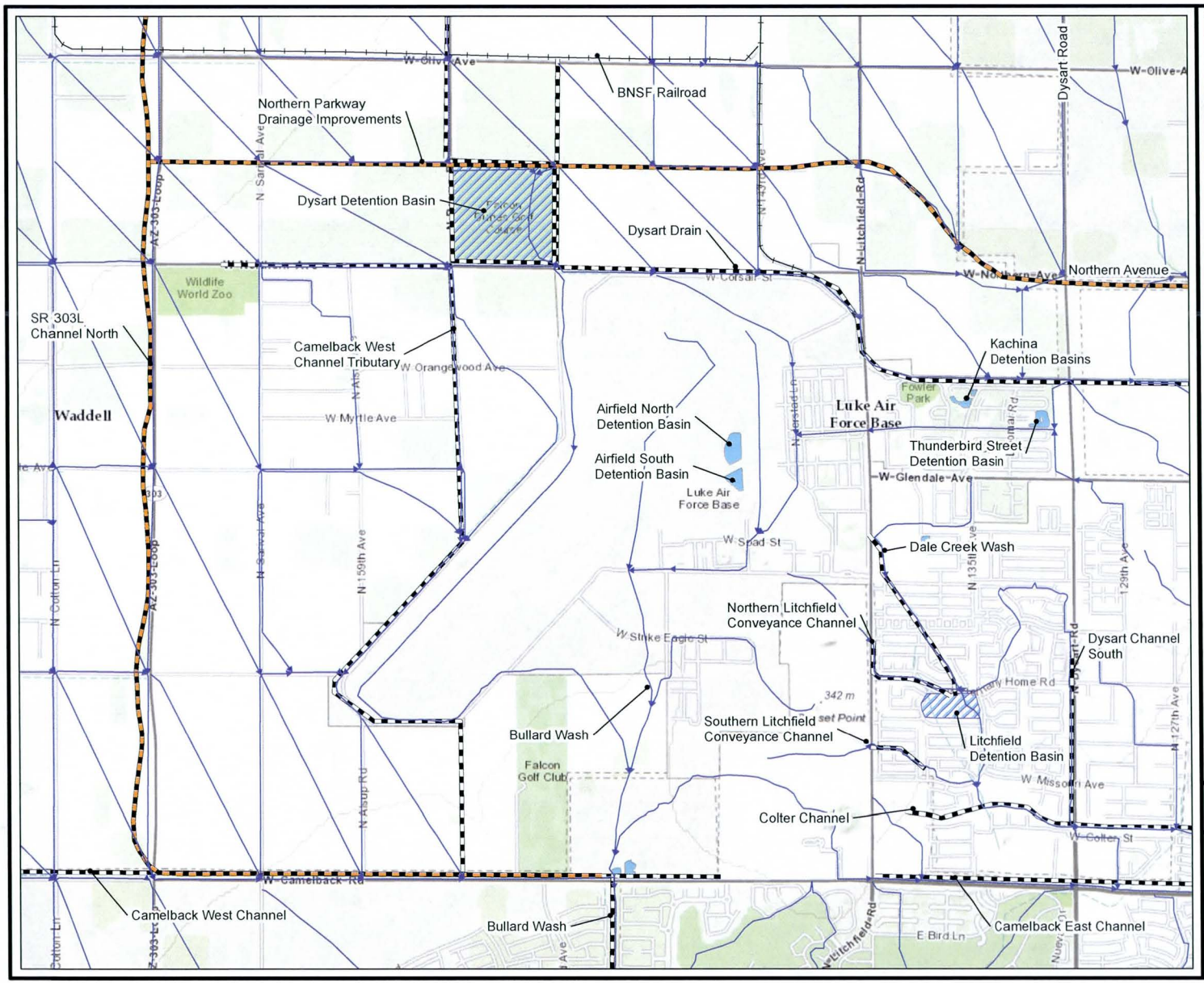
Northern Parkway Drainage Improvement and SR 303L Channel North are estimated to be completed in 2014. These facilities are assumed to be Existing Condition for this analysis. The final locations and configurations of the basins may not correspond directly to what is depicted in the Figure.

0 2,000 4,000 8,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 4
CAPITAL IMPROVEMENT PROJECTS MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Drainage Path Line
- Drainage Facility (2014)
- Existing Drainage Facility
- Railroads
- Existing Detention Basin
- Luke AFB Detention Basin

Notes:

Drainage Facilities shown are according to September 2009 report titled Loop 303/ White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona.

Northern Parkway Drainage Improvement and SR 303L Channel North are estimated to be completed in 2014. These facilities are assumed to be Existing Condition for this analysis.

N

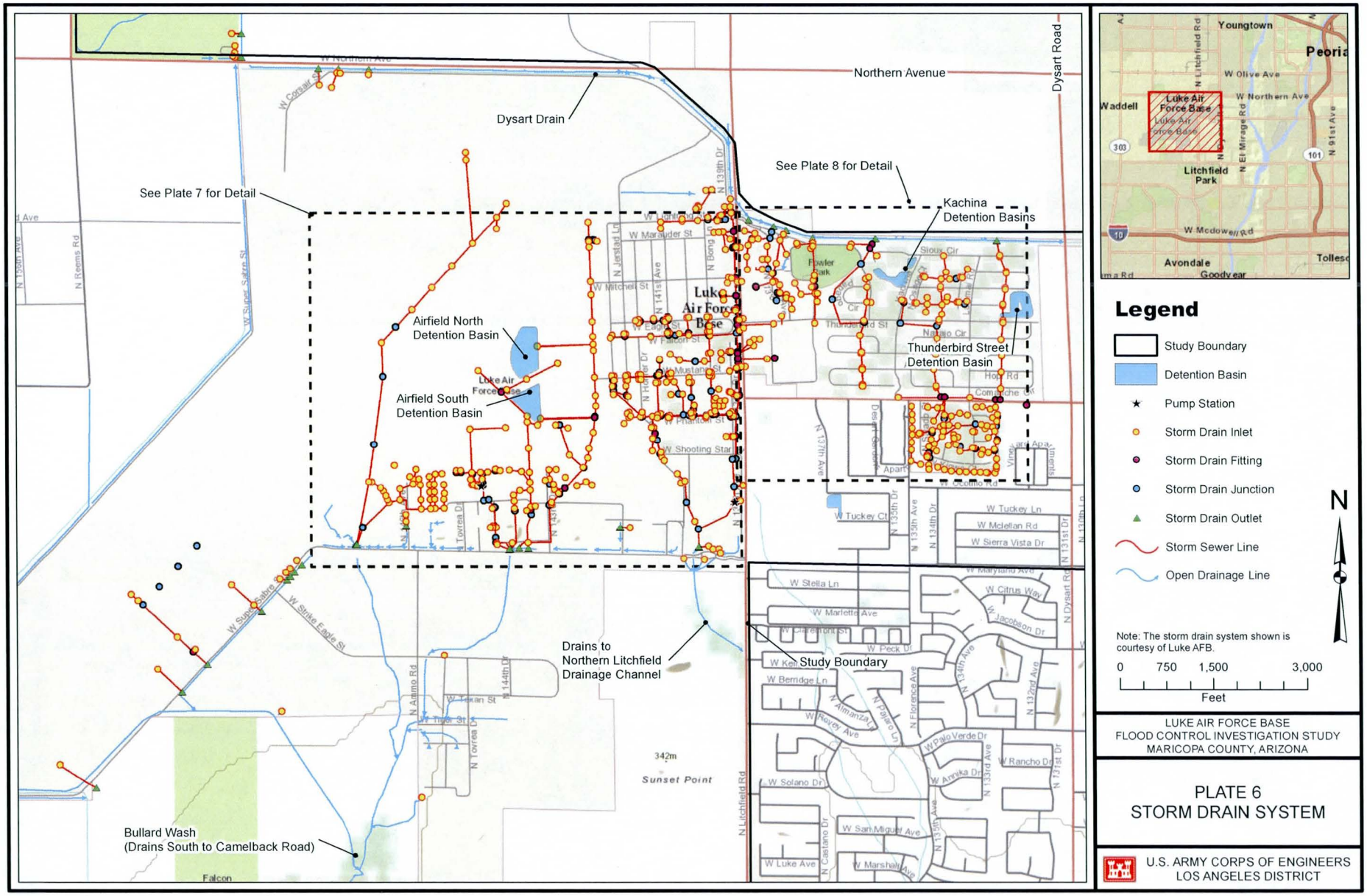
0 1,250 2,500 5,000

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 5
ON-SITE DRAINAGE

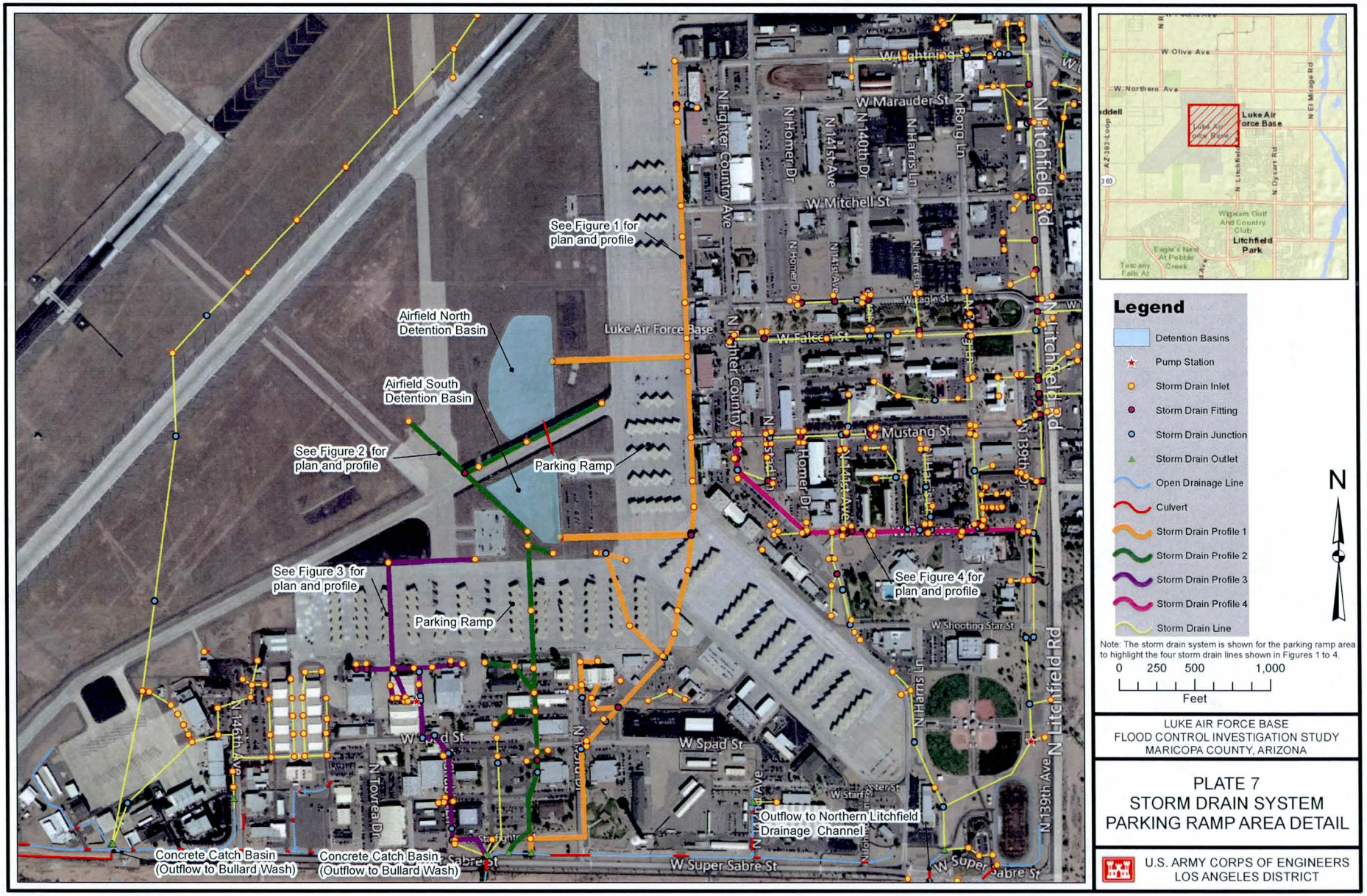
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 6
STORM DRAIN SYSTEM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Detention Basins
- Pump Station
- Storm Drain Inlet
- Storm Drain Fitting
- Storm Drain Junction
- Storm Drain Outlet
- Open Drainage Line
- Culvert
- Storm Drain Profile 1
- Storm Drain Profile 2
- Storm Drain Profile 3
- Storm Drain Profile 4
- Storm Drain Line

N

Note: The storm drain system is shown for the parking ramp area to highlight the four storm drain lines shown in Figures 1 to 4.

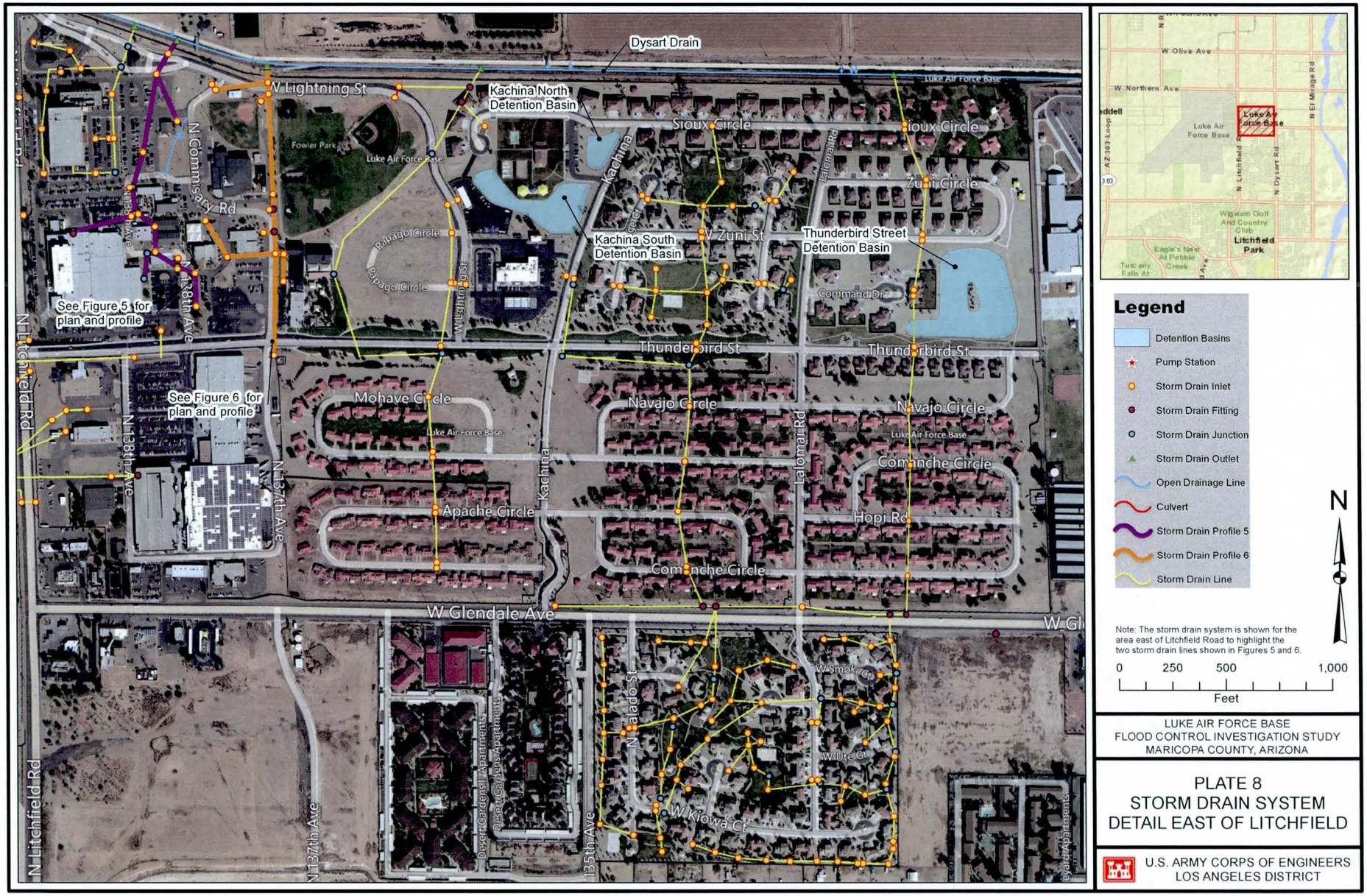
0 250 500 1,000

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 7
STORM DRAIN SYSTEM
PARKING RAMP AREA DETAIL

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Detention Basins
- Pump Station
- Storm Drain Inlet
- Storm Drain Fitting
- Storm Drain Junction
- Storm Drain Outlet
- Open Drainage Line
- Culvert
- Storm Drain Profile 5
- Storm Drain Profile 6
- Storm Drain Line

N

Note: The storm drain system is shown for the area east of Litchfield Road to highlight the two storm drain lines shown in Figures 5 and 6.

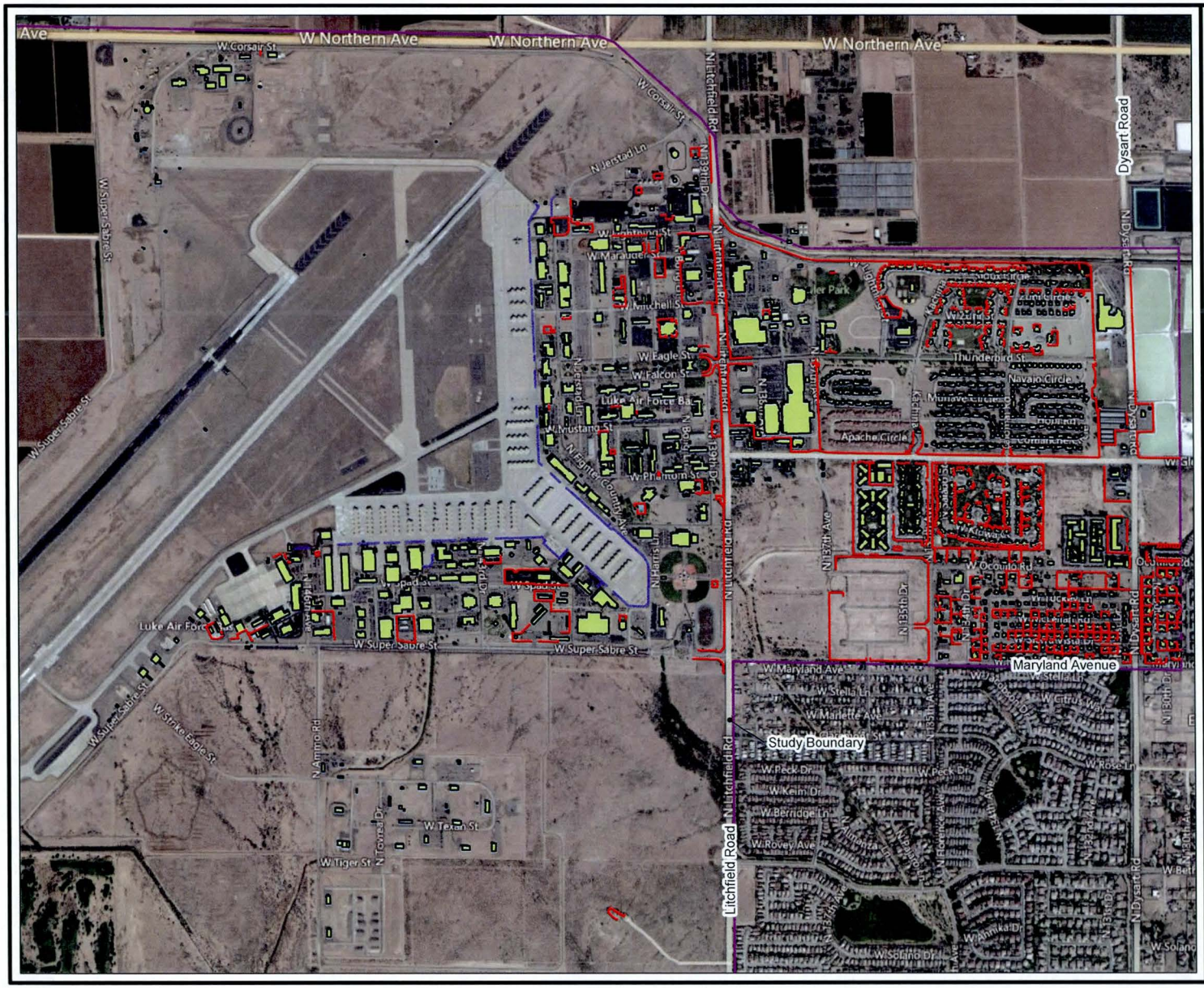
0 250 500 1,000

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 8
STORM DRAIN SYSTEM DETAIL EAST OF LITCHFIELD

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- *Levees - Jersey Barriers
- *Levees - Base Walls
- Buildings
- Study Boundary

N

*Levees in the Luke AFB FLO-2D model do not represent actual certified levees. Levees represent walls on the base and Jersey Barriers.

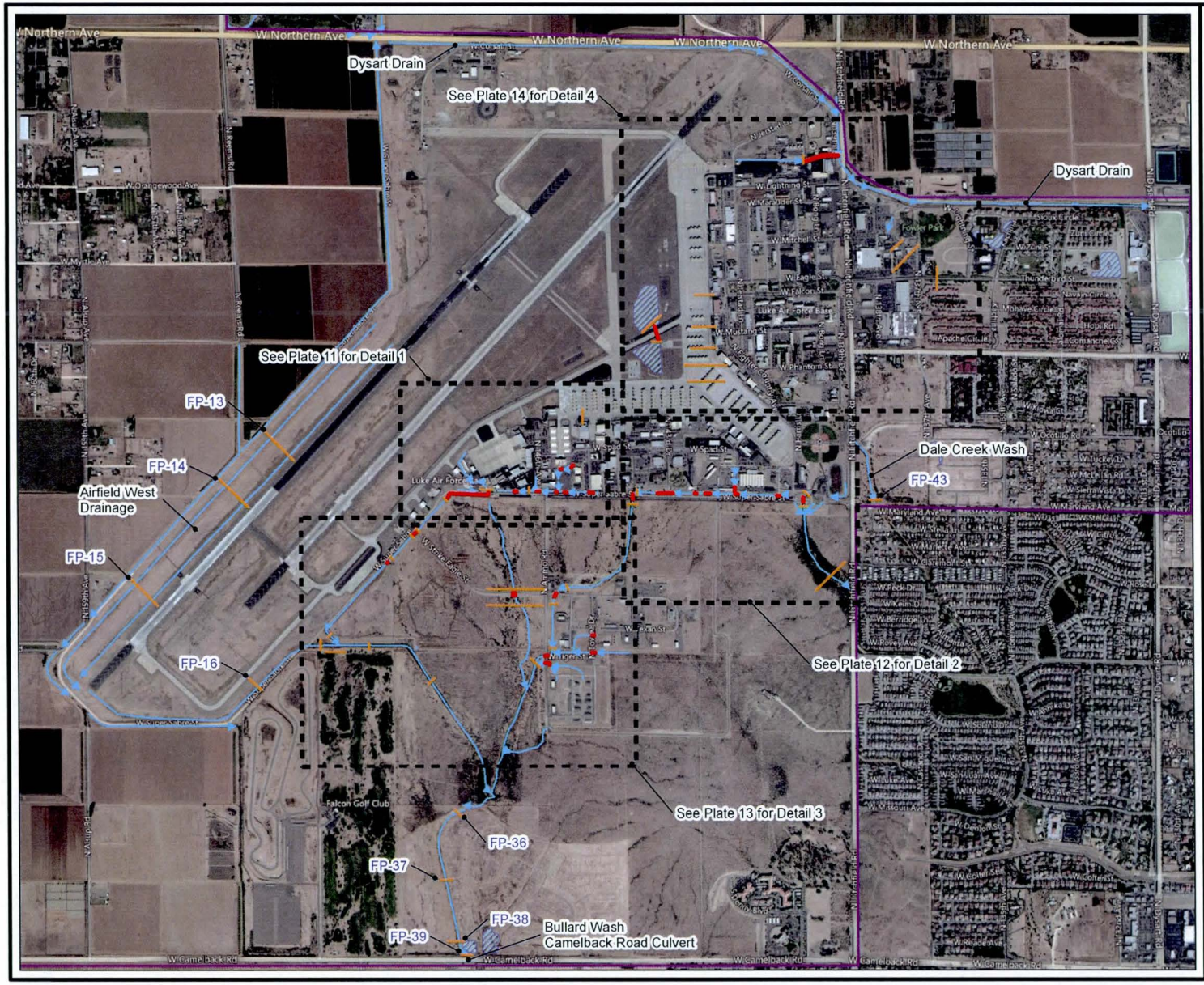
0 750 1,500 3,000

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 9
FLO-2D COMPONENTS BUILDINGS AND LEVEES*

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Floodplain Cross-Section
- Hydraulic Structure
- Study Boundary
- Detention Basins
- Open Drainage Line

N

HS = HYDRAULIC STRUCTURE

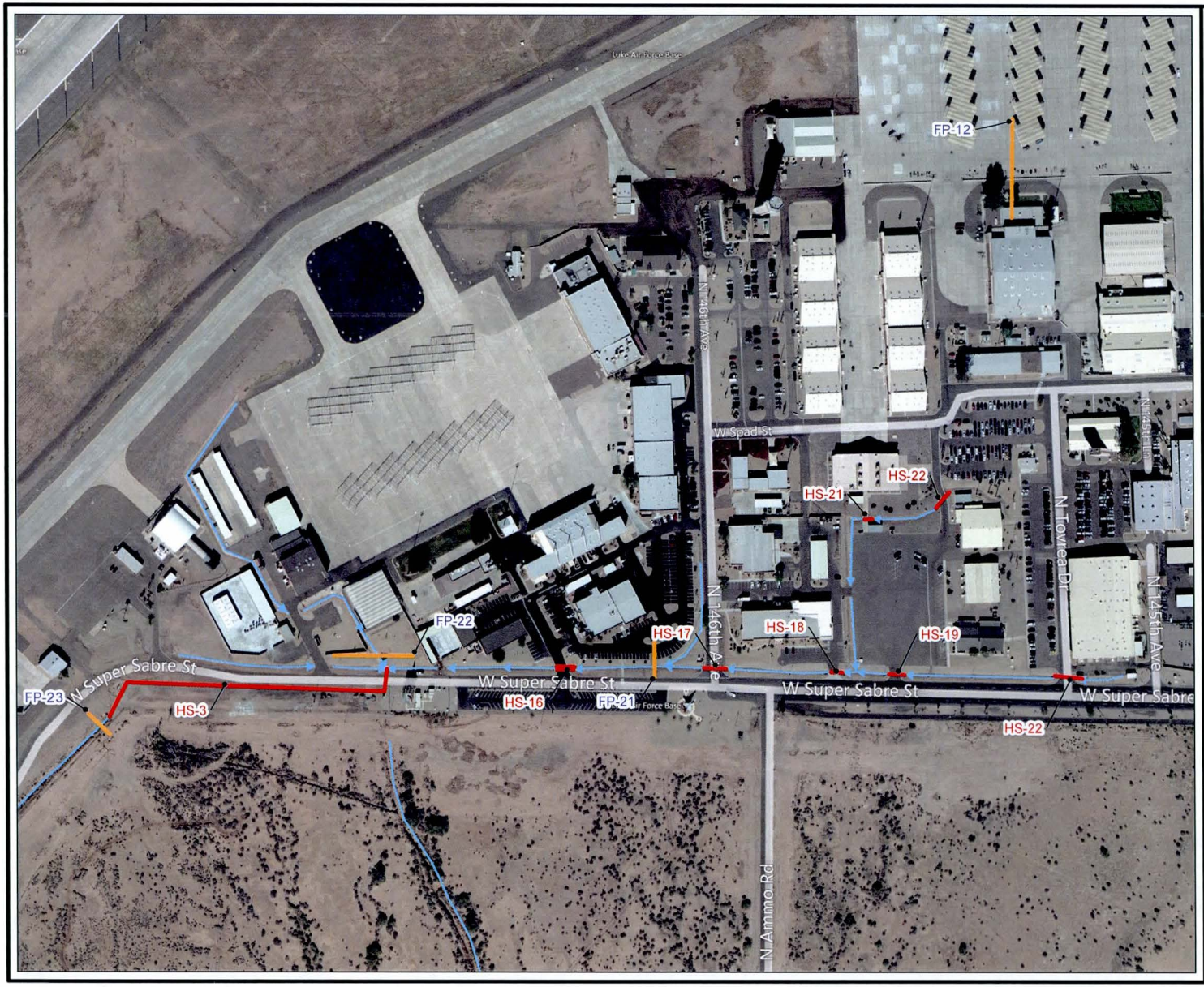
0 1,000 2,000 4,000

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 10
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Hydraulic Structure
- Floodplain Cross-Sections
- Open Drainage Line

N

HS = HYDRAULIC STRUCTURE
FP = FLOODPLAIN CROSS-SECTION

0 125 250 500
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 11
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 1

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Legend

- Hydraulic Structure
- Floodplain Cross-Section
- Open Drainage Line

N

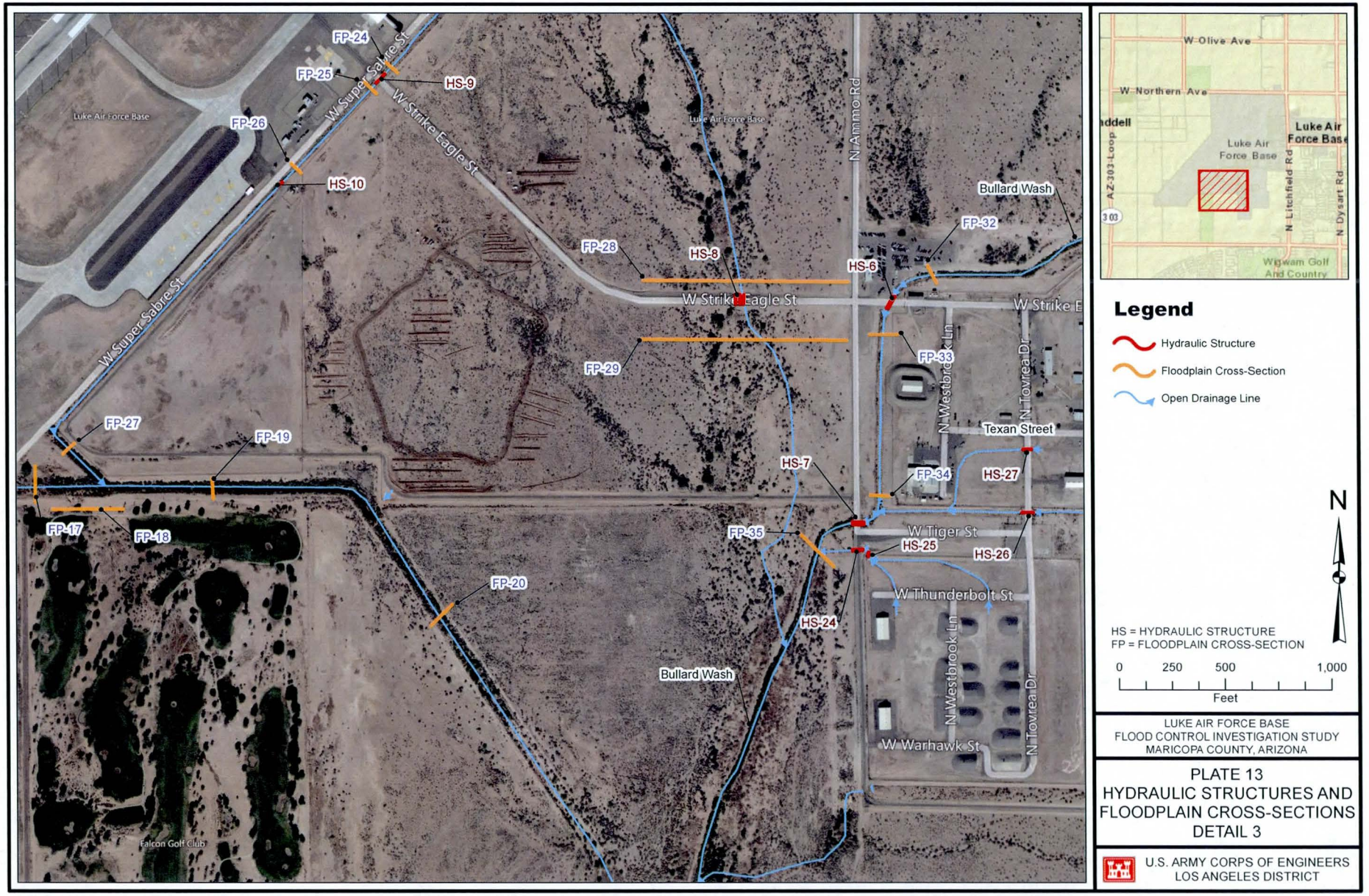
HS = HYDRAULIC STRUCTURE
FP = FLOODPLAIN CROSS-SECTION

0 125 250 500
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 12
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 2

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 13
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 3

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Legend

- Hydraulic Structure
- Floodplain_Cross_Sections
- Detention Basins
- Open Drainage Line

N

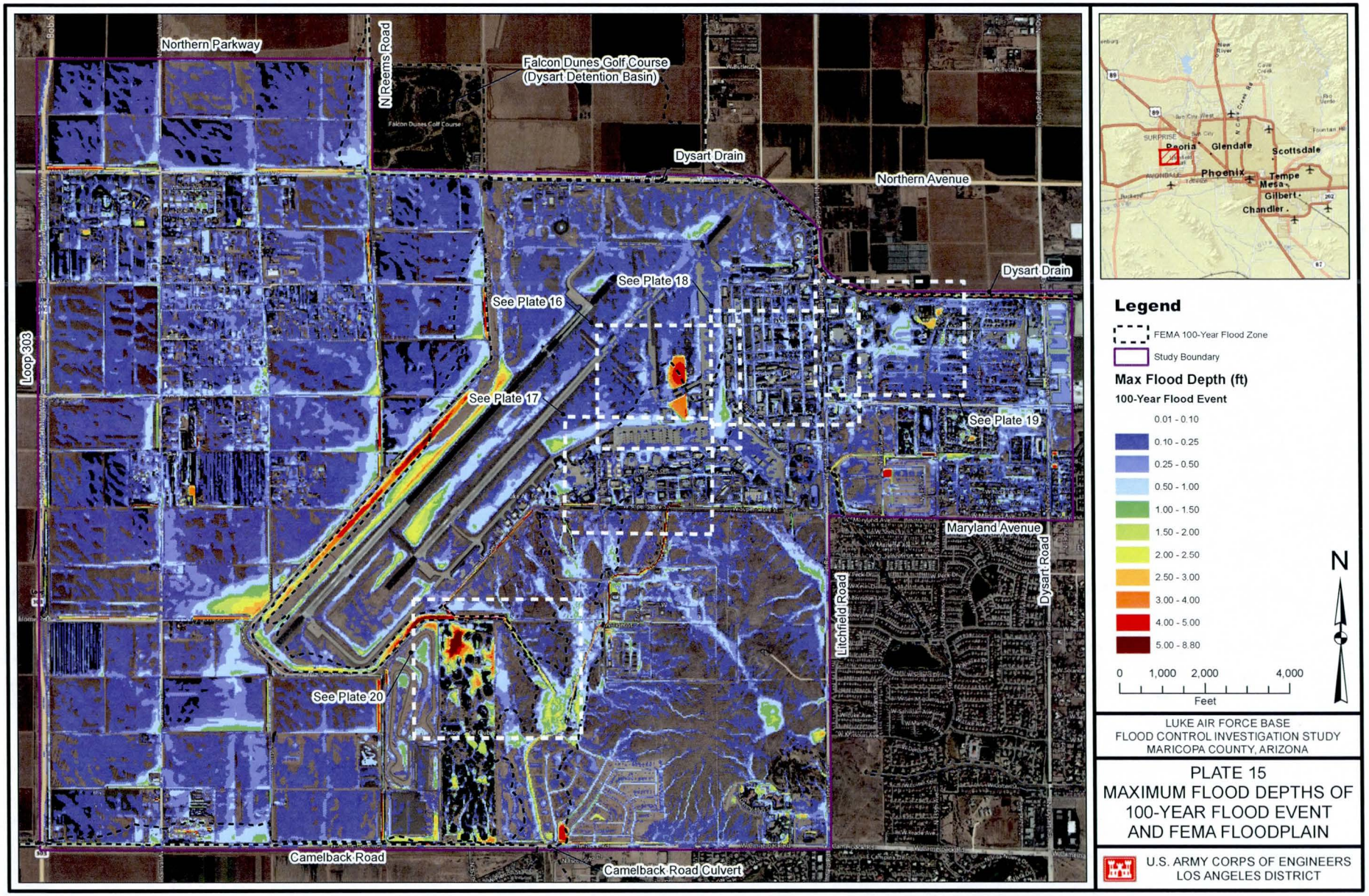
HS = HYDRAULIC STRUCTURE
FP = FLOODPLAIN CROSS-SECTION

0 250 500 1,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 14
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 4

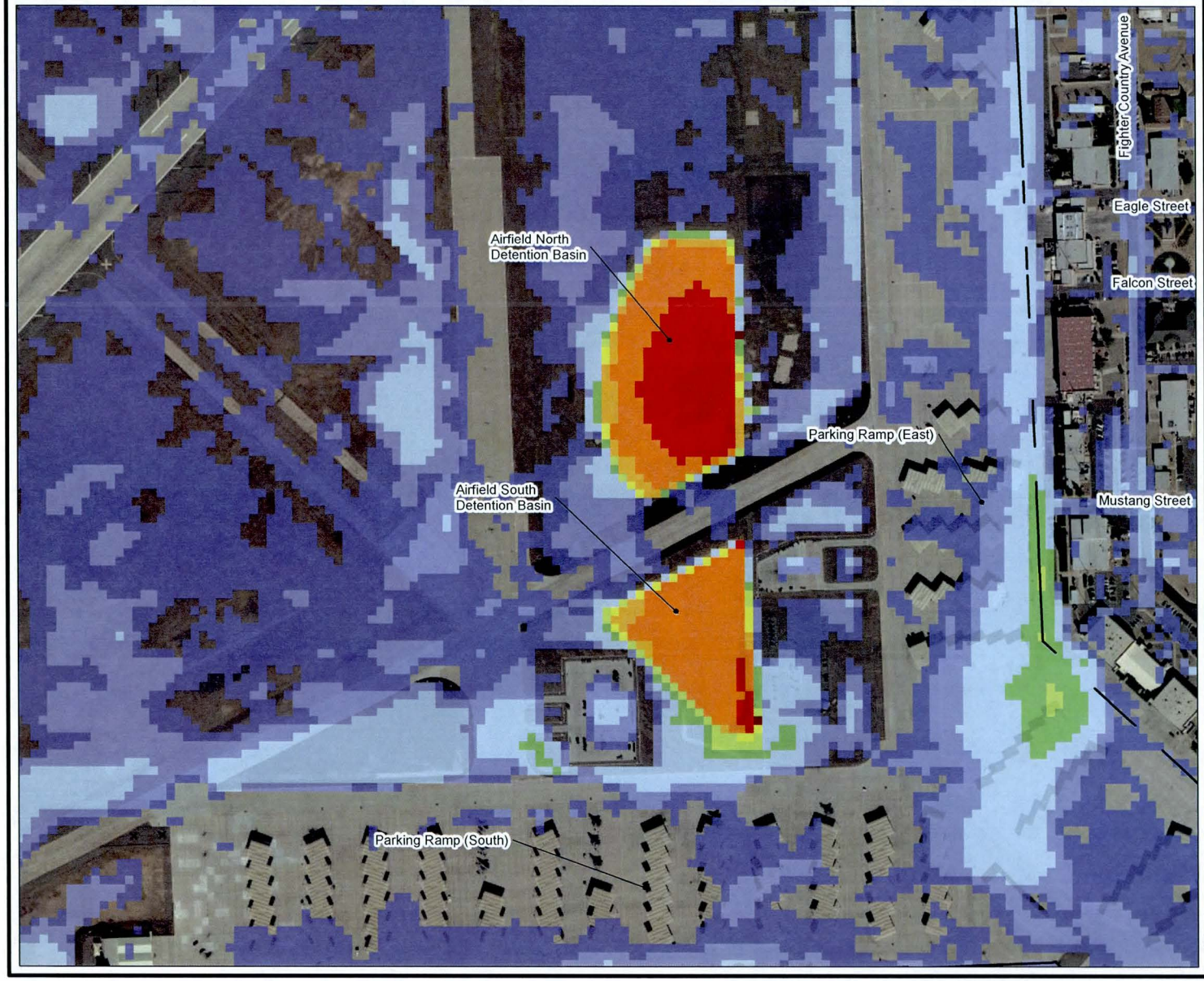
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 15
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT AND FEMA FLOODPLAIN

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

Jersey_Barriers

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

N

0 125 250 500

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 16
MAXIMUM FLOOD DEPTHS OF
100-YEAR FLOOD EVENT
MAJOR FLOODED AREA 1

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Legend

Jersey_Barriers

Hydraulic_Structures

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

0 125 250 500

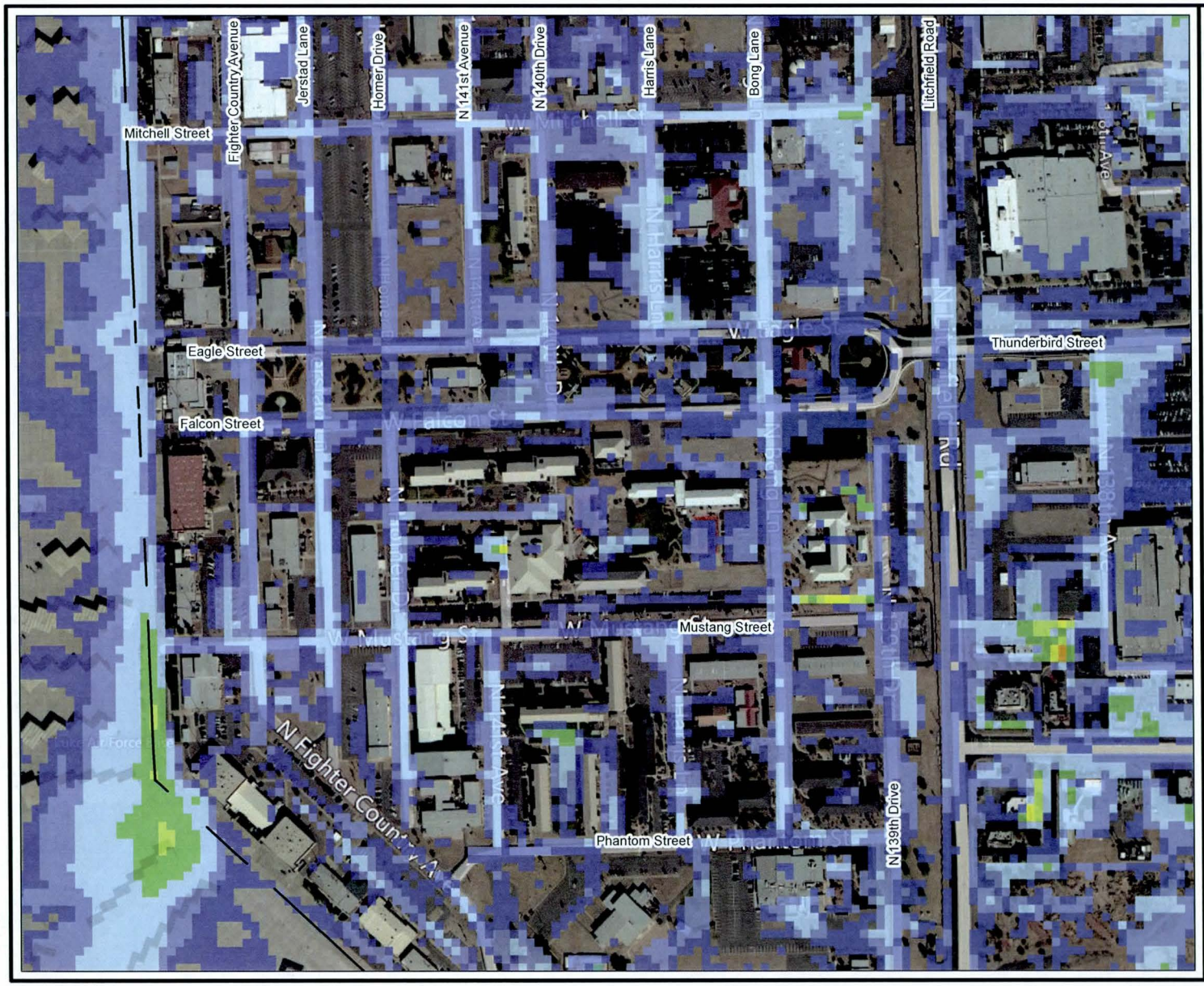
Feet

N

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 17
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT MAJOR FLOODED AREA 2

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

Jersey_Barriers

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

0 125 250 500

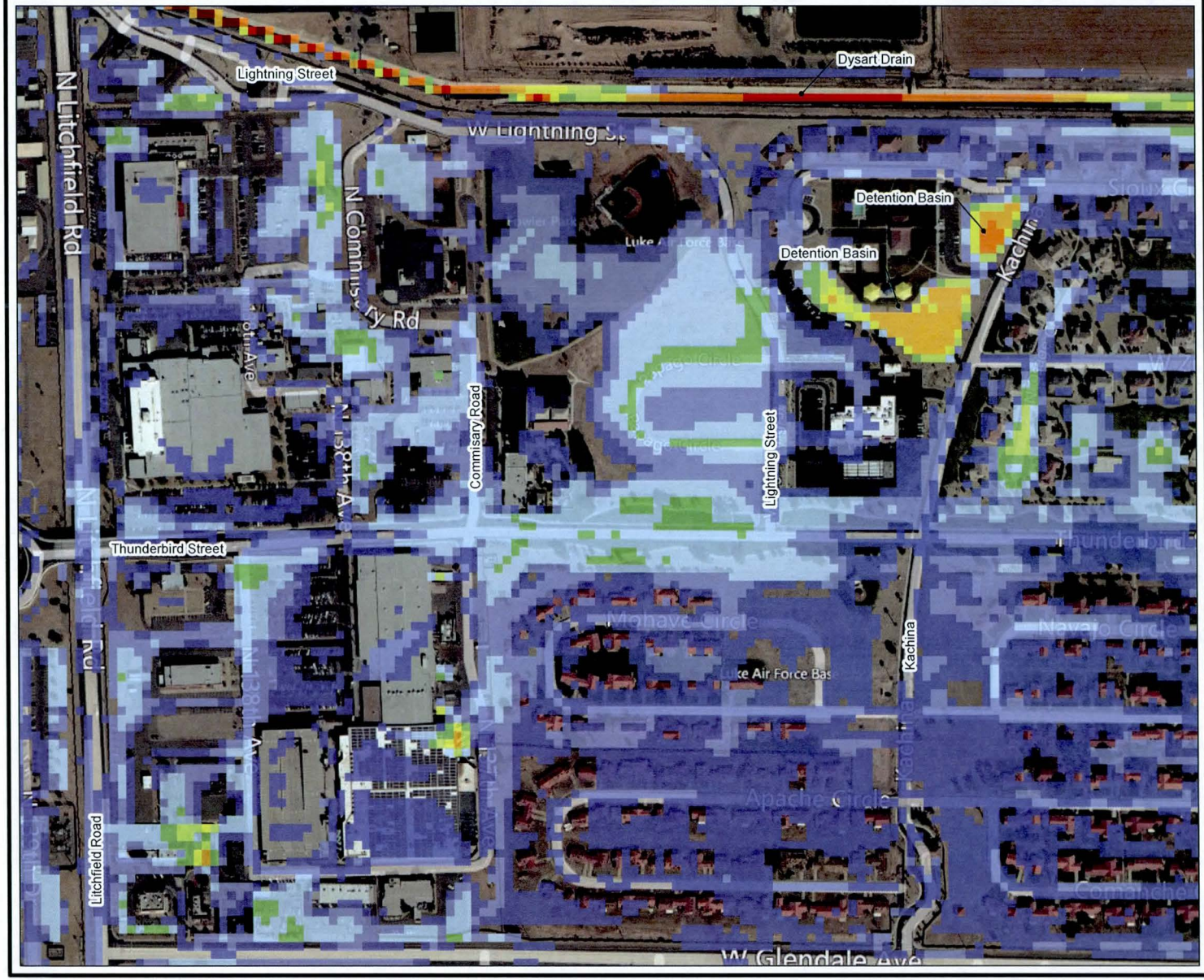
Feet

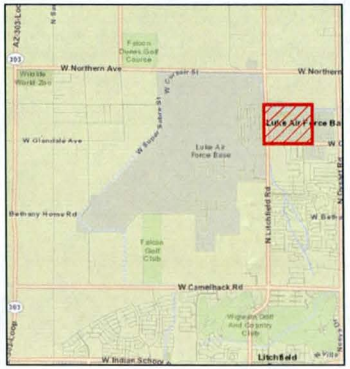
N

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 18
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT MAJOR FLOODED AREA 3

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT





Legend

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

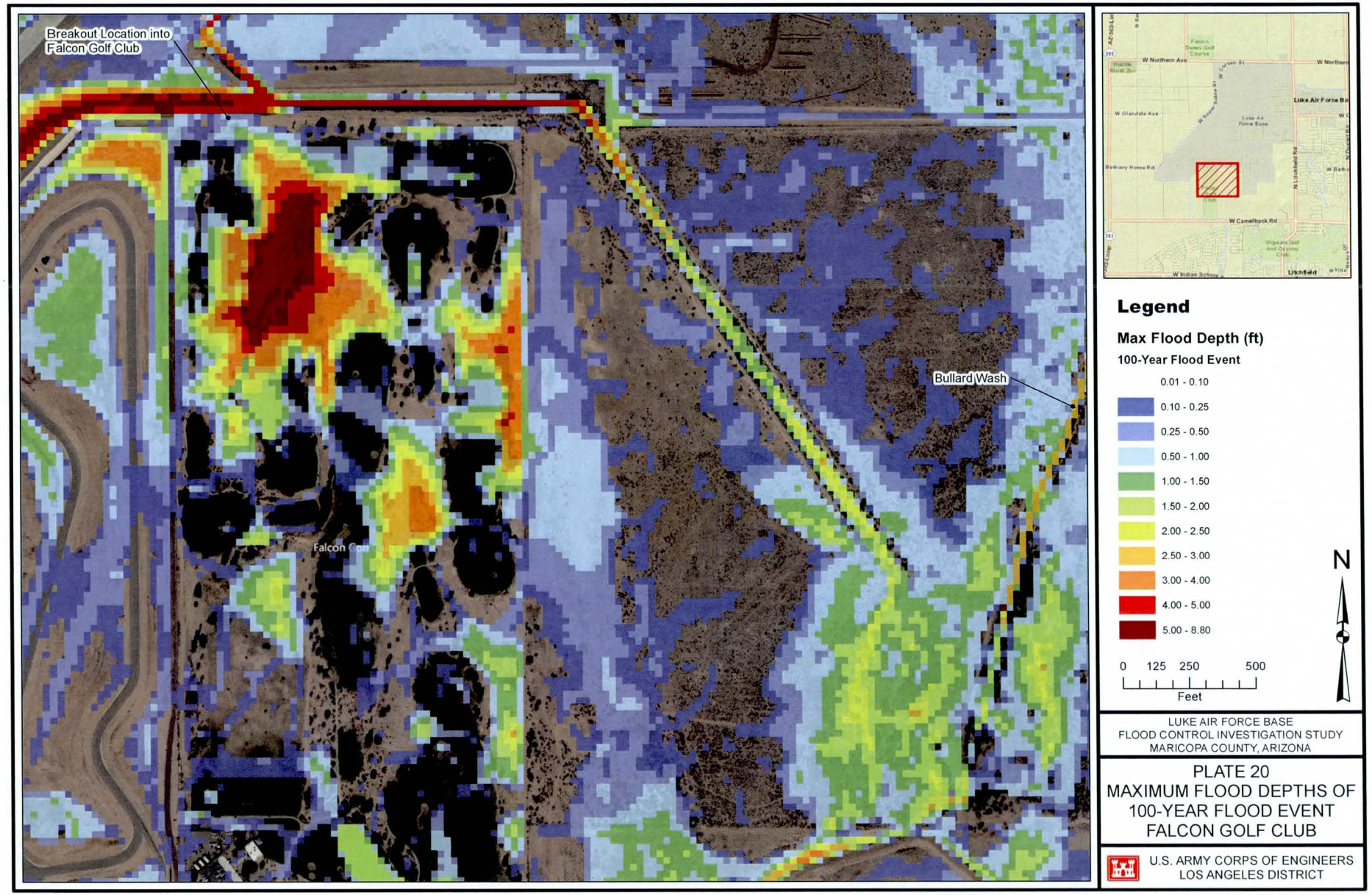
N

0 125 250 500
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 19
MAXIMUM FLOOD DEPTHS OF
100-YEAR FLOOD EVENT
MAJOR FLOODED AREA 4

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



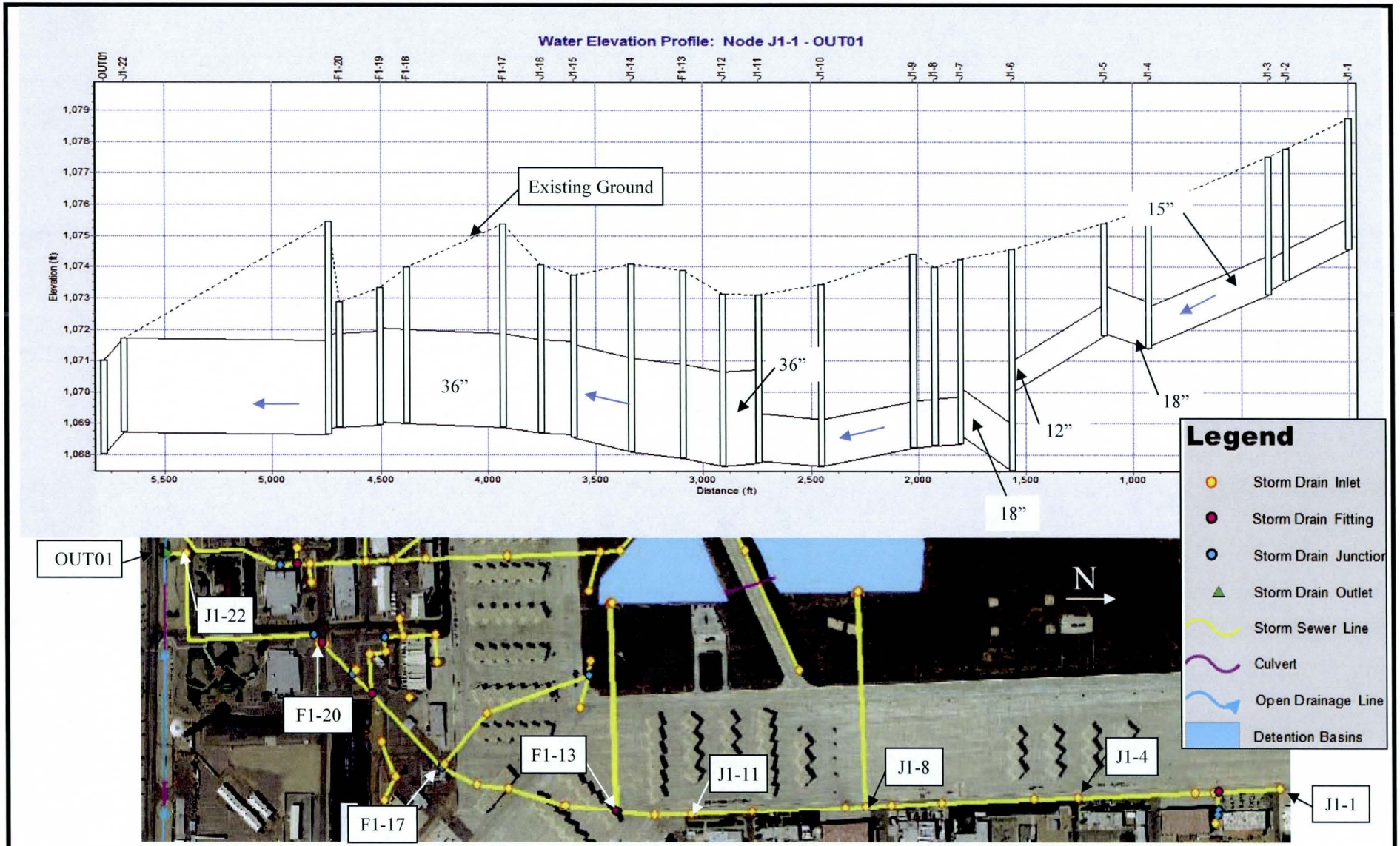
LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 20
MAXIMUM FLOOD DEPTHS OF
100-YEAR FLOOD EVENT
FALCON GOLF CLUB

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

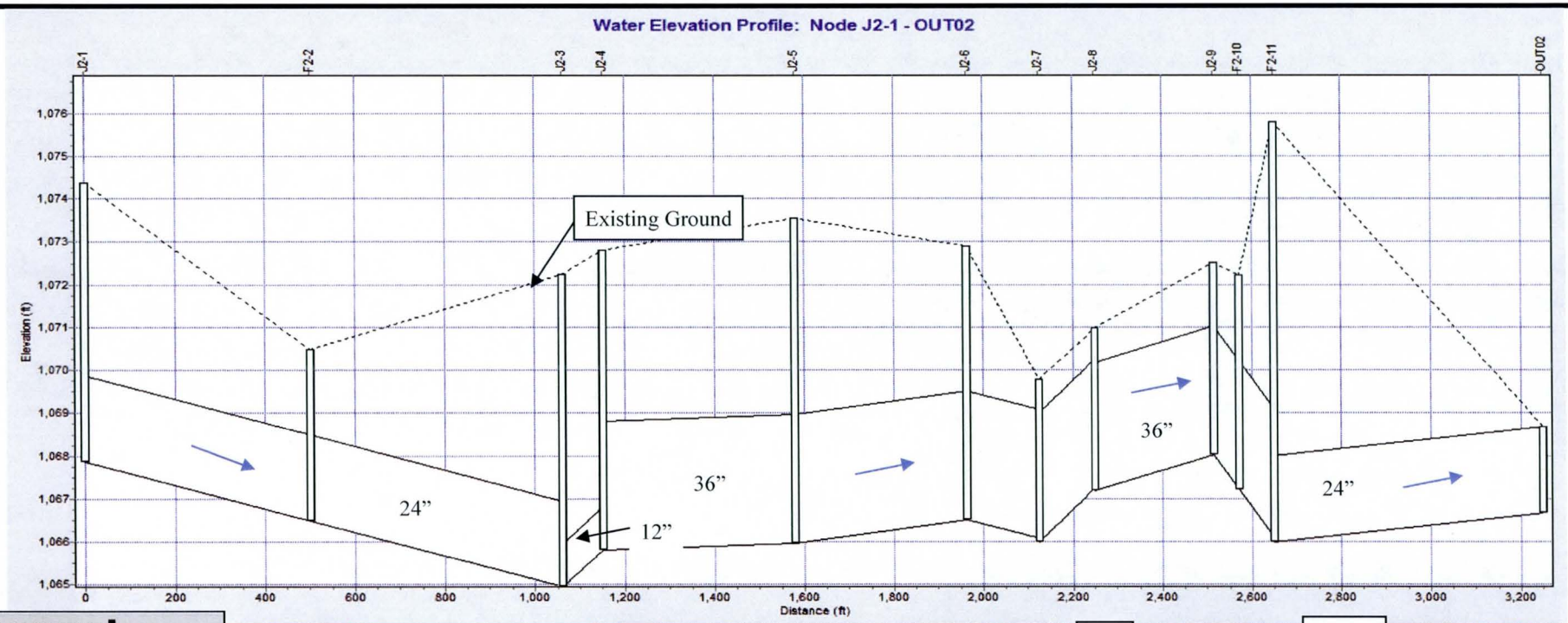
FIGURES

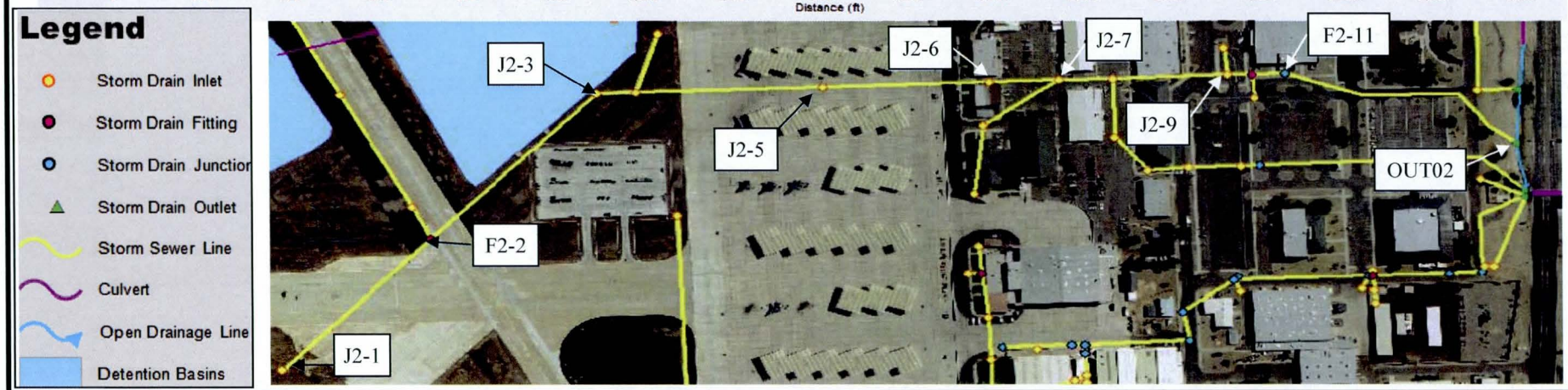
LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013



Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

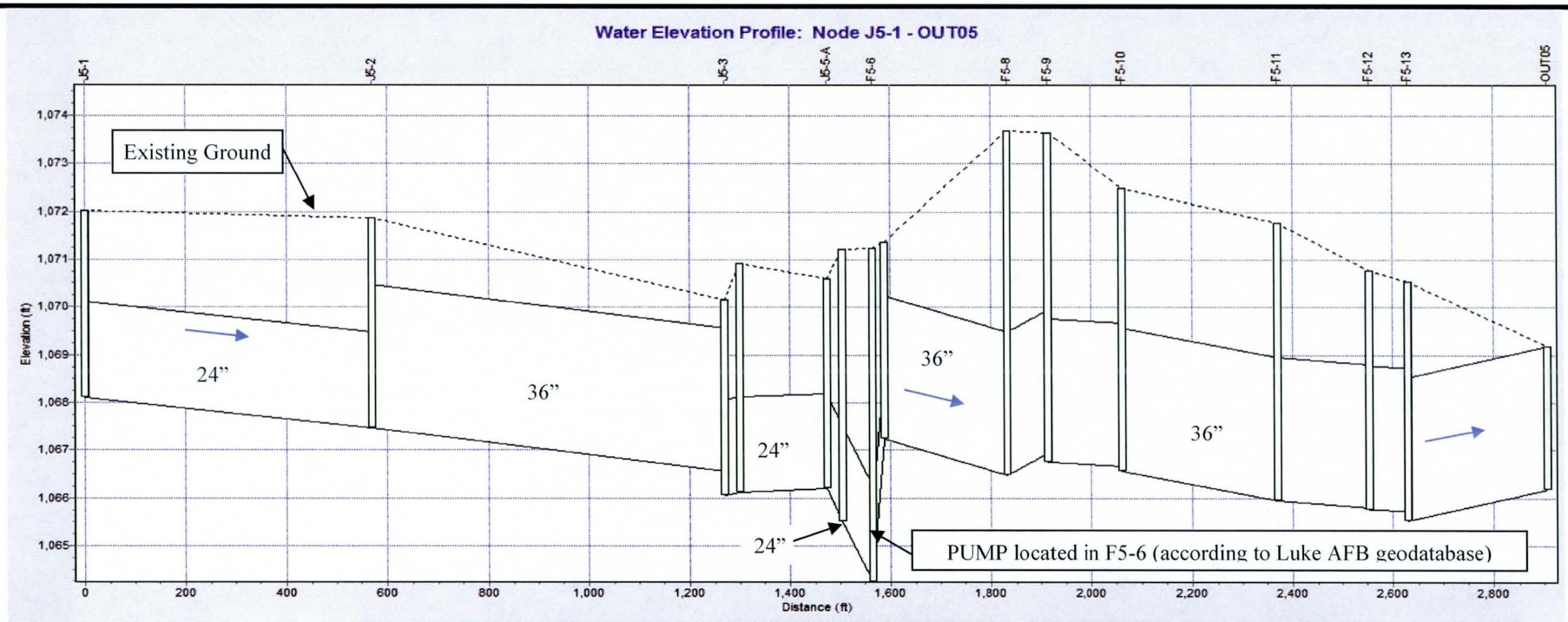
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 1** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 1**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

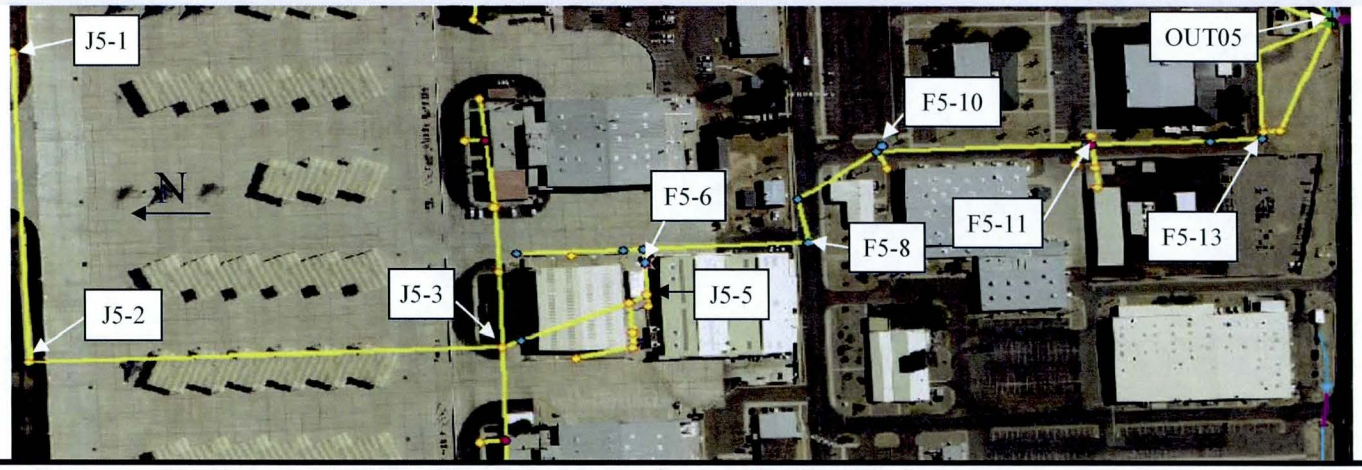




Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

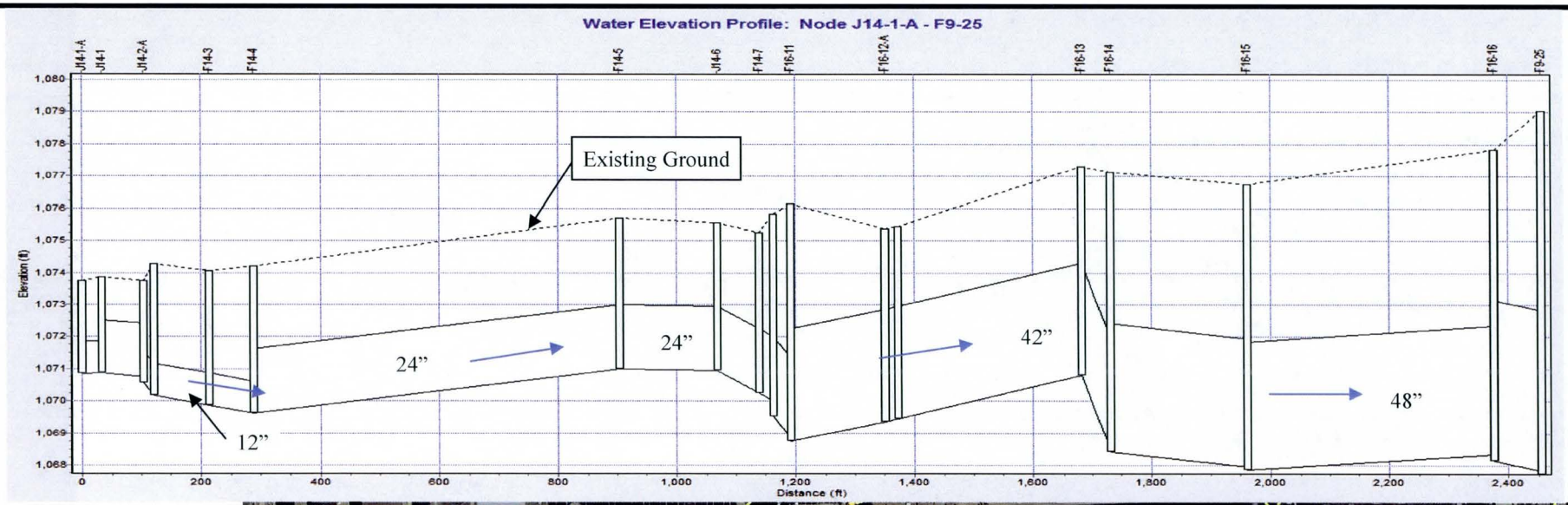
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 2** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 2**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

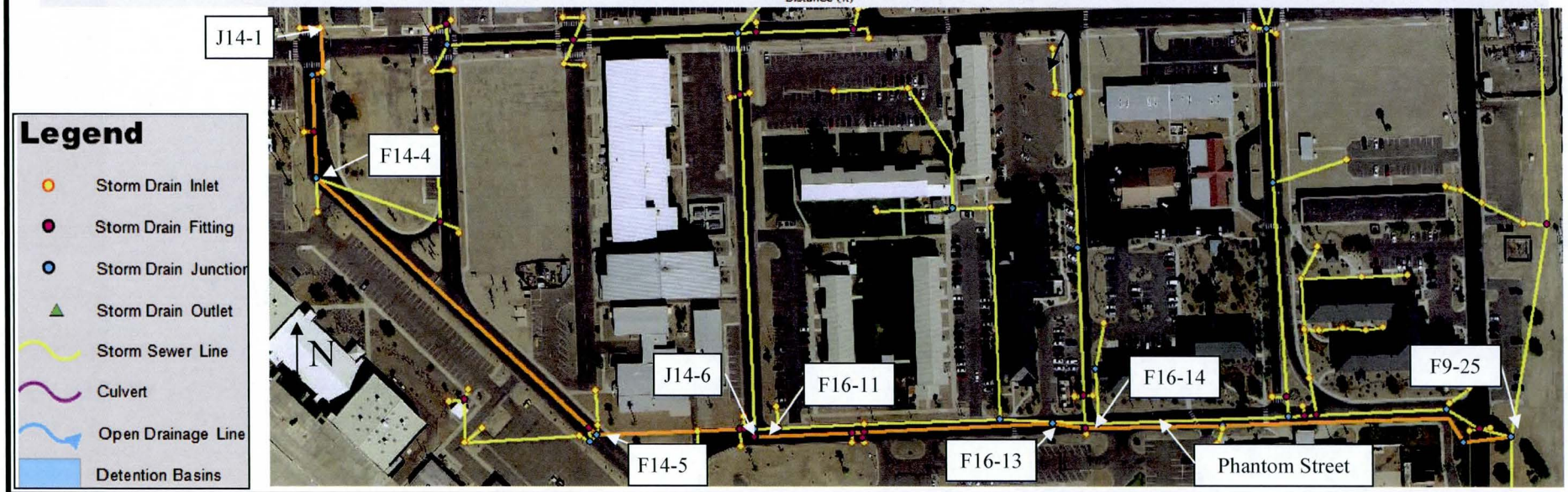




Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

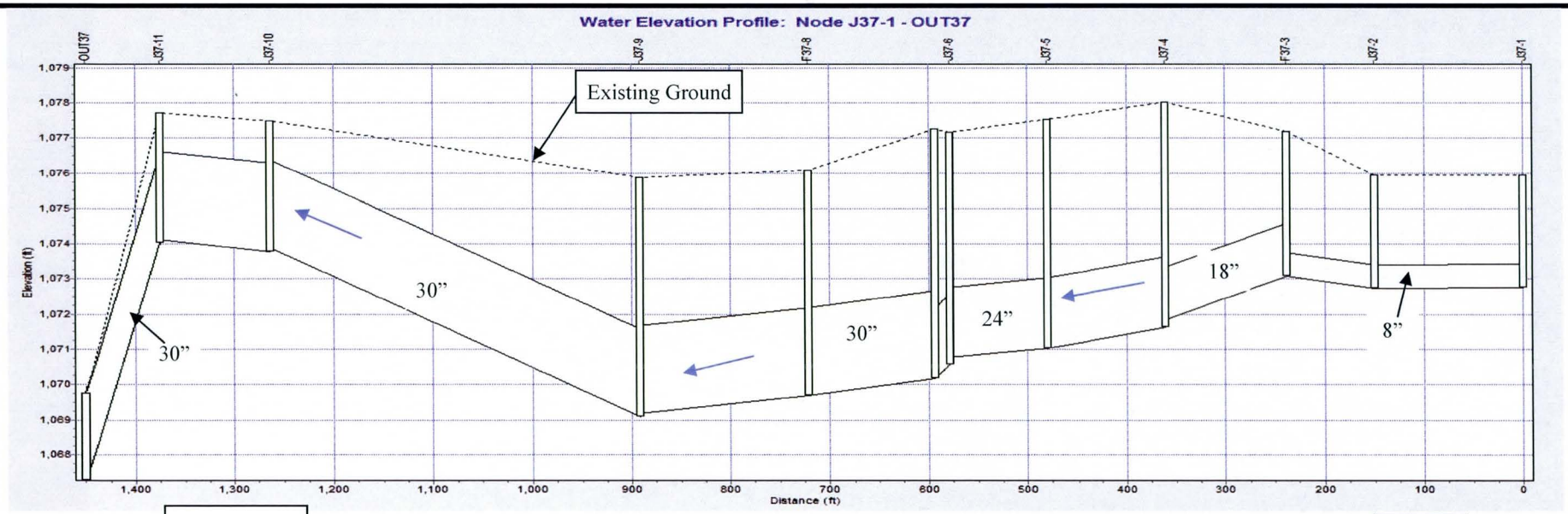
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 3** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 3**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

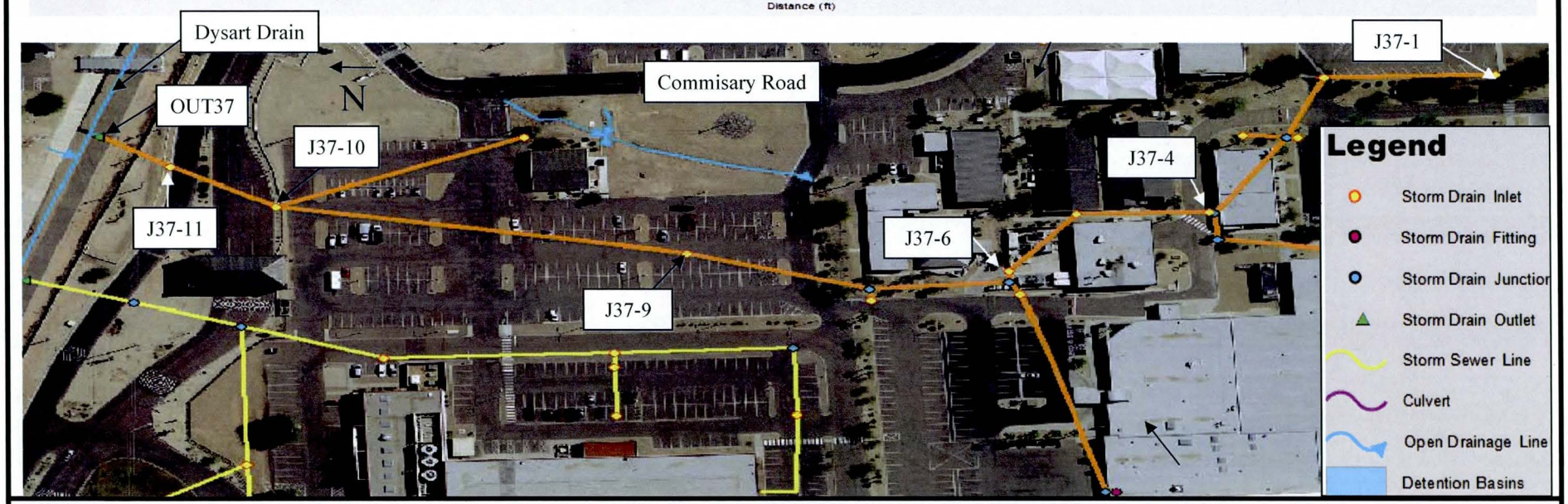




Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

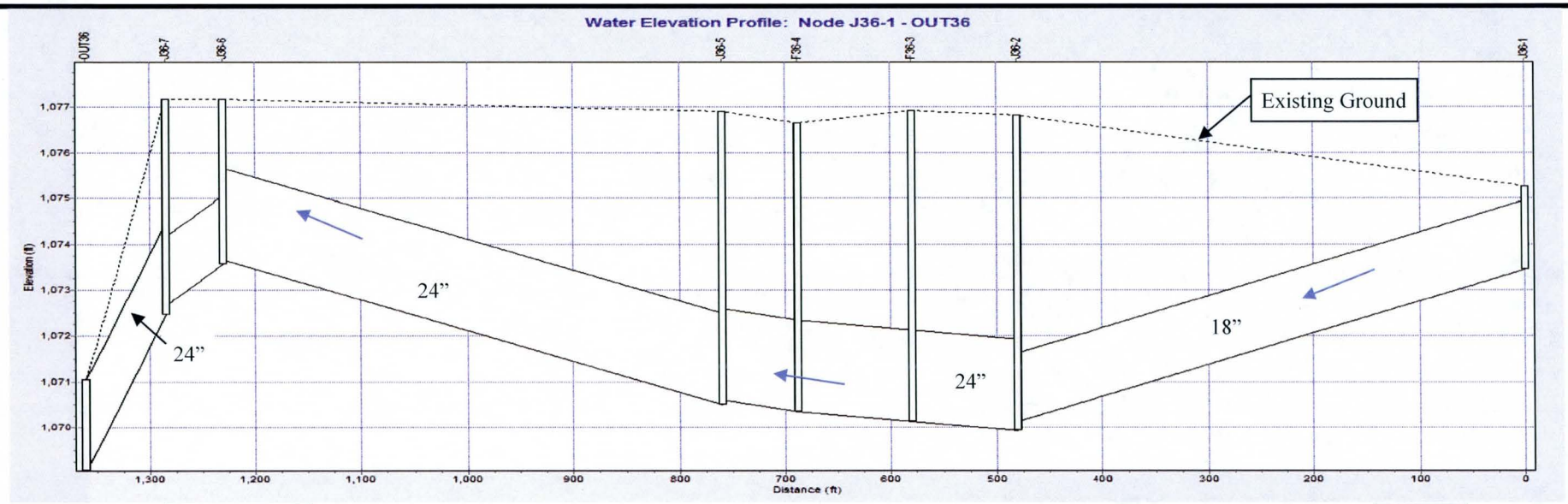
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 4** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 4**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

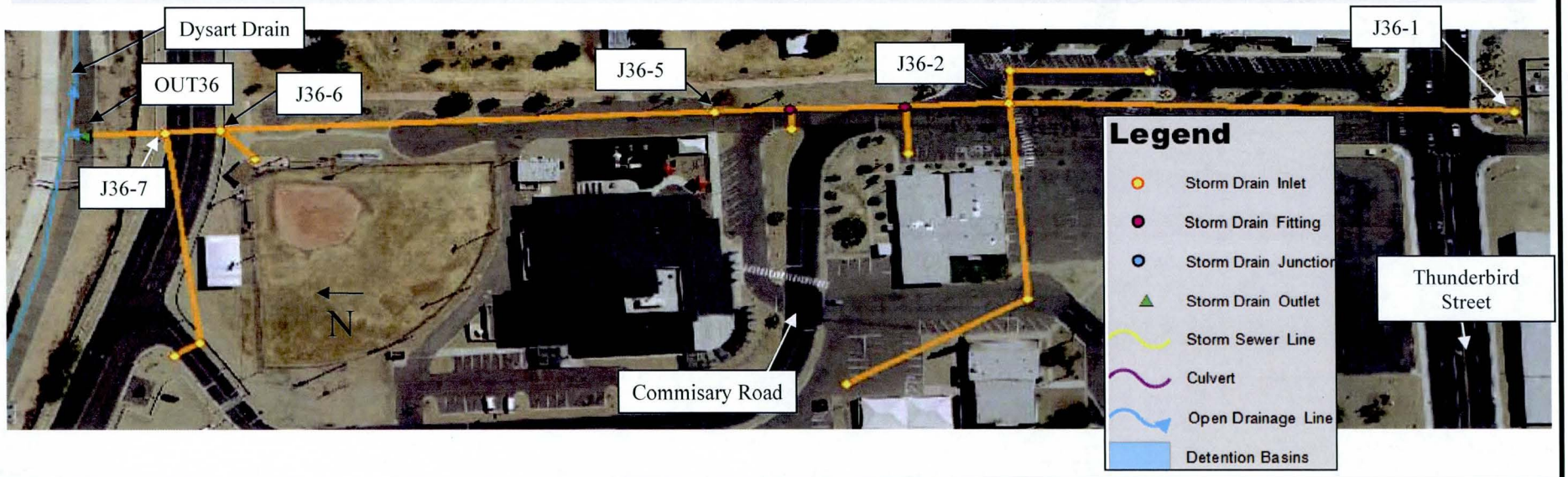




Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 8 for larger map.

LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 5** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 5**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT





Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 8 for larger map.

LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 6** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 6**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

APPENDIX 1

PROJECT ORDER PROJECT MANAGEMENT PLAN

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

Project Order Project Management Plan (PMP)

FY13

Project Title: Luke AFB Flood Control Investigation

Project Number: NUEX120203
Project Order Number: F2U3082272J001

Location: Luke Air Force Base, Arizona

Date: 4 June 2013

Table of Contents

1. Scope of Project:
2. Technical requirements/ inputs:
3. Key Deliverables:
4. Available Resources:
5. Acquisition Strategy:
6. Cost Estimate:
7. Project Schedule:
8: Change Management

Appendix A: Scope of Work
Appendix B: Schedule
Appendix C: Budget
Appendix D: Draft 1391 & AF IMT 332
Appendix E: Flood Control Limits Aerial

This PMP, with any required attachments completed by the SPL Project Manager will be attached to the MIPR / Project Order as required by ER 37-1-26 to demonstrate the terms of the proposed project order and is scaled to the size of this project.

Definition of a Project Management Plan:

a. The Project Management Plan for phase, herein after referred to as the PMP defines a contract between the Corps and the Luke AFB customer, and reflects a "buy in" on the part of the customers and SPL, as well as those who will be performing, and reviewing, the activities involved in the project. The PMP describes the initial tasks of the study phase, continues through the preparation of the final study report, with the project management plan for project implementation and design agreement.

b. The PMP is a basis for defining the scope of work, cost, schedule and quality expectations. The study is an iterative process without a predetermined outcome. Therefore, estimated time and cost can and does change. It may be necessary to revise the scope following reformulation and evaluations of the alternatives. *The scope and assumptions, for this study effort, should be clearly outlined and stated so the Corps and the Customer understand the objectives and agree with the level of detail contained in the PMP.* If study tasks are added or removed from the plan contained herein, and significantly impact cost or schedule beyond that allowable, this PMP will be revised to reflect the required change. Any impact in time or cost can be assessed and an appropriate decision or recommendation can be made on how to proceed. The PMP provides the basis for change as well as allows the documentation of significant alterations.

c. The PMP is a basis for review and evaluation of the study report. Since the PMP represents a contract among study participants, it will be used as the basis to determine if the draft study report has been developed in accordance with established procedures and previous agreements. The PMP reflects the agreed upon scope between the Corps and the Customers and outlines the intent of the study to the Corps' District. It not only contains the scope but also critical assumptions, methodologies, and the level of detail for the studies that are to be conducted during the Detailed Project Report. A review of the draft report will be completed to ensure that the study has been prepared consistent with the contents of this PMP. The objective is to provide early assurance that the study activities, tasks and documentation is preformed consistent with Corps policies and guidelines and will be supported by Corps Headquarters and the Customer's management.

1. Scope of Project:
See Appendix A for Scope of Work attached: The effort involved in this Project Order is to develop documentation of existing conditions at Luke Air Force Base for future design documents and the eventual construction of flood controls to mitigate flooding of aircraft parking ramps and structures. This project includes site investigation and hydrologic/hydraulic modeling.

2. Technical requirements/ inputs:
A data gathering site trip will be conducted by the PDT to meet the Customer, their county partner MCCFC and obtain all pertinent project requirements. This meeting shall be a minimum 2-day trip and be conducted within 35 days of the issuance of notice to proceed. Items to be collected include but are not limited to:

Existing LIDAR digital elevation model (from LAFB).
Depict existing utilities on the survey based on LAFB GIS data
Unprocessed survey data from Maricopa County Flood Control (MCCFC)

3. Key Deliverables:

1. Draft Existing Conditions Hydrologic and Hydraulic Analyses Report
2. Final H&H report and models

Based on a Friday 28 Sept 2012 teleconference kickoff , considered notice to proceed (NTP) deliverables will be provided and considered complete 14 June 2013. NTP + 259 calendar days

4. Available Resources:
See Appendix B for specific Budgets attached: The effort entailed to develop documentation of existing conditions at Luke Air Force Base and associated fee was coordinated with the following assigned Technical Lead and committed by the Resource Manager of each Section.

Cuong T. Ly, PE
US Army Corps of Engineers
Chief of Hydrology & GIS Section
915 Wilshire Blvd., Suite 12008
Los Angeles, CA 90017-3401
213-452-3566
213-452-4202 - Fax
cuong.ly@usace.army.mil

5. Acquisition Strategy:
The effort is projected to be 100% In-House effort. At this time there are no contract actions required. If required, only minimal contract action would be required to provide investigative data to meet schedule or expertise needs, for example video documentation of the existing storm drains.

6. Cost Estimate:
See Appendix B for specific Budgets attached: The effort entailed to develop documentation of existing conditions at Luke Air Force Base and associated fee is for in-house labor and does not require an IGE.

7. Project Schedule:
See Appendix C Schedule attached: The effort entailed to develop documentation of existing conditions at Luke Air Force Base and associated deliverables was coordinated with the following assigned Technical Lead and committed by the Resource Manager of each Section.

Based on a Friday 28 Sept 2012 Teleconference kickoff , considered notice to proceed (NTP) deliverables will be provided and considered complete **14 June 2013.** NTP + 259 calendar days

8. Change Management:
Project orders have a completion date. In order to extend a project order, there must be a valid reason that could not have been foreseen at the time that the project order was accepted. Project orders will not be extended where ambiguity in this PMP has resulted in an inability to complete before the completion date. Several tasks cannot be bundled in one project order because change to one task may negatively impact the associated tasks.

9. Review. The Hydrologic and Hydraulic Analysis Report shall go through Agency Technical Review (ATR). The purpose of this review is to ensure the proper application of clearly established criteria, regulations, laws, codes, principles and professional practices. The ATR is an in-depth review, managed within the USACE, and conducted by a qualified team outside of the local district that is not involved in

the day-to-day production of a project/product. The ATR team reviews the various work products and assures that all the parts fit together in a coherent whole. The Flood Control District of Maricopa County shall be included in the ATR process.

Approval for any change to project orders must be obtained through discussion (at one single meeting) with PPMD Program Manager (branch chief level), RM (budget officer), and SPL Office of Counsel.

The Scope of Work shall be reviewed at each deliverable submittal to prevent scope creep and will meet the project budget. If a change must occur due to unforeseen conditions, the following strategy will be implemented:

- For increases to scope or cost, decisions will be made and strategy approval requested for District concurrence at the lowest level possible: Customer; PM; Design Tech Lead
- If a decision cannot be reached at the lowest level, it will be raised to the next higher level: PM Branch; Design Branch; Office of Counsel & RM Branch.
- If a decision cannot still be reached, it will raise to the highest level: PPMD, OC, RM and Engineering Division Chiefs as indicated above

PROJECT LEADS

Luke AFB CES Command:

- Tauny Woo: Base CE Office; Programs Flight Chief; (623) 856-3635; tauny.woo@luke.af.mil
    - Alan C. Thomas: Environmental Programs Manager: CES Project POC; 623-856-3621 alan1.thomas@luke.af.mil

SPL Project Management:

- Glenn Arakaki: Acting SPL Chief, PM; 213-452-3389; glenn.t.arakaki@usace.army.mil
    - Jonathan Stratton: SPL PM; 602-230-6939; jonathan.w.stratton@usace.army.mil

SPL Technical Lead:

Cuong T. Ly, PE, Chief of Hydrology & GIS Section;213-452-3566 cuong.ly@usace.army.mil

APPENDIX A

Scope of Work

Project: **Luke AFB Flood Control Investigation**

Date: **09.27.12, updated 06.04.13**

Subject: **Scope of Work – Existing Conditions Analysis**

1. Project Goals
    a. Identify areas of flooding of aircraft parking ramps.
    b. Identify areas of flooding of structures.
    c. Identify areas of the Zone AE floodplain that includes portions of the parking ramps and developed portion of the base located west of Litchfield Road and north of Super Saber Street.
2. Data Collection, Field Investigations, Coordination
    a. Conduct search to obtain required/available data.
    b. Field Investigation
    c. Attend coordination meetings.
3. Topographic Survey - to be completed by MCFCD contractor and reviewed by USACE SPL Survey Section.
    a. Prepare a topographic survey in support of hydrologic and hydraulic modeling: from one of two possible data sources:
        (i). Prepare topographic survey from unprocessed data (from FCDMC).
            1. Aerial photography collected in March 2008. Minimum contour interval is 2.0-ft.
            2. Redevelopment of base housing area was largely completed by March 2008.
            3. Depict existing utilities on the survey based on LAFB GIS data.
            4. Use WGS84 UTM as the coordinate system
            5. Some updating of the cartography will be required and some field survey will be necessary to clarify critical changes in the topography
        (ii). Prepare new topographic survey.
            1. 1.0-ft minimum contour intervals.
            2. Include base and the properties between the base and Camelback Road (Fisher parcels and City of Goodyear parcel)
            3. Include base housing area.
            4. Depict existing utilities on the survey based on LAFB GIS data.
            5. Use WGS84 UTM as the coordinate system.

4. Storm Drain System Existing Conditions

    a. ~~Evaluate condition of key storm drains with video camera (No more than 15 major storm drains).~~ This task was determined to be unnecessary at this time. Task b was expanded to include additional storm drain inlets and channel surveys.

    b. Field-verify inlet and invert elevations of key drainage system components including storm drains and channels.

    c. Evaluate pumping capacity and operation of storm drain pumping systems.

5. Existing Conditions Hydrologic and Hydraulic Models

    a. Identify the watershed limits. Develop FLO-2D model for general watershed including:

        (i). Northern Parkway and Loop 303.

        (ii). Dysart Drain.

        (iii). Base housing area.

    b. Prepare the FLO-2D model with 15-ft grid resolution for the 100-year flood event (NOAA Atlas 14) for the base and immediate surrounding area as depicted on the watershed exhibit.

    c. Evaluate flows approaching base from the northwest as identified in the White Tanks/Loop 303 ADMPU Area Hydrologic Analysis HEC-1 model; revise sub-basin boundaries as necessary. Incorporate information from existing White Tanks/Loop 303 ADMPU AHA HEC-1 model into FLO-2D model developed in item 5a. The most current hydrology for the watershed is the Loop 303/White Tanks ADMPU AHA, dated September 2009.

    d. Prepare SWMM models to analyze the capacity of the storm drain systems within the base and any portion of the base housing area that discharges to the west of Litchfield Road.

    e. Identify the capacity of open channels using FLO-2D.

6. Deliverables

    a. Existing Conditions Hydrologic and Hydraulic Analysis Report

        (i). Draft H&H report

        (ii). Final H&H report and models

7. Review

    a. District Quality Control (DQC) - DQC is the review of basic science and engineering work products by the local U.S. Army Corps of Engineers District office.

    b. Agency Technical Review (ATR) – The purpose of this review is to ensure the proper application of clearly established criteria, regulations, laws, codes, principles and professional practices. The ATR is an in-depth review, managed within the USACE, and conducted by a qualified team outside of the local district that is not involved in the day-to-day production of a project/product. The ATR team reviews the various work products and assures that all the parts fit together in a coherent whole. The Flood Control District of Maricopa County shall be included in the ATR process.

APPENDIX B

Budget

USACE Los Angeles District, Engineering Division
Cost Estimate
Project: Luke AFB Flooding Mitigation and Outfall Project

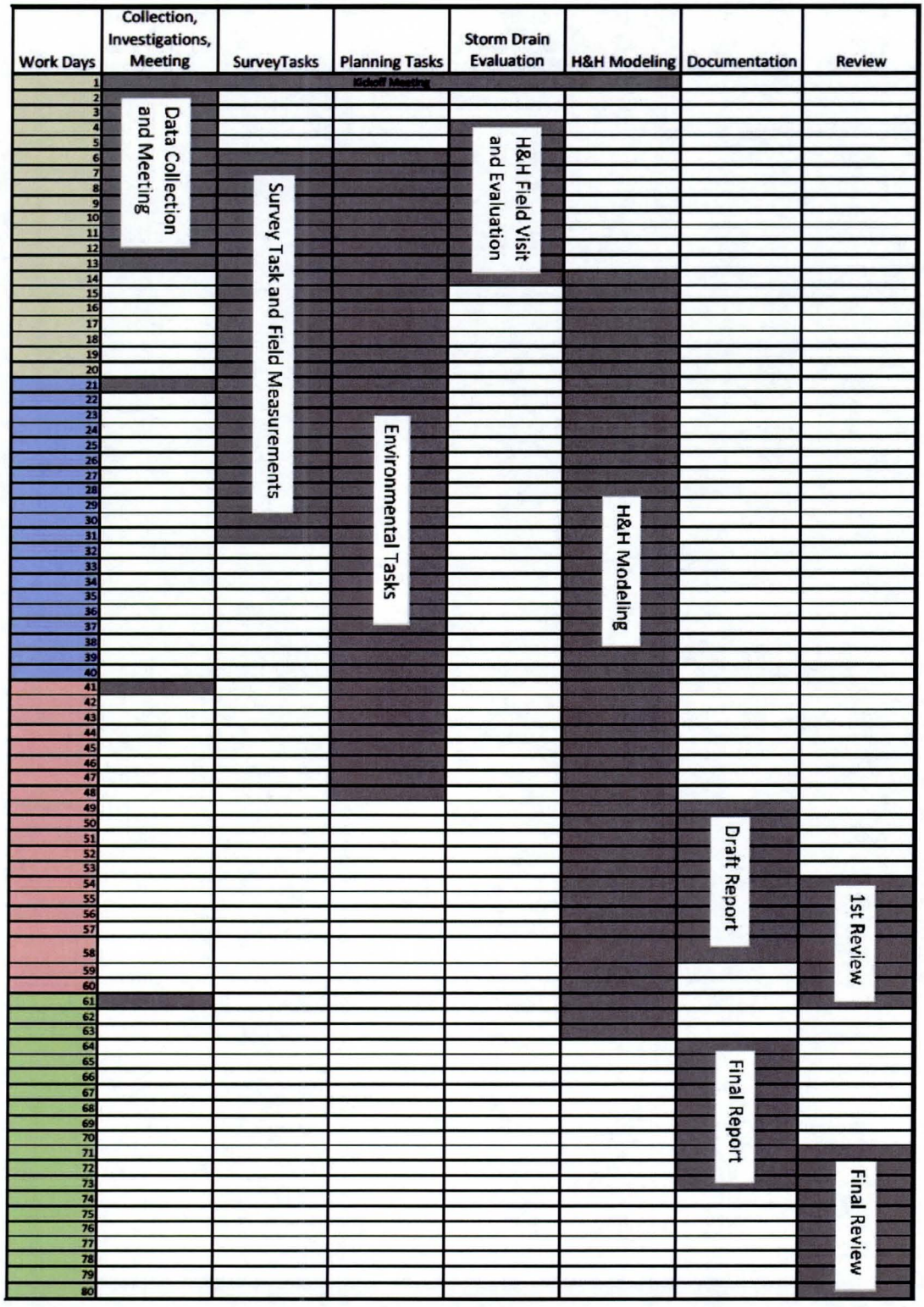
	Data Collection, Investigations, Meeting			Survey Tasks			Evaluation of Existing Condition Storm Drain System			H&H Existing Condition Models					Documentation			Review				
Labor Category	Refer to Scope Section 2 for Task Description			Refer to Scope Section 3 for Task Description			Refer to Scope Section 4 for Task Description			Refer to Scope Section 5 for Task Description					Refer to Scope Section 6 for Task Description			Refer to Scope Section 7 for Task Description		Total Hours	Basic Hourly Rate	Budget Estimate
	a	b	c	(i)	(ii)	(iii)	a	b	c	a	b	c	d	e	a	b	c	a	b			
Project Manager	8	16	24				16	16	16	40	40	20	20			10	32	8	8	274	$132.60	$36,332.40
Hydraulic Engineer	16	16	24				28	28	28	40	160		80	40		10	80	8	8	566	$124.25	$70,325.50
Hydrologist	16	16	24							180	40	80					80	8	8	444	$95.57	$42,433.08
Sedimentation Specialist							28	28	28							10				94	$95.57	$8,983.58
Survey Team				120	120	320									40			20		620	$105.15	$65,193.00
Technician	16	16	24				28	28	28		40	40	80	80		10	80			470	$83.62	$39,301.40
GIS Analyst				16	16	16					80	40					40			208	$83.62	$17,392.96
Report Writer																	40			40	$65.90	$2,636.00
Environmental Specialist															8	8	8	8	8	40	$110.00	$4,400.00
Management																		60	60	120	$170.13	$20,415.60
Subtotal	56	64	96	136	136	336	100	100	100	260	360	180	180	120	48	48	360	112	92	2884		

Project Management	$40,000.00
Other Costs (Travel, etc)	$12,000.00
Office Costs (Repo, Misc)	$500.00
TOTAL (OTHER COSTS)	$12,500.00
TOTAL	$359,913.52

APPENDIX C

Schedule

Luke AFB Schedule



APPENDIX D

Draft 1391

DRAFT 1

1. COMPONENT	FY 2013 PROJECT DATA	2. DATE
AIR FORCE	(computer generated)	

3. INSTALLATION, SITE AND LOCATION	4. PROJECT TITLE
LUKE AIR FORCE BASE LUKE A F BASE SITE # 1 ARIZONA	LUKE AFB FLOOD CONTROL INVESTIGATION AND FRASIBILITY PLAN

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. RDSUID/PROJECT NUMBER	8. PROJECT COST ($000)
22176	871-183	2517/MUEX120203	EEIC 53200 360

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT	COST
PRIMARY FACILITIES				360.0
INVESTIGATION STUDY	LS			(360.0)
SUBTOTAL				360.0
PROFIT AND OVERHEAD (.0%)				0.0
TOTAL FUNDED COST				360.0
UNFUNDED COST (.0%)				0.0
TOTAL REQUEST				360.0

10. Description of Proposed Work: This plan will confirm the conceptual documents for the rehabilitation of the installation's southern drainage system and to connect to improvements to be accomplished by the Maricopa County Flood Control District. This plan will provide phasing options and ensure archeological requirements. The primary objective of this plan is to reduce the risk of catastrophic flooding. This project will be cost shared between Maricopa County Flood Control District and Luke AFB. The Flood Control District Board of Directors has already voted and prioritized this project #1 on their 2013 Capital Improvement Program.

11. Requirement: As Required.

PROJECT: LUKE AFB FLOOD CONTROL INVRSTIGATION AND FRASIBILITY PLAN

REQUIREMENT: Provide an investigatory study and plan for the rehabilitation of the installation's southern drainage system and to connect to improvements to be accomplished by the Maricopa County Flood Control District. The primary objective of this plan is to reduce the risk of catastrophic flooding.

CURRENT SITUATION: Existing storm drainage system in this area of the installation is in poor condition. Overgrown with vegetation, substantial erosion and lack of maintenance has impacted the ability of the channel to carry away storm water.

IMPACT IF NOT PROVIDED: The current effective floodplain delineation by FEMA impacts 128 aircraft parking spots (aircraft valued at more than $3 billion) and 94 buildings, 1.25MM SF, valued at $345M, including the Wing HQ, Command Post, control tower, RAPCON and simulator complex, 4 hangars including all phase & corrosion control, 3 drinking water wells, both fire stations, the dining hall, and 90% of the dorm space

APPENDIX D

AF IMT 332

BASE CIVIL ENGINEER WORK REQUEST
(See Reverse for Instructions)

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 3 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to HQ AFESC/DEMS.

SECTION I - TO BE COMPLETED BY REQUESTER

1. FROM (Organization)	2. OFFICE SYMBOL	3. DATE OF REQUEST	4. WORK REQUEST NO. (For BCE Use)
56 CES	CEPD	20120213	83728

5. NAME AND PHONE NO. OF REQUESTER	6. REQUIRED COMPLETION DATE	7. BUILDING, FACILITY OR STREET ADDRESS WHERE WORK IS TO BE ACCOMPLISHED
Ricardo Rhoads 6-6535	20130213	65006 - Drainage ditches

8. DESCRIPTION OF WORK TO BE ACCOMPLISHED (Include Sketch or Plan, when appropriate)

This plan will prepare documents for the rehabilitation of the installation's southern drainage system and to connect to improvements to be accomplished by the Maricopa County Flood Control District. The primary objective of this plan is to reduce the risk of catastrophic flooding.

NVEX 12 0203 Repair Southern Drainage Channel STUDY (Design)

9. BRIEF JUSTIFICATION FOR WORK TO BE ACCOMPLISHED (Not required for maintenance and repair)

Existing storm drainage system in this area of the installation is in poor condition. Overgrown with vegetation, substantial erosion and lack of maintenance has impacted the ability of the channel to carry away storm water. The current effective floodplain delineation by FEMA impacts 128 aircraft parking spots (aircraft valued at more than $3 billion) and 94 buildings, 1.25MM SF, valued at $345M, including the Wing HQ, Command Post, control tower, RAPCON and simulator complex, 4 hangars including all phase & corrosion control, 3 drinking water wells, both fire stations, the dining hall, and 98% of the dorm space.

10. DONATED RESOURCES

FUNDS		LABOR		MATERIAL		CONTRACT BY REQUESTER	✓	NONE

11. NAME OF REQUESTER	12. GRADE OF REQUESTER	13. SIGNATURE OF REQUESTER (See Reverse of Form)
Tauny Woo	GS-13	

14. COORDINATION
OK/CCAN 56 Pus/SLCK 21 Feb 12 21 Feb 12 DOS
Sq Rmds/SCPB 21Feb12 SLFM/AT 21Feb12 SL CES/CEPI
BCE 21Feb12 BCE/JAH

SECTION II - FOR BASE CIVIL ENGINEER USE

21 FEB 2012
CEAD

15. WORK ORDER (Place an "X" in the appropriate box.)

IN-SERVICE		SELF-HELP		CONTRACT		SABER	

16. DIRECT SCHEDULED WORK (Place an "X" in the appropriate box.)

EMERGENCY		URGENT		ROUTINE		SELF-HELP		M/C	

17. SELF-HELP (Place an "X" in the appropriate box.)

	BRIEFING REQUIRED		ADEQUATE COORDINATION		INSPECTION REQUIRED

SECTION III - COMPLETE ONLY IF WORK IS TO BE ACCOMPLISHED BY WORK ORDER

18. WORK CLASS	19. PRIORITY	20. ESTIMATED HOURS	21. ESTIMATED FUNDED COST	22. ESTIMATED TOTAL COST
53200				400,000

✓	23. THERE IS NO NEED FOR AN ENVIRONMENTAL ASSESSMENT (AFR 19-2)		24. A WRITTEN ASSESSMENT IS BEING/HAS BEEN PROCESSED		25. APPROVED		26. DISAPPROVED

27. REMARKS CEAD CAPEX A2-3 10.

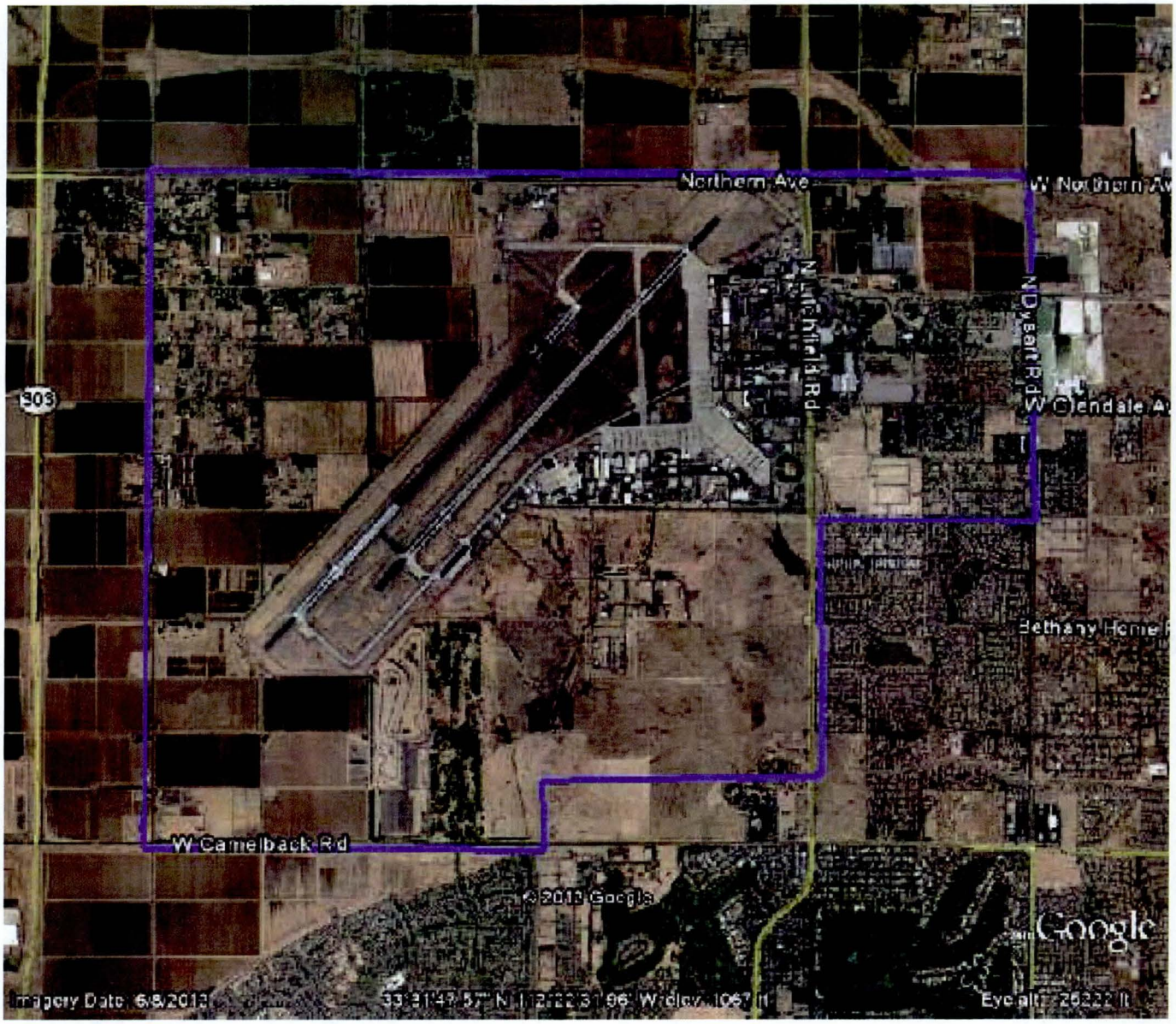
SECTION IV - APPROVING AUTHORITY

28. NAME AND GRADE (Please Type or Print)	29. SIGNATURE	30. DATE
NEIL D. WENTZ, GS-14, DAF Deputy BCE, 56CES		18 Sept 12

AF IMT 332, 19910101, V4 — PREVIOUS EDITION IS OBSOLETE — MASTER FILE COPY

APPENDIX E

Flood Control Limit



APPENDIX 2

EPA-SWMM MODELING ASSUMPTIONS

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

APPENDIX 2: EPA-SWMM MODELING ASSUMPTIONS

Introduction

The FLO-2D Pro model has been integrated with the EPA-SWMM version 5.0 to simulate the exchange of surface water flow (FLO-2D) with a storm drain system (EPA-SWMM). EPA-SWMM was used to model the storm drain system for Luke AFB and was requested by Luke AFB and the District. The two models run simultaneously; whereas, FLO-2D calculates all hydraulic and hydrologic surface water flow routing while EPA-SWMM only solves the conduit hydraulics and routing of the storm drain network. The FLO-2D model computes the storm drain inflow discharge based on the predicted grid element headwater depth and exchanges this discharge with the EPA-SWMM model to compute the storm drain system pipe hydraulics and the potential return of flows to the surface through downstream manholes, outlets, and storm drains. The return flow is routed based on FLO-2D surface hydraulic and hydrologic calculations.

Data Source

The EPA-SWMM Model was completed using three data sources: the Luke AFB GIS Geodatabase, the COE spot survey completed in December 2012, and the Luke AFB inlet survey completed in April 2012. The Luke AFB GIS Geodatabase was the main source for the storm drain system including inlet invert elevations, depth of inlet (max depth), conduit size, conduit length, conduit roughness, conduit outlet offset, and outfall invert elevation. The COE spot survey was used to verify information from the GIS database and was used in lieu of the Geodatabase data in the EPA-SWMM model as appropriate. The Luke AFB inlet survey provided dimensions for 39 inlets in the study area.

Model Input Parameters

Model input parameters for the EPA-SWMM model were set with the assistance of Jimmy O'Brien and Noemi Gonzalez from FLO-2D. The following are model input parameters for the EPA-SWMM model.

- Flow Units: CFS
- Infiltration: Green-Ampt
- Flow Routing: Dynamic Wave
- Force Main Equation: Darcy Weisbach
- Report Step: 3 minutes
- Wet Step: 5 Minutes
- Dry Step: 1 hour
- Routing Step: 1 second
- Allow Ponding: Yes
- Variable Time Step: 0.50
- Lengthening Step: 0
- Minimum Slope: 0
- Rainfall: Rainfall event provided by FLO-2D (RAIN.DAT)

Inlets – Junctions – Fittings - Outfalls

Inlets, junctions (manholes), and fittings were modeled as "Junctions" in EPA-SWMM. Inlets receive storm flow, are designated with the letter "J" in EPA-SWMM, and were modeled with subcatchments attached. Fittings and junctions (manholes) do not receive storm flow, are designated with the letter "F" in EPA-SWMM, and do not have subcatchments attached. The fittings and manholes do not appear in the SWMMFLO.DAT input file. Outfalls were used at the end of storm drain lines where the flow discharges.

Invert elevations for fittings were not provided by the Luke AFB GIS Geodatabase; however, fitting locations were provided. The invert elevations for the fittings in the EPA-SWMM model were estimated by straight line interpolation using known upstream and downstream elevations of manholes and inlets.

The maximum depth of inlets and junctions represents the distance from the invert elevation up to the ground surface.

Inlet geometry was based on three sources. Thirty-nine inlets had the dimension measured during the Luke AFB inlet survey completed in April 2012. Approximately ninety inlets were determined to be similar to the thirty-nine surveyed inlets. Approximately 300 inlets were measured using Google Imagery.

Curb inlets are modeled as Type 2 inlets which are described as "curb opening inlet with sag." Required input information includes the following: weir coefficient, curb opening length, curb opening height, and curb opening width. For type 2 inlets, the weir coefficient was assumed to be 2.3. For the curb inlets with estimated dimensions, the height was estimated to be 5 inches or 0.42 ft for a six inch curb. The length and width dimensions vary for each inlet.

Drop inlets are modeled as Type 3 inlets which are described as "grate (gutter) inlet with or without sag." Required input information includes the following: weir coefficient, grate perimeter (not including the curb side), grate open area, and grate sag height. The weir coefficient was assumed to be 3.0 based on the FLO-2D SWMM manual instructions. The grate perimeter was calculated by summing the length and twice the width. The area was calculated by multiplying the length and width for rectangular inlets and by multiplying the radius squared by pi for circular inlets. The drop inlets were assumed to be at grade, so the grate sag height was assumed to be 0 feet. Additionally, for both inlet types, the orifice flow coefficient is 0.67.

Each inlet was assigned a FLO-2D grid cell when creating the SWMMFLO.DAT. In the case where 2 inlets shared the same FLO-2D grid cell, one of the inlets was moved to an adjacent grid cell. Table A1 shows the inlets that were moved from their originally assigned grid cell.

Table A1 – Inlets moved to an adjacent grid cell

J11-6-B1	J12-5-A	J15-5-A	J16-15-A
J11-B-A1	J13-4-A	J16-10-A	J30-3-E
J11-3-A	J14-5-F	J16-12-B	J37-3-B
J5-11-A	J14-7-A	J16-12-D	J37-6
J1-20-A	J14-15-A	J16-14-A	J18-5-B

Element Count in EPA-SWMM model

- Inlets – 435
- Junctions/Fittings – 154
- Conduits – 593
- Outfalls – 21

Conduits/Pipes

Conduits route inflow to the downstream junction/manhole in the storm drain system. The slope of the conduit is calculated based on the upstream and downstream invert elevations. Conduit geometry was based on the Luke AFB GIS Geodatabase, including size, material, length, and outlet offset. Three materials are found in the storm drain system: reinforced concrete, corrugated metal, and PVC. The majority (93 percent) of the pipes are reinforced concrete (Manning's n-value of 0.013). Approximately 5 percent of the pipes are PVC (Manning's n-value 0.013). Approximately 2 percent of the pipes are corrugated metal (Manning's n-value 0.024).

For continuity reasons, some of the shorter pipes in the EPA-SWMM model had the conduit length increased. The following conduits were manually lengthened for the final EPA-SWMM model (SWMM.inp). See Table A2 below.

Table A2 – Conduits lengthened for the EPA-SWMM model

Name	Pipe Length (GIS)	Pipe Length (EPA-SWMM)
C11-2-A	15	50
C11-2-B	16	50
C11-3-A	5	51
C11-6-A1	15	50
C11-6-A2	17	50
C9-15-B	13	30
C11-6-B1	13	30
C14-15-B	10	30
C16-1-E	10	30
C16-11	13	30
C16-14-A	9	30
C37-3-A	10	30
C38-7-A	14	30
C1-20-B	18	30
C11-6-C1	16	30
C11-6-C2	16	30
C18-5-A	15	30
C1-20-A	17	30
C9-6-A	16	30
C5-11-A	17	30

APPENDIX 3

INLET INFORMATION FOR FLO-2D

SWMMFLO.DAT

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

APPENDIX 3 – INLET INFORMATION FOR FLO-2D

TERMS

FLO-2D Cell # - The FLO-2D grid cell number

GIS OBJECTID – Luke AFB GIS identifier

LUKE AFB INLET_ID – Luke AFB inlet identification number

SWMM_NAME – Inlet identifier assigned in EPA-SWMM model

INVERT_ELV – Invert elevation (feet, NAVD 88)

MAX_DEPTH – Distance from inlet invert to ground surface

INLET_TYPE – Inlet Identifier for FLO-2D Computations

LENGTH[2] OR PERIMTER[3] – Length of inlet or perimeter (length plus twice the width)

WIDTH[2] OR AREA[3] – Width of inlet or area of inlet

WIDTH[2] OR AREA[3] (80%) – Width of inlet or area of inlet (Reduced by 20% to account for area of bars on the inlet grate)

HEIGHT – Height of inlet opening in curb face

WEIR_COEFF – Weir Coefficient for FLO-2D computations

NOTE – Comment relating to inlet

2. Inlet Type 2 uses length and width of inlet for FLO-2D computations

3. Inlet Type 3 uses perimeter (L+2W) and area of inlet for FLO-2D computations

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
109474	515	9-STMH-1	J1-1	1074.56	4.2	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
119708	8	9-STMH-2	J1-2	1073.56	4.2	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
123600	316	9-STMH-4	J1-3	1073.11	4.4	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
145007	431	15-STIN-85	J1-4	1071.37	4.5	3	10.50	12.25	9.8	0.00	3.00	Luke AFB Survey (Apr 2013)
152792	252	15-STIN-86	J1-5	1071.79	3.6	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
169333	490	15-STIN-87	J1-6	1067.47	7.1	3	10.50	12.25	9.8	0.00	3.00	Luke AFB Survey (Apr 2013)
179064	83	15-STIN-88	J1-7	1068.34	5.9	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
184866	283	14-STIN-4	J1-8-A	1069.63	4.0	2	12.00	20.00	16.0	4.00	2.30	Google Imagery (2013)
183929	37	15-STIN-94	J1-8	1068.27	5.7	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
187821	496	15-STIN-93	J1-9	1068.20	6.2	3	6.90	5.30	4.2	0.00	3.00	Google Imagery (2013)
204363	31	15-STIN-84	J1-10	1067.62	5.8	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
215066	491	15-STIN-73	J1-11	1067.71	5.4	3	15.00	25.00	20.0	0.00	3.00	Google Imagery (2013)
221877	321	21-STIN-1	J1-12	1067.63	5.5	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
229626	287	20-STIN-15	J1-13-A	1068.99	4.0	2	12.00	20.00	16.0	4.00	2.30	Google Imagery (2013)
238417	187	21-STIN-2	J1-14	1068.08	6.0	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
248144	368	21-STIN-6	J1-15	1068.52	5.2	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
253981	67	21-STIN-3	J1-16	1068.67	5.4	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
235481*	186	20-STIN-23	J1-17-A	1069.42	4.6	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
233527	66	20-STIN-22	J1-17-B	1070.68	2.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
252023	470	20-STIN-24	J1-17-D	1067.89	6.6	3	11.00	14.00	11.2	0.00	3.00	Google Imagery (2013)
259816	272	21-STIN-39	J1-17-E	1069.12	5.3	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
270500	504	20-STIN-52	J1-18-A	1069.43	4.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
273420	1	20-STIN-53	J1-18-B	1069.66	3.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
276341	160	20-STIN-54	J1-19-A	1070.30	2.4	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
281201	159	20-STIN-55	J1-20-A	1070.10	2.9	2	2.00	1.42	1.1	0.66	2.30	Luke AFB Survey (Apr 2013)
283148	158	20-STIN-56	J1-20-B	1070.15	2.9	2	2.00	1.42	1.1	0.66	2.30	Based on Luke AFB Survey
306485	161	27-STIN-8	J1-22	1068.71	1.6	2	2.00	1.42	1.1	0.42	2.30	Based on Luke AFB Survey
200396	231	14-STIN-9	J2-1	1067.86	6.7	3	12.00	16.00	12.8	0.00	3.00	Google Imagery (2013)
195582	14	14-STIN-7	J2-2-A	1071.54	3.3	3	8.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
205292	64	14-STIN-5	J2-2-B	1069.02	4.6	3	8.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
212091	229	14-STIN-3	J2-2-C	1067.51	5.7	3	8.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
228644	469	20-STIN-20	J2-3	1064.94	7.8	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
233516	230	20-STIN-25	J2-4-A	1068.80	4.0	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
231563	367	20-STIN-36	J2-4	1065.81	7.1	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
248105	15	20-STIN-37	J2-5	1065.96	7.6	3	11.50	15.75	12.6	0.00	3.00	Google Imagery (2013)
N/A	3	20-STIN-57	J2-6	1066.50	6.4	3	*Not an Inlet in FLO-2D*		0.0		3.00	
261715	406	20-STIN-75	J2-7-A	1068.37	2.4	3	6.51	4.71	3.8	0.00	3.00	Luke AFB Survey (Apr 2013)
262696	301	20-STIN-41	J2-7-B	1067.01	4.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
269512	4	20-STIN-67	J2-7	1065.98	5.7	3	10.50	12.25	9.8	0.00	3.00	Google Imagery (2013)
277285	54	20-STIN-76	J2-8-A	1069.74	1.1	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
274370	307	20-STIN-42	J2-8-B	1068.83	2.0	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
274377	302	20-STIN-48	J2-8	1067.17	3.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
284110*	404	20-STIN-69	J2-9-A	1069.96	1.5	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
285080*	274	20-STIN-39	J2-9	1068.01	4.2	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
287024*	303	20-STIN-46	J2-10-A	1067.12	4.6	3	9.42	7.07	5.7	0.00	3.00	Google Imagery (2013)
281178	163	20-STIN-28	J3-1	1070.03	2.9	2	3.50	1.33	1.1	0.66	2.30	Luke AFB Survey (Apr 2013)
286043	405	20-STIN-77	J3-2	1068.99	2.4	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
307448	506	27-STIN-1	J4-1	1069.02	2.0	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
235442	65	20-STIN-21	J5-1	1068.11	3.9	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
236392	199	20-STIN-43	J5-2	1067.47	4.4	3	12.00	16.00	12.8	0.00	3.00	Google Imagery (2013)
262682	454	20-STIN-74	J5-3-A1	1068.86	1.9	3	6.75	5.06	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
261706	275	20-STIN-73	J5-3-A2	1068.79	2.0	3	6.51	4.71	3.8	0.00	3.00	Based on Luke AFB Survey
262674	308	20-STIN-72	J5-3-A4	1068.04	2.7	3	8.25	8.13	6.5	0.00	3.00	Based on Luke AFB Survey
263642	55	20-STIN-65	J5-3-A5	1067.56	2.7	3	8.25	8.13	6.5	0.00	3.00	Luke AFB Survey (Apr 2013)
262654	80	20-STIN-45	J5-3-B1	1069.09	1.8	3	6.75	5.06	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
261684	246	20-STIN-44	J5-3-B3	1068.78	2.0	3	6.50	4.50	3.6	0.00	3.00	Based on Luke AFB Survey
263637	456	20-STIN-66	J5-3	1066.06	4.1	3	11.32	14.64	11.7	0.00	3.00	Google Imagery (2013)
N/A	276	20-STIN-70	J5-5-A	1066.20	4.4	3	*Not an Inlet in FLO-2D*		0.0		3.00	
271425*	455	20-STIN-71	J5-5	1065.51	5.7	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
286029	457	20-STIN-64	J5-10-A	1069.35	1.8	3	6.50	5.00	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
297708	305	27-STIN-5	J5-11-A	1065.37	6.1	3	10.74	14.42	11.5	0.00	3.00	Luke AFB Survey (Apr 2013)
296732	306	27-STIN-4	J5-11-B	1066.66	4.7	3	7.50	7.00	5.6	0.00	3.00	Luke AFB Survey (Apr 2013)
297705	507	27-STIN-3	J5-11-C	1065.96	4.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
308411	304	27-STIN-6	J6-1	1063.99	6.0	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
271403	458	20-STIN-60	J7-1-A	1067.71	2.5	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
276268	358	20-STIN-61	J7-1-B	1067.78	2.9	3	6.32	4.87	3.9	0.00	3.00	Luke AFB Survey (Apr 2013)
280160	277	20-STIN-62	J7-1-C	1067.11	4.4	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
285025	509	20-STIN-63	J7-2	1067.18	3.2	3	6.83	5.67	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
263618	310	20-STIN-59	J7-3-A	1068.36	2.0	3	6.48	4.67	3.7	0.00	3.00	Luke AFB Survey (Apr 2013)
264586	510	20-STIN-40	J7-3-B	1067.06	3.4	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
270424	460	20-STIN-16	J7-3-C	1066.70	3.7	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
275289	511	20-STIN-14	J7-3-D	1066.78	3.9	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
280154	408	20-STIN-11	J7-3-E	1066.99	3.8	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
285992*	56	20-STIN-1	J7-3	1066.66	4.6	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
265556	459	20-STIN-26	J7-4-A	1067.19	3.0	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
270421	311	20-STIN-17	J7-4-B	1067.43	3.0	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
275286	407	20-STIN-13	J7-4-C	1066.45	4.2	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
280151	278	20-STIN-12	J7-4-D	1066.77	4.1	3	5.33	3.33	2.7	0.00	3.00	Luke AFB Survey (Apr 2013)
285989*	461	20-STIN-9	J7-4	1066.28	4.8	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
271388	5	20-STIN-6	J7-5-A	1067.72	2.6	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
280145	512	20-STIN-7	J7-5-B	1067.44	3.2	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
285983	312	20-STIN-18	J7-5	1066.48	4.5	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
261655	57	20-STIN-4	J7-6	1069.58	1.8	3	7.00	5.43	4.3	0.00	3.00	Luke AFB Survey (Apr 2013)
265543*	513	20-STIN-3	J7-7-A	1069.00	1.8	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
267495*	410	20-STIN-5	J7-7-B	1067.59	2.5	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
267492	58	20-STIN-27	J7-7	1067.56	3.1	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
270410	514	20-STIN-10	J7-8	1066.98	3.1	3	6.50	5.00	4.0	0.00	3.00	Google Imagery (2013)
273321	409	20-STIN-8	J7-9	1066.34	3.8	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
280132	359	20-STIN-32	J7-10	1066.22	4.6	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
269411	12	19-STIN-3	J7-11-A	1065.69	3.6	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
272335*	320	19-STIN-1	J7-11-B	1065.91	4.3	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
275256*	6	19-STIN-2	J7-11-C	1065.90	5.1	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
277204*	360	20-STIN-19	J7-11-D	1065.89	5.1	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
280124*	315	20-STIN-30	J7-11-E	1066.01	5.0	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
282071	125	20-STIN-31	J7-11	1065.41	5.2	2	2.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
76118	87	8-STIN-2	J8-1	1080.24	7.5	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
79798	36	8-STIN-4	J8-2	1079.81	8.2	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
106404	184	8-STIN-5	J8-3-A	1078.07	4.5	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
112465*	207	8-STIN-3	J8-3-B	1080.04	2.1	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
120607	183	8-STIN-7	J8-3	1075.03	6.8	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
134216	433	8-STIN-1	J8-4	1073.53	7.3	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
147825	88	14-STIN-6	J8-5	1072.47	7.7	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
161434	340	14-STIN-1	J8-6	1071.44	7.8	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
182820	382	13-STIN-1	J8-8	1068.73	8.8	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
269409	468	19-STIN-4	J8-11	1063.98	6.0	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
112570	317	9-STMH-6	J9-1	1076.82	1.4	3	6.75	5.06	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
108765	279	9-STMH-5	J9-2	1075.03	2.8	3	5.42	3.42	2.7	0.00	3.00	Luke AFB Survey (Apr 2013)
107274	413	9-STMH-8	J9-3-A	1075.87	1.6	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
108779	412	9-STMH-7	J9-3	1074.38	3.1	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
108036	9	9-STMH-9	J9-4	1074.84	3.1	3	8.00	6.88	5.5	0.00	3.00	Luke AFB Survey (Apr 2013)
107291	128	9-STMH-34	J9-5-A	1075.11	3.0	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
108802	130	9-STMH-17	J9-6-A	1074.24	3.5	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
105797	129	9-STMH-16	J9-7-A	1074.23	3.7	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
105798	516	9-STMH-15	J9-7-B	1074.46	2.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
102068	282	9-STMH-18	J9-8	1071.16	6.4	3	11.16	15.57	12.5	0.00	3.00	Luke AFB Survey (Apr 2013)
102072	521		J9-9	1070.82	7.7	2	2.50	2.50	2.0	0.42	2.30	Google Imagery (2013)
105056	131	9-STMH-19	J9-10	1071.14	7.9	2	5.00	1.50	1.2	0.42	2.30	Based on Luke AFB Survey
114153	280	9-STMH-12	J9-11-A	1074.44	2.1	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
123697	126	9-STMH-32	J9-12-A	1074.71	3.7	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
123695	127	9-STMH-33	J9-12-B	1071.02	7.2	2	3.00	2.00	1.6	0.15	2.30	Google Imagery (2013)
142177	369	15-STIN-49	J9-13-A	1073.60	1.2	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
143152	254	15-STIN-101	J9-13-B	1072.01	3.3	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
155796	232	15-STIN-51	J9-14-A	1073.59	1.8	3	6.50	5.00	4.0	0.00	3.00	Google Imagery (2013)
151903*	383	15-STIN-54	J9-14-B	1073.68	1.8	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
164554	188	15-STIN-3	J9-15-A	1073.75	1.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
162614	115	15-STIN-53	J9-15-B	1070.94	4.9	2	3.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
161641	114	15-STIN-52	J9-15-C	1070.70	5.1	2	3.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
167484	110	15-STIN-45	J9-16-A	1072.33	2.7	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
168454	111	15-STIN-82	J9-16-B	1071.80	3.3	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
171395	213	16-STIN-23	J9-17-A	1071.74	3.5	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
173322	109	15-STIN-44	J9-18-A	1071.05	4.1	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
175266	108	15-STIN-43	J9-18-B	1069.09	6.3	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
193741	416	15-STIN-5	J9-19-A	1073.35	2.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
188876	494	15-STIN-67	J9-19-B	1072.25	3.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
187908	16	15-STIN-7	J9-19-D	1071.86	3.5	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
187909	189	15-STIN-4	J9-19-E	1073.25	2.1	3	3.50	1.50	1.2	0.00	3.00	Google Imagery (2013)
180144	104	16-STIN-35	J9-20-A	1073.14	2.7	2	3.50	2.00	1.6	0.42	2.30	Google Imagery (2013)
181113	63	15-STIN-59	J9-20-B	1071.73	3.8	3	6.16	4.66	3.7	0.00	3.00	Luke AFB Survey (Apr 2013)
182083	185	15-STIN-92	J9-20-C	1068.79	5.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
185005	105	15-STIN-61	J9-20-D	1072.02	4.1	2	3.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
192797*	394	16-STIN-22	J9-21-A	1070.54	6.4	3	6.28	3.14	2.5	0.00	3.00	Luke AFB Survey (Apr 2013)
197648	106	15-STIN-41	J9-22-A	1074.62	1.8	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
197646	107	15-STIN-42	J9-22-B	1073.26	3.2	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
200557	17	15-STIN-16	J9-23-A	1071.39	4.2	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
198615	322	15-STIN-1	J9-23-B	1070.77	4.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
213206	417	15-STIN-32	J9-24-A	1074.17	2.0	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
213207	471	15-STIN-37	J9-24-B	1073.00	3.1	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
214181	371	15-STIN-30	J9-24-C	1072.44	3.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
215157	418	15-STIN-20	J9-24-D	1071.86	3.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
241421	439	21-STIN-37	J9-26-A	1076.05	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
240451	343	21-STIN-51	J9-26-B	1074.36	3.8	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
240452	497	21-STIN-58	J9-26-C	1073.28	4.9	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
271594	402	21-STIN-38	J9-29-A	1078.51	1.3	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
281323	291	21-STIN-19	J9-30-A	1078.19	2.0	3	8.00	7.50	6.0	0.00	3.00	Google Imagery (2013)
268638	452	21-STIN-45	J9-31-A	1077.49	3.6	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
293942	299	21-STIN-43	J9-31-C	1077.47	2.5	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
311472	155	28-STIN-4	J10-1	1080.75	4.2	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
311468	154	28-STIN-3	J10-2	1081.33	2.8	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
309519	153	28-STIN-2	J10-3	1079.60	4.1	2	3.00	1.50	1.2	0.00	2.30	Google Imagery (2013)
180048	336	15-STIN-89	J11-1-A	1072.36	2.4	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
178103	335	15-STIN-90	J11-1-B	1072.57	2.2	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
177136	489	15-STIN-91	J11-2-A	1071.54	3.1	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
177140	82	15-STIN-39	J11-2-B	1071.64	3.1	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
181046	206	15-STIN-29	J11-3-A	1070.06	4.6	3	11.00	14.00	11.2	0.00	3.00	Luke AFB Survey (Apr 2013)
167449	249	15-STIN-55	J11-5-A	1072.22	2.8	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167448	202	15-STIN-2	J11-5-B	1071.71	3.2	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
177173	485	15-STIN-8	J11-5-D	1072.37	3.0	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
178152	203	15-STIN-27	J11-5	1068.78	6.1	3	11.00	14.00	11.2	0.00	3.00	Luke AFB Survey (Apr 2013)
166486	429	15-STIN-36	J11-6-A1	1070.56	4.5	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
166490	334	15-STIN-35	J11-6-A2	1071.14	3.7	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
172328	333	15-STIN-34	J11-6-B1	1070.64	4.5	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
175245	233	15-STIN-22	J11-6-C1	1069.71	5.8	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
175247	332	15-STIN-33	J11-6-C2	1072.21	2.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
178166	18	15-STIN-23	J11-7	1068.53	6.3	3	11.00	14.00	11.2	0.00	3.00	Luke AFB Survey (Apr 2013)
169361	430	15-STIN-15	J12-1	1072.82	2.4	3	5.50	3.50	2.8	0.00	3.00	Luke AFB Survey (Apr 2013)
168390	81	15-STIN-6	J12-2-A	1072.36	2.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
170336	205	15-STIN-17	J12-2-B	1072.44	2.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167426	488	15-STIN-14	J12-3-A	1072.41	2.8	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
170353	380	15-STIN-19	J12-5-A	1071.59	3.7	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
168407	251	15-STIN-13	J12-6-A	1070.80	4.2	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167434	204	15-STIN-12	J12-6-B	1070.28	4.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167436	487	15-STIN-11	J12-6-C	1072.67	2.5	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
176192	486	15-STIN-10	J12-7-A	1072.25	2.7	3	5.42	3.42	2.7	0.00	3.00	Luke AFB Survey (Apr 2013)
176194	250	15-STIN-9	J12-7-B	1071.89	3.0	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
189816	86	15-STIN-66	J13-1	1073.28	1.6	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
193714*	253	15-STIN-56	J13-2	1070.18	3.7	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
189841	192	15-STIN-25	J13-4-A	1070.63	4.2	3	8.50	8.75	7.0	0.00	3.00	Based on Luke AFB Survey
188869	472	15-STIN-24	J13-4-B	1072.37	2.6	3	8.50	8.75	7.0	0.00	3.00	Luke AFB Survey (Apr 2013)
203401	173	15-STIN-98	J14-1-A	1070.86	2.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
203402	172	15-STIN-99	J14-1	1070.87	3.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
206321	174	15-STIN-100	J14-2-A	1070.56	3.2	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
209239	492	15-STIN-79	J14-3-A	1070.24	3.3	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
215078	337	15-STIN-80	J14-4-A	1070.65	3.2	3	11.00	15.00	12.0	0.00	3.00	Google Imagery (2013)
209248	32	15-STIN-77	J14-4-B	1070.57	3.7	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
216060	338	15-STIN-78	J14-4-C	1070.64	3.9	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
226762	393	21-STIN-29	J14-5-A	1072.18	2.8	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
225791	294	21-STIN-28	J14-5-B	1071.88	3.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
227737	500	21-STIN-32	J14-5-D	1072.47	2.4	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
228709	41	21-STIN-31	J14-5-E	1071.87	3.0	3	9.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
228716	259	21-STIN-21	J14-5-F	1070.96	4.2	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
227745	212	21-STIN-25	J14-5-H	1071.99	3.1	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
228725	260	21-STIN-26	J14-6	1070.96	4.6	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
226781	443	21-STIN-22	J14-7-A	1072.66	2.3	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
229700	499	21-STIN-23	J14-7-B	1072.20	3.3	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
226784	391	21-STIN-7	J14-9-A	1072.68	3.1	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
227762	293	21-STIN-18	J14-10	1070.78	5.6	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
221940	90	21-STIN-50	J14-12-A	1073.58	2.3	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
226818	440	21-STIN-10	J14-13-A	1074.51	2.4	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
225856	290	21-STIN-52	J14-15-A	1073.12	3.8	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
225855	388	21-STIN-53	J14-15-B	1071.91	5.3	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
227802	256	21-STIN-56	J14-16-A	1072.93	4.2	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
227804	342	21-STIN-62	J14-16-B	1072.15	4.9	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
254028	149	21-STIN-47	J15-1-A	1075.23	2.6	2	3.50	1.00	0.8	0.42	2.30	Based on Luke AFB Survey
255976	150	21-STIN-46	J15-1	1075.70	2.8	2	3.50	1.00	0.8	0.42	2.30	Based on Luke AFB Survey
251109	223	21-STIN-48	J15-2-A	1075.55	2.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
250130	51	21-STIN-49	J15-4-A	1074.44	1.4	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
242346	347	21-STIN-30	J15-4-B	1072.81	2.8	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
235534	346	21-STIN-27	J15-5-A	1071.80	3.4	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
235536	345	21-STIN-36	J15-5-B	1072.12	4.1	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
205357	169	15-STIN-75	J16-1-A	1071.74	2.2	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
206328	168	15-STIN-76	J16-1-B	1070.02	3.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
203409	171	15-STIN-81	J16-1-D	1071.80	1.9	2	3.50	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
202438	170	15-STIN-74	J16-1-E	1071.52	2.4	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
205365	178	15-STIN-63	J16-2-A	1070.11	3.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
205364	177	15-STIN-95	J16-2-B	1071.12	3.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
202446	176	15-STIN-96	J16-2-C	1071.20	3.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
202445	175	15-STIN-97	J16-2-D	1071.75	2.4	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
201492	180	15-STIN-70	J16-5-A	1072.99	1.8	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
201491	179	15-STIN-71	J16-5-B	1072.83	1.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
203438	33	15-STIN-48	J16-6	1071.70	3.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
202458	381	15-STIN-46	J16-8-A	1072.20	2.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
207320	182	15-STIN-57	J16-10-A	1070.53	4.0	2	7.00	2.00	1.6	0.42	2.30	Luke AFB Survey (Apr 2013)
207322	181	15-STIN-21	J16-10-B	1070.55	4.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
229707	442	21-STIN-20	J16-12-B	1073.74	2.5	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
229708	258	21-STIN-34	J16-12-D	1073.81	2.5	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
229723	210	21-STIN-60	J16-14-A	1073.66	3.1	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
229732	39	21-STIN-8	J16-15-A	1074.75	3.3	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
207328	85	15-STIN-68	J17-1	1072.31	2.8	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
207332	84	15-STIN-69	J17-2	1072.18	3.3	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
215114	432	15-STIN-58	J17-3	1071.83	3.3	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
214149	339	15-STIN-60	J17-5	1071.11	6.7	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
204423	35	15-STIN-64	J18-1	1073.85	1.5	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
207342	493	15-STIN-62	J18-2	1073.32	2.2	3	7.50	7.00	5.6	0.00	3.00	Luke AFB Survey (Apr 2013)
207344	34	15-STIN-72	J18-3-A	1071.83	3.7	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
225830	387	21-STIN-59	J18-5-A	1073.84	2.2	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
203463	323	15-STIN-28	J19-1-A	1070.30	5.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
200544	419	15-STIN-26	J19-1-B	1072.24	3.1	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
201519	372	15-STIN-18	J19-1-C	1073.21	2.3	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
203465	191	15-STIN-38	J19-1-D	1072.54	2.9	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
211253	190	15-STIN-31	J19-2-A	1072.01	4.0	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
225843	441	21-STIN-11	J19-3-A	1073.12	3.0	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
217089	91	15-STIN-83	J20-1	1074.76	2.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
219041	438	21-STIN-5	J20-2-A	1075.83	2.1	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
219038	289	21-STIN-55	J20-2-B	1075.73	2.6	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
219034	38	21-STIN-33	J20-2	1074.01	3.1	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221959	257	21-STIN-17	J20-3-A	1074.44	4.2	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
221957	40	21-STIN-16	J20-3-B	1074.06	4.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221956	344	21-STIN-15	J20-3-C	1074.20	4.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221954	211	21-STIN-14	J20-3-D	1073.26	4.7	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221953	390	21-STIN-13	J20-3	1073.38	4.8	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
224873	498	21-STIN-12	J20-4	1071.97	4.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
324603	227	26-STIN-6	J21-1	1066.91	2.6	3	3.50	1.50	1.2	0.00	3.00	Google Imagery (2013)
329763	200	26-STIN-2	J22-1	1066.08	4.2	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
340165	366	26-STIN-5	J22-2	1066.83	2.8	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
334150	247	25-STIN-2	J23-1	1067.41	2.4	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
337865	29	25-STIN-1	J23-2	1066.34	3.0	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
354956	201	25-STIN-3	J23-4	1061.75	3.4	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
360904	483	30-STIN-3	J23-5-A	1064.26	2.6	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
370526	30	30-STIN-2	J24-1	1062.67	2.5	3	5.50	3.75	3.0	0.00	3.00	Google Imagery (2013)
415681	484	30-STIN-1	J25-1	1064.15	3.0	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
263972	74	23-STIN-8	J26-1	1075.82	10.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
260081	422	23-STIN-6	J26-2	1075.71	11.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
255216	239	23-STIN-5	J26-3	1075.20	10.5	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
249376	72	23-STIN-1	J26-5	1075.34	8.0	3	4.00	2.00	1.6	0.00	3.00	Google Imagery (2013)
244513*	195	23-STIN-18	J26-6	1074.99	9.3	3	9.42	7.07	5.7	0.00	3.00	Google Imagery (2013)
241588	117	23-STIN-24	J26-8-A	1077.60	4.7	2	2.50	2.50	2.0	0.42	2.30	Google Imagery (2013)
237701	325	23-STIN-19	J26-8	1074.51	9.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
231864	421	23-STIN-10	J26-10	1074.31	8.7	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
228942	116	23-STIN-17	J26-11-A	1077.17	4.5	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
227972	193	23-STIN-25	J26-12	1074.30	8.4	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
224076	19	23-STIN-14	J26-13-A	1074.13	7.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
223098	376	23-STIN-9	J26-13-B	1074.15	8.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
223094	375	23-STIN-12	J26-13-C	1074.78	8.1	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
223106	20	23-STIN-16	J26-13	1073.81	9.8	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
216232*	136	16-STIN-48	J26-14-A	1079.69	2.7	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
217252	70	17-STIN-6	J26-14-D	1073.77	9.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
211434	420	17-STIN-7	J26-16	1073.75	9.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
200731	69	17-STIN-13	J26-17	1075.34	7.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
191001	374	17-STIN-9	J26-18	1074.13	8.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
181271	324	17-STIN-4	J26-19	1074.33	7.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
169596	236	17-STIN-1	J26-20	1074.42	6.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
158893	235	17-STIN-3	J26-22	1074.08	6.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
149165	473	17-STIN-8	J26-24	1073.92	5.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
139436	373	17-STIN-5	J26-25	1073.84	5.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
129702	234	11-STIN-4	J26-26	1074.42	4.7	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
128729	451	11-STIN-2	J26-27	1077.09	2.1	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
260043*	77	22-STIN-9	J27-1	1077.38	5.4	3	9.42	7.07	5.7	0.00	3.00	Google Imagery (2013)
261993	427	22-STIN-5	J27-2	1077.44	5.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262971	426	23-STIN-26	J27-3	1077.06	7.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262976	198	23-STIN-30	J27-4	1076.66	6.7	3	4.50	2.50	2.0	0.00	3.00	Google Imagery (2013)
262980	25	23-STIN-31	J27-5	1076.73	8.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262985	423	23-STIN-43	J27-6	1076.59	8.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262989	240	23-STIN-36	J27-7	1076.42	8.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
263966	475	23-STIN-28	J27-8	1076.13	10.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
246428	164	23-STIN-29	J28-1-A	1077.05	4.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
241569	378	23-STIN-34	J28-1-B	1076.73	5.0	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
242540	479	23-STIN-35	J28-1	1076.82	2.9	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
246433	244	23-STIN-33	J28-2	1076.61	3.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
250327	245	23-STIN-32	J28-4	1076.43	3.4	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
248391	118	23-STIN-42	J28-5-A	1079.98	4.6	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
248390	119	23-STIN-41	J28-5-B	1079.92	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
252287	196	23-STIN-4	J28-6-A	1075.78	9.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
249369	73	23-STIN-3	J28-6	1073.85	9.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
251319	474	23-STIN-2	J28-7	1075.38	9.8	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
234780	238	23-STIN-20	J29-1	1074.37	7.8	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
236722	71	23-STIN-22	J29-2-A	1074.47	6.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
234777	194	23-STIN-21	J29-2	1074.66	6.3	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
237688	120	23-STIN-40	J29-3-A	1079.59	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
237687	121	23-STIN-39	J29-3-B	1079.69	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
234758	122	23-STIN-38	J29-4	1077.60	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
237668	243	22-STIN-12	J29-5-A	1077.88	2.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
227943	241	23-STIN-37	J29-5-B	1077.53	4.9	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
226975	424	23-STIN-13	J29-5-C	1077.83	4.6	3	10.50	12.25	9.8	0.00	3.00	Google Imagery (2013)
227953	237	23-STIN-11	J29-5-D	1079.13	3.4	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
233779	476	23-STIN-27	J29-5	1075.53	5.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
261010	330	22-STIN-6	J30-1	1077.82	3.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
258091	26	22-STIN-7	J30-2	1077.51	5.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
254198	124	22-STIN-15	J30-3-A	1077.56	4.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
248364	22	22-STIN-17	J30-3-C	1077.43	5.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
245446	329	22-STIN-11	J30-3-D	1077.28	4.4	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
240586	24	22-STIN-13	J30-3-E	1077.04	3.9	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
253225	123	22-STIN-16	J30-3	1077.07	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
247388	478	22-STIN-18	J30-5	1076.08	5.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
242525	425	22-STIN-22	J30-6	1075.69	3.9	3	9.50	10.50	8.4	0.00	3.00	Google Imagery (2013)
236688	21	22-STIN-19	J30-8	1075.56	4.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
234747	76	22-STIN-10	J30-9	1075.22	5.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
233776	242	22-STIN-1	J30-10	1074.95	5.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
227938	377	22-STIN-2	J30-12	1074.28	5.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
223072	75	22-STIN-4	J30-13-A	1073.94	7.8	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
223069	477	22-STIN-3	J30-13-B	1074.48	7.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
223063	78	22-STIN-29	J30-13-C	1075.99	6.5	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
259059	379	22-STIN-8	J31-1	1078.15	3.9	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
256134	428	22-STIN-25	J31-2	1077.34	3.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
249323	79	22-STIN-33	J31-3	1076.82	4.1	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
244458	28	22-STIN-23	J31-4	1076.65	4.8	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
222079	480	22-STIN-28	J31-5-A	1077.88	4.5	3	8.00	7.50	6.0	0.00	3.00	Google Imagery (2013)
230836	27	22-STIN-26	J31-5-B	1076.83	5.5	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
239593	482	22-STIN-24	J31-5	1076.42	5.4	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
239597	42	22-STIN-21	J31-6	1076.22	5.4	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
238626	165	22-STIN-32	J31-7	1076.41	4.2	2	1.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
128692	450	10-STIN-7	J32-1	1074.39	2.5	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
139397	297	11-STIN-3	J32-2	1073.28	2.9	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
143286	49	16-STIN-37	J32-3	1072.79	4.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
148150	140	16-STIN-45	J32-4	1071.78	5.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
149123	139	16-STIN-44	J32-5	1071.84	5.7	2	3.00	1.50	1.2	0.00	2.30	Google Imagery (2013)
158854	400	16-STIN-50	J32-6	1071.59	4.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
164692	271	16-STIN-51	J32-7	1071.88	5.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
169555	353	16-STIN-53	J32-8	1071.70	6.3	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
156883	143	16-STIN-47	J32-9-C	1073.60	3.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
155909	144	16-STIN-40	J32-9-D	1074.68	2.5	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
180257	352	16-STIN-55	J32-10	1071.77	6.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
189986	270	16-STIN-56	J32-11	1072.26	7.6	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
199715	269	16-STIN-57	J32-12	1072.65	8.1	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
209446	398	16-STIN-54	J32-13	1073.25	8.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
137465	356	11-STIN-1	J33-1	1075.24	2.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
142326	148	17-STIN-10	J33-2	1074.79	2.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
142325	147	17-STIN-18	J33-3	1074.72	2.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
143291	401	17-STIN-11	J33-5	1074.61	2.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
141328	145	16-STIN-39	J33-6	1073.95	2.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
142302	146	16-STIN-38	J33-7	1073.60	3.1	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
156924	448	17-STIN-14	J33-10	1076.71	1.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
157892	138	17-STIN-15	J33-12	1075.41	2.4	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
157891	137	17-STIN-16	J33-13	1075.50	2.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
153993	354	17-STIN-17	J33-14-A	1076.30	1.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
156911	48	17-STIN-12	J33-14	1074.70	3.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
157864	141	16-STIN-30	J33-15	1074.34	2.1	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
157865	142	16-STIN-43	J33-16	1073.93	2.5	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
154953	222	16-STIN-34	J33-17-A	1074.48	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
163709	355	16-STIN-41	J33-17-B	1074.62	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
158845	449	16-STIN-42	J33-17	1073.12	3.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
209399	447	16-STIN-36	J34-1	1072.01	7.5	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
198696	267	16-STIN-15	J34-2	1071.26	7.1	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
188965	221	16-STIN-14	J34-3	1070.95	6.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
178262	220	16-STIN-1	J34-4	1070.68	6.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
168534	503	16-STIN-9	J34-6	1070.27	5.6	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
157836	103	16-STIN-8	J34-7-A	1073.35	3.1	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
157834	102	16-STIN-7	J34-7-B	1073.84	2.7	2	4.00	1.50	1.2	0.00	2.30	Google Imagery (2013)
157833	446	16-STIN-16	J34-7	1070.60	5.6	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
148103	47	16-STIN-6	J34-8	1071.17	4.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
142266	101	16-STIN-5	J34-9-A	1072.82	3.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
143237	100	16-STIN-4	J34-9	1072.69	3.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
128649	92	10-STIN-2	J35-3-A	1071.66	5.0	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
121822	98	10-STIN-13	J35-4-A	1073.08	3.4	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
170449	219	16-STIN-10	J36-1	1073.45	1.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
151964	445	16-STIN-31	J36-2-A	1074.13	2.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
156828	266	16-STIN-26	J36-2-B	1074.25	2.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
152926*	262	16-STIN-19	J36-2-C	1073.36	2.5	3	4.71	1.77	1.4	0.00	3.00	Google Imagery (2013)
146111	214	16-STIN-18	J36-2-D	1074.28	1.2	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
151962	444	16-STIN-24	J36-2	1069.92	6.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
148068	218	16-STIN-29	J36-3-A	1073.86	2.0	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
144177	265	16-STIN-12	J36-4-A	1074.16	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
141259	502	16-STIN-27	J36-5	1070.49	6.4	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
123742	46	10-STIN-16	J36-6-A	1075.32	1.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
122771	95	10-STIN-17	J36-6	1073.56	3.6	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
121788	96	10-STIN-12	J36-7-A	1074.27	2.9	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
120814	97	10-STIN-15	J36-7-B	1074.50	2.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
120825	94	10-STIN-18	J36-7	1072.46	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
161677	1158		J37-1	1072.75	3.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
155839	1159		J37-2	1072.74	3.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
155835	348	16-STIN-21	J37-3-A	1073.40	2.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
152917	43	16-STIN-3	J37-3-B	1071.88	3.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
151940	295	16-STIN-2	J37-4	1071.63	6.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
N/A	44	16-STIN-32	J37-5	1071.03	6.5	3	*Not an Inlet in FLO-2D*		0.0		3.00	
145124	395	16-STIN-25	J37-6-A	1073.04	3.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
145126	349	16-STIN-17	J37-6	1070.56	6.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
139285	501	16-STIN-28	J37-8-A	1069.90	6.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
133450*	215	10-STIN-6	J37-9	1069.08	6.8	3	4.71	1.77	1.4	0.00	3.00	Google Imagery (2013)
127619	216	10-STIN-8	J37-10-A	1072.95	2.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
118858	217	10-STIN-9	J37-10	1073.78	3.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
115941	93	10-STIN-11	J37-11	1074.02	3.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
137333	263	10-STIN-3	J38-1	1073.68	4.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
131495	350	10-STIN-4	J38-3-A	1072.54	4.4	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
130525	45	10-STIN-1	J38-3-B	1071.94	5.4	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
130526*	351	10-STIN-5	J38-3	1071.19	6.0	3	4.71	1.77	1.4	0.00	3.00	Google Imagery (2013)
122742	264	10-STIN-10	J38-4	1069.99	6.9	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
114950	134	9-STMH-27	J38-6-A	1073.93	3.2	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
113394	132	9-STMH-25	J38-6-B	1075.73	3.5	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
117871	60	9-STMH-28	J38-6	1069.55	6.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
118840	133	9-STMH-26	J38-7-A	1072.04	5.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
122729	61	9-STMH-29	J38-8	1071.01	4.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
129540	462	9-STMH-30	J38-9	1073.32	3.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
137324	7	9-STMH-31	J38-10	1074.31	2.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
102794	363	9-STMH-24	J42-1	1076.04	2.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
102052	319	9-STMH-22	J42-2	1076.07	2.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
101308	11	9-STMH-23	J42-3	1075.98	3.4	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

APPENDIX 4

District Quality Control (DQC)

Comments and Responses from Dr. Checks

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

CESPL-ED 20 May 2013

MEMORANDUM FOR CESPL-PM-M, Attn.: Joe Derungs

Subject: Transmittal of Flood Investigation Study for Luke Air Force Base, Maricopa County, Arizona.

1. References

a. EC 1165-2-209, "Civil Works Review Policy", dated 31 January 2012.

2. Enclosed is the Flood Investigation Study for Luke Air Force Base, Maricopa County, Arizona along with Engineering Division DQC Certification.

3. The Engineering Division District Quality Control Process has been completed for this work product in accordance with reference 1 a. During the DQC, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. All important comments resulting from the DQC have been resolved.

4. This work product may be incorporated into the associated draft report and may be submitted to the ATR Leader for review.

5. If you have any questions or concerns, the Engineering Division point of contact is Cuong Ly (Chief, Hydrology and GIS Section) at extension 3566.

RICHARD J. LEIFIELD, P.E.
Chief, Engineering Division

CESPL-ED

Subject: Transmittal of Flood Investigation Study for Luke Air Force Base, Maricopa County, Arizona.

CF:
CESPL-ED
CESPL-ED-H
CESPL-ED-HH

LEIFIELD
CESPL-ED

VERMEEREN RV
CESPL-ED-H 5/23/13

LY CTL 5/23/13
CESPL-ED-HH

VC 5/23/13
CRISOSTOMO
CESPL-ED-HE

5/23/13
CASEY
CESPL-ED-HE

AB 5/23/2013
BIER
CESPL-ED-HH

COMPLETION OF ENGINEERING DIVISION DQC

The Engineering Division District Quality Control (DQC) Process has been completed for the Flood Investigation Study at Luke Air Force Base, Maricopa County, Arizona. The DQC was conducted as defined in the project's Review Plan to comply with the requirements of EC 1165-2-209. During the DQC, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. All important comments resulting from the DQC have been resolved.

5/23/2013

Adam Bier, P.E. — *Date*
Hydraulic Engineer, Hydraulic Section
CESPL-ED-HH

5/23/2013

Kerry Casey — *Date*
Hydrologic Engineer, Hydrology & GIS Section
CESPL-ED-HE

5/23/13

Van Crisostomo, P.E. — *Date*
Chief, Hydraulics Section
CESPL-ED-HH

5/23/13

Cuong Ly, P.E. — *Date*
Chief, Hydrology & GIS Section
CESPL-ED-HE

29 May 2013

Rene Vermeeren, P.E. — *Date*
Chief, Hydrology and Hydraulics Branch
CESPL-ED-H

CERTIFICATION OF ENGINEERING DIVISION DQC

As noted above, Engineering Division DQC has been conducted for this work product and all resulting concerns have been fully resolved.

5/28/13

Richard J. Leifield, P.E. — *Date*
Chief, Engineering Division
CESPL-ED

DQC Comments - Luke Air Force Base Luke Air Force Base

Comments by Cuong Ly (17 May 2013)

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Cuong Ly
Comment: The purpose should read, "The purpose of this report is to document the existing conditions of the storm drain system and to provide the hydrologic and hydraulic analysis of the existing condition at Luke AFB."			
			Evaluator: Adam Bier
Evaluation: Concur; the purpose has been updated in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Cuong Ly
Comment: Regarding the use of FLO-2D, text should read, "The existing condition hydrologic and hydraulic analysis for surface flows was performed using FLO-2D modeling software.			
			Evaluator: Adam Bier
Evaluation: Concur; the purpose has been updated in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Cuong Ly
Comment: Add Appendix 2 (original PMP for this study) and include a reference in section 1.1			
			Evaluator: Adam Bier
Evaluation: Concur, the original PMP for this study was added as Appendix 2 and a reference was added to Section 1.1.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.3 Mapping	**Reviewer:**	Cuong Ly
Comment: Be consistent with the acronym referencing the Flood Control District of Maricopa County as the District.			
			Evaluator: Adam Bier
Evaluation: Concur; the Flood Control District of Maricopa County will be referred to as the District.			
Back-check: Concur			
Status: Closed			

Comment Location:	2.1 SWMM Overview	**Reviewer:**	Cuong Ly
Comment: Add that the SWMM model was requested by the Flood Control District of Maricopa County (the District)			
			Evaluator: Adam Bier
Evaluation: Concur, text has been added to the report regarding SWMM being requested by Luke AFB and the District.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.1 FLO-2D Introduction	**Reviewer:**	Cuong Ly
Comment: Add that the FLO-2D model was requested by the District and Luke AFB.			
			Evaluator: Adam Bier
Evaluation: Concur, text has been added to the report regarding FLO-2D being requested by Luke AFB and the District.			
Back-check: Concur			
Status: Closed			

Comments by Kerry Casey (16 May 2013)

Comment Location:	Title Page	**Reviewer:**	Kerry Casey
Comment: Remove FLO-2D floodplain from Luke AFB aerial and move "SOUTH PACIFIC DIVISION" above "LOS ANGELES DISTRICT" on the title block			
			Evaluator: Adam Bier
Evaluation: Concur; the title page has an updated aerial without the FLO-2D floodplain displayed. Additionally, the title block was adjusted to have South Pacific Division listed above Los Angeles District.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Kerry Casey
Comment: Add "for surface flows" when mentioning that FLO-2D was used for the hydrologic and hydraulic analysis.			
			Evaluator: Adam Bier
Evaluation: Concur, the text "for surface flow" has been added to the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.2 Mapping	**Reviewer:**	Kerry Casey
Comment: Add "and mapping" to the first sentence after mentioning aerial photography.			
			Evaluator: Adam Bier
Evaluation: Concur, the text now reads "Aerial photography and mapping collected in…"			
Back-check: Concur			
Status: Closed			

Comment Location:	1.4 Site Investigation	**Reviewer:**	Kerry Casey
Comment: Add the following sentences before paragraphs 1 and 2 before mentioning the purpose of visit. Paragraph 1: "An initial meeting and field investigation was held 6-8 November 2012." Paragraph 2: A follow up site visit was held 11-13 December 2012."			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been added to the beginning of each paragraph.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.5 Data Sources	**Reviewer:**	Kerry Casey
Comment: Change shape file to one-word "shapefile". Applies throughout report.			
			Evaluator: Adam Bier
Evaluation: Concur; the report now refers to shapefile as one word.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.1 FLO-2D Introduction	**Reviewer:**	Kerry Casey
Comment: Change FLO-2D components to "surface water" components in the first sentence.			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been modified to reflect this change			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.2 Roughness Coefficients	**Reviewer:**	Kerry Casey
Comment: Move the first two sentences to after the bullet list of Manning's values.			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been moved and added as paragraph 2 in this section.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.3 Infiltration and Abstraction	**Reviewer:**	Kerry Casey
Comment: Change "global assumptions" to "global values" when discussing global values used in the INFIL.DAT			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been modified.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.3 Infiltration and Abstraction	**Reviewer:**	Kerry Casey
Comment: Please revise the fifth paragraph beginning "In FLO-2D, TOL (in the TOLER.DAT file) represents…"			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been revised to the following: "In FLO-2D, TOL (in the TOLER.DAT file) represents the minimum water depth necessary to initiate sharing of volume between grids. Depression storage (TOL) is an initial loss from the potential surface flow. According to the District, it functions as a surface detention and should be set to a value less than 0.03 feet. The District has been using a value of 0.004 feet (equivalent to 0.048 inches), based on the smallest value of IA in Table 6.5 in the *Drainage Policies and Standards for Maricopa County, Arizona.* The initial abstraction (IA) calculated by the GDS when assigning infiltration data to each grid cell represents the total initial abstraction (which includes the TOL value of 0.048 inches). However, the IA in the INFIL.DAT file should not include the TOL value since FLO-2D adds it when running a simulation. Consequently, the IA value initially assigned by the GDS should be adjusted such that the TOL plus IA equals the total initial abstraction."			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.4 Rainfall and Inflow	**Reviewer:**	Kerry Casey
Comment: Change "a rain storm" to "precipitation" Change "discharge a" 100-year storm event" to "convey the" 100-year storm event. Change "west" of the airfield to "east"			
			Evaluator: Adam Bier
Evaluation: Concur, the text changes have been made in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.8 Hydraulic Structures	**Reviewer:**	Kerry Casey
Comment: Be consistent in referencing the Los Angeles District, either COE or LAD			
			Evaluator: Adam Bier
Evaluation: Concur; the report has been updated to refer to the LA District with COE.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.10 SWMM – FLO-2D Interface	**Reviewer:**	Kerry Casey
Comment: Add FLO-2D Interface to the title to differentiate from previous section on SWMM			
			Evaluator: Adam Bier
Evaluation: Concur, the title has been updated to SWMM – FLO-2D Interface			
Back-check: Concur			
Status: Closed			

Comment Location:	3.3 Analysis Results	**Reviewer:**	Kerry Casey
Comment: Change "without project condition" to "Existing conditions"			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been modified.			
Back-check: Concur			
Status: Closed			

Comments by Van Crisostomo (17 May 2013)

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Overall a good report considering we have very little experience using SWMM and FLO-2d in combination. This should provide good experience in the future for urban drainage type of floodplain analyses.			
			Evaluator: Adam Bier
Evaluation: Thank you.			
Back-check: Concur			
Status: Closed			

Comment Location:	Appendix 2	**Reviewer:**	Van Crisostomo
Comment: Appendix 2 is missing			
			Evaluator: Adam Bier
Evaluation: Appendix 2 will be included in future submittals			
Back-check: Concur			
Status: Closed			

Comment Location:	Storm Drain Profiles	Reviewer:	Van Crisostomo

Comment:
Storm Drain Profiles 1-3 - Unclear as to where these are located. Suggest a figure similar to Figure 4 that includes all these. Are these the only storm drains of concern?

Evaluator: Adam Bier

Evaluation: A Figure will be added to show the storm drain system. The figure will identify the storm drain lines. The three storm drain profiles provided are the storm drains directly affecting the parking ramp (critical) area. Other storm drain lines (not in the parking ramp) may have drainage problems as well. The following text has been added to Section 2.4 of the report:

"Three storm drain lines in the parking ramp area were identified as possible systems to be improved. Storm drain lines elsewhere on Luke AFB may also cause flooding problems; however, an emphasis was placed on the storm drains that directly affect the parking ramps for this analysis. See Figure 3 for an aerial showing the storm drain system in the parking ramp area which highlights the three storm drain lines discussed below."

Back-check: Concur

Status: Closed

Comment Location:	3.2.4 (page 7)	Reviewer:	Van Crisostomo

Comment:
Should the last sentence refer to Figure 2 not Figure 1

Evaluator: Adam Bier

Evaluation: Concur; text has been changed to reference Figure 2.

Back-check: Concur

Status: Closed

Comment Location:	General Comment	Reviewer:	Van Crisostomo

Comment:
Any data available for calibration, i.e. past flooding history? Looks like there may be some historical photos of flooding.

Evaluator: Adam Bier

Evaluation: Concur. The following text was added to Section 3.4

Historical flood depths were not available to calibrate the floodplain produced in this analysis; however, the FEMA 100-year floodplain was used for comparison. Furthermore, Alan Thomas from Luke AFB, upon viewing the initial floodplain map, provided reasonable verification that the flooded areas represent areas where flooding has been observed.

Back-check: Concur

Status: Closed

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Any recommendations, i.e. are there obvious major contributors to flooding? This would help out the local sponsors when doing their alternatives.			
			Evaluator: Adam Bier
Evaluation: Concur. A conclusion & recommendations section was added at the end of the report. See Section 4.0			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: How long would the flooding last (hours, days, etc.)?			
			Evaluator: Adam Bier
Evaluation: Concur. Text has been added to the report in Section 3.4 regarding the length of significant (0.5 feet) flooding.			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Is the video camera inspection still part of the scope of work?			
			Evaluator: Adam Bier
Evaluation: Do Not Concur. The video camera inspection was replaced by SWMM storm drain profiles. The profiles were used in the critical parking ramp area to see if there are inconsistencies in the storm drain system which could potentially be a cause for flooding. Text has been added to Section 1.1 to discuss.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 4	**Reviewer:**	Van Crisostomo
Comment: Table 4 - Add (NAVD 1988) to the invert elevation column headings.			
			Evaluator: Adam Bier
Evaluation: Concur, the reference will be added to Table 4			
Back-check: Concur			
Status: Closed			

Comments by Rene Vermeeren (20 May 2013)

Comment Location:	Section 1.3	**Reviewer:**	Rene Vermeeren
Comment: Delete in the parenthesis the word "The" and leave the word "District".			
			Evaluator: Adam Bier
Evaluation: Concur, "The" was removed from the parenthesis.			
Back-check: Concur			
Status: Closed			

Comment Location:	Title Page	**Reviewer:**	Rene Vermeeren
Comment: Reformat the title page to present more as an A-E document for a client. Include the same project name, project number, and order number as part of the page. Follow examples from A-E submittals or even some of the models studies ERDC has produced.			
			Evaluator: Adam Bier
Evaluation: Concur. The title page has been reformatted. Megan Craig provided a sample cover page of the template she is working on for Engineering Division. I added project number and project order number per your request.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table of Contents	**Reviewer:**	Rene Vermeeren
Comment: Include "List of Acronyms" after APPENDICES in preface page. Suggest adding a Coordination page to list individuals associated with the study from the Corps, Luke AFB, and Maricopa County FCD.			
			Evaluator: Adam Bier
Evaluation: Concur, a "List of Acronyms" has been included and follows after the Table of Contents, List of Tables, and List of Figures. A listing of project team members was added to a preface which was inserted between the title page and the table of contents. Team member names and agency are listed as well as DQC reviewers. ATR reviews will be added prior to final submittal of report after the ATR process.			
Back-check: Concur			
Status: Closed			

Comment Location:	Add Executive Summary	**Reviewer:**	Rene Vermeeren
Comment: This document if very technical in text. Add "Executive Summary" page to highlight the study scope of work, general procedures used, and study results.			
			Evaluator: Adam Bier
Evaluation: An executive summary was added after the table of contents.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 1.1, Study Purpose and Scope	**Reviewer:**	Rene Vermeeren
Comment: Expand the discussion to explain what items in this report are covered and what items if any are not covered with respect to Section 3.0, Key Deliverables in the PMP. Add discussion on local agency relationship. What is their role and why?			
			Evaluator: Adam Bier
Evaluation: Section 1 "General Description of Study" was expanded to include the following subsections which discussed the PMP and added more overall project detail. Study Purpose and Scope Study Goals Deliverables Study Area Topographic Survey Field Investigation Data Collection Coordination Previous Studies			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Rene Vermeeren
Comment: Add a section "Previous Studies and Study Procedure" between 1.0 General Description and Section 2.0 Storm Drain Conditions to describe previous H&H work in the area and analysis procedure for this study and how the application of the non-Corps models was applied. It is confusing to state an EPA model that does rainfall runoff analysis and then describe FLO-2D that also does some form of rainfall run-off analysis. Has the combined model of FLO-2D and the EPA SWMM been Corps approved? In addition, include a subsection on results of any other related studies and how they were incorporated in this study.			
			Evaluator: Adam Bier

Evaluation: Section 1.9 was added to discuss previous studies. The results from the previous studies are discussed in Section 2.0 Hydrology. Discussion was added to Section 1.9 regarding the use of FLO-2D and EPA-SWMM to complete the H&H analysis. The combination of FLO-2D and EPA-SWMM is not a Corps approved model, but was used at the request of Luke AFB and Maricopa County.
Back-check: Concur
Status: Closed

Comment Location:	General Comment	**Reviewer:**	Rene Vermeeren
Comment: In the EPA and FLO-2D analysis, there seems to be a lot of information provided on modeling input parameters and files used. Appendix 1 provides a summary of input data, but I don't see a reference to any plates or diagrams from which to view this information. Suggest adding a section where reference to back-up electronic data for this analysis can be found.			
			Evaluator: Adam Bier
Evaluation: Added a new section 4.5 FLO-2D and SWMM Output – The output for the FLO-2D and EPA-SWMM model is provided in electronic format. The EPA-SWMM model output is provided as "SWMM.rpt". The FLO-2D output is provided electronically in various ".OUT" text files, including SUMMARY.OUT. Other important output files include those for levees, hydraulic structures, floodplain cross sections, Manning's n-values, infiltration, and flood depths.			
Back-check: Concur			
Status: Closed			

Comment Location:	Figures	**Reviewer:**	Rene Vermeeren
Comment: Although the background showing an aerial photo is interesting to look at, it makes it difficult to view the key purpose of the Figure and items on the legend. a. Figure 3 is hard to detect the yellow shade. b. Add asterisk to the word Levee in Figure 3 and define in legend. c. Figure 4 shows both the study boundary and cross sections in Red. The cross sections have no alignment tie nor are they labeled. d. On Figure 5, why is the FEMA flood boundary shown on Government land? The FEMA flood boundaries in some areas are difficult to view the flooded area and the flooding limits.			
			Evaluator: Adam Bier
Evaluation: Concur. The figures were re-arranged and some were added. Some changes are mentioned below: a. A grey background was added to the legend to help the legend items to stand out.) b. An asterisk was added to the legend before the word levees. A description was also added. c. The color representing the project boundary has been changed to purple.			

d. The existing FEMA floodplain was provided by Luke AFB and is shown as a comparison to the FLO-2D floodplain results. The goal of the final product of this study (not this phase) is to produce an updated FEMA floodplain. The FEMA floodplain has been edited to just show the extents of the flooding. See updated Figure 7.
Back-check: Concur
Status: Closed

Comment Location:	Section 1.5 last paragraph and section 2.4 Storm Drain Profile Analysis	**Reviewer:**	Rene Vermeeren
Comment: Add a figure (?) to just show all exiting flood control features related to the base before the Profiles. Suggest labeling the "Profiles" as Figures, Exhibits or Plates. Profiles show both plan view and profile – should they be re-titled as such? Re-label section 2.4 to "Existing Flood Control Features" and then use subheadings to describe (1) Detention Basins, (2) Storm Drains (both open and closed), (3) Storm drain inlets, (4) Culverts, and any other appurtenant flood control structures (pumps).			
		Evaluator: Adam Bier	
Evaluation: Concur. Two figures were added (Figures 5 and 6). Figure 5 shows the storm drain system for the main base area. Figure 6 shows a detail of the parking ramp area. Figure 6 was included per DQC comment from Van to highlight the storm drain profiles. The storm drain profiles have been re-named Plates 1-3. These will be placed after the figures and before the appendices. The Plates were renamed "Plan and Profile". Section 3.1 was labeled to "Existing Flood Control Features", and sub headings with the appropriate sections were added as requested.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 2.2	**Reviewer:**	Rene Vermeeren
Comment: "What method was used to calculate hydraulics for the storm drain? Why are Green Ampt and Dynamic Wave mentioned here relative to storm drain hydraulics?			
		Evaluator: Adam Bier	
Evaluation: Concur. The FLO-2D model uses the momentum and continuity equations to calculate hydraulics. Text was added to section 4.1. The Green-Ampt method and dynamic wave were mentioned because those methods are also used in the FLO-2D and SWMM modeling for the purposes stated in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2	**Reviewer:**	Rene Vermeeren
Comment: Suggest subsections to Components such as (a) Hydrology (infiltration, rainfall and inflow, etc.,) (b) Geometric Features (Elevations, Streets, Buildings, Levees, etc.,) and (c) Model Application (Models, x- sections, "n" values, inlets, and outflows).			
			Evaluator: Adam Bier
Evaluation: Concur, the FLO-2D Components section was split into three sections (4.2 Hydrology Components, 4.3 Geometric Components, and 4.4 Model Components.			
Back-check: Concur			
Status: Closed			

Comment Location:	Hydrology	**Reviewer:**	Rene Vermeeren
Comment: Hydrology: There is not a separate section. a. What is the drainage area of the upstream watershed? b. What are the impacts of upstream drainage on the study area? c. Suggest adding figure on the watershed drainage area. d. Are there any stream systems entering the base and what are the systems within the base? e. What are exit points on the downstream end of the base and do they impact any downstream developed areas? f. What are the configuration /characteristics of detention basins? g. There are no hydrologic results presented in terms CPs, discharges, storm drain discharges (both inlet and outlet at peak of event.) h. Why was study only done for 100-year? Should other events be studied to present a broader view of flood risk?			
			Evaluator: Adam Bier
Evaluation: A Hydrology Section was added to the report a. The upstream watershed drainage area is approximately 2800 square miles (added to report) b. Added to report, see Section 2.2 c. A Vicinity Map was created which shows a portion of the watershed surrounding Luke AFB. d. Yes there are stream systems entering the base, text added in Section 2.2. Figure 3 created to show existing facilities. Figure 4 created to show Capital Improvement Projects based on the 2009 Hydrologic Report. e. Text has been added to Section 2.4 to discuss the exit points from the base. f. The Dysart Detention Basin is discussed in Section 2.4.1 and the on base basins in 3.1.1 g. Hydrology was completed using FLO-2D. Storm drain discharges will be added to the final June 14 report. h. The project goal is to get updated FEMA 100-year floodplain, so all analysis was done using the 100-year event.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2.2	**Reviewer:**	Rene Vermeeren
Comment: Manning's "n" values seem inconsistent with other published data or seem not appropriate for given condition. a. "n" value for swimming pools appears high for a water body. b. "n" value for concrete appears high at "n" equal to 0.02 c. What "n" value was used to represent highly developed areas (housing tracts, buildings, etc.)?			
			Evaluator: Adam Bier
Evaluation: Do not concur. It was agreed upon within the PDT that we would use the shapefiles already developed for Luke AFB by Maricopa County at the November 2012 meeting.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2.7 Levees and Section 3.2.4	**Reviewer:**	Rene Vermeeren
Comment: Is Loop 303 a block wall and is it structurally fortified to divert upstream flood flows around the base?			
			Evaluator: Adam Bier
Evaluation: Loop 303 is not a block wall. This description was provided by Maricopa County and has been inserted into the report. See Section 4.2.2 "Each roadway project (Loop 303 and Northern Parkway) includes a corresponding drainage project with facilities that will intercept, detain, and convey the 100-year peak flows. Since the Northern Parkway is currently under construction and ADOT identifies 2014 as the completion date of the Loop 303, base improvements will be designed based upon those roadways being in place. The submittal to FEMA for re-delineation of the floodplain will not occur before both roadway projects are completed."			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2.10	**Reviewer:**	Rene Vermeeren
Comment: State reference for storm drain curb inlets and storm drain drop inlets.			
			Evaluator: Adam Bier
Evaluation: Concur. A reference to the FLO-*2D Pro Model and EPA SWMM Model Integration* manual was added to the end of the paragraph preceding the discussion on curb and drop inlets. See Section 3.4.3.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.3	**Reviewer:**	Rene Vermeeren
Comment: No hydraulic results are shown for the storm drains and detention basins. a. It would be useful to know where and what discharges enter and exit storm drain system and what flows by-pass the system and stay overland. Do any of the inlets have flow exiting out under peak flow conditions? b. What impact do on-site detention basins have on flood attenuation?			
			Evaluator: Adam Bier
Evaluation: Concur. At this time, the SWMM model has not been fully integrated into the FLO-2D model. We have been working with FLO-2D to get the SWMM subsurface model to work with our surface flow model. The results provided include only surface flow at this time. It is anticipated that the SWMM model will be integrated prior to final submission on June 14. Results will be added to the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 2 Classification	**Reviewer:**	Rene Vermeeren
Comment: The "MUkey" is not shown or reference to anything else. The impervious values are all 100%. What is the purpose of having this table?			
			Evaluator: Adam Bier
Evaluation: Concur. This table has been removed.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 1-3 Rainfall Hydrograph	**Reviewer:**	Rene Vermeeren
Comment: Is this the correct label for a table? A hydrograph refers to an x-y graphic relationship. Was the Pattern 1 distribution varied to produce the worst case scenario for the areas of interest?			
			Evaluator: Adam Bier
Evaluation: Concur. The name of the table has been changed to "Rainfall Distribution". The pattern 1 distribution was not varied to produce the worst case scenario for the areas of interest. Maricopa County recommended we use the pattern 1 distribution.			
Back-check: Concur			
Status: Closed			

Comment Location:	Profiles	**Reviewer:**	Rene Vermeeren
Comment: Add legend to identify features on profile.			
			Evaluator: Adam Bier
Evaluation: Concur. Legend added to Plates 1-3.			
Back-check: Concur			
Status: Closed			

Comment Location:	Figure 5	**Reviewer:**	Rene Vermeeren
Comment: Encircle the areas shown on the following figures for ease of viewing problem areas.			
			Evaluator: Adam Bier
Evaluation: Concur See Updated Figure 7			
Back-check: Concur			
Status: Closed			

Comments by Rene Vermeeren (23 and 28 May 2013)

Comment Location:	Figure 5	**Reviewer:**	Rene Vermeeren
Comment: Editorial comments and report organization suggestions			
			Evaluator: Adam Bier
Evaluation: Additional editorial comments provided by Rene Vermeeren from 23 May and 28 May 2013 have been incorporated into the report. Some of the editorial comments include the following: 1. A sentence regarding Maricopa County's role and relationship has been added to the Executive Summary. 2. Editorial changes were made regarding the Preface, Executive Summary, 1.1 Study Purpose and Scope, 1.9 Previous Studies, 1.10 Modeling Procedure, 2.4 Existing Facilities, 4.1 FLO-2D Introduction. 3. Sections on EPA-SWMM modeling were moved from Sections 3.2 - 3.5 to Section 4.6 - 4.9 to follow the discussion on FLO-2D modeling. 4. List of Acronyms moved to a separate page from table of contents.			
Back-check: Concur			
Status: Closed			

APPENDIX 5

Agency Technical Review (ATR)

Comments and Responses from Dr. Checks

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

COMPLETION OF AGENCY TECHNICAL REVIEW

The Agency Technical Review (ATR) has been completed for the Flood Control Investigation Study for Luke Air Force Base, Maricopa County, Arizona. The ATR was conducted as defined in the project's Review Plan to comply with the requirements of EC 1165-2-214. During the ATR, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing U.S. Army Corps of Engineers policy. The ATR also assessed the District Quality Control (DQC) documentation and made the determination that the DQC activities employed appear to be appropriate and effective. All comments resulting from the ATR have been resolved and the comments have been closed in DrChecks[sm].

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Mike Lin — Date
Senior Hydraulic Engineer
CESPK-ED-HD

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Stephen Graff, P.E. — Date
Chief, Hydraulic Design Section
CESPK-ED-HD

06.25.13

Tony Beuche, P.E. — Date
Project Manager, Project Management Branch
Flood Control District of Maricopa County

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Adam Bier, P.E. — Date
Hydraulic Engineer
CESPL-ED-HH

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Kerry Casey — Date
Senior Hydrologic Engineer
CESPL-ED-HG

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Cuong Ly, P.E. — Date
Chief, Hydrology & GIS Section
CESPL-ED-HG

CERTIFICATION OF AGENCY TECHNICAL REVIEW

As noted above, all concerns resulting from the ATR of the project have been fully resolved.

27 JUNE 13

Richard J. Leifield, P.E. — Date
Chief, Engineering Division
CESPL-ED

ATR Comments - Luke Air Force Base

Comments from Pedro Melo Rodriguez and Richard Waskowski from the Flood Control District of Maricopa County (FCDMC) - 03 June 2013

Comment Location:	Section 1.3 Deliverables, Page 2	**Reviewer:**	FCDMC
Comment: On page 2, please specify a reason why the pump capacity was not necessary (e.g. the peak flow was negligible, neglecting the pump gives the worst case scenario, etc.)			
			Evaluator: Adam Bier
Evaluation: Concur; data was not available regarding the specific pump capacity. If such data were available it could be added to the report. The following text was added to Section 1.2 Deliverables. "An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis. However, a pump was included in the EPA-SWMM model using the default parameters assuming an ideal pump curve."			
Back-check: 1) Section 1.3 Deliverables, Page 2 - Please change "An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis. However, a pump was included in the EPA-SWMM model using the default parameters assuming an ideal pump curve" to "An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis because the data for specific pump capacity was not available. However, a pump that used default parameters assuming an ideal pump curve was included in the EPA-SWMM model as an estimate until better data is obtained" 2) Section 4.9, Page 19 - Please add some discussion to the report that documents the 80% reduction in the area of the inlet.			
Evaluation: Concur. The text in section 1.3 Deliverables was changed to the recommended text.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 1.6, Page 3	**Reviewer:**	FCDMC
Comment: In Section 1.6, page 3, please add that these structures were surveyed to obtain a representative sample of the total number of structures.			
			Evaluator: Adam Bier
Evaluation: Concur, the following was added to Section 1.6 (Now Section 2.2), "The structures were surveyed to obtain a representative sample of the total number of structures in the study area."			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 1.7 Data Collection	**Reviewer:**	FCDMC
Comment: Please add a note to the Jersey Barriers and Walls shapefile explanation that these are only the 'major' ones.			
			Evaluator: Adam Bier
Evaluation: Concur, the following was added to the descriptions: Jersey Barriers: "Only the major Jersey Barriers were included in the shapefile (i.e. the barriers surrounding the parking ramps)." Walls: "Only the major walls were modeled in FLO-2D. Major walls include security boundary walls, walls surrounding parking areas, and walls surrounding buildings and yards."			
Back-check: Concur			
Status: Closed			

Comment Location:	Subsection 3.1.3, Page 10	**Reviewer:**	FCDMC
Comment: In Sub-Section 3.1.3, page 10; were the invert elevations that were provided part of the surveyed ones? Please clarify whether these elevations were part of the original GIS database or the subsequent survey.			
			Evaluator: Adam Bier
Evaluation: Concur, the following text was added to the report in previous section 3.1.3 (new section 4.2.3), "Of the 435 inlet invert elevations obtained from the Luke AFB GIS geodatabase, 43 of those were surveyed by the COE. The invert elevations surveyed by the COE were used in lieu of the elevations provided by Luke AFB for the respective inlets."			
Back-check: Concur			
Status: Closed			

Comment Location:	Figure 6	**Reviewer:**	FCDMC
Comment: In Figure 6, culverts are hard to see on the map as lines, is there any better way of displaying these? Maybe thicker lines?			
			Evaluator: Adam Bier
Evaluation: Concur; a thicker line will be used in an attempt to make the culverts more visible.			
Evaluation: Concur, the structures were difficult to see on Figure 6, so additional detailed maps were created. See Plates 10-14 for detailed hydraulic structure locations.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 4.1, Page 11	**Reviewer:**	FCDMC
Comment: In Section 4.1, page 11, please list the exact number (551,096) of cells as this will help to make sure that the FLO2D files are the right ones, based on grid numbers.			
			Evaluator: Adam Bier
Evaluation: Concur, the exact number of grid cells (551,096) was added to the text.			
Back-check: Concur			
Status: Closed			

Comment Location:	Sub-section 4.2.1, Page 11	**Reviewer:**	FCDMC
Comment: In Sub-Section 4.2.1, page 11, was the GDS interface used to calculate the Green-Ampt parameters or was this done outside of GDS? If so, please add a sentence that indicates GDS was used.			
			Evaluator: Adam Bier
Evaluation: Concur, text was added to the first sentence of section 4.2.1 (now Section 5.3.1) indicating that GDS was used to calculate the Green-Ampt parameters. The following text was added, "The Green-Ampt method was used to simulate infiltration using FLO-2D GDS Pro."			
Back-check: Concur			
Status: Closed			

Comment Location:	Page 12 & List of Acronyms	**Reviewer:**	FCDMC
Comment: At the top of page 12 and the "List of Acronyms", "SOLID" should be "SOILD".			
			Evaluator: Adam Bier
Evaluation: Concur, the text and list of acronyms were corrected to say "SOILD"			
Back-check: Concur			
Status: Closed			

Comment Location:	Subsection 4.3.5, Page 15	Reviewer:	FCDMC
Comment: In Sub-Section 4.3.5, page 15, were all the hydraulic structures surveyed? For example, HS-8 was added after the survey was performed. Were other structures surveyed from the initial survey? Why does page 15 of the report indicate that 7 culvert locations are modeled, but 17 locations are shown on Figure 9? Please clarify this section.			
			Evaluator: Adam Bier
Evaluation: Concur. The following text was clarified in new Section 5.4.5, "There are approximately 40 culvert locations within the project study area, consisting of approximately 80 individual culverts. The culverts vary in size, shape, and material but typically are constructed of either reinforced concrete or corrugated metal. Twenty seven culvert locations were judged to significantly impact the hydraulic results and were chosen to be incorporated into the FLO-2D model." Table 3 now provides a column listing the source of the culvert information regarding culvert size, inlet invert elevations, outlet invert elevation. In particular, HS-8 was measured in the field on June 5, 2013 but the upstream and downstream invert elevations are based on the TIN surface elevation. Additionally, 27 culvert locations are now included in the model.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 3	Reviewer:	FCDMC
Comment: In Table 3, are the elevations from survey and/or from the TIN surface? For example, HS-8 was added after the survey was performed and there was talk about using the elevations from the TIN surface. Please add a column that lists the source of the elevation, whether it was from field survey or the TIN.			
			Evaluator: Adam Bier
Evaluation: Concur, a column was added to Table 3 showing the source of the elevation data.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 4.8, Page 18	Reviewer:	FCDMC
Comment: In Section 4.8, page 18, please add Storm Drain Profile 1, 2 or 3 after the reference to Plates 1, 2 or 3 so there is a direct correlation between those references, Figure 7, Section 5.0 and the Plates. Also, Plate 3 should reference Storm Drain profile 3 rather than 5.			
			Evaluator: Adam Bier
Evaluation: Concur, the Storm Drain Profiles (Plates) will be presented after the Figures. The reference to Plate 3 has been corrected.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 4.9, Page 19	**Reviewer:**	FCDMC
Comment: In Section 4.9, page 19, the area of the inlets is the actual open available area for water to flow through. The size of the inlet grate openings affects this. The area should be calculated based on the total open area, and not just by multiplying the width times the length (or using just the radius).			
			Evaluator: Adam Bier
Evaluation: Concur. For all the drop inlets in the model, the area of the inlet will be reduced by 80% in the SWMMFLO.DAT.			
Back-check: 2) Section 4.9, Page 19 - Please add some discussion to the report that documents the 80% reduction in the area of the inlet.			
Evaluation: Concur, the following text was added to former section 4.9, now section 5.10). "After calculating the total area of each drop inlet, the area was reduced to 80 percent of the total area for the SWMMFLO.DAT to account for the area of inlet obstructed by the metal bars of the inlet grate. Since Luke AFB has a variety of grate types and a complete inlet survey has not been completed, COE and District personnel decided to globally assume 80 percent open area for water to flow through for each inlet. Furthermore, to account for the reduction in available area for water to flow into curb inlets, the inlet width was reduced by 80 percent."			
Back-check: Concur			
Status: Closed			

Comment Location:	Page 20, Section 4.9	**Reviewer:**	FCDMC
Comment: At the top of page 20, "SMM" should be "SWMM".			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been corrected to "EPA-SWMM"			
Back-check: Concur			
Status: Closed			

Comment Location:	Appendix 1	**Reviewer:**	FCDMC
Comment: In Appendix 1, please add comments to the Note column that will indicate how (or if) the inlet was field verified. For example, some comments could be "Field verified by Luke personnel" or "Estimated from Google imagery" or "Needs additional survey".			
			Evaluator: Adam Bier
Evaluation: Concur. A column has been added to Appendix 1 to indicate the source of the data.			
Back-check: Concur			
Status: Closed			

Comment Location:	Figure 4 – Existing Features	**Reviewer:**	FCDMC
Comment: On Figure 4, the Reems Road Channel and Basin are now existing features.			
			Evaluator: Adam Bier
Evaluation: Concur, Reems Road Channel and basin were added to Figure 3 "Existing Features" and shown on Figure 4 as existing features.			
Back-check: Concur			
Status: Closed			

Comments from Tony Beuché from the Flood Control District of Maricopa County - 04 June 2013

Comment Location:	General Comments	**Reviewer:**	Tony Beuché

Comment:

The following are comments from review of the draft report of the Luke AFB Flood Control Investigation submitted to FCDMC on 05.28.13. Please review the comments and respond with any questions that you may have.

1. Section 1.4, third sentence – The Gila River is located due south of LAFB (the confluence of the Salt and Gila is three miles east of Litchfield Road).
2. Section 2.1, third sentence – The Agua Fria River Watershed is approximately 238 squares miles in area.
3. Section 2.2, first paragraph, third sentence – Add as follows: "…west side of Reems Road ***and*** lies west…"
4. Section 2.2, second paragraph, first sentence – Add as follows: "…Parkway Drainage Improvement***s***…"
5. Section 2.2, second paragraph, fifth sentence – Replace as follows: "…and their drainage facilities ***are*** included…"
6. Section 2.2, second paragraph – In clarification, the Northern Parkway, the Loop 303 and their associated drainage improvements are currently under construction.
7. Section 2.3 – Note that the Dysart Drain adjacent to the north boundary of the base was improved in 1994 to address adverse slope caused by ground subsidence.
8. Section 2.4.2, third sentence – Note that the existing culvert under Camelback Road at Bullard Wash was designed to have capacity for the 100-year peak flow.
9. Section 2.4.3, second sentence – The final design of the Loop 303 drainage improvements has been completed and construction of those improvements is underway.
10. Section 3.1.2, first and second paragraphs, last sentences – Add as follows: "See Figure 6 ***for***…"
11. Section 4.4.3, first and second sentences – Correct font size.
12. Section 5.0 – Can any conclusions and recommendations be made regarding the performance of the existing drainage channels located south of Super Saber Street and east of the airfield or for the infield detention basins (Airfield North Detention Basin and Airfield South Detention Basin)?
13. Figure 1 – Label for Agua Fria River is misspelled.
14. Figure 4 – Note that some of the Future Detention Basins shown adjacent to the Loop 303 and Northern Parkway are either currently under construction or will be constructed with roadway projects. The Loop 303 is an ADOT project and the final locations and configurations of the basins may not correspond directly to what is depicted on the figure.

Evaluator: Adam Bier
Evaluation: Concur; The following are responses to the comments above. 1. The text was corrected to reference the Gila River being south of Luke AFB. (Section 1.4) 2. The Agua Fria River watershed area was revised to say 238 square miles. (now Section 3.1) 3. The text correction was made. (now Section 3.2) 4. The text correction was made. (now Section 3.2) 5. The text correction was made. (now Section 3.2) 6. The text was clarified to report that the Northern Parkway and Loop 303 drainage facilities are currently under construction. (now Section 3.2) 7. Text was added to the Dysart Drain section to note that the channel was improved in 1994 to address adverse ground slope. (now Section 4.1.1) 8. Text was added to the Bullard wash Section to discuss the design capacity and to give the culvert dimensions. (now Section 4.1.2) 9. Text was added to the section regarding the final design of the Loop 303 drainage improvements being completed and that construction is underway (now Section 4.1.3). 10. "For" was added to the respective sentences (now Section 4.2.1). 11. The font size was corrected in Section 4.5.3 (now 5.4.3). 12. Discussion regarding the performance/capacity of existing features will be added to the report based on the SWMM results. 13. The label was corrected for Agua Fria River in Figure 1. 14. A Note was added to Figure 4 regarding the final locations and configurations of the basins. Additionally, the following text was added to Section 3.2 "Some of the future detention basins shown adjacent to the Loop 303 and Northern Parkway are either under construction or will be constructed with roadway projects. The Loop 303 is an ADOT project and the final locations and configurations of the basins may not correspond directly to what is depicted on the on Figure 4."
Back-check: Concur
Status: Closed

Comments from Pedro Melo Rodriguez and Richard Waskowski from the Flood Control District of Maricopa County (FCDMC) - 04 June 2013

Comment Location:	FLO-2D – Hydraulic Structures	**Reviewer:**	FCDMC

Comment:

1) After reviewing the hydraulic structures file along with the grid elevations, there are some adjustments needed. The following Figure 1 represents Hydraulic Structure 1 – Headwall with Flared Wing Walls. The top half of the figure shows the current condition in FLO2D, where the hydraulic structure's invert elevation is below the grid elevation. The same thing happens at the downstream, where the hydraulic structure is below the grid cells. After checking all of the 17 hydraulic structures in the model, all of these have the same issue as hydraulic structure 1.

   When FLO2D is calculates the flow using the head, it uses the grid elevation to the water surface elevation. When the hydraulic structure is below the grid cell, the flow is under estimated and can cause instabilities in the model.

   The bottom half of the figure shows how the hydraulic structures should look like in the model. The grid elevations must be adjusted to the invert elevations of the hydraulic structures upstream and downstream. The elevation adjustment must continue to other grid elements upstream and downstream from the hydraulic structure (shown with blue grids in Figure 2).

   Figure 2, shows an aerial of Hydraulic Structure 1. As shown on the aerial, due to the grid cells size, the grids that represent the channel (Shown with blue Grid) are an average of top of bank and channel bottom. When these grids are averaged the channel bottom is raised, these elevations need to be adjusted to maintain continuity in the model with a positive slope.

Evaluator: Adam Bier

Evaluation: Concur, the grid elevations have been adjusted according to the TIN upstream and downstream from the culverts. The inlet and outlet grid elevations were based on the source of the elevation (COE Survey, Luke AFB GIS Geodatabase, or TIN). A positive slope was maintained as found according to the TIN and available data; however, there were a few locations that do not have a positive slope according to the TIN.

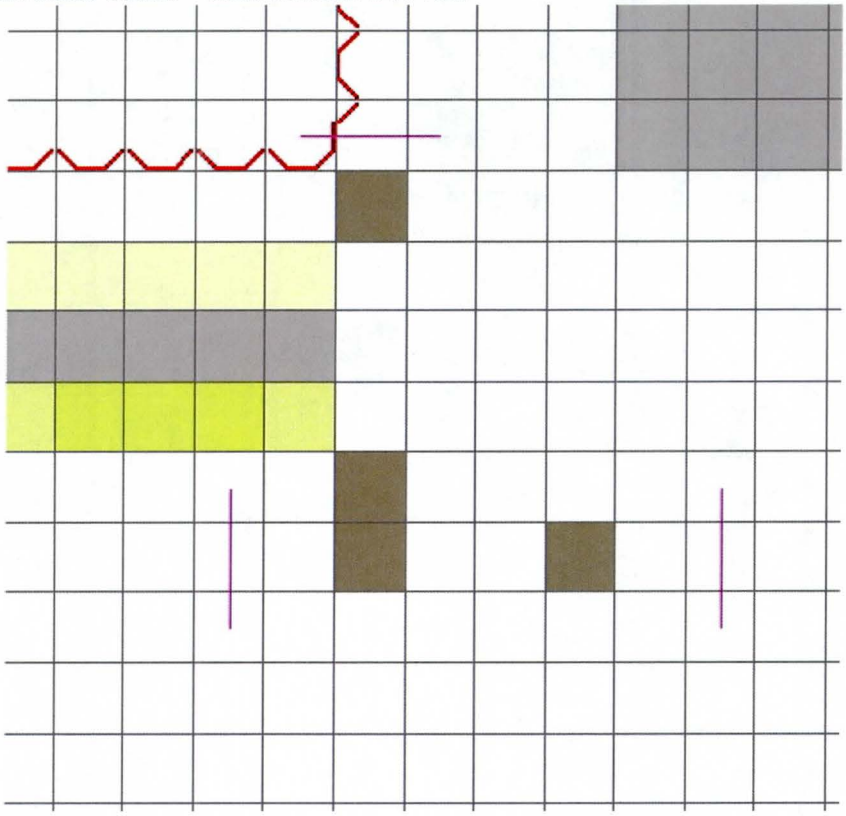
Back-check: Concur

Status: Closed

Comment Location:	FLO-2D Hydraulic Structures	**Reviewer:**	FCDMC

Comment:

2) Figure 3 shows structure 13 & 14. To avoid possible instabilities structure 13 and 14 can share the same outlet – Grid number 311408.



Evaluator: Adam Bier

Evaluation: Concur, hydraulic structures 13 and 14 have been revised to share the same outlet – Grid Cell Number 311408.

Back-check: Concur

Status: Closed

Comment Location:	Section 1.3 Deliverables, Page 2	**Reviewer:**	FCDMC
Comment: 3) Some floodplain cross-sections do not contain much flow. It is recommended that some cross-sections be removed, but some cross-sections be added at other locations of interest, e.g. upstream of the Bullard Wash culvert at Camelback Road and upstream of the flow breakout near the golf course at the end of the runway.			
			Evaluator: Adam Bier
Evaluation: Concur, floodplain cross-sections that do not contain much flow will be removed from the model and additional floodplain cross sections will be added to the model.			
Evaluation: Concur; low flow floodplain cross sections were removed and additional floodplain cross sections were added at Bullard Wash, Northern Litchfield Drainage Channel, the channel/swale that begins on the east side of the runway and eventually runs north of the golf course, and at the breakout location at the northwest corner of the golf course. A table was created to better explain the floodplain cross section locations and the cross sections are now shown on the new hydraulic structure figures.			
Back-check: Concur			
Status: Closed			

Comments from Mike Lin, Corps of Engineers, Sacramento District - 11 June 2013

Comment Location:	1) Contents in 1.0 General Description of Study	**Reviewer:**	Mike Lin, SPK

Comment: Recommend to include in "1.0 General Description of Study" only subjects which are general in nature, such as Objectives, Study Area, Previous Studies and Coordination.

Recommend:

(1) Combine 1.1 Study Purpose and Scope and 1.2 Study Goals into a single sub-section – Study Objectives

(2) Move 1.5 Topographic Survey, 1.6 Field Investigation and 1.7 Data Collection into a new section 2.0 Data Collection

(3) Delete 1.3 Deliverables and present contents of this sub-section in various respective sections.

(4) Move 1.10 Modeling Procedures to Section 4.0.

(5) Refer to file attached to this comment named "Recommended Revised Table of Contents" for application to Sections 1.0 through 4.0)

Evaluator: Adam Bier

Evaluation: Check and Resolve

First of all, thank you for the suggestions on reorganizing the report. Many of the suggested comments have been implemented in the Final Report; however, a few of the suggestions were not and reasons will be given in the respective ATR comment sections.

1) Concur; the sections 1.1 and 1.2 have been combined to be a new section titled 1.1 Study Objectives.
2) Concur, the sections regarding survey, field investigation, and data collection has been moved to a new 2.0 Data Collection Section.
3) Non-concur, the deliverables section was added after DQC comments received from the H&H Branch Chief. The goal of this section is to clearly present the deliverables that were included in the PMP.
4) Concur, Modeling Procedures has been moved to Section 5.0 (Now Section 5.1)
5) Thank you for providing the revised Table of Contents.

Back-check: Concur

Status: Closed

Comment Location:	2) Previous Studies	**Reviewer:**	Mike Lin, SPK

Comment: The following sub-sections under Section 2.0 EXISTING HYDROLOGIC DATA:

2.1 Watershed
2.2 Existing Conditions
2.3 Subsidence

Discuss in length about the previous study "Loop 303 Hydrologic Report". All of the contents in the above 3 sub-sections should be placed under Previous Studies in Section 1.0 GENERAL DESCRIPTION OF STUDY.

Evaluator: Adam Bier

Evaluation: Non- Concur, the three sections discuss the previous report's hydrologic data, and a separate section was requested via DQC comments from the H&H Branch Chief. The sections have been moved to become Section 3.1, 3.2, and 3.3 (after creating a new section for Section 2.0 Data Collection). A reference to the hydrologic data section (now 3.0) was added to the short Section 1.4 Previous Studies.

Back-check: Concur

Status: Closed

Comment Location:	3) Watershed Boundary vs. Study Boundary	**Reviewer:**	Mike Lin, SPK

Comment: The study area is a small part of a large watershed. Despite storm water conveyance elements along the periphery of the study area, storm water generated from upstream areas of the watershed could potentially become overland flow into the study area. Revise the Report to clarify that the study includes only flows generated from the rainfall within the study area.

Evaluator: Adam Bier

Evaluation: Concur, the following text was added to the report in new Section 3.2 Existing Storm Water Conveyance Features (3rd paragraph), "The study includes only flows generated from the rainfall within the study area and does not include potential overland flows from the Loop 303 and Northern Parkway Drainage Improvements from the west and north, respectively. See Section 5.3.2 for further discussion regarding rainfall and inflows."

Back-check: Concur

Status: Closed

Comment Location:	4) Section 3.0 Existing Storm Drain System	**Reviewer:**	Mike Lin, SPK

Comment:

Change the title "EXISTING STORM DRAIN SYSTEM" to "EXISTING STORM WATER DRAINAGE SYSTEM"
Move sub-sections 2.4.1, 2.4.2 and 2.4.3 to Section 3.0 under a sub-section name "3.1 Storm Water Conveyance System"
Call the local storm water drain system as sub-section "3.2 Storm Water Sewer System"
Re-name all current sub-sections 3.1.1, 3.1.2, 3.1.3 ...3.1.7 as 3.2.1...3.2.7.

Evaluator: Adam Bier

Evaluation: Check and Resolve
Concur, the title of new Section 4.0 was renamed "EXISTING STORM WATER DRAINAGE SYSTEM." Previous Section 2.4.1, 2.4.2 and 2.4.3 were moved to new Section 4.1 under Section 4.0 "Existing Storm Water Conveyance System". Now 4.1.1, 4.1.2, 4.1.3 and 4.1.4.

Non-concur with proposed title to new Section 4.2. We decided to use the title "Existing Storm Water Drainage System Components." It was requested by Branch Chief DQC to not refer to the storm drains as storm sewers for this project. The component sections were renamed 4.2.1, 4.2.2...4.2.7

Back-check: Concur

Status: Closed

Comment Location:	5) Existing Conditions Flows	**Reviewer:**	Mike Lin, SPK

Comment:

Existing condition flows were cited for Dysart Drain, Bullard Wash and other existing facilities. State in the Report how the existing condition flows were defined.

Evaluator: Adam Bier

Evaluation: Concur, a paragraph was added under new Section 4.1 Existing Storm Water Conveyance System.

"The Loop 303 Hydrologic Report from September 2009 presented information on existing storm water conveyance features in the study area. The results presented in this section were obtained from the HEC-1 model completed as part of the September 2009 Hydrologic Report."

Back-check: Concur

Status: Closed

Comment Location:	6) Floodplain Analysis Using FLO-2D and EPA-SWMM	**Reviewer:**	Mike Lin, SPK
Comment: Move sub-section 1.10 Modeling Procedure to the beginning Section 4.0 as Modeling Procedures			
			Evaluator: Adam Bier
Evaluation: Concur, previous section 1.10 was moved to section 5.1 to precede discussion regarding the FLO-2D and SWMM discussions.			
Back-check: Concur			
Status: Closed			

Comment Location:	7) FLO-2D Justification	**Reviewer:**	Mike Lin, SPK
Comment: ***a.*** In second paragraph, Section 4.1 the sentence "Because the overland flooding is not limited by significant topographic changes (i.e. flat areas) in terms of flow directions FLO-2D was selected to analyze the flooding at Luke AFB" is not a true statement and it should be deleted and/or replaced with something more objective as to why Flo-2d is an appropriate analysis tool for this study. b. Revise the last sentence in the 1st paragraph of Section 4.1 from "FLO-2D is a COE approved model for surface water hydraulic applications." to "FLO-2D is a USACE approved model for surface water hydraulic applications and was selected to analyze the flooding at Luke AFB."			
			Evaluator: Adam Bier
Evaluation: **a.** Concur, the sentence from previous section 4.1 (now 5.2) was removed from the report. **b.** Concur, the sentence (in new section 5.2) was revised to read, "FLO-2D is a USACE approved model for surface water hydraulic applications and was selected to analyze the flooding at Luke AFB."			
Back-check: Concur			
Status: Closed			

Comment Location:	8) Storm Water System: accuracy of SWMM model profiles and pipe sizes	**Reviewer:**	Mike Lin, SPK

Comment:
The Report cited a few questionable segments, however, a cursory check of approximately 1/3 of the drain system data indicates many potentially erroneous pipe profiles and pipe sizes in the EPA SWMM model (see file attached to this comment "Profile_Check.pdf" submitted as preliminary review comment May 22, 2013). Experience indicates that GIS data often contains numerous errors, and is more appropriate for use as an O&M management tool than as a foundation for hydraulic modeling. Addressing this issue requires much more effort than simply adjusting a few profiles identified to-date, and should be well documented for future information and recommendation.

Therefore, the Report should be revised to better document this situation, specifically as regards: a) the model is based on potentially erroneous GIS data (for example, due to incorrect input of field survey data, vertical datum discrepancies, etc); b) whether or not potentially erroneous data has been confirmed; c) the extent of such erroneous data; d) whether or not any erroneous data was corrected; e) potential significance and consequences of such discrepancies to the analysis (assuming it was overlooked in the current analysis); f) how future effort to correct these discrepancies might be significant (i.e. securing accurate as-built drawings, performing additional field surveys, etc); and g) how such effort must be expended prior to future use of the model to simulate actual alternatives for improvement.

Evaluator: Adam Bier

Evaluation: Concur. The following text was added to the introduction of the GIS data, "Some of the elevations for the GIS data points appeared to be consistent with the TIN described below. A select set of inlets were field surveyed, which verified that adverse slopes do occur in the system. The GIS data was used as provided by Luke AFB, but it is recommended that the remainder of the inverts and culverts be re-surveyed to verify the data."

Back-check: Concur

Status: Closed

Comment Location:	9) Infrequent Flood Event	**Reviewer:**	Mike Lin, SPK

Comment:

In general practice, storm water system is analyzed for a minimum of two rainfall events:

(1) 1/10 or 1/15annual chance exceedance event to evaluate the average and more frequent conditions for minimum functionality; and
(2) 1/100 annual chance exceedance event to assess a larger design objective for overall system storage (detention/retention basins) and conveyance capacity.

For infrequent flood events, temporary storage on the streets is considered as an accepted practice if it does not constitute loss of life or significant property damage. Revise the Report to recommend future modeling consider this modeling approach.

Evaluator: Adam Bier

Evaluation: Non- concur. This was a specific study to evaluate the existing flood problems for the 100-year flood event as requested by Luke AFB. There is no intent to provide design information regarding the storm drain system.

Back-check: Concur

Status: Closed

Comment Location:	10) Frequent Flood Event	**Reviewer:**	Mike Lin, SPK

Comment:

The activities at AFB have a much higher probability to be impacted by more frequent flooding than the 1/100 annual chance exceedance event. Experience indicates it is often not cost effective to implement flood protection for the 1/100 event based solely infrequent events for the overall system. The storm water sewer system is therefore, commonly designed to function best for the more frequent flood event. Therefore, to ensure a feasible baseline condition and minimum level of functionality, this study and Report should be revised include the 10- or 15-year rainfall events.

Evaluator: Adam Bier

Evaluation: Non- concur. This was a specific study to evaluate the existing flood problems for the 100-year flood event as requested by Luke AFB. There is no intent to provide design information regarding the storm drain system.

Back-check: Concur

Status: Closed

Comment Location:	11) Maximum Water Depth	**Reviewer:**	Mike Lin, SPK
Comment: Revise titles in Figures 10 through 14 to indicate that the floodplain shown in each of the figure was the maximum water depth for the design 1/100 event (not the depth at any given time).			
			Evaluator: Adam Bier
Evaluation: Concur, the titles of the Figure 10 has been revised to Maximum Flood Depth of 100-Year Design Event vs. FEMA Floodplain. Figures 11-14 have been revised to Maximum Food Depth of 100-Year Design Event.			
Back-check: Concur			
Status: Closed			

Comment Location:	12) Maximum Depth	**Reviewer:**	Mike Lin, SPK
Comment: Define "MAX_Depth" in Column 6, Appendix 1.			
			Evaluator: Adam Bier
Evaluation: Concur, Max_Depth and the other table headings are defined on the page preceding Appendix 1, but a note defining Max_Depth will also be added at the base of each page in the table.			
Back-check: Concur			
Status: Closed			

Comment Location:	13) Assumptions in Boundary Conditions	**Reviewer:**	Mike Lin, SPK
Comment: Report needs to document important assumptions regarding boundary conditions, especially the western boundary (future raised freeway assumed to be raised), and golf course development on the north side assumed to intercepts ALL overland flow from entering the model domain.			
			Evaluator: Adam Bier
Evaluation: Non- Concur, the third paragraph in the section discussing Rainfall and Inflow (new Section 5.3.2) discusses the assumptions regarding the Loop 303 and Northern Parkway drainage improvements as well as the Falcon Dunes Golf Course having a design capacity to convey a 100-year event. Furthermore, discussion regarding the boundary conditions is discussed in section titled Existing Storm Water Conveyance Features (new section 3.2).			
Back-check: Concur			
Status: Closed			

TABLES

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

TABLES

Table 1: Land Use Classifications

Class ID	Class Type	Initial Abstraction (IA)	Percent Impervious (RTIMP)	Vegetative Cover (VC)	Initial Saturation
		(inches)	(percent)	(percent)	
3	Urban High Vegetation	0.1	0	100	normal
5	Urban Low Vegetation	0.1	0	60	normal
9	Urban Bare Ground	0.2	0	0	normal
12	Wash Bottom	0.1	0	0	normal
13	Concrete	0.05	98	0	normal
14	Asphalt	0.05	95	0	normal
15	Buildings	0.05	95	0	normal
16	Shade Structures	0.05	98	0	normal
17	Water	0	100	0	saturated
18	Swimming Pools	0	100	0	saturated
21	Unpaved Road	0.1	50	0	normal
22	Agricultural	0.5	0	85	normal

Table 2: Rainfall Distribution

Time (hrs)	Pattern 1 Distribution	Cumulative Rainfall (inches)
0.00	0.000	0.000
0.25	0.008	0.019
0.50	0.016	0.038
0.75	0.025	0.060
1.00	0.033	0.079
1.25	0.041	0.098
1.50	0.050	0.120
1.75	0.058	0.139
2.00	0.066	0.158
2.25	0.074	0.178
2.50	0.087	0.209
2.75	0.099	0.238
3.00	0.118	0.283
3.25	0.138	0.331
3.50	0.216	0.518
3.75	0.377	0.905
4.00	0.834	2.002
4.25	0.911	2.186
4.50	0.931	2.234
4.75	0.950	2.280
5.00	0.962	2.309
5.25	0.972	2.333
5.50	0.983	2.359
5.75	0.991	2.378
6.00	1.000	2.400
Notes:		
1. Total rainfall is 2.4 inches at Luke AFB according to Figure A.58 from the *Drainage Design Manual for Maricopa County*		
2. A Pattern 1 distribution was used		

Table 3: Hydraulic Structures (Culvert Descriptions)

Structure ID	Culvert Entrance Description	Location	# Culverts	Culvert Size	Culvert Size Source	Culvert Shape	Culvert Material	Culvert Length (feet)
1	Headwall with Flared Wing Walls	Travels south beneath Super Sabre Street approximately 200ft west of Super Sabre St entrance gate	2	5 Ft W 4.25 Ft H	COE Survey	Box	RC	85
2*	Flared Wing Walls and Trash Racks	Travels N-S beneath Super Sabre Street approximately 630ft west of N 143rd Dr and 230ft east of Shubin Lane.	2	6 Ft W 4 Ft H	COE Survey	Box	RC	93
3	Projected Out From Fill	Travels N-S beneath Super Sabre Street approximately 840ft west of 146th Dr along Super Sabre St	1	60-in	COE Survey	Circular	CM	815
4	Mitered to Conform to Slope	Travels N-S, connecting the two detention basins near the airfield	1	36-in	COE Survey	Circular	RC	240
5	Square Edge Entrance with Headwall	Travels W-E, draining an open ditch, north of Lightning St., underneath a parking lot and into Dysart Drain.	4	30-in	Luke GIS	Circular	RC	565
6	Square Edge Entrance with Headwall	Travels southwest beneath Strike Eagle Street near N Ammo Rd.	2	40-in	COE Survey	Circular	RC	63
7*	Square Edge Entrance with Headwall, Trash Racks	Travels southwest beneath N Ammo Rd just north of Tiger St	3	6 Ft W 4 Ft H	COE Survey	Box	RC	55
8**	Projected Out From Fill	Travels south beneath Strike Eagle Street approximately 550 feet west of N. Ammo Road	3	96-in	COE Survey	Circular	CM	45
9	Projected Out From Fill	Travels southwest beneath Strike Eagle Street approximately 45 feet east of Super Sabre Street	1	84 in	COE Survey	Circular	CM	60
10	Headwall with Flared Wing Walls	Travels southwest beneath Access Road alongside Super Sabre Street approximately 690 feet south of Strike Eagle Street	1	60-in	COE Survey	Circular	RC	25
11	Headwall with Flared Wing Walls	Travels west beneath 143rd Dr on the north side of Super Sabre St	1	24-in	COE Survey	Circular	CM	268
12	Square Edge Entrance with Headwall	Travels west beneath driveway on the north side of Super Sabre St, about 620 feet east of 143rd Dr.	2	18- in	COE Survey	Circular	RC	90
13	Square Edge Entrance with Headwall	Travels west beneath 142nd drive alongside Super Sabre Street	1	18-in	COE Survey	Circular	RC	53
14	Square Edge Entrance with Headwall	Travels south beneath driveway on the west side of 142nd, approximately 100 feet north of Super Sabre St	1	12-in	COE Survey	Circular	RC	86

Table 3: Hydraulic Structures (Culvert Descriptions) - Continued

Structure ID	Culvert Entrance Description	Location	# Culverts	Culvert Size	Culvert Size Source	Culvert Shape	Culvert Material	Culvert Length (feet)
15	Square Edge Entrance with Headwall	Travels west beneath Johnson Drive, north of Super Sabre Street	1	18-in	COE Survey	Circular	RC	51
16	18 in CMP Mitered to Conform to Slope, 2 x 12 in RCP with Square Edge Headwall	Travels west beneath driveway, West of 146th, along Super Sabre Street	3	1 x 18 in 2 x 12 in	COE Survey	Circular	CM	45
17	Mitered to Conform to Slope	Travels west beneath 146th along Super Sabre Street	1	36-in	COE Survey	Circular	CM	55
18	Mitered to Conform to Slope	Travels west beneath driveway along Super Sabre Street (200 feet east of Ammo Road)	1	36-in	COE Survey	Circular	CM	28
19	Mitered to Conform to Slope	Travels west beneath driveway along Super Sabre Street (350 feet east of Ammo Road)	1	18-in	COE Survey	Circular	CM	40
20	Mitered to Conform to Slope	Travels west beneath Tovrea Drive (450 ft north of Super Sabre Street)	1	18-in	Luke GIS	Circular	CM	54
21	Mitered to Conform to Slope	Travels west beneath driveway (450 ft north of Super Sabre Street between 145th and 146th Drive)	1	18-in	Luke GIS	Circular	CM	20
22	Mitered to Conform to Slope	Travels west beneath 145th Drive just north of Super Sabre Street	1	18-in	COE Survey	Circular	CM	72
23	Projected Out From Fill	Travels west beneath driveway along Super Sabre Street 450 ft east of 143rd Drive	2	18-in	COE Survey	Circular	CM	43
24	Square Edge Entrance with Headwall	Travels west beneath North Ammo Drive just south of Tiger Street	2	24-in	Luke GIS	Circular	RC	50
25	Square Edge Entrance with Headwall	Travels north beneath berm near intersection of Ammo Drive and Tiger Street	2	24-in	Luke GIS	Circular	RC	22
26	Square Edge Entrance with Headwall	Travels west beneath Torvea Street North of Tiger Street	1	72-in W 36 in H	Luke GIS	Semi-Circular	CM	54
27	Square Edge Entrance with Headwall	Travels west beneath Torvea Street South of Texan Street	1	4 Ft W 2 Ft H	Luke GIS	Box	RC	41

Notes:

See Plates 10-14 for Hydraulic Structure Locations

CM - Corrugated Metal

RC - Reinforced Concrete

*Indicates Trash Rack; Culvert area decreased by 50%

**3 x 96-inch culverts blocked by sediment, culverts modeled as 96-inch with 50% sediment. Invert of pipe assumed 4 ft lower than TIN elevations

Culvert Length Measured using GIS

Table 4: Hydraulic Structures (Elevations)

Structure ID	Location	# Culverts	FLO-2D Grid Element Number		Invert Elevation (NAVD 88)		Elevation Source	Approx. Max Discharge[1] (cfs)
			Inlet	Outlet	Inlet	Outlet		
1	Travels south beneath Super Sabre Street approximately 200ft west of Super Sabre St entrance gate	2	313401	318266	1076.87 1076.87	1076.70 1076.70	Inlet: COE Outlet: TIN	36
2*	Travels N-S beneath Super Sabre Street approximately 630ft west of N 143rd Dr and 230ft east of Shubin Lane	2	311338	315230	1065.96 1065.87	1064.93 1065.25	Inlet: COE Outlet: Luke	330
3	Travels N-S beneath Super Sabre Street approximately 840ft west of 146th Dr along Super Sabre St	1	309294	315103	1062.68	1061.97	Inlet: COE Outlet: COE	175
4	Travels N-S, connecting the two detention basins near the airfield	1	199457	209191	1069.71	1069.61	Inlet: COE Outlet: COE	50
5	Travels W-E, draining an open ditch, north of Lightning St., underneath a parking lot and into Dysart Drain	4	96136	93215	1076.91 1077.20 1076.91 1076.87	1070.42 1070.37 1070.45 1070.50	Inlet: Luke Outlet: Luke	93
6	Travels southwest beneath Strike Eagle Street near N Ammo Rd.	2	363279	366245	1061.59 1061.56	1061.92 1061.45	Inlet: COE Outlet: COE	130
7*	Travels southwest beneath N Ammo Rd just north of Tiger St	3	395904	395901	1061.15 1061.11 1061.13	1060.69 1060.69 1060.69	Inlet: COE Outlet: TIN	325
8**	Travels south beneath Strike Eagle Street approximately 550 feet west of N. Ammo Road	3	363249	365475	1060.96 1060.96 1060.96	1060.75 1060.75 1060.75	Inlet: TIN Outlet: TIN	82
9	Travels southwest beneath Strike Eagle Street approximately 45 feet east of Super Sabre Street	1	332761	334243	1063.24	1062.6	Inlet: COE Outlet: COE	255
10	Travels southwest beneath Access Road alongside Super Sabre Street approximately 690 feet south of Strike Eagle Street	1	347582	349064	1063.39	1063.3	Inlet: TIN Outlet: TIN	140
11	Travels west beneath 143rd Dr on the north side of Super Sabre St	1	310393	311354	1074.52	1072.72	Inlet: Luke Outlet: COE	17
12	Travels west beneath driveway on the north side of Super Sabre St, about 620 feet east of 143rd Dr.	2	311392	311387	1077.18 1077.18	1077.15 1077.15	Inlet: TIN Outlet: TIN	16
13	Travels west beneath 142nd drive alongside Super Sabre Street	1	311411	311408	1078.22	1078.15	Inlet: TIN Outlet: TIN	9
14	Travels south beneath driveway on the west side of 142nd, approximately 100 feet north of Super Sabre St	1	306543	311408	1079.62	1078.72	Inlet: TIN Outlet: TIN	3
15	Travels west beneath Johnson Drive, north of Super Sabre Street	1	312412	312409	1078.66	1078.29	Inlet: COE Outlet: Luke	9

Table 4: Hydraulic Structures (Elevations) - Continued

Structure ID	Location	# Culverts	FLO-2D Grid Element Number		Invert Elevation (NAVD 88)		Elevation Source	Approx. Max Discharge[1] (cfs)
			Inlet	Outlet	Inlet	Outlet		
16	Travels west beneath driveway, West of 146th, along Super Sabre Street	3	309313	309311	1065.64 1066.68 1066.68	1065.51 1066.21 1066.21	Inlet: TIN Outlet: TIN	20
17	Travels west beneath 146th along Super Sabre Street	1	309329	309326	1065.9	1065.46	Inlet: COE Outlet: COE	30
18	Travels west beneath driveway along Super Sabre Street (200 feet east of Ammo Road)	1	310314	310312	1067.19	1067.08	Inlet: COE Outlet: COE	25
19	Travels west beneath driveway along Super Sabre Street (350 feet east of Ammo Road)	1	310320	310318	1067.38	1067.12	Inlet: COE Outlet: COE	9
20	Travels west beneath Tovrea Drive (450 ft north of Super Sabre Street)	1	291838	293782	1068.84	1068.25	Inlet: TIN Outlet: TIN	9
21	Travels west beneath driveway (450 ft north of Super Sabre Street between 145th and 146th Drive)	1	294749	294747	1067.91	1068.02	Inlet: TIN Outlet: TIN	8
22	Travels west beneath 145th Drive just north of Super Sabre Street	1	310338	310335	1071.81	1069.56	Inlet: TIN Outlet: COE	2
23	Travels west beneath driveway along Super Sabre Street 450 ft east of 143rd Drive	2	311382	311380	1076.92	1076.55	Inlet: TIN Outlet: TIN	17
24	Travels west beneath North Ammo Drive just south of Tiger Street	2	399609	399606	1062.36 1062.37	1061.44 1061.50	Inlet: Luke Outlet: Luke	85
25	Travels north beneath berm near intersection of Ammo Drive and Tiger Street	2	401091	399609	1062.82 1062.95	1062.65 1062.71	Inlet: Luke Outlet: Luke	35
26	Travels west beneath Torvea Street North of Tiger Street	1	394454	394451	1067.82	1067.59	Inlet: Luke Outlet: Luke	27
27	Travels west beneath Tovrea Street South of Texan Street	1	385562	385559	1068.81	1068.54	Inlet: Luke Outlet: Luke	15

Notes:

See Plates 10-14 for Hydraulic Structure Locations

Elev. Source: COE = Data from COE spot survey, completed Dec 2012; Luke = Data from Luke AFB GIS Geodatabase; TIN = Data from Luke TIN surface

* Indicates Trash Rack; Culvert area decreased by 50%

**3 x 96-inch culverts blocked by sediment, culverts modeled as 96-inch with 50% sediment (Invert of pipe assumed 4 ft lower than TIN elevations)

1. Approximate Maximum Discharge (cfs) through hydraulic structure during FLO-2D 12-hour simulation of the 6-hour local storm with 100-year frequency

Table 5: Floodplain Cross-Sections

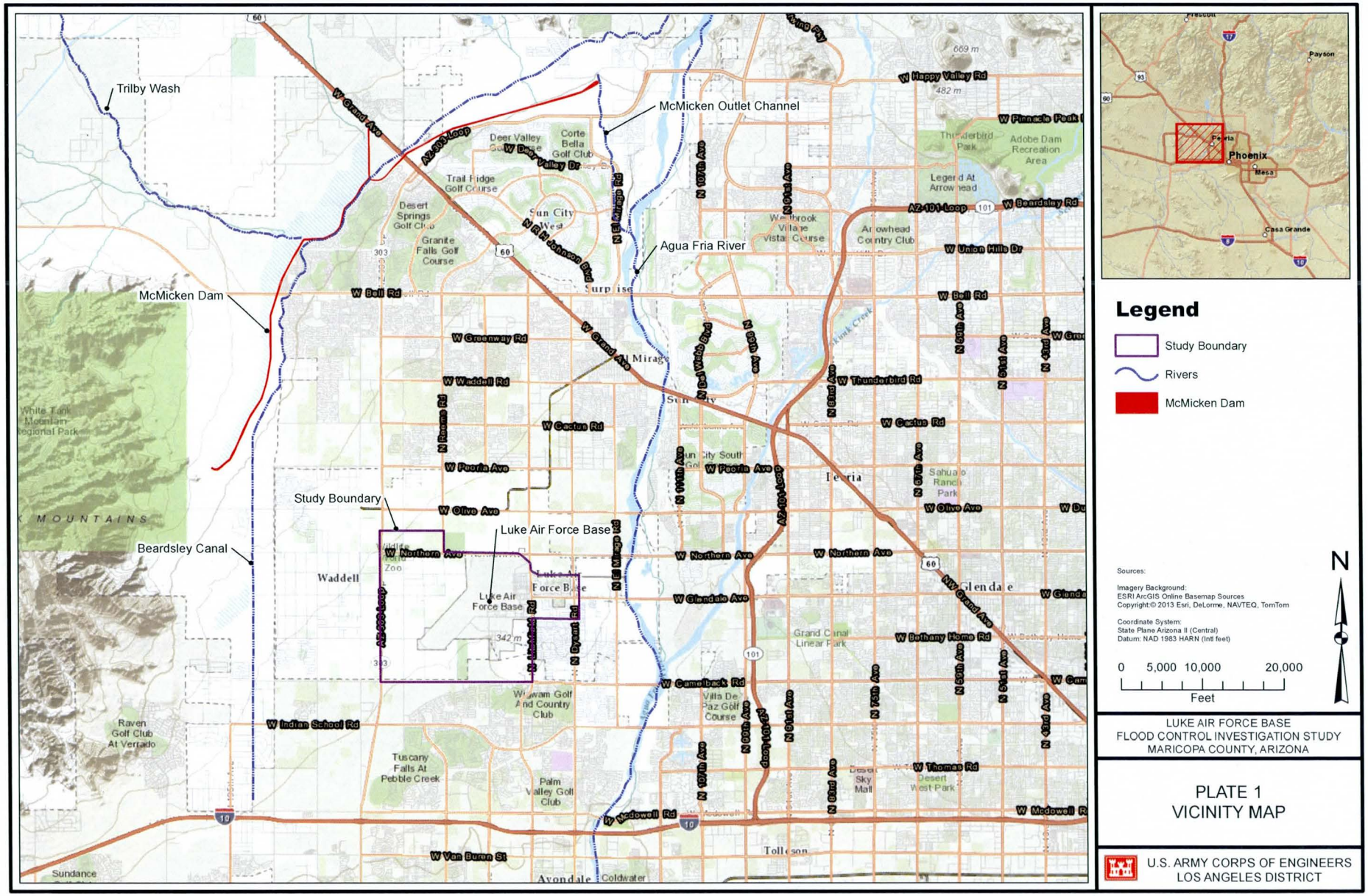
Cross Section	Reference Plate	Location / Description	Flow Direction	# Elements in Cross-section	Grid Cell	Approx. Max Discharge[3] (cfs)
1	14	Upstream from HS-5	East	7	97607	100
2	14	Across Thunderbird Street near Commisary Road	West	14	173381	25
3	14	Across parking lot between Commisary Road and N 138th Ave, north of Thunderbird Street	Northwest	19	163621	35
4	14	Across parking lot between Commisary Road and N 138th Ave, north of Thunderbird Street	Northwest	8	142222	20
5	14	Across airfield parking ramp (Major Flooded Area 1)	South	14	179053	55
6	14	Across airfield parking ramp (Major Flooded Area 1)	South	16	200457	55
7	14	Across airfield parking ramp (Major Flooded Area 1)	South	18	214078	80
8	14	Across airfield parking ramp (Major Flooded Area 1)	South	30	225750	40
9	14	Across airfield parking ramp (Major Flooded Area 1)	South	27	236455	45
10	14	Upstream from HS-8 (Airfield North Detention Basin)	Southeast	13	204315	465
11	14	Downstream from HS-8 (Airfield South Detention Basin)	South	9	210159	220
12	11	Across airfield parking ramp (Major Flooded Area 2)	West	10	262654	5
13	10	Airfield drainage path west of runway	Southwest	21	269247	335
14	10	Airfield drainage path west of runway	Southwest	20	301326	380
15	10	Airfield drainage path west of runway	Southwest	18	356310	270
16	10	Airfield drainage path east of runway	Northeast	9	406814	550
17	13	Airfield drainage path before Falcon Golf Course breakout	East	9	386856	585
18	13	Falcon Golf Club breakout	South	14	393528	135
19	13	Airfield drainage path after Falcon Golf Course breakout	East	4	389112	75
20	13	Airfield drainage path east of Falcon Golf Course	Southeast	5	409901	70
21	11	Upstream from HS-16	West	4	310294	40
22	11	Upstream from HS-3	South	9	308315	210
23	11	Downstream from HS-3	Southwest	4	314128	75
24	13	Upstream from HS-9	Southwest	3	331277	45
25	13	Downstream from HS-9	Southwest	3	334241	35
26	13	Upstream from HS-10	Southwest	3	345357	30
27	13	Across drainage along Super Sabre St before Golf Course	Southeast	4	386120	95
28	13	Upstream from HS-8	South	40	361747	60
29	13	Downstream from HS-8	South	40	369909	75
30	12	Upstream from HS-2	West	5	308422	130

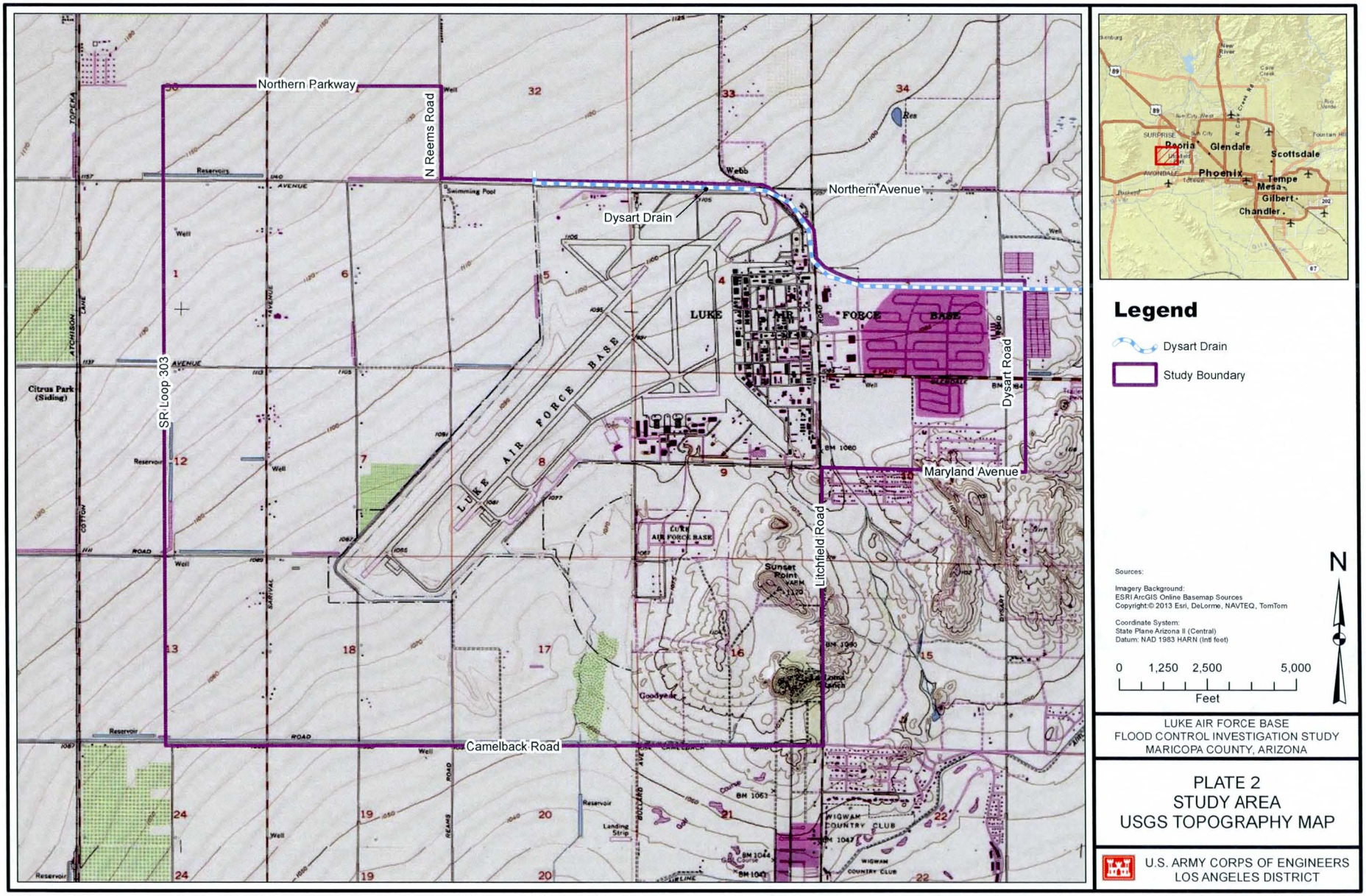
Table 5: Floodplain Cross-Sections (continued)

Cross Section	Reference Plate	Location / Description	Flow Direction	# Elements in Cross-section	Grid Cell	Approx. Max Discharge[3] (cfs)
31	12	Downstream from HS-2	South	8	318145	110
32	13	Upstream from HS-6	West	5	359577	255
33	13	Downstream from HS-6	South	6	369210	205
34	13	Upstream from HS-7	South	5	390718	170
35	13	Downstream from HS-7	Southwest	7	397374	145
36	10	Bullard Wash (2600 ft upstream from Camelback Road)	Southwest	5	473652	325
37	10	Bullard Wash (1400 ft upstream from Camelback Road)	South	9	509258	320
38	10	Bullard Wash (300 ft upstream from Camelback Road)	South	12	540427	320
39	10	Bullard Wash (50 ft upstream from Camelback Road)	South	8	547114	345
40	12	Upstream from HS-1	Southwest	5	309509	15
41	12	Downstream From HS-1	South	6	320166	20
42	12	Drainage upstream from N. Litchfield Conveyance Channel	Southeast	21	362714	130
43	10	Dale Creek Wash	South	9	315392	20

Notes:

1. See Plates 10-14 for Floodplain Cross-Section Locations.
2. Grid Cell indicates first grid cell listed on FPSEC.DAT
3. Maximum discharge across floodplain cross-section according to FLO-2D 12-hour simulation of 6-hour storm, 100-year frequency

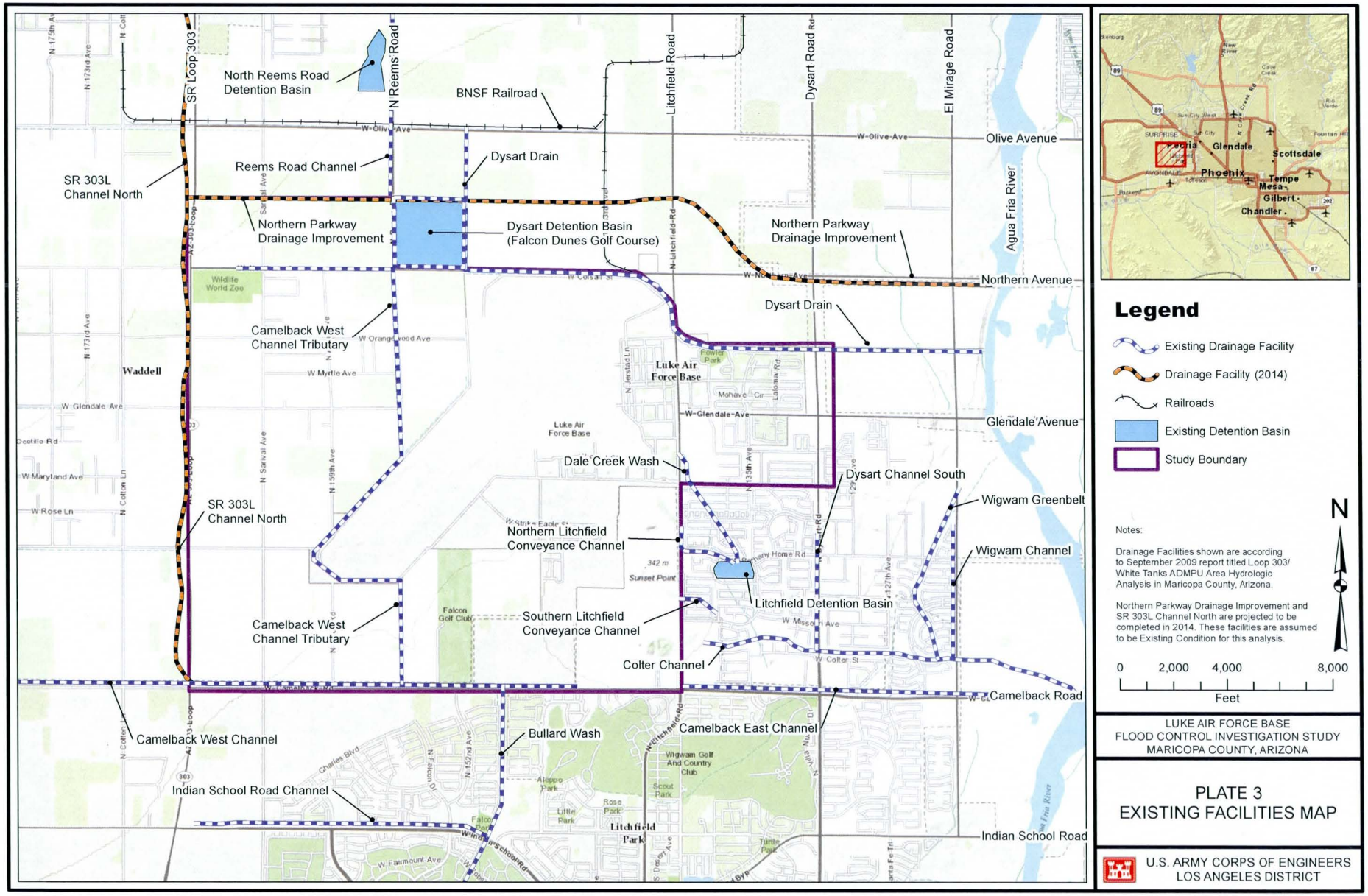

Trilby Wash
McMicken Outlet Channel
McMicken Dam
Agua Fria River
Study Boundary
Luke Air Force Base
Beardsley Canal
Legend
Study Boundary
Rivers
McMicken Dam
Sources:
Imagery Background:
ESRI ArcGIS Online Basemap Sources
Copyright:© 2013 Esri, DeLorme, NAVTEQ, TomTom
Coordinate System:
State Plane Arizona II (Central)
Datum: NAD 1983 HARN (Intl feet)
0 5,000 10,000 20,000
Feet
N
LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA
PLATE 1
VICINITY MAP
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 2
STUDY AREA
USGS TOPOGRAPHY MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Existing Drainage Facility
- Drainage Facility (2014)
- Railroads
- Existing Detention Basin
- Study Boundary

N

Notes:

Drainage Facilities shown are according to September 2009 report titled Loop 303/ White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona.

Northern Parkway Drainage Improvement and SR 303L Channel North are projected to be completed in 2014. These facilities are assumed to be Existing Condition for this analysis.

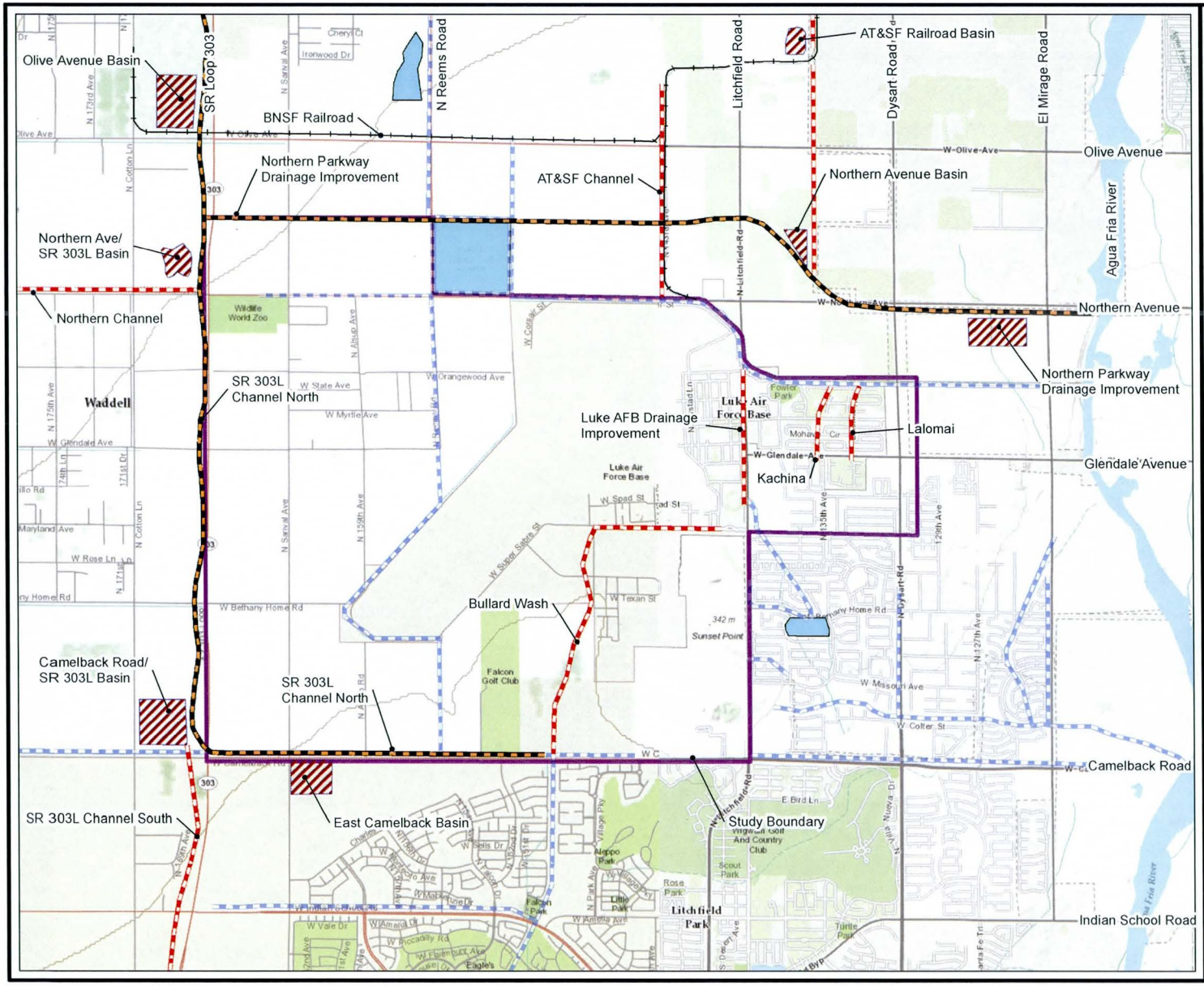
0 2,000 4,000 8,000

Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 3
EXISTING FACILITIES MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Drainage Facility (2014)
- Future Drainage Facility
- Existing Drainage Facility
- Railroads
- Existing Detention Basin
- Future Detention Basin
- Study Boundary

N

Notes:
Drainage Facilities shown are according to September 2009 report titled Loop 303/ White Tanks ADMPU Area Hydrologic Analysis in Maricopa County, Arizona.

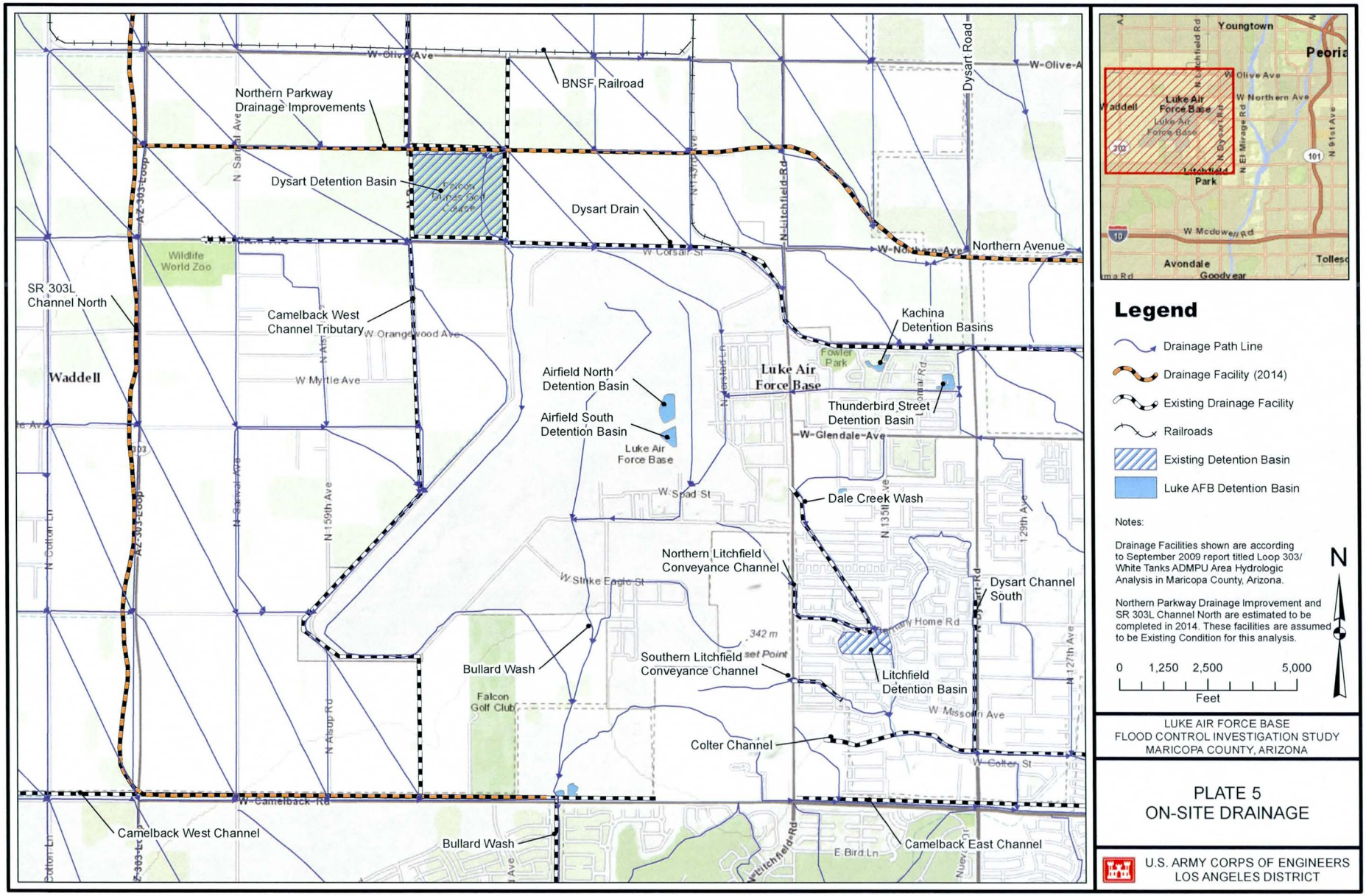
Northern Parkway Drainage Improvement and SR 303L Channel North are estimated to be completed in 2014. These facilities are assumed to be Existing Condition for this analysis. The final locations and configurations of the basins may not correspond directly to what is depicted in the Figure.

0 2,000 4,000 8,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 4
CAPITAL IMPROVEMENT PROJECTS MAP

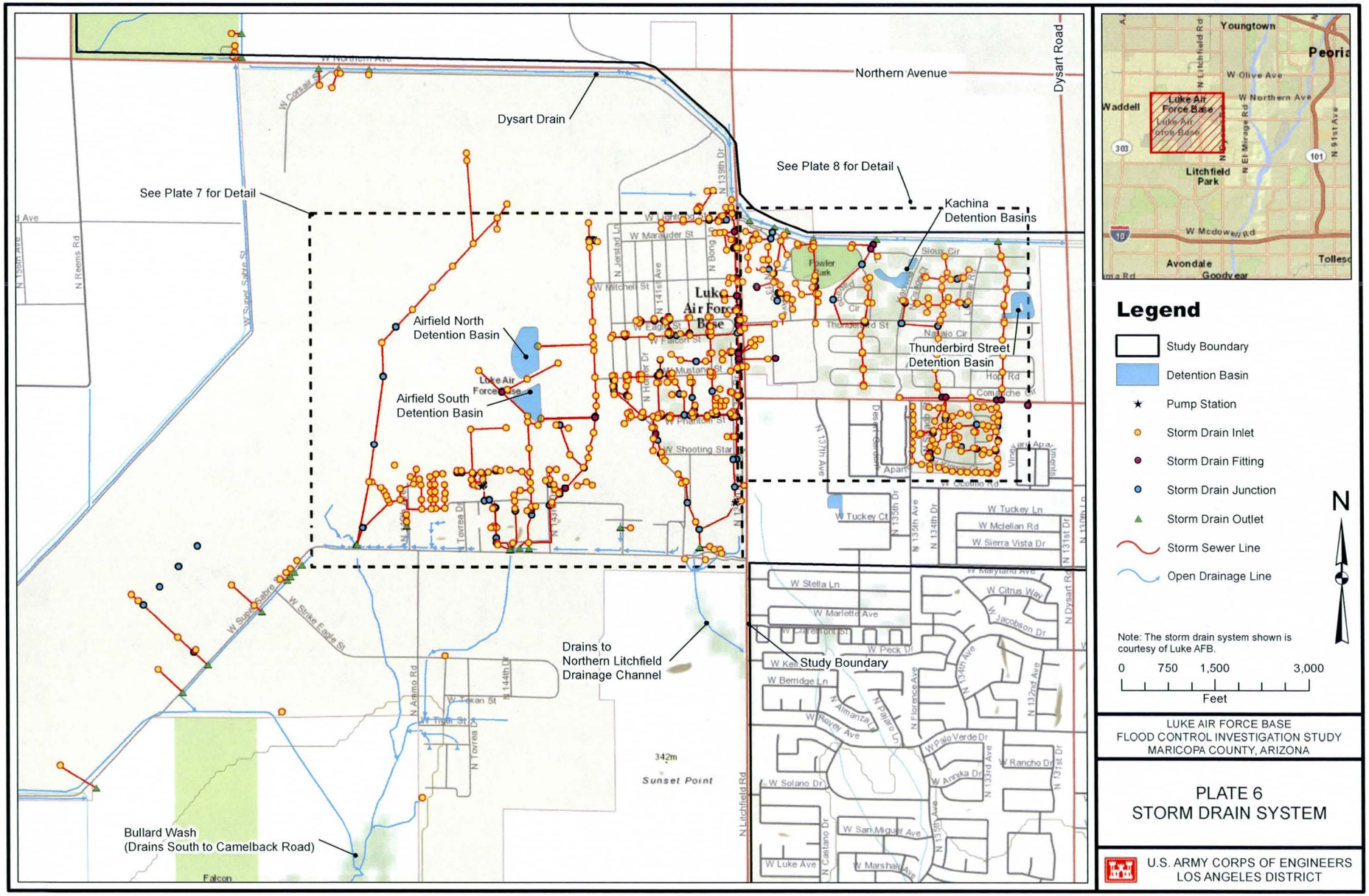
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 5
ON-SITE DRAINAGE

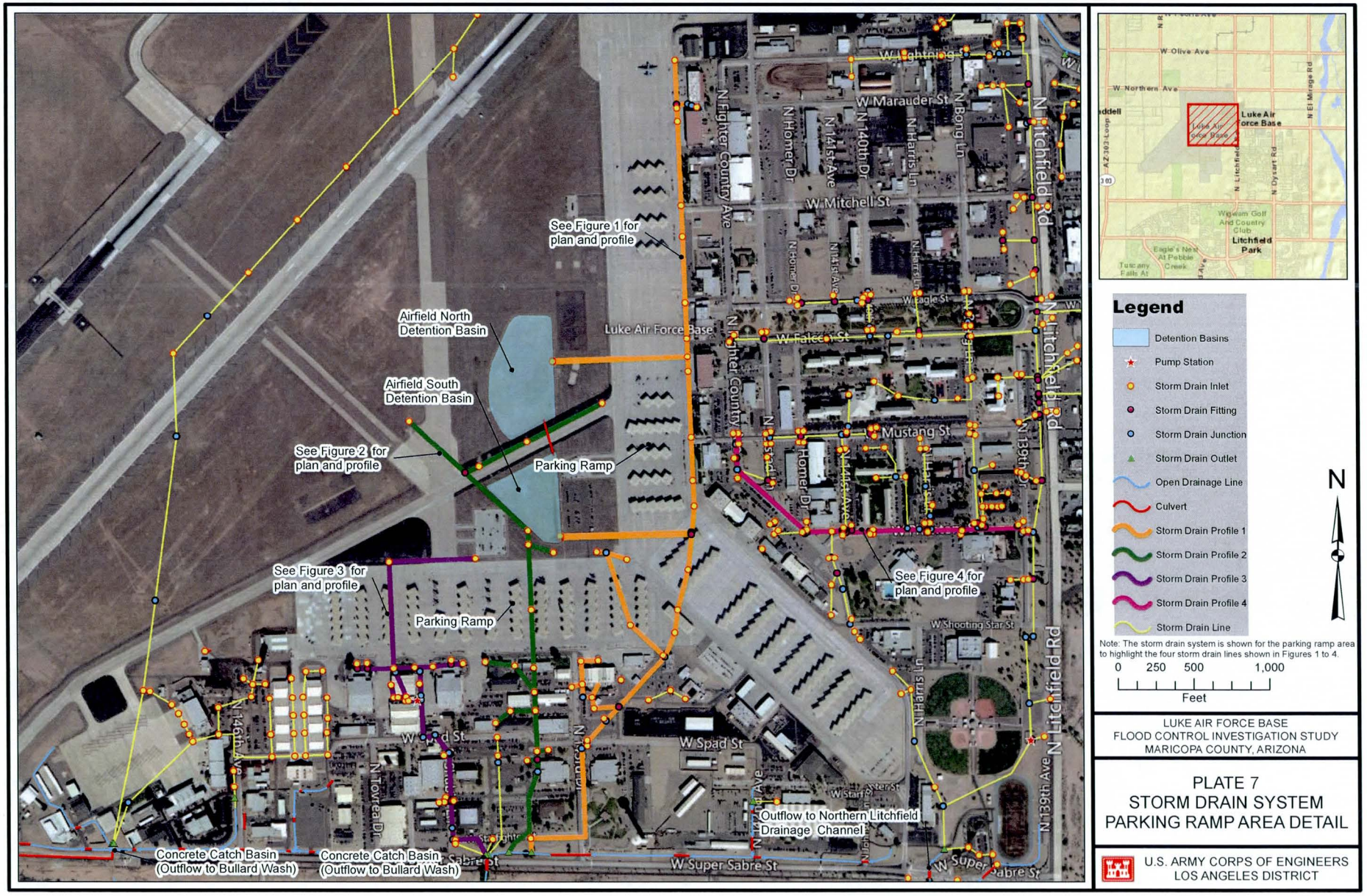
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 6
STORM DRAIN SYSTEM

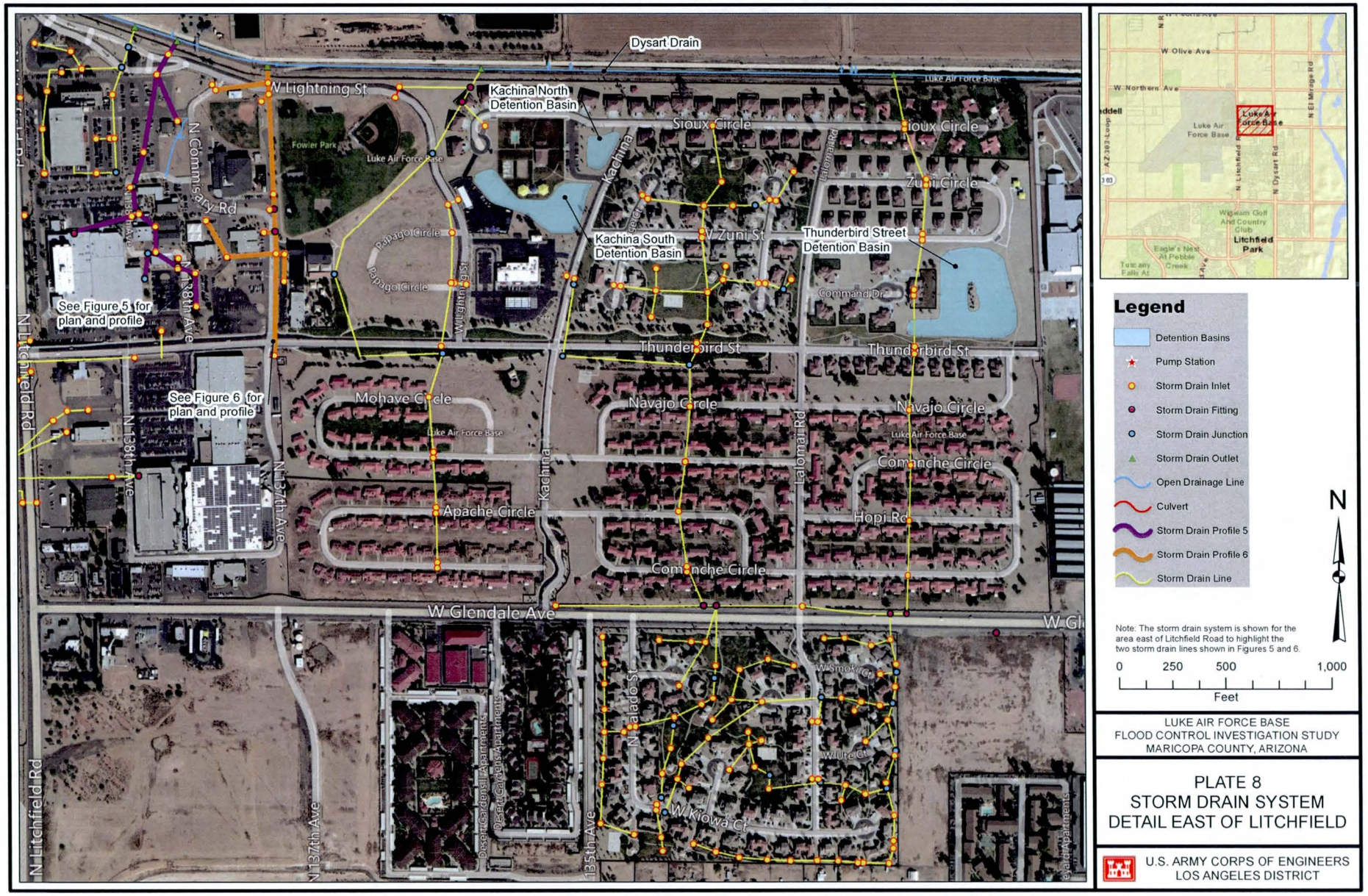
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 7
STORM DRAIN SYSTEM
PARKING RAMP AREA DETAIL

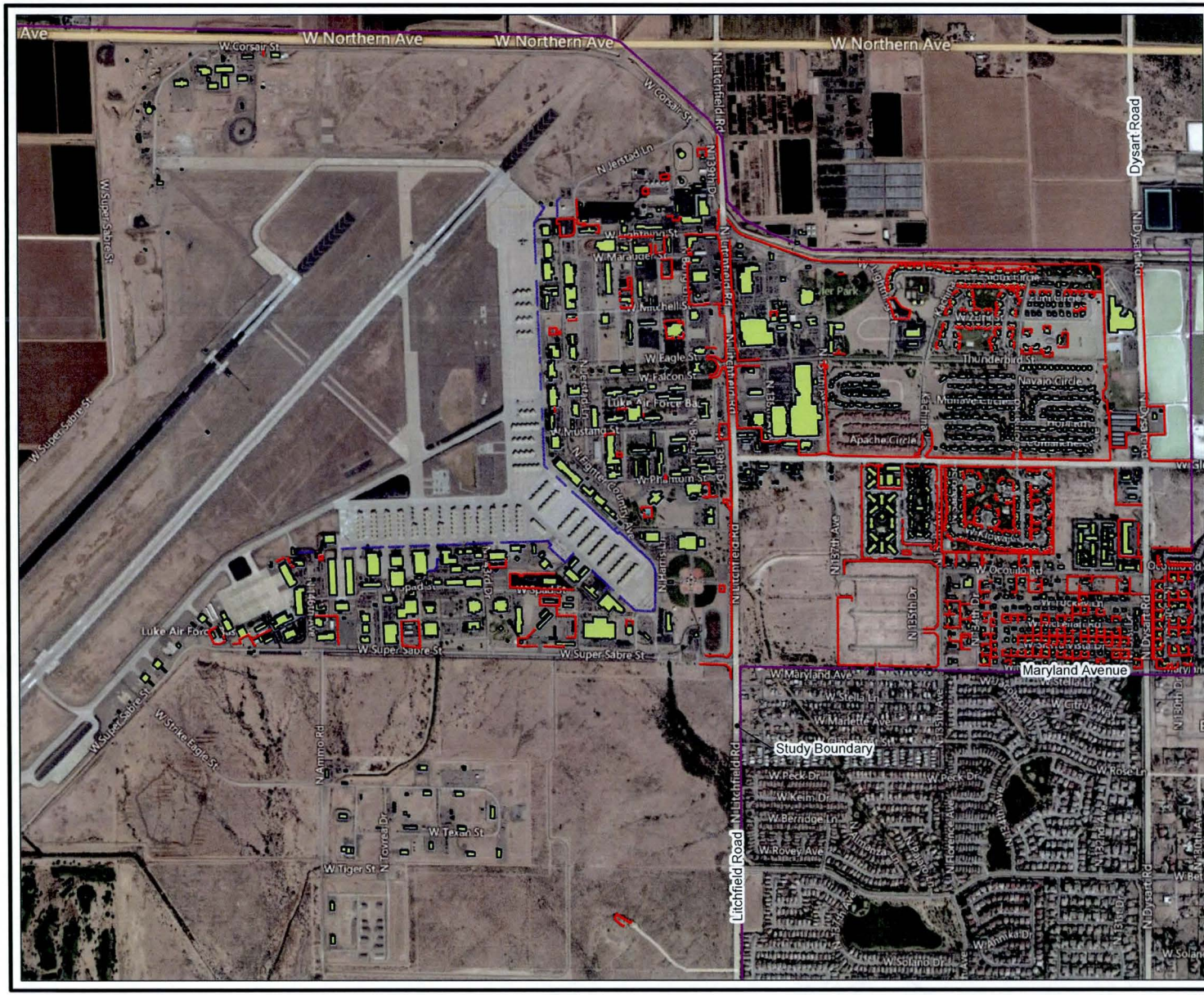
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 8
STORM DRAIN SYSTEM DETAIL EAST OF LITCHFIELD

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- *Levees - Jersey Barriers
- *Levees - Base Walls
- Buildings
- Study Boundary

N

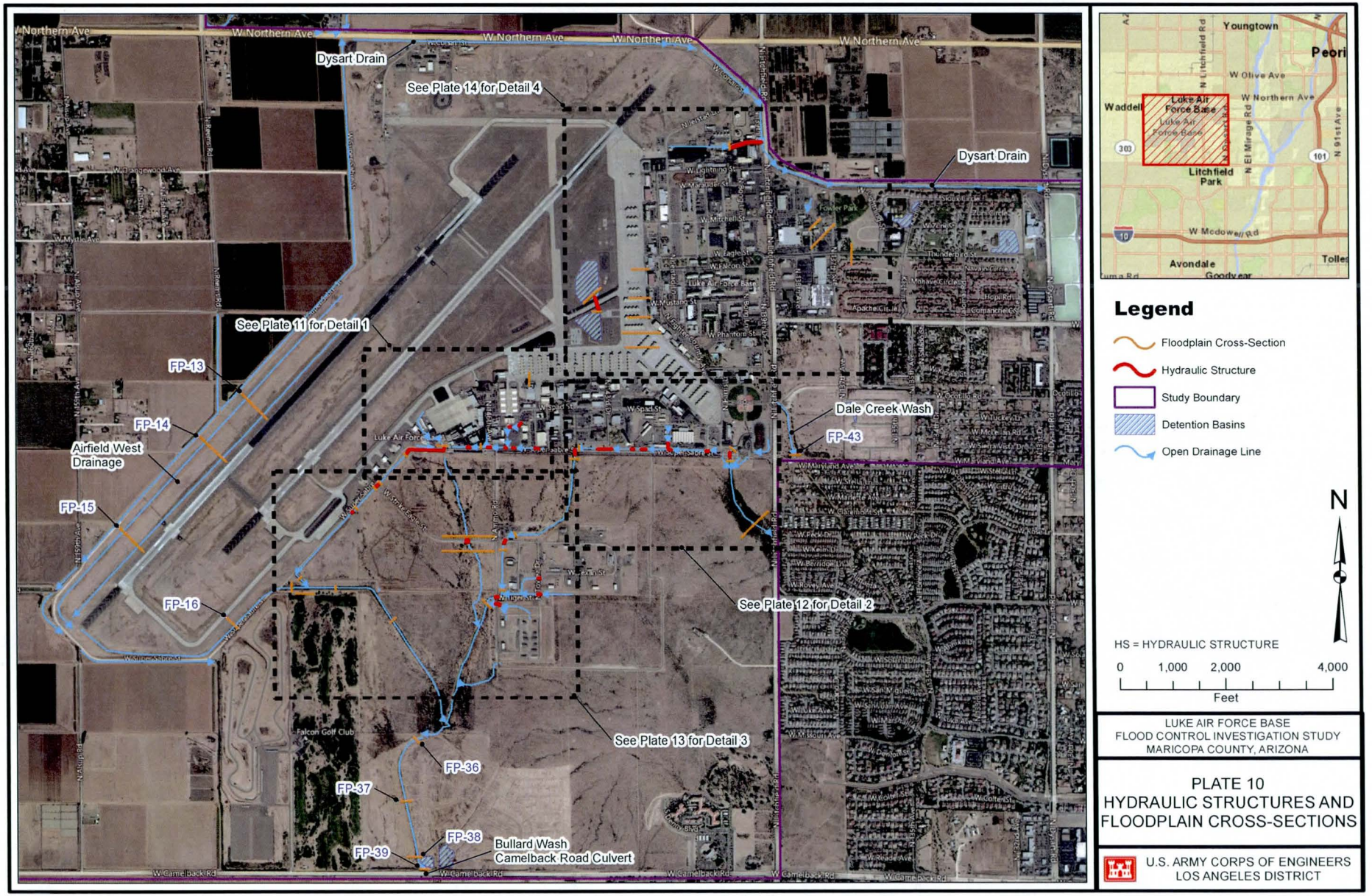
*Levees in the Luke AFB FLO-2D model do not represent actual certified levees. Levees represent walls on the base and Jersey Barriers.

0 750 1,500 3,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 9
FLO-2D COMPONENTS
BUILDINGS AND LEVEES*

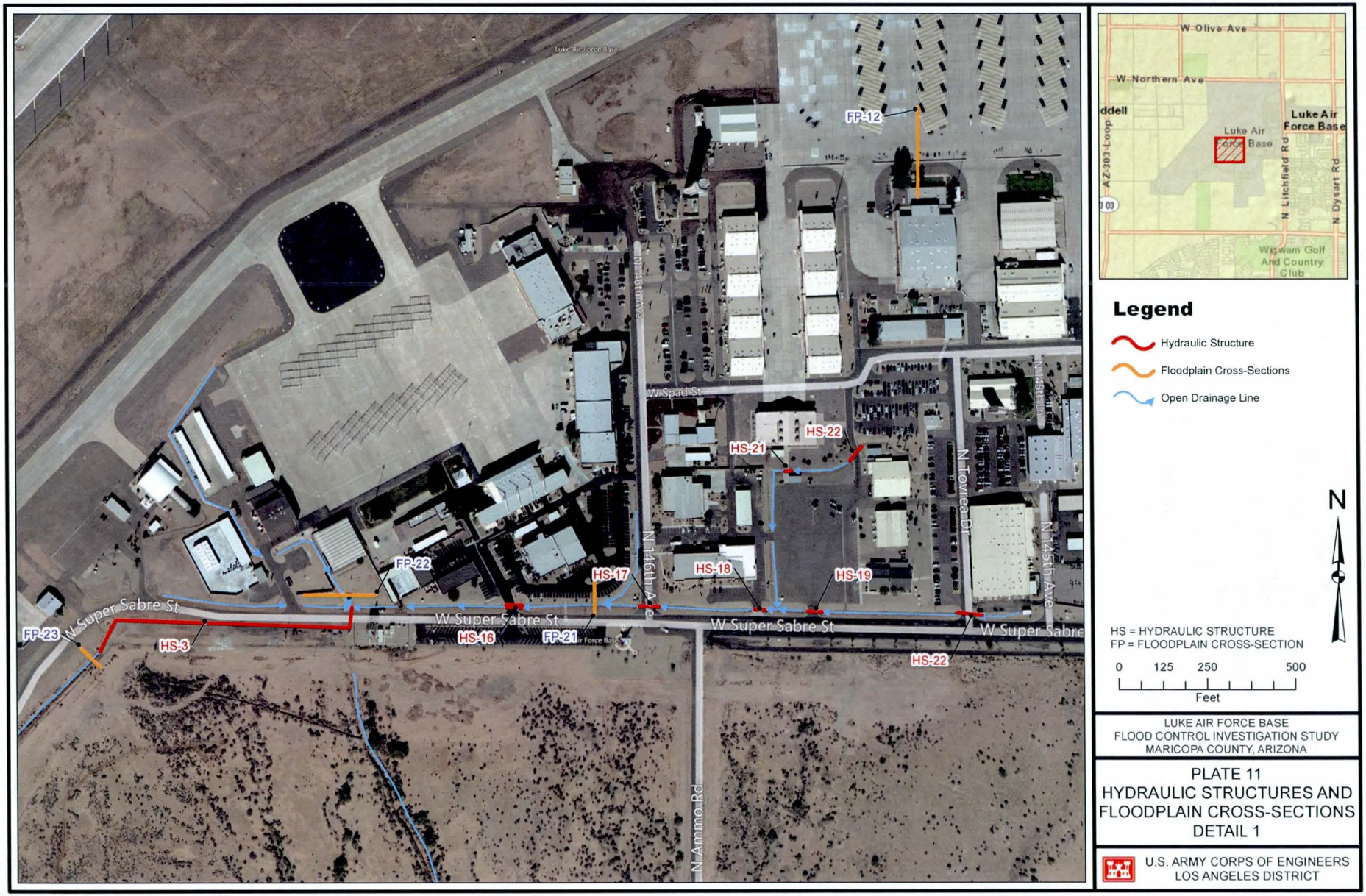
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 10
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 11
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 1

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Legend

- Hydraulic Structure
- Floodplain Cross-Section
- Open Drainage Line

N

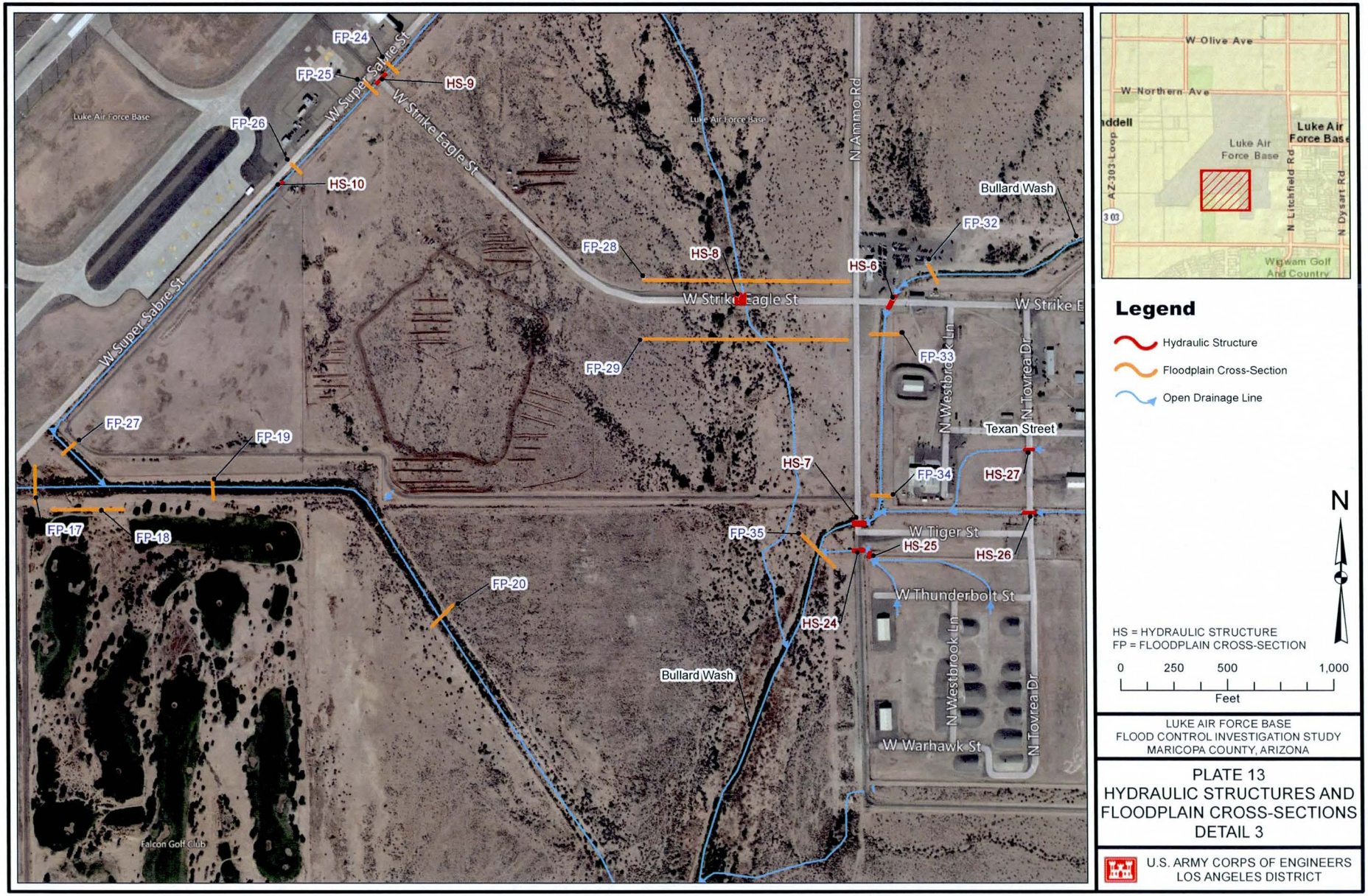
HS = HYDRAULIC STRUCTURE
FP = FLOODPLAIN CROSS-SECTION

0 125 250 500
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 12
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 2

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 13
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 3

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

Legend

- Hydraulic Structure
- Floodplain_Cross_Sections
- Detention Basins
- Open Drainage Line

N

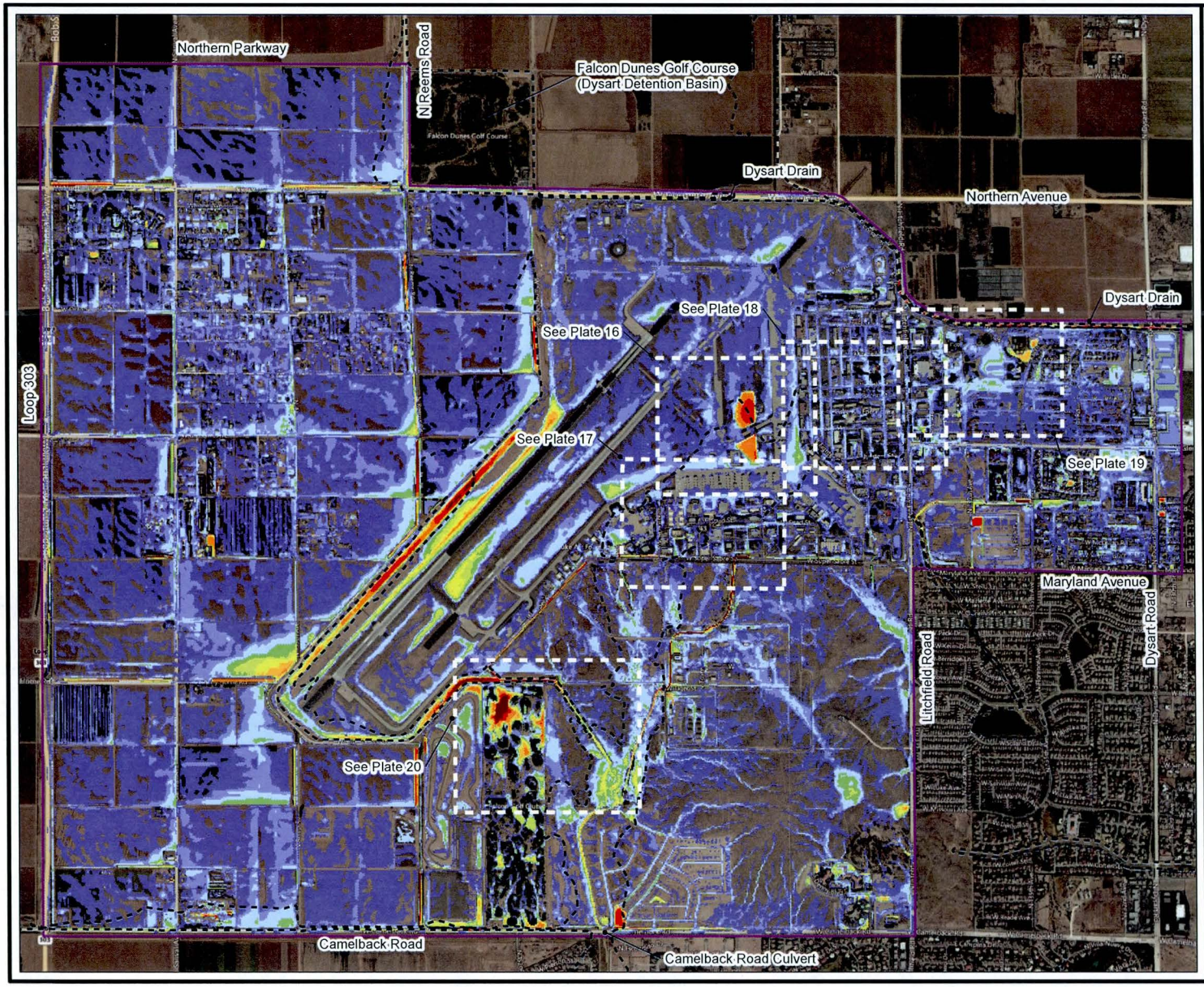
HS = HYDRAULIC STRUCTURE
FP = FLOODPLAIN CROSS-SECTION

0 250 500 1,000
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 14
HYDRAULIC STRUCTURES AND FLOODPLAIN CROSS-SECTIONS DETAIL 4

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

FEMA 100-Year Flood Zone

Study Boundary

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

0 1,000 2,000 4,000

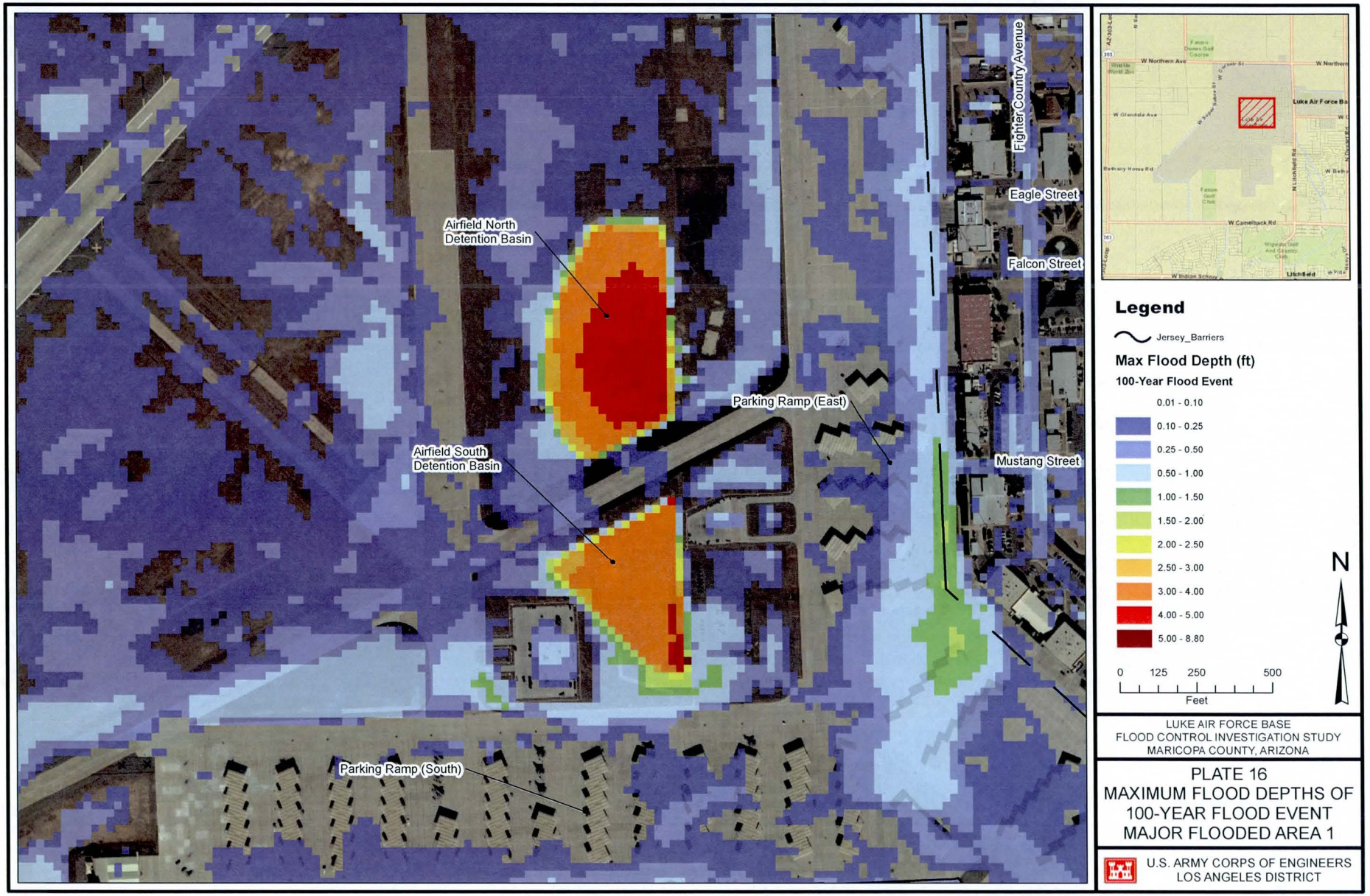
Feet

N

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 15
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT AND FEMA FLOODPLAIN

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

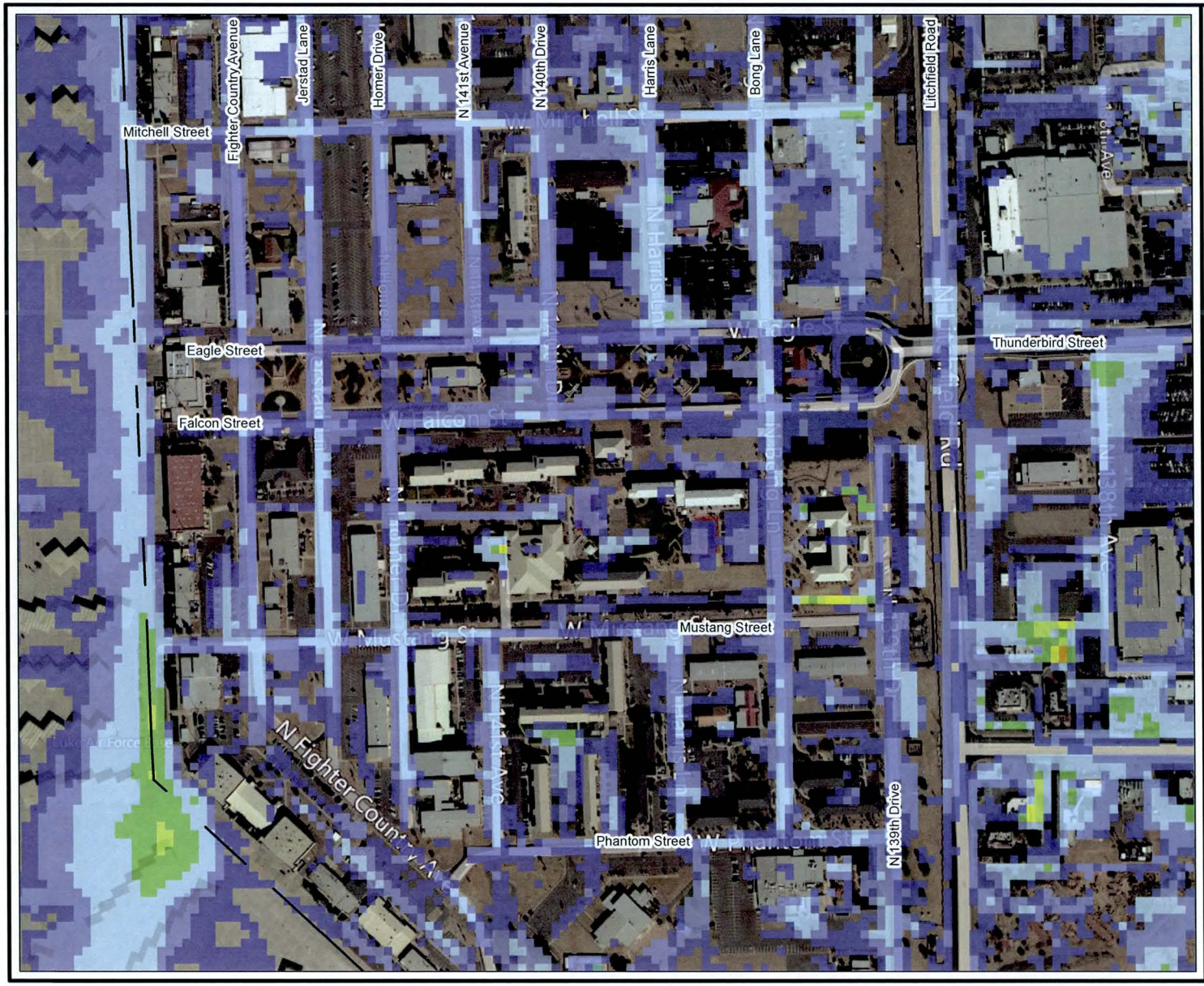
PLATE 16
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT MAJOR FLOODED AREA 1

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 17
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT MAJOR FLOODED AREA 2

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

Jersey_Barriers

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

0 125 250 500

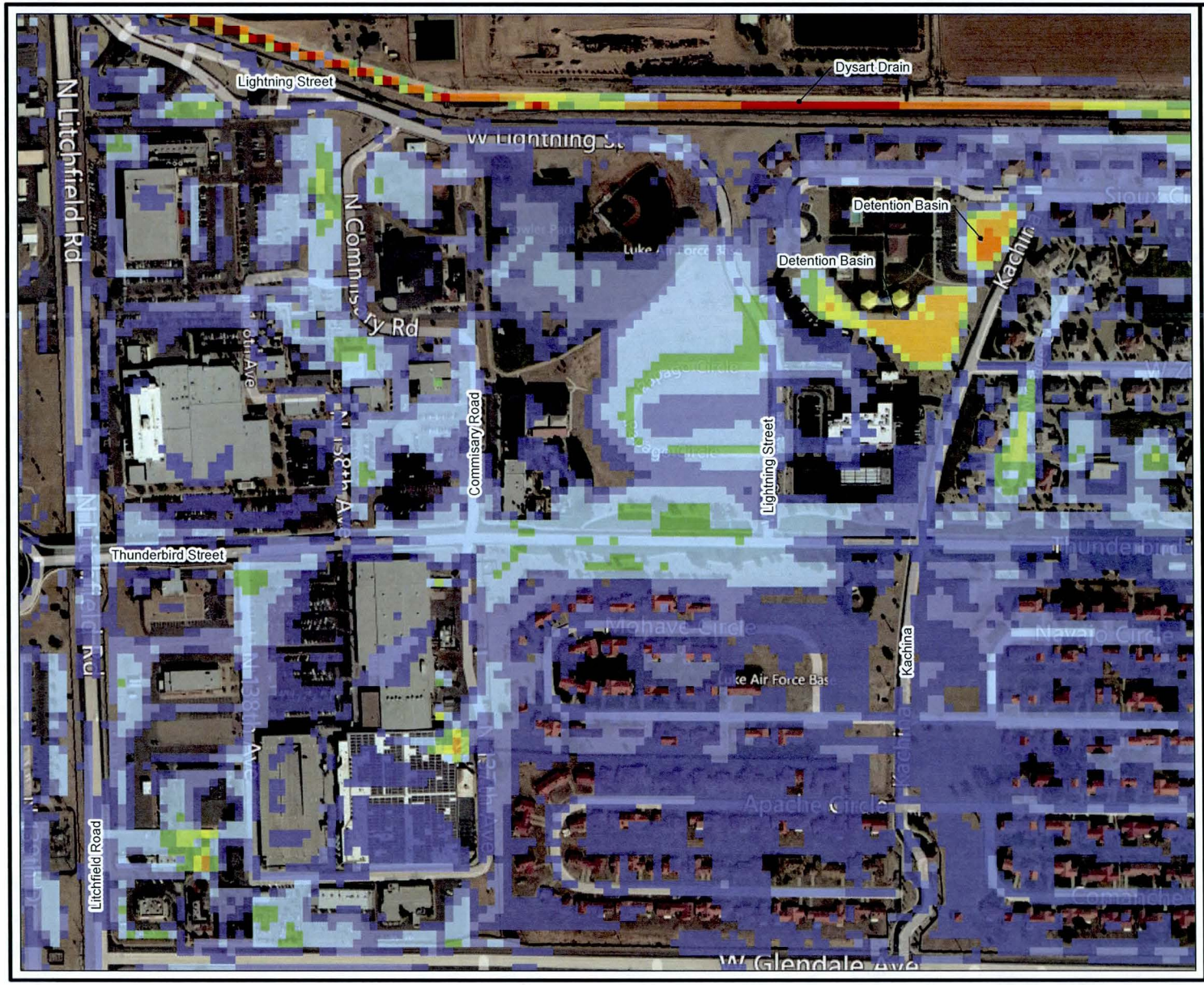
Feet

N

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 18
MAXIMUM FLOOD DEPTHS OF 100-YEAR FLOOD EVENT MAJOR FLOODED AREA 3

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

Max Flood Depth (ft)

100-Year Flood Event

- 0.01 - 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- 5.00 - 8.80

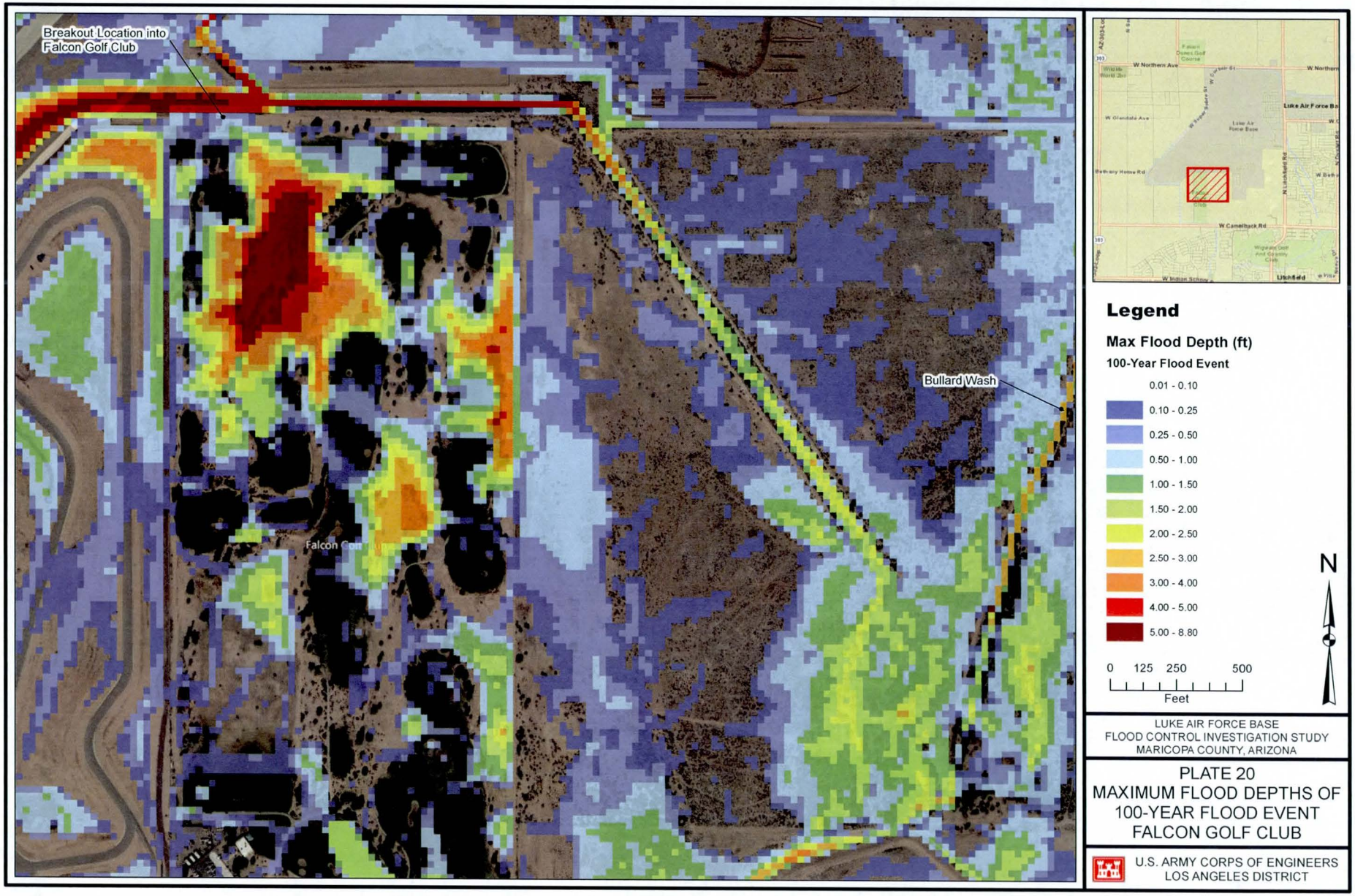
N

0 125 250 500
Feet

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 19
MAXIMUM FLOOD DEPTHS OF
100-YEAR FLOOD EVENT
MAJOR FLOODED AREA 4

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



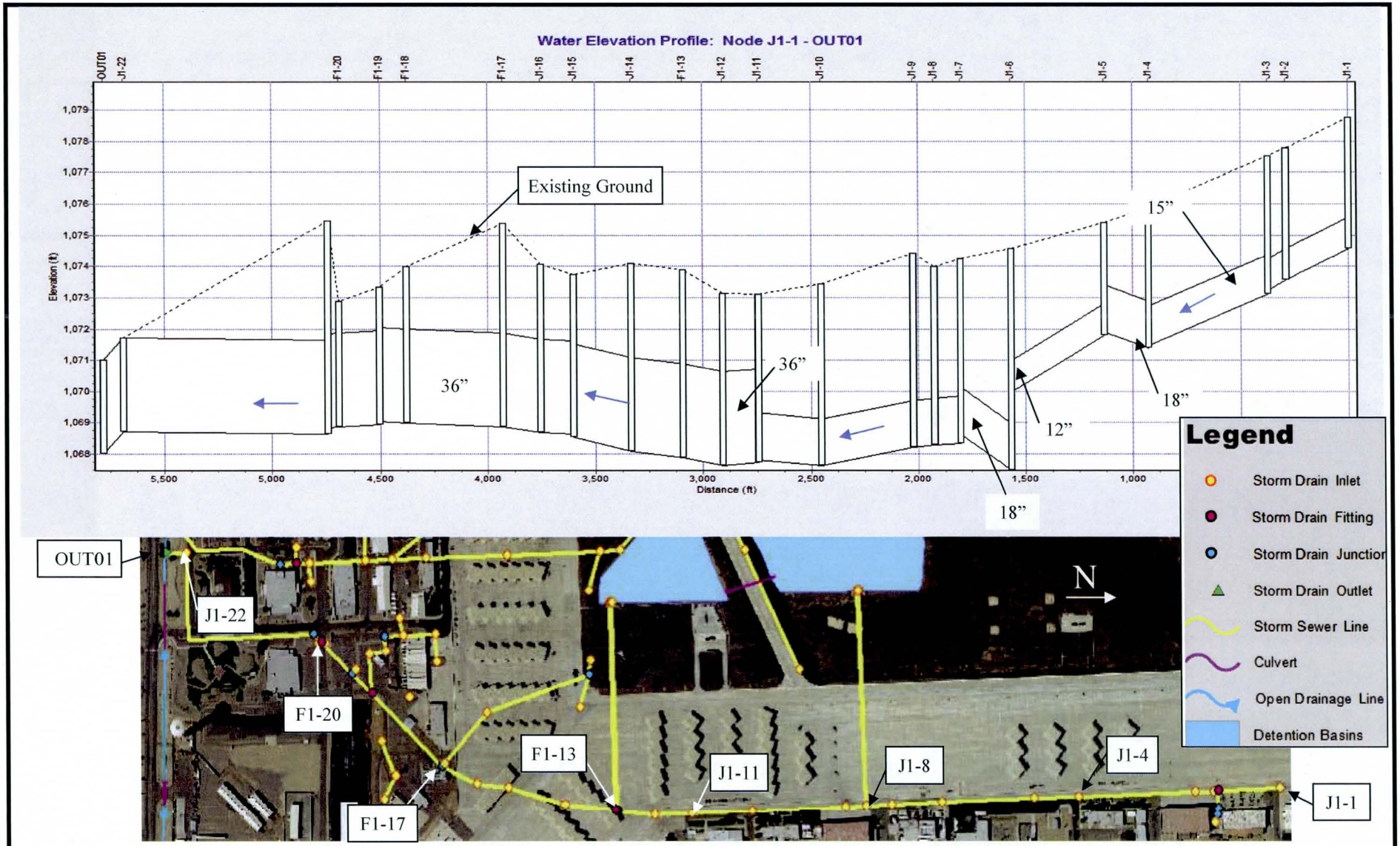
LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
MARICOPA COUNTY, ARIZONA

PLATE 20
MAXIMUM FLOOD DEPTHS OF
100-YEAR FLOOD EVENT
FALCON GOLF CLUB

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

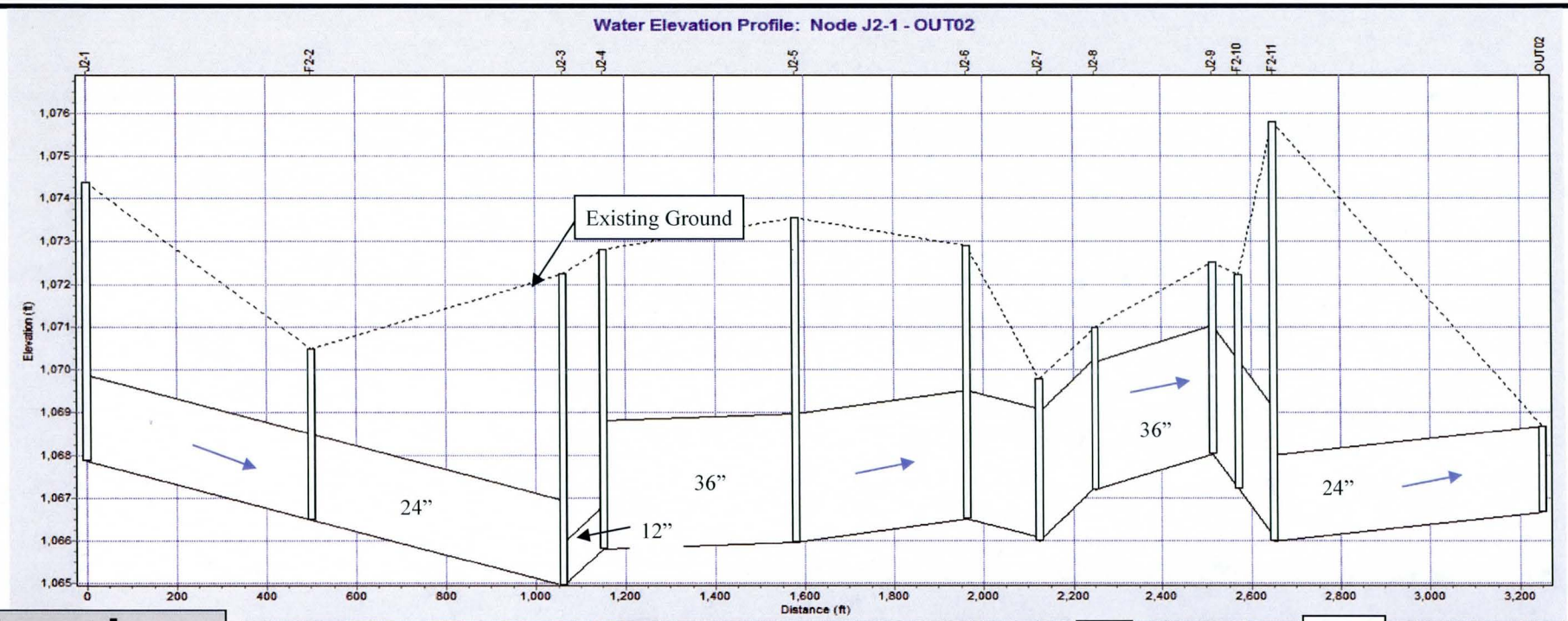
FIGURES

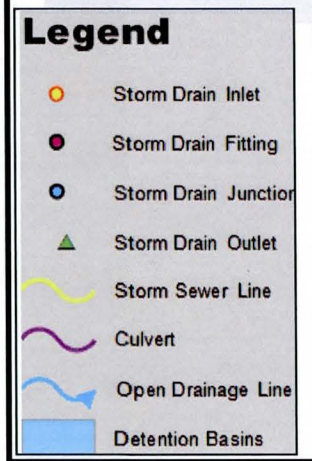
LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013



Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

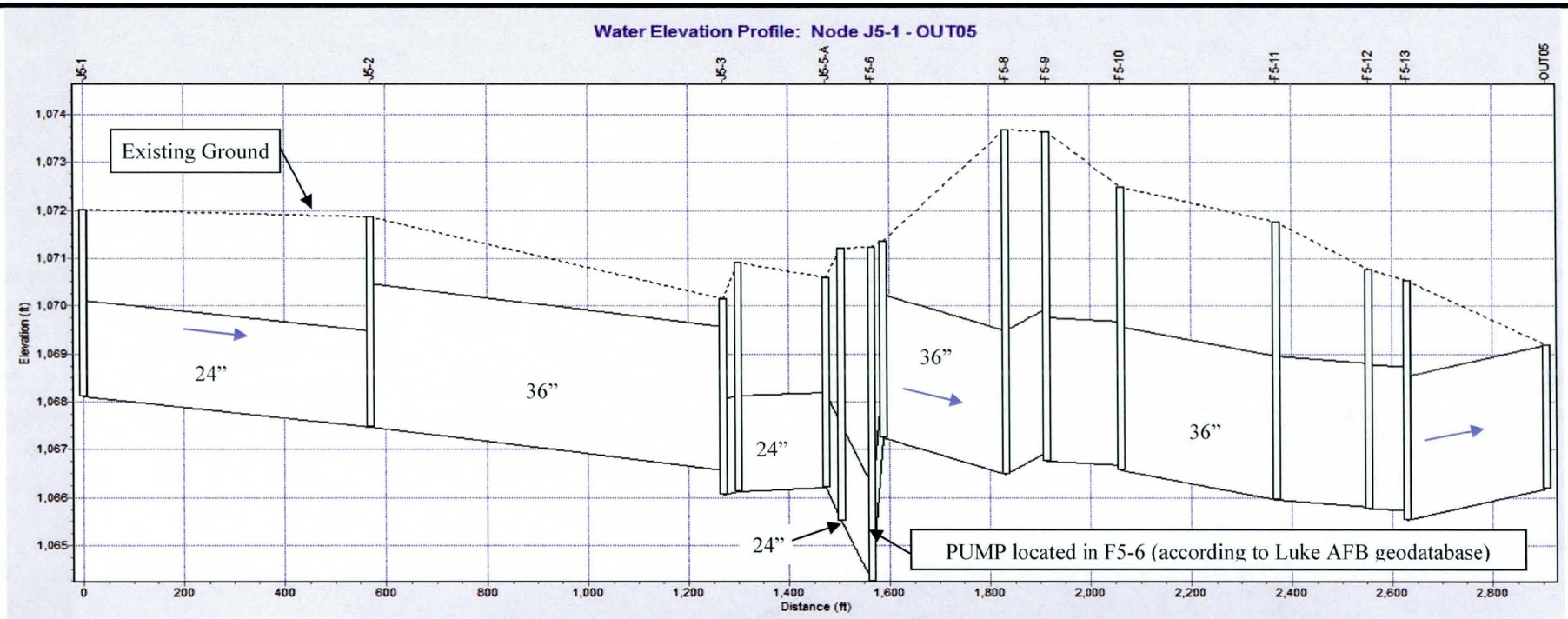
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 1** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 1**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

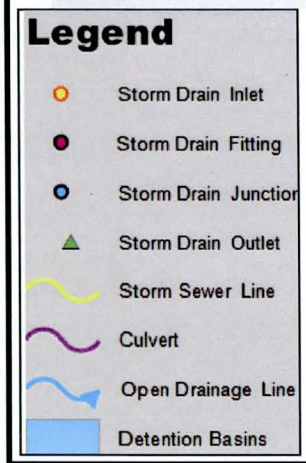


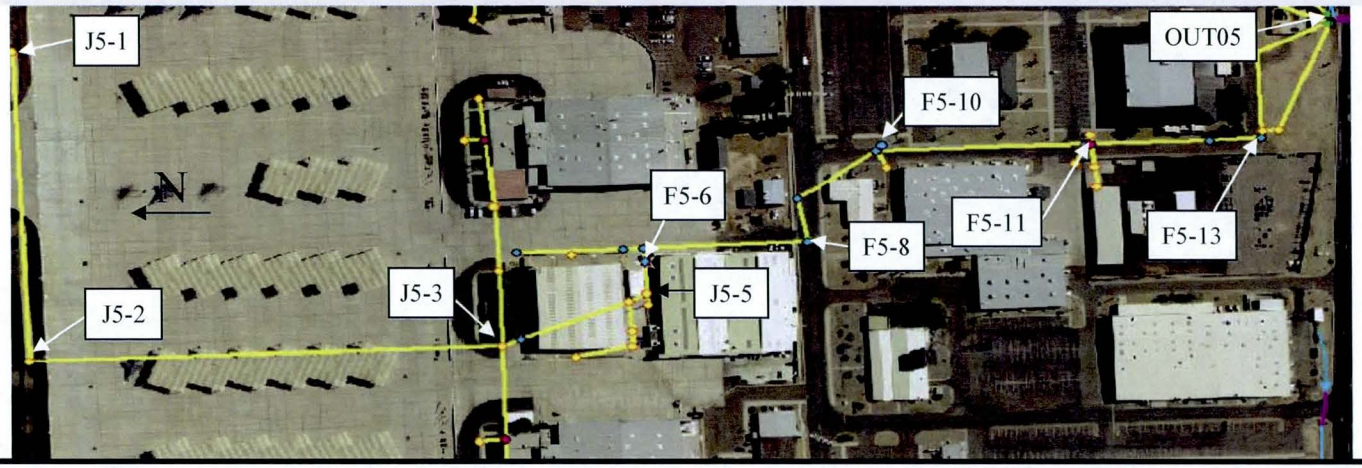


Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 2** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 2**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

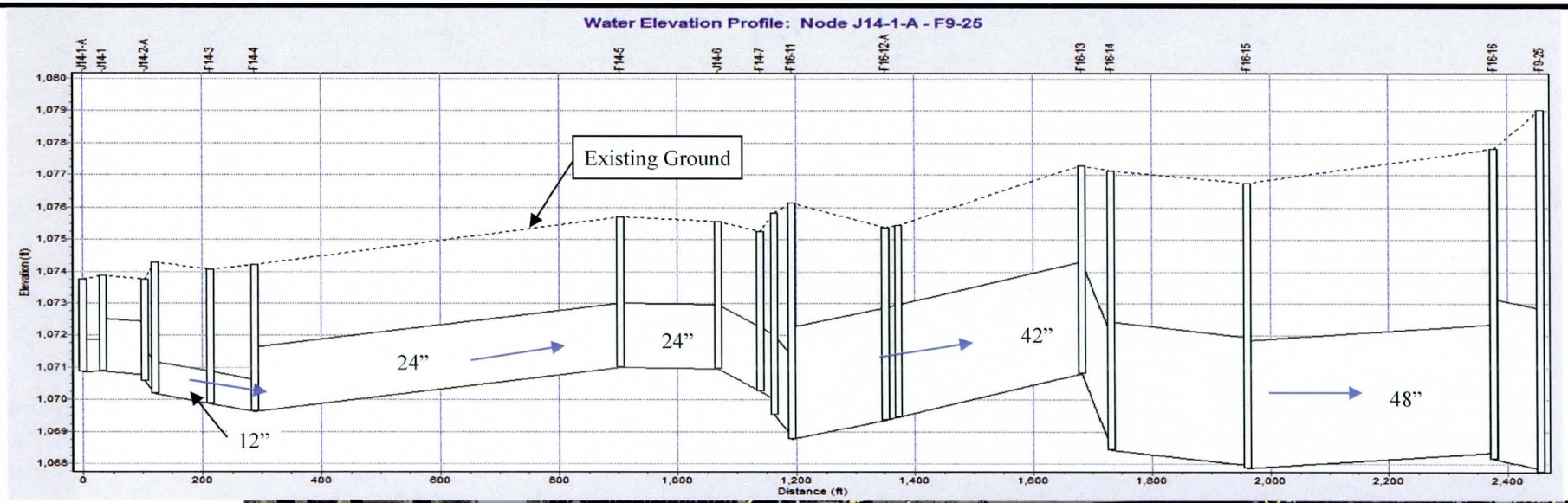


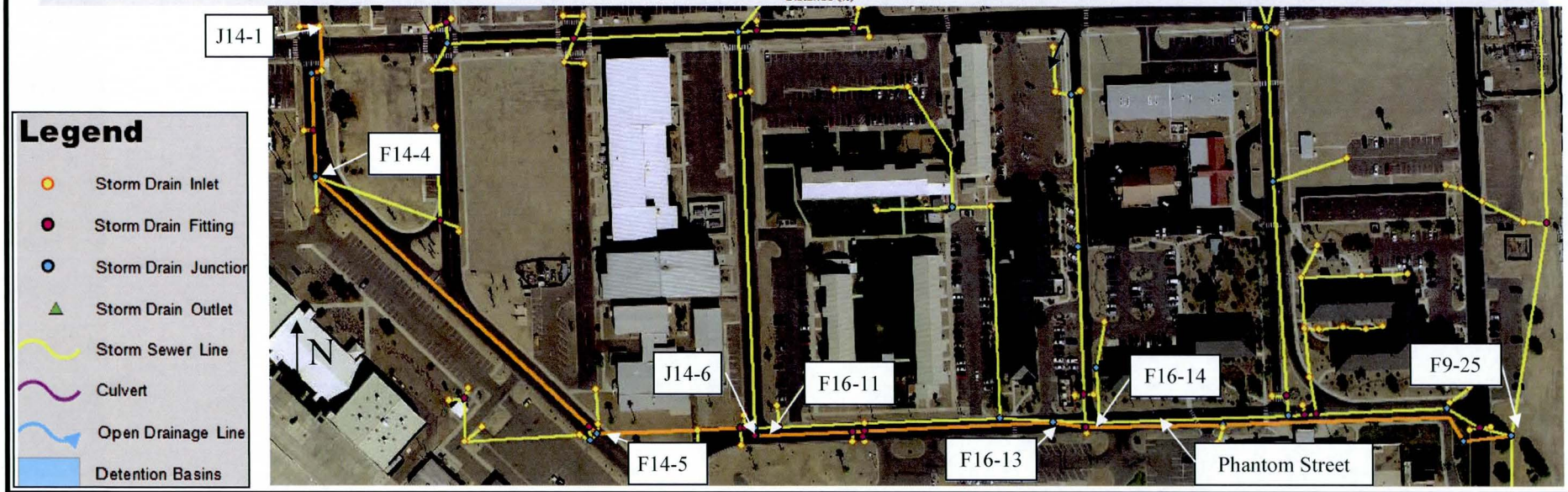




Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

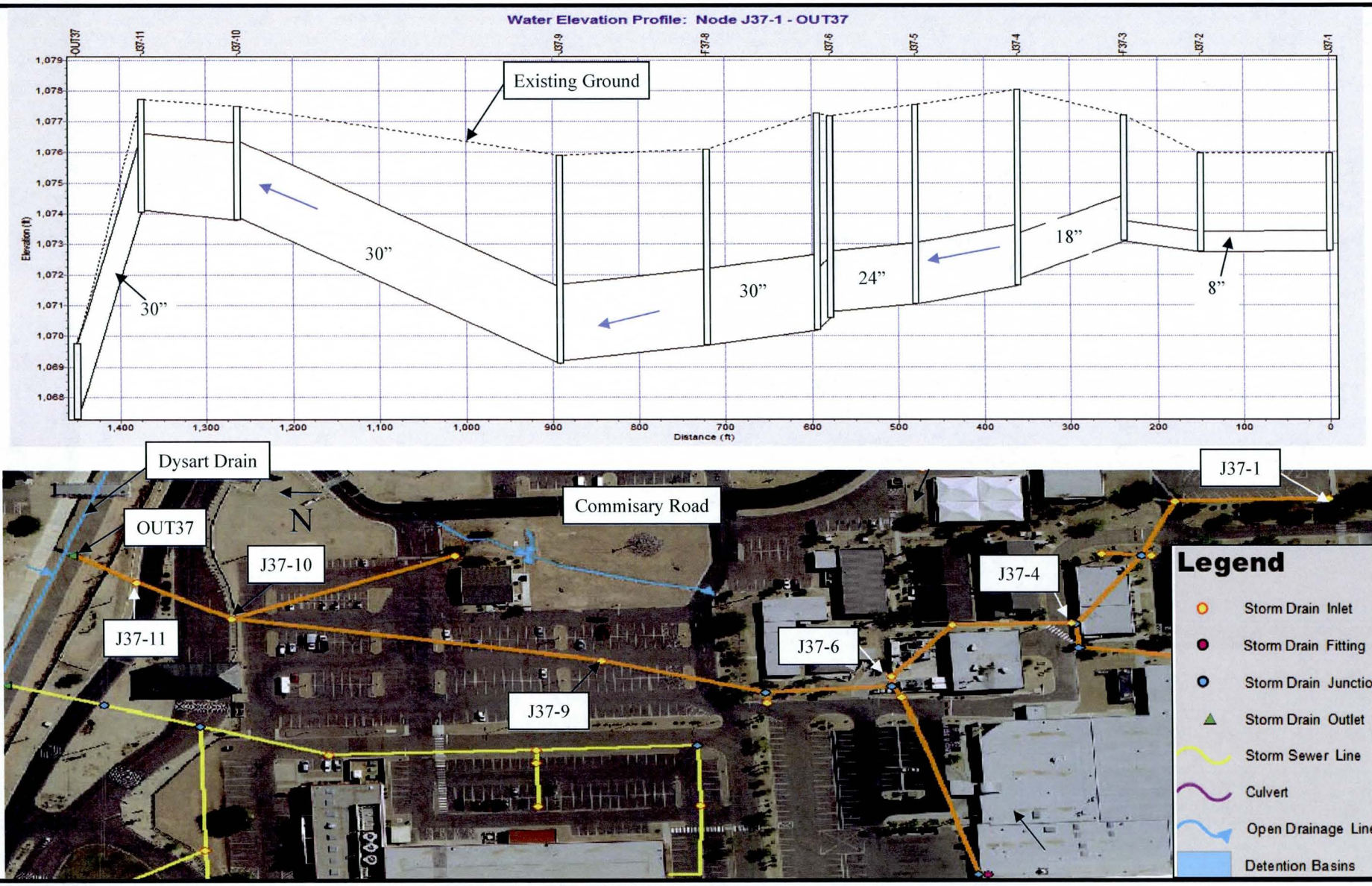
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 3** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 3**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT





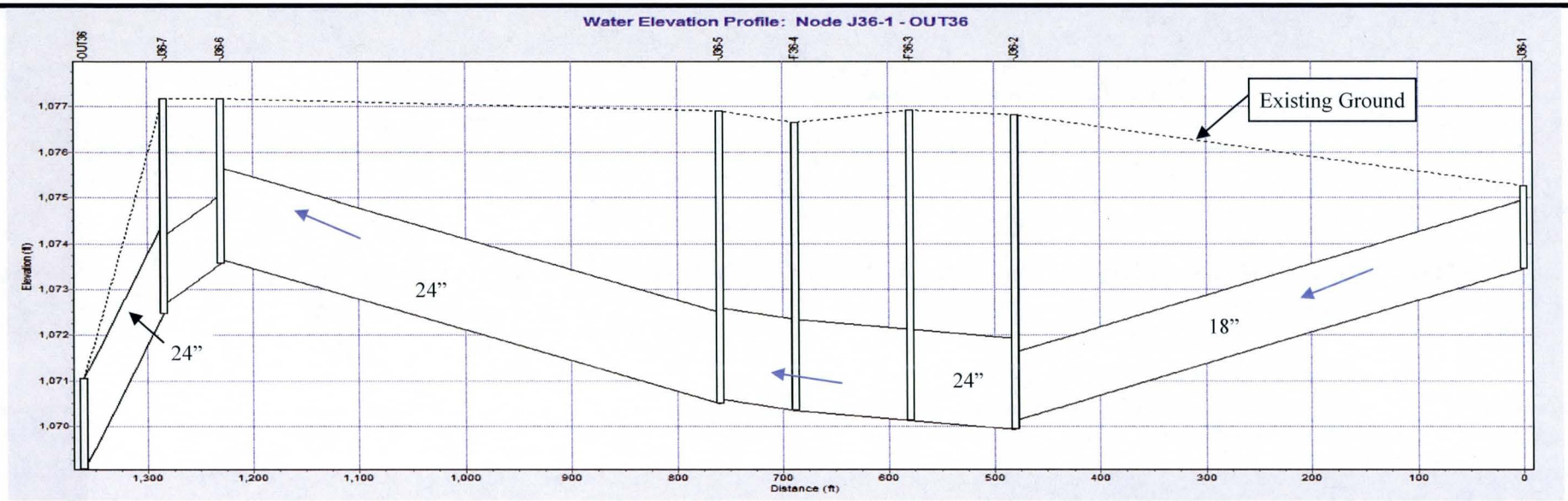
Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 7 for larger map.

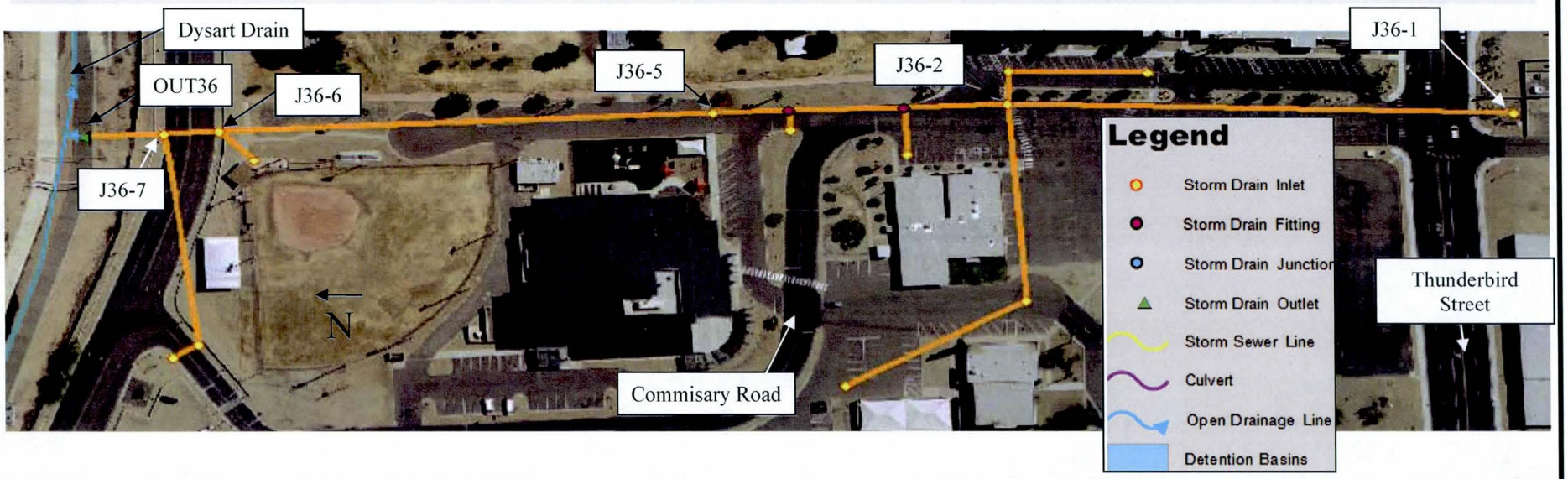
LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 4** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 4**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT



Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 8 for larger map.

LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 5** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 5**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT





Notes: The junctions from the profile do not line up exactly with the aerial. The profile uses straight-line distance. See Plate 8 for larger map.

LUKE AIR FORCE BASE, AZ FLOOD INVESTIGATION STUDY	**FIGURE 6** **LUKE AIR FORCE BASE** **EXISTING STORM DRAIN PLAN & PROFILE 6**		U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

APPENDIX 1

PROJECT ORDER PROJECT MANAGEMENT PLAN

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

Project Order Project Management Plan (PMP)

FY13

Project Title: Luke AFB Flood Control Investigation

Project Number: NUEX120203
Project Order Number: F2U3082272J001

Location: Luke Air Force Base, Arizona

Date: 4 June 2013

Table of Contents

1. Scope of Project:
2. Technical requirements/ inputs:
3. Key Deliverables:
4. Available Resources:
5. Acquisition Strategy:
6. Cost Estimate:
7. Project Schedule:
8: Change Management

Appendix A: Scope of Work
Appendix B: Schedule
Appendix C: Budget
Appendix D: Draft 1391 & AF IMT 332
Appendix E: Flood Control Limits Aerial

This PMP, with any required attachments completed by the SPL Project Manager will be attached to the MIPR / Project Order as required by ER 37-1-26 to demonstrate the terms of the proposed project order and is scaled to the size of this project.

Definition of a Project Management Plan:

a. The Project Management Plan for phase, herein after referred to as the PMP defines a contract between the Corps and the Luke AFB customer, and reflects a "buy in" on the part of the customers and SPL, as well as those who will be performing, and reviewing, the activities involved in the project. The PMP describes the initial tasks of the study phase, continues through the preparation of the final study report, with the project management plan for project implementation and design agreement.

b. The PMP is a basis for defining the scope of work, cost, schedule and quality expectations. The study is an iterative process without a predetermined outcome. Therefore, estimated time and cost can and does change. It may be necessary to revise the scope following reformulation and evaluations of the alternatives. *The scope and assumptions, for this study effort, should be clearly outlined and stated so the Corps and the Customer understand the objectives and agree with the level of detail contained in the PMP.* If study tasks are added or removed from the plan contained herein, and significantly impact cost or schedule beyond that allowable, this PMP will be revised to reflect the required change. Any impact in time or cost can be assessed and an appropriate decision or recommendation can be made on how to proceed. The PMP provides the basis for change as well as allows the documentation of significant alterations.

c. The PMP is a basis for review and evaluation of the study report. Since the PMP represents a contract among study participants, it will be used as the basis to determine if the draft study report has been developed in accordance with established procedures and previous agreements. The PMP reflects the agreed upon scope between the Corps and the Customers and outlines the intent of the study to the Corps' District. It not only contains the scope but also critical assumptions, methodologies, and the level of detail for the studies that are to be conducted during the Detailed Project Report. A review of the draft report will be completed to ensure that the study has been prepared consistent with the contents of this PMP. The objective is to provide early assurance that the study activities, tasks and documentation is preformed consistent with Corps policies and guidelines and will be supported by Corps Headquarters and the Customer's management.

1. Scope of Project:
See Appendix A for Scope of Work attached: The effort involved in this Project Order is to develop documentation of existing conditions at Luke Air Force Base for future design documents and the eventual construction of flood controls to mitigate flooding of aircraft parking ramps and structures. This project includes site investigation and hydrologic/hydraulic modeling.

2. Technical requirements/ inputs:
A data gathering site trip will be conducted by the PDT to meet the Customer, their county partner MCCFC and obtain all pertinent project requirements. This meeting shall be a minimum 2-day trip and be conducted within 35 days of the issuance of notice to proceed. Items to be collected include but are not limited to:

Existing LIDAR digital elevation model (from LAFB).
Depict existing utilities on the survey based on LAFB GIS data
Unprocessed survey data from Maricopa County Flood Control (MCCFC)

3. Key Deliverables:

1. Draft Existing Conditions Hydrologic and Hydraulic Analyses Report
2. Final H&H report and models

Based on a Friday 28 Sept 2012 teleconference kickoff , considered notice to proceed (NTP) deliverables will be provided and considered complete 14 June 2013. NTP + 259 calendar days

4. Available Resources:
See Appendix B for specific Budgets attached: The effort entailed to develop documentation of existing conditions at Luke Air Force Base and associated fee was coordinated with the following assigned Technical Lead and committed by the Resource Manager of each Section.

Cuong T. Ly, PE
US Army Corps of Engineers
Chief of Hydrology & GIS Section
915 Wilshire Blvd., Suite 12008
Los Angeles, CA 90017-3401
213-452-3566
213-452-4202 - Fax
cuong.ly@usace.army.mil

5. Acquisition Strategy:
The effort is projected to be 100% In-House effort. At this time there are no contract actions required. If required, only minimal contract action would be required to provide investigative data to meet schedule or expertise needs, for example video documentation of the existing storm drains.

6. Cost Estimate:
See Appendix B for specific Budgets attached: The effort entailed to develop documentation of existing conditions at Luke Air Force Base and associated fee is for in-house labor and does not require an IGE.

7. Project Schedule:
See Appendix C Schedule attached: The effort entailed to develop documentation of existing conditions at Luke Air Force Base and associated deliverables was coordinated with the following assigned Technical Lead and committed by the Resource Manager of each Section.

Based on a Friday 28 Sept 2012 Teleconference kickoff , considered notice to proceed (NTP) deliverables will be provided and considered complete **14 June 2013.** NTP + 259 calendar days

8. Change Management:
Project orders have a completion date. In order to extend a project order, there must be a valid reason that could not have been foreseen at the time that the project order was accepted. Project orders will not be extended where ambiguity in this PMP has resulted in an inability to complete before the completion date. Several tasks cannot be bundled in one project order because change to one task may negatively impact the associated tasks.

9. Review. The Hydrologic and Hydraulic Analysis Report shall go through Agency Technical Review (ATR). The purpose of this review is to ensure the proper application of clearly established criteria, regulations, laws, codes, principles and professional practices. The ATR is an in-depth review, managed within the USACE, and conducted by a qualified team outside of the local district that is not involved in

the day-to-day production of a project/product. The ATR team reviews the various work products and assures that all the parts fit together in a coherent whole. The Flood Control District of Maricopa County shall be included in the ATR process.

Approval for any change to project orders must be obtained through discussion (at one single meeting) with PPMD Program Manager (branch chief level), RM (budget officer), and SPL Office of Counsel.

The Scope of Work shall be reviewed at each deliverable submittal to prevent scope creep and will meet the project budget. If a change must occur due to unforeseen conditions, the following strategy will be implemented:

- For increases to scope or cost, decisions will be made and strategy approval requested for District concurrence at the lowest level possible: Customer; PM; Design Tech Lead
- If a decision cannot be reached at the lowest level, it will be raised to the next higher level: PM Branch; Design Branch; Office of Counsel & RM Branch.
- If a decision cannot still be reached, it will raise to the highest level: PPMD, OC, RM and Engineering Division Chiefs as indicated above

PROJECT LEADS

Luke AFB CES Command:

- Tauny Woo: Base CE Office; Programs Flight Chief; (623) 856-3635; tauny.woo@luke.af.mil
    - Alan C. Thomas: Environmental Programs Manager: CES Project POC; 623-856-3621 alan1.thomas@luke.af.mil

SPL Project Management:

- Glenn Arakaki: Acting SPL Chief, PM; 213-452-3389; glenn.t.arakaki@usace.army.mil
    - Jonathan Stratton: SPL PM; 602-230-6939; jonathan.w.stratton@usace.army.mil

SPL Technical Lead:

Cuong T. Ly, PE, Chief of Hydrology & GIS Section;213-452-3566 cuong.ly@usace.army.mil

APPENDIX A

Scope of Work

Project: **Luke AFB Flood Control Investigation**

Date: **09.27.12, updated 06.04.13**

Subject: **Scope of Work – Existing Conditions Analysis**

1. Project Goals
    a. Identify areas of flooding of aircraft parking ramps.
    b. Identify areas of flooding of structures.
    c. Identify areas of the Zone AE floodplain that includes portions of the parking ramps and developed portion of the base located west of Litchfield Road and north of Super Saber Street.
2. Data Collection, Field Investigations, Coordination
    a. Conduct search to obtain required/available data.
    b. Field Investigation
    c. Attend coordination meetings.
3. Topographic Survey - to be completed by MCFCD contractor and reviewed by USACE SPL Survey Section.
    a. Prepare a topographic survey in support of hydrologic and hydraulic modeling: from one of two possible data sources:
        (i). Prepare topographic survey from unprocessed data (from FCDMC).
            1. Aerial photography collected in March 2008. Minimum contour interval is 2.0-ft.
            2. Redevelopment of base housing area was largely completed by March 2008.
            3. Depict existing utilities on the survey based on LAFB GIS data.
            4. Use WGS84 UTM as the coordinate system
            5. Some updating of the cartography will be required and some field survey will be necessary to clarify critical changes in the topography
        (ii). Prepare new topographic survey.
            1. 1.0-ft minimum contour intervals.
            2. Include base and the properties between the base and Camelback Road (Fisher parcels and City of Goodyear parcel)
            3. Include base housing area.
            4. Depict existing utilities on the survey based on LAFB GIS data.
            5. Use WGS84 UTM as the coordinate system.

4. Storm Drain System Existing Conditions

    a. ~~Evaluate condition of key storm drains with video camera (No more than 15 major storm drains).~~ This task was determined to be unnecessary at this time. Task b was expanded to include additional storm drain inlets and channel surveys.

    b. Field-verify inlet and invert elevations of key drainage system components including storm drains and channels.

    c. Evaluate pumping capacity and operation of storm drain pumping systems.

5. Existing Conditions Hydrologic and Hydraulic Models

    a. Identify the watershed limits. Develop FLO-2D model for general watershed including:

        (i). Northern Parkway and Loop 303.

        (ii). Dysart Drain.

        (iii). Base housing area.

    b. Prepare the FLO-2D model with 15-ft grid resolution for the 100-year flood event (NOAA Atlas 14) for the base and immediate surrounding area as depicted on the watershed exhibit.

    c. Evaluate flows approaching base from the northwest as identified in the White Tanks/Loop 303 ADMPU Area Hydrologic Analysis HEC-1 model; revise sub-basin boundaries as necessary. Incorporate information from existing White Tanks/Loop 303 ADMPU AHA HEC-1 model into FLO-2D model developed in item 5a. The most current hydrology for the watershed is the Loop 303/White Tanks ADMPU AHA, dated September 2009.

    d. Prepare SWMM models to analyze the capacity of the storm drain systems within the base and any portion of the base housing area that discharges to the west of Litchfield Road.

    e. Identify the capacity of open channels using FLO-2D.

6. Deliverables

    a. Existing Conditions Hydrologic and Hydraulic Analysis Report

        (i). Draft H&H report

        (ii). Final H&H report and models

7. Review

    a. District Quality Control (DQC) - DQC is the review of basic science and engineering work products by the local U.S. Army Corps of Engineers District office.

    b. Agency Technical Review (ATR) – The purpose of this review is to ensure the proper application of clearly established criteria, regulations, laws, codes, principles and professional practices. The ATR is an in-depth review, managed within the USACE, and conducted by a qualified team outside of the local district that is not involved in the day-to-day production of a project/product. The ATR team reviews the various work products and assures that all the parts fit together in a coherent whole. The Flood Control District of Maricopa County shall be included in the ATR process.

APPENDIX B

Budget

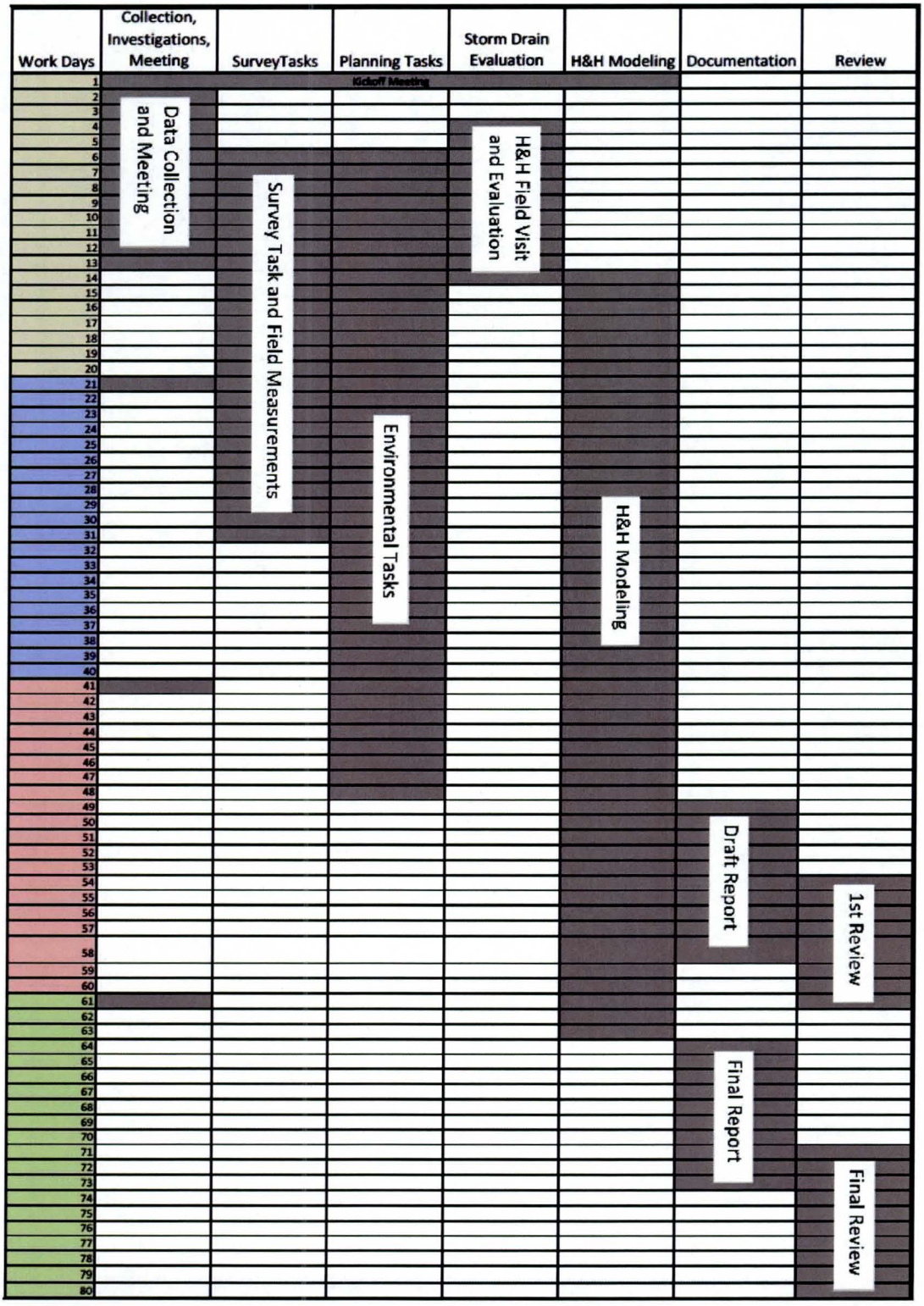
USACE Los Angeles District, Engineering Division
Cost Estimate
Project: Luke AFB Flooding Mitigation and Outfall Project

	Data Collection, Investigations, Meeting			Survey Tasks			Evaluation of Existing Condition Storm Drain System			H&H Existing Condition Models					Documentation			Review				
Labor Category	Refer to Scope Section 2 for Task Description			Refer to Scope Section 3 for Task Description			Refer to Scope Section 4 for Task Description			Refer to Scope Section 5 for Task Description					Refer to Scope Section 6 for Task Description			Refer to Scope Section 7 for Task Description		Total Hours	Basic Hourly Rate	Budget Estimate
	a	b	c	(i)	(ii)	(iii)	a	b	c	a	b	c	d	e	a	b	c	a	b			
Project Manager	8	16	24				16	16	16	40	40	20	20			10	32	8	8	274	$132.60	$36,332.40
Hydraulic Engineer	16	16	24				28	28	28	40	160		80	40		10	30	8	8	566	$124.25	$70,325.50
Hydrologist	16	16	24							180	40	80					30	8	8	444	$95.57	$42,433.08
Sedimentation Specialist							28	28	28							10				94	$95.57	$8,983.58
Survey Team				120	120	320									40			20		620	$105.15	$65,193.00
Technician	16	16	24				28	28	28		40	40	80	80		10	30			470	$83.62	$39,301.40
GIS Analyst				16	16	16					80	40					40			208	$83.62	$17,392.96
Report Writer																	40			40	$65.90	$2,636.00
Environmental Specialist															8	8	8	8	8	40	$110.00	$4,400.00
Management																		60	60	120	$170.13	$20,415.60
Subtotal	56	64	96	136	136	336	100	100	100	260	360	180	180	120	48	48	160	112	92	2884		$307,413.52
																				Project Management		$40,000.00
																				Other Costs (Travel, etc)		$12,000.00
																				Office Costs (Repo, Misc)		$500.00
																				TOTAL (OTHER COSTS)		$12,500.00
																				TOTAL		$359,913.52

APPENDIX C

Schedule

Luke AFB Schedule



APPENDIX D

Draft 1391

DRAFT 1

1. COMPONENT	FY 2013 PROJECT DATA	2. DATE
AIR FORCE	(computer generated)	

3. INSTALLATION, SITE AND LOCATION	4. PROJECT TITLE
LUKE AIR FORCE BASE LUKE A F BASE SITE # 1 ARIZONA	LUKE AFB FLOOD CONTROL INVESTIGATION AND FEASIBILITY PLAN

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. RPSUID/PROJECT NUMBER	8. PROJECT COST ($000)
22176	871-183	2517/WUEX120203	EEIC 53200 360

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT	COST
PRIMARY FACILITIES				360.0
INVESTIGATION STUDY	LS			(360.0)
SUBTOTAL				360.0
PROFIT AND OVERHEAD (.0%)				0.0
TOTAL FUNDED COST				360.0
UNFUNDED COST (.0%)				0.0
TOTAL REQUEST				360.0

10. Description of Proposed Work: This plan will confirm the conceptual documents for the rehabilitation of the installation's southern drainage system and to connect to improvements to be accomplished by the Maricopa County Flood Control District. This plan will provide phasing options and ensure archeological requirements. The primary objective of this plan is to reduce the risk of catastrophic flooding. This project will be cost shared between Maricopa County Flood Control District and Luke AFB. The Flood Control District Board of Directors has already voted and prioritized this project #1 on their 2013 Capital Improvement Program.

11. Requirement: As Required.

PROJECT: LUKE AFB FLOOD CONTROL INVESTIGATION AND FEASIBILITY PLAN

REQUIREMENT: Provide an investigatory study and plan for the rehabilitation of the installation's southern drainage system and to connect to improvements to be accomplished by the Maricopa County Flood Control District. The primary objective of this plan is to reduce the risk of catastrophic flooding.

CURRENT SITUATION: Existing storm drainage system in this area of the installation is in poor condition. Overgrown with vegetation, substantial erosion and lack of maintenance has impacted the ability of the channel to carry away storm water.

IMPACT IF NOT PROVIDED: The current effective floodplain delineation by FEMA impacts 128 aircraft parking spots (aircraft valued at more than $3 billion) and 94 buildings, 1.25MM SF, valued at $345M, including the Wing HQ, Command Post, control tower, RAPCON and simulator complex, 4 hangars including all phase & corrosion control, 3 drinking water wells, both fire stations, the dining hall, and 90% of the dorm space

APPENDIX D

AF IMT 332

BASE CIVIL ENGINEER WORK REQUEST
(See Reverse for Instructions)

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 3 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project 0704-0188, Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to HQ AFESCIDEMS.

SECTION I - TO BE COMPLETED BY REQUESTER

1. FROM *(Organization)*	2. OFFICE SYMBOL	3. DATE OF REQUEST	4. WORK REQUEST NO. *(For BCE Use)*
56 CES	CEPD	20120213	83728

5. NAME AND PHONE NO. OF REQUESTER	6. REQUIRED COMPLETION DATE	7. BUILDING, FACILITY OR STREET ADDRESS WHERE WORK IS TO BE ACCOMPLISHED
Ricardo Rhoads 6-6535	20130213	65006 - Drainage ditches

8. DESCRIPTION OF WORK TO BE ACCOMPLISHED *(Include Sketch or Plan, when appropriate)*

This plan will prepare documets for the rehabilitation of the installation's southern drainage system and to connect to improvements to be accomplished by the Maricopa County Flood Control District. The primary objective of this plan is to reduce the risk of catastrophic flooding.

NUEX 12 0203 Repair Southern Drainage Channel STUDY
(Design)

9. BRIEF JUSTIFICATION FOR WORK TO BE ACCOMPLISHED *(Not required for maintenance and repair)*

Existing storm drainage system in this area of the installation is in poor condition. Overgrown with vegetation, substantial erosion and lack of maintenance has impacted the ability of the channel to carry away storm water. The current effective floodplain delineation by FEMA impacts 128 aircraft parking spots (aircraft valued at more than $3 billion) and 94 buildings, 1.25MM SF, valued at $345M, including the Wing HQ, Command Post, control tower, RAPCON and simulator complex, 4 hangars including all phase & corrosion control, 3 drinking water wells, both fire stations, the dining hall, and 90% of the dorm space.

10. DONATED RESOURCES

FUNDS	LABOR	MATERIAL		CONTRACT BY REQUESTER	✓	NONE

11. NAME OF REQUESTER	12. GRADE OF REQUESTER	13. SIGNATURE OF REQUESTER *(See Reverse of Form)*
Tauny Woo	GS-13	[signature]

14. COORDINATION

OK/CEAN 21Feb12	56 FW/SEG	56FW/AT	21 Feb 12	21 FEB 12 DJS
56 FWOS / 56PB	56DB 21 Feb 12	21Feb12	56DB/JAH	56 CES/CEPI
CWO 21Feb12				21 FEB 2012
				CEAO [signature]

SECTION II - FOR BASE CIVIL ENGINEER USE

15. WORK ORDER *(Place an "X" in the appropriate box.)*

IN-SERVICE		SELF-HELP		CONTRACT		SABER

16. DIRECT SCHEDULED WORK *(Place an "X" in the appropriate box.)*

EMERGENCY		URGENT		ROUTINE		SELF-HELP		M/C

17. SELF-HELP *(Place an "X" in the appropriate box.)*

	BRIEFING REQUIRED	ADEQUATE COORDINATION		INSPECTION REQUIRED

SECTION III - COMPLETE ONLY IF WORK IS TO BE ACCOMPLISHED BY WORK ORDER

18. WORK CLASS	19. PRIORITY	20. ESTIMATED HOURS	21. ESTIMATED FUNDED COST	22. ESTIMATED TOTAL COST
53200				400,000

✓	23. THERE IS NO NEED FOR AN ENVIRONMENTAL ASSESSMENT (AFR 19-2)		24. A WRITTEN ASSESSMENT IS BEING/HAS BEEN PROCESSED		25. APPROVED		26. DISAPPROVED

27. REMARKS CEAO CATEX A2.3 10.

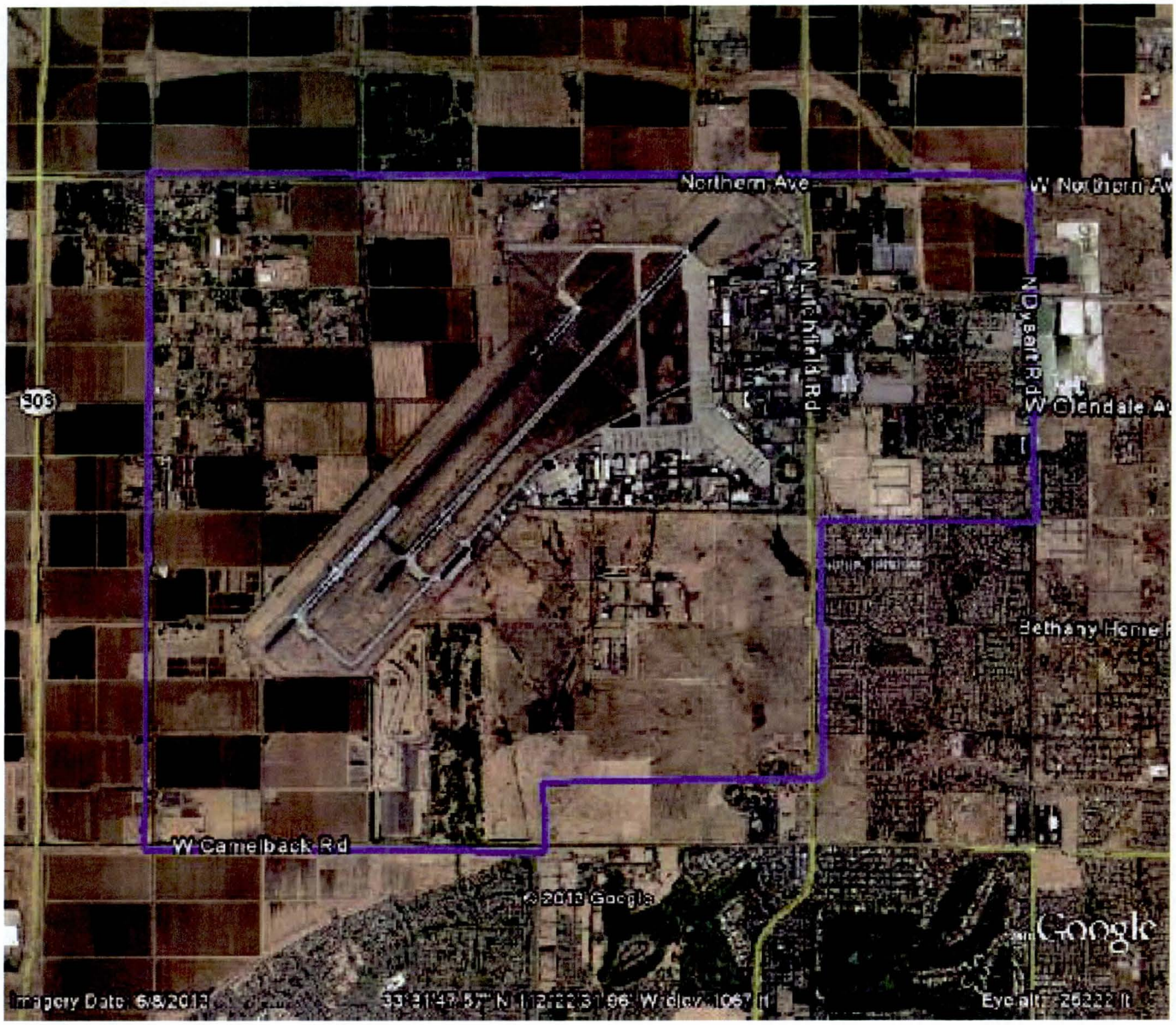
SECTION IV - APPROVING AUTHORITY

28. NAME AND GRADE *(Please Type or Print)*	29. SIGNATURE	30. DATE
NEIL D. WENTZ, GS-14, DAF Deputy BCE, 56CES	[signature]	18 Sept 12

AF IMT 332, 19910101, V4 PREVIOUS EDITION IS OBSOLETE MASTER FILE COPY

APPENDIX E

Flood Control Limit



APPENDIX 2

EPA-SWMM MODELING ASSUMPTIONS

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

APPENDIX 2: EPA-SWMM MODELING ASSUMPTIONS

Introduction

The FLO-2D Pro model has been integrated with the EPA-SWMM version 5.0 to simulate the exchange of surface water flow (FLO-2D) with a storm drain system (EPA-SWMM). EPA-SWMM was used to model the storm drain system for Luke AFB and was requested by Luke AFB and the District. The two models run simultaneously; whereas, FLO-2D calculates all hydraulic and hydrologic surface water flow routing while EPA-SWMM only solves the conduit hydraulics and routing of the storm drain network. The FLO-2D model computes the storm drain inflow discharge based on the predicted grid element headwater depth and exchanges this discharge with the EPA-SWMM model to compute the storm drain system pipe hydraulics and the potential return of flows to the surface through downstream manholes, outlets, and storm drains. The return flow is routed based on FLO-2D surface hydraulic and hydrologic calculations.

Data Source

The EPA-SWMM Model was completed using three data sources: the Luke AFB GIS Geodatabase, the COE spot survey completed in December 2012, and the Luke AFB inlet survey completed in April 2012. The Luke AFB GIS Geodatabase was the main source for the storm drain system including inlet invert elevations, depth of inlet (max depth), conduit size, conduit length, conduit roughness, conduit outlet offset, and outfall invert elevation. The COE spot survey was used to verify information from the GIS database and was used in lieu of the Geodatabase data in the EPA-SWMM model as appropriate. The Luke AFB inlet survey provided dimensions for 39 inlets in the study area.

Model Input Parameters

Model input parameters for the EPA-SWMM model were set with the assistance of Jimmy O'Brien and Noemi Gonzalez from FLO-2D. The following are model input parameters for the EPA-SWMM model.

- Flow Units: CFS
- Infiltration: Green-Ampt
- Flow Routing: Dynamic Wave
- Force Main Equation: Darcy Weisbach
- Report Step: 3 minutes
- Wet Step: 5 Minutes
- Dry Step: 1 hour
- Routing Step: 1 second
- Allow Ponding: Yes
- Variable Time Step: 0.50
- Lengthening Step: 0
- Minimum Slope: 0
- Rainfall: Rainfall event provided by FLO-2D (RAIN.DAT)

Inlets – Junctions – Fittings - Outfalls

Inlets, junctions (manholes), and fittings were modeled as "Junctions" in EPA-SWMM. Inlets receive storm flow, are designated with the letter "J" in EPA-SWMM, and were modeled with subcatchments attached. Fittings and junctions (manholes) do not receive storm flow, are designated with the letter "F" in EPA-SWMM, and do not have subcatchments attached. The fittings and manholes do not appear in the SWMMFLO.DAT input file. Outfalls were used at the end of storm drain lines where the flow discharges.

Invert elevations for fittings were not provided by the Luke AFB GIS Geodatabase; however, fitting locations were provided. The invert elevations for the fittings in the EPA-SWMM model were estimated by straight line interpolation using known upstream and downstream elevations of manholes and inlets.

The maximum depth of inlets and junctions represents the distance from the invert elevation up to the ground surface.

Inlet geometry was based on three sources. Thirty-nine inlets had the dimension measured during the Luke AFB inlet survey completed in April 2012. Approximately ninety inlets were determined to be similar to the thirty-nine surveyed inlets. Approximately 300 inlets were measured using Google Imagery.

Curb inlets are modeled as Type 2 inlets which are described as "curb opening inlet with sag." Required input information includes the following: weir coefficient, curb opening length, curb opening height, and curb opening width. For type 2 inlets, the weir coefficient was assumed to be 2.3. For the curb inlets with estimated dimensions, the height was estimated to be 5 inches or 0.42 ft for a six inch curb. The length and width dimensions vary for each inlet.

Drop inlets are modeled as Type 3 inlets which are described as "grate (gutter) inlet with or without sag." Required input information includes the following: weir coefficient, grate perimeter (not including the curb side), grate open area, and grate sag height. The weir coefficient was assumed to be 3.0 based on the FLO-2D SWMM manual instructions. The grate perimeter was calculated by summing the length and twice the width. The area was calculated by multiplying the length and width for rectangular inlets and by multiplying the radius squared by pi for circular inlets. The drop inlets were assumed to be at grade, so the grate sag height was assumed to be 0 feet. Additionally, for both inlet types, the orifice flow coefficient is 0.67.

Each inlet was assigned a FLO-2D grid cell when creating the SWMMFLO.DAT. In the case where 2 inlets shared the same FLO-2D grid cell, one of the inlets was moved to an adjacent grid cell. Table A1 shows the inlets that were moved from their originally assigned grid cell.

Table A1 – Inlets moved to an adjacent grid cell

J11-6-B1	J12-5-A	J15-5-A	J16-15-A
J11-B-A1	J13-4-A	J16-10-A	J30-3-E
J11-3-A	J14-5-F	J16-12-B	J37-3-B
J5-11-A	J14-7-A	J16-12-D	J37-6
J1-20-A	J14-15-A	J16-14-A	J18-5-B

Element Count in EPA-SWMM model

- Inlets – 435
- Junctions/Fittings – 154
- Conduits – 593
- Outfalls – 21

Conduits/Pipes

Conduits route inflow to the downstream junction/manhole in the storm drain system. The slope of the conduit is calculated based on the upstream and downstream invert elevations. Conduit geometry was based on the Luke AFB GIS Geodatabase, including size, material, length, and outlet offset. Three materials are found in the storm drain system: reinforced concrete, corrugated metal, and PVC. The majority (93 percent) of the pipes are reinforced concrete (Manning's n-value of 0.013). Approximately 5 percent of the pipes are PVC (Manning's n-value 0.013). Approximately 2 percent of the pipes are corrugated metal (Manning's n-value 0.024).

For continuity reasons, some of the shorter pipes in the EPA-SWMM model had the conduit length increased. The following conduits were manually lengthened for the final EPA-SWMM model (SWMM.inp). See Table A2 below.

Table A2 – Conduits lengthened for the EPA-SWMM model

Name	Pipe Length (GIS)	Pipe Length (EPA-SWMM)
C11-2-A	15	50
C11-2-B	16	50
C11-3-A	5	51
C11-6-A1	15	50
C11-6-A2	17	50
C9-15-B	13	30
C11-6-B1	13	30
C14-15-B	10	30
C16-1-E	10	30
C16-11	13	30
C16-14-A	9	30
C37-3-A	10	30
C38-7-A	14	30
C1-20-B	18	30
C11-6-C1	16	30
C11-6-C2	16	30
C18-5-A	15	30
C1-20-A	17	30
C9-6-A	16	30
C5-11-A	17	30

APPENDIX 3

INLET INFORMATION FOR FLO-2D

SWMMFLO.DAT

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

APPENDIX 3 – INLET INFORMATION FOR FLO-2D

TERMS

FLO-2D Cell # - The FLO-2D grid cell number

GIS OBJECTID – Luke AFB GIS identifier

LUKE AFB INLET_ID – Luke AFB inlet identification number

SWMM_NAME – Inlet identifier assigned in EPA-SWMM model

INVERT_ELV – Invert elevation (feet, NAVD 88)

MAX_DEPTH – Distance from inlet invert to ground surface

INLET_TYPE – Inlet Identifier for FLO-2D Computations

LENGTH[2] OR PERIMTER[3] – Length of inlet or perimeter (length plus twice the width)

WIDTH[2] OR AREA[3] – Width of inlet or area of inlet

WIDTH[2] OR AREA[3] (80%) – Width of inlet or area of inlet (Reduced by 20% to account for area of bars on the inlet grate)

HEIGHT – Height of inlet opening in curb face

WEIR_COEFF – Weir Coefficient for FLO-2D computations

NOTE – Comment relating to inlet

2. Inlet Type 2 uses length and width of inlet for FLO-2D computations

3. Inlet Type 3 uses perimeter (L+2W) and area of inlet for FLO-2D computations

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
109474	515	9-STMH-1	J1-1	1074.56	4.2	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
119708	8	9-STMH-2	J1-2	1073.56	4.2	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
123600	316	9-STMH-4	J1-3	1073.11	4.4	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
145007	431	15-STIN-85	J1-4	1071.37	4.5	3	10.50	12.25	9.8	0.00	3.00	Luke AFB Survey (Apr 2013)
152792	252	15-STIN-86	J1-5	1071.79	3.6	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
169333	490	15-STIN-87	J1-6	1067.47	7.1	3	10.50	12.25	9.8	0.00	3.00	Luke AFB Survey (Apr 2013)
179064	83	15-STIN-88	J1-7	1068.34	5.9	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
184866	283	14-STIN-4	J1-8-A	1069.63	4.0	2	12.00	20.00	16.0	4.00	2.30	Google Imagery (2013)
183929	37	15-STIN-94	J1-8	1068.27	5.7	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
187821	496	15-STIN-93	J1-9	1068.20	6.2	3	6.90	5.30	4.2	0.00	3.00	Google Imagery (2013)
204363	31	15-STIN-84	J1-10	1067.62	5.8	3	10.50	12.25	9.8	0.00	3.00	Based on Luke AFB Survey
215066	491	15-STIN-73	J1-11	1067.71	5.4	3	15.00	25.00	20.0	0.00	3.00	Google Imagery (2013)
221877	321	21-STIN-1	J1-12	1067.63	5.5	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
229626	287	20-STIN-15	J1-13-A	1068.99	4.0	2	12.00	20.00	16.0	4.00	2.30	Google Imagery (2013)
238417	187	21-STIN-2	J1-14	1068.08	6.0	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
248144	368	21-STIN-6	J1-15	1068.52	5.2	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
253981	67	21-STIN-3	J1-16	1068.67	5.4	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
235481*	186	20-STIN-23	J1-17-A	1069.42	4.6	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
233527	66	20-STIN-22	J1-17-B	1070.68	2.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
252023	470	20-STIN-24	J1-17-D	1067.89	6.6	3	11.00	14.00	11.2	0.00	3.00	Google Imagery (2013)
259816	272	21-STIN-39	J1-17-E	1069.12	5.3	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
270500	504	20-STIN-52	J1-18-A	1069.43	4.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
273420	1	20-STIN-53	J1-18-B	1069.66	3.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
276341	160	20-STIN-54	J1-19-A	1070.30	2.4	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
281201	159	20-STIN-55	J1-20-A	1070.10	2.9	2	2.00	1.42	1.1	0.66	2.30	Luke AFB Survey (Apr 2013)
283148	158	20-STIN-56	J1-20-B	1070.15	2.9	2	2.00	1.42	1.1	0.66	2.30	Based on Luke AFB Survey
306485	161	27-STIN-8	J1-22	1068.71	1.6	2	2.00	1.42	1.1	0.42	2.30	Based on Luke AFB Survey
200396	231	14-STIN-9	J2-1	1067.86	6.7	3	12.00	16.00	12.8	0.00	3.00	Google Imagery (2013)
195582	14	14-STIN-7	J2-2-A	1071.54	3.3	3	8.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
205292	64	14-STIN-5	J2-2-B	1069.02	4.6	3	8.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
212091	229	14-STIN-3	J2-2-C	1067.51	5.7	3	8.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
228644	469	20-STIN-20	J2-3	1064.94	7.8	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
233516	230	20-STIN-25	J2-4-A	1068.80	4.0	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
231563	367	20-STIN-36	J2-4	1065.81	7.1	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
248105	15	20-STIN-37	J2-5	1065.96	7.6	3	11.50	15.75	12.6	0.00	3.00	Google Imagery (2013)
N/A	3	20-STIN-57	J2-6	1066.50	6.4	3	*Not an Inlet in FLO-2D*		0.0		3.00	
261715	406	20-STIN-75	J2-7-A	1068.37	2.4	3	6.51	4.71	3.8	0.00	3.00	Luke AFB Survey (Apr 2013)
262696	301	20-STIN-41	J2-7-B	1067.01	4.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
269512	4	20-STIN-67	J2-7	1065.98	5.7	3	10.50	12.25	9.8	0.00	3.00	Google Imagery (2013)
277285	54	20-STIN-76	J2-8-A	1069.74	1.1	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
274370	307	20-STIN-42	J2-8-B	1068.83	2.0	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
274377	302	20-STIN-48	J2-8	1067.17	3.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
284110*	404	20-STIN-69	J2-9-A	1069.96	1.5	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
285080*	274	20-STIN-39	J2-9	1068.01	4.2	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
287024*	303	20-STIN-46	J2-10-A	1067.12	4.6	3	9.42	7.07	5.7	0.00	3.00	Google Imagery (2013)
281178	163	20-STIN-28	J3-1	1070.03	2.9	2	3.50	1.33	1.1	0.66	2.30	Luke AFB Survey (Apr 2013)
286043	405	20-STIN-77	J3-2	1068.99	2.4	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
307448	506	27-STIN-1	J4-1	1069.02	2.0	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
235442	65	20-STIN-21	J5-1	1068.11	3.9	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
236392	199	20-STIN-43	J5-2	1067.47	4.4	3	12.00	16.00	12.8	0.00	3.00	Google Imagery (2013)
262682	454	20-STIN-74	J5-3-A1	1068.86	1.9	3	6.75	5.06	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
261706	275	20-STIN-73	J5-3-A2	1068.79	2.0	3	6.51	4.71	3.8	0.00	3.00	Based on Luke AFB Survey
262674	308	20-STIN-72	J5-3-A4	1068.04	2.7	3	8.25	8.13	6.5	0.00	3.00	Based on Luke AFB Survey
263642	55	20-STIN-65	J5-3-A5	1067.56	2.7	3	8.25	8.13	6.5	0.00	3.00	Luke AFB Survey (Apr 2013)
262654	80	20-STIN-45	J5-3-B1	1069.09	1.8	3	6.75	5.06	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
261684	246	20-STIN-44	J5-3-B3	1068.78	2.0	3	6.50	4.50	3.6	0.00	3.00	Based on Luke AFB Survey
263637	456	20-STIN-66	J5-3	1066.06	4.1	3	11.32	14.64	11.7	0.00	3.00	Google Imagery (2013)
N/A	276	20-STIN-70	J5-5-A	1066.20	4.4	3	*Not an Inlet in FLO-2D*		0.0		3.00	
271425*	455	20-STIN-71	J5-5	1065.51	5.7	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
286029	457	20-STIN-64	J5-10-A	1069.35	1.8	3	6.50	5.00	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
297708	305	27-STIN-5	J5-11-A	1065.37	6.1	3	10.74	14.42	11.5	0.00	3.00	Luke AFB Survey (Apr 2013)
296732	306	27-STIN-4	J5-11-B	1066.66	4.7	3	7.50	7.00	5.6	0.00	3.00	Luke AFB Survey (Apr 2013)
297705	507	27-STIN-3	J5-11-C	1065.96	4.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
308411	304	27-STIN-6	J6-1	1063.99	6.0	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
271403	458	20-STIN-60	J7-1-A	1067.71	2.5	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
276268	358	20-STIN-61	J7-1-B	1067.78	2.9	3	6.32	4.87	3.9	0.00	3.00	Luke AFB Survey (Apr 2013)
280160	277	20-STIN-62	J7-1-C	1067.11	4.4	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
285025	509	20-STIN-63	J7-2	1067.18	3.2	3	6.83	5.67	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
263618	310	20-STIN-59	J7-3-A	1068.36	2.0	3	6.48	4.67	3.7	0.00	3.00	Luke AFB Survey (Apr 2013)
264586	510	20-STIN-40	J7-3-B	1067.06	3.4	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
270424	460	20-STIN-16	J7-3-C	1066.70	3.7	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
275289	511	20-STIN-14	J7-3-D	1066.78	3.9	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
280154	408	20-STIN-11	J7-3-E	1066.99	3.8	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
285992*	56	20-STIN-1	J7-3	1066.66	4.6	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
265556	459	20-STIN-26	J7-4-A	1067.19	3.0	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
270421	311	20-STIN-17	J7-4-B	1067.43	3.0	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
275286	407	20-STIN-13	J7-4-C	1066.45	4.2	3	6.83	5.66	4.5	0.00	3.00	Based on Luke AFB Survey
280151	278	20-STIN-12	J7-4-D	1066.77	4.1	3	5.33	3.33	2.7	0.00	3.00	Luke AFB Survey (Apr 2013)
285989*	461	20-STIN-9	J7-4	1066.28	4.8	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
271388	5	20-STIN-6	J7-5-A	1067.72	2.6	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
280145	512	20-STIN-7	J7-5-B	1067.44	3.2	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
285983	312	20-STIN-18	J7-5	1066.48	4.5	3	6.83	5.66	4.5	0.00	3.00	Luke AFB Survey (Apr 2013)
261655	57	20-STIN-4	J7-6	1069.58	1.8	3	7.00	5.43	4.3	0.00	3.00	Luke AFB Survey (Apr 2013)
265543*	513	20-STIN-3	J7-7-A	1069.00	1.8	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
267495*	410	20-STIN-5	J7-7-B	1067.59	2.5	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
267492	58	20-STIN-27	J7-7	1067.56	3.1	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
270410	514	20-STIN-10	J7-8	1066.98	3.1	3	6.50	5.00	4.0	0.00	3.00	Google Imagery (2013)
273321	409	20-STIN-8	J7-9	1066.34	3.8	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
280132	359	20-STIN-32	J7-10	1066.22	4.6	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
269411	12	19-STIN-3	J7-11-A	1065.69	3.6	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
272335*	320	19-STIN-1	J7-11-B	1065.91	4.3	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
275256*	6	19-STIN-2	J7-11-C	1065.90	5.1	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
277204*	360	20-STIN-19	J7-11-D	1065.89	5.1	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
280124*	315	20-STIN-30	J7-11-E	1066.01	5.0	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
282071	125	20-STIN-31	J7-11	1065.41	5.2	2	2.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
76118	87	8-STIN-2	J8-1	1080.24	7.5	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
79798	36	8-STIN-4	J8-2	1079.81	8.2	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
106404	184	8-STIN-5	J8-3-A	1078.07	4.5	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
112465*	207	8-STIN-3	J8-3-B	1080.04	2.1	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
120607	183	8-STIN-7	J8-3	1075.03	6.8	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
134216	433	8-STIN-1	J8-4	1073.53	7.3	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
147825	88	14-STIN-6	J8-5	1072.47	7.7	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
161434	340	14-STIN-1	J8-6	1071.44	7.8	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
182820	382	13-STIN-1	J8-8	1068.73	8.8	3	10.00	12.50	10.0	0.00	3.00	Google Imagery (2013)
269409	468	19-STIN-4	J8-11	1063.98	6.0	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
112570	317	9-STMH-6	J9-1	1076.82	1.4	3	6.75	5.06	4.0	0.00	3.00	Luke AFB Survey (Apr 2013)
108765	279	9-STMH-5	J9-2	1075.03	2.8	3	5.42	3.42	2.7	0.00	3.00	Luke AFB Survey (Apr 2013)
107274	413	9-STMH-8	J9-3-A	1075.87	1.6	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
108779	412	9-STMH-7	J9-3	1074.38	3.1	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
108036	9	9-STMH-9	J9-4	1074.84	3.1	3	8.00	6.88	5.5	0.00	3.00	Luke AFB Survey (Apr 2013)
107291	128	9-STMH-34	J9-5-A	1075.11	3.0	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
108802	130	9-STMH-17	J9-6-A	1074.24	3.5	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
105797	129	9-STMH-16	J9-7-A	1074.23	3.7	2	2.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
105798	516	9-STMH-15	J9-7-B	1074.46	2.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
102068	282	9-STMH-18	J9-8	1071.16	6.4	3	11.16	15.57	12.5	0.00	3.00	Luke AFB Survey (Apr 2013)
102072	521		J9-9	1070.82	7.7	2	2.50	2.50	2.0	0.42	2.30	Google Imagery (2013)
105056	131	9-STMH-19	J9-10	1071.14	7.9	2	5.00	1.50	1.2	0.42	2.30	Based on Luke AFB Survey
114153	280	9-STMH-12	J9-11-A	1074.44	2.1	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
123697	126	9-STMH-32	J9-12-A	1074.71	3.7	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
123695	127	9-STMH-33	J9-12-B	1071.02	7.2	2	3.00	2.00	1.6	0.15	2.30	Google Imagery (2013)
142177	369	15-STIN-49	J9-13-A	1073.60	1.2	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
143152	254	15-STIN-101	J9-13-B	1072.01	3.3	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
155796	232	15-STIN-51	J9-14-A	1073.59	1.8	3	6.50	5.00	4.0	0.00	3.00	Google Imagery (2013)
151903*	383	15-STIN-54	J9-14-B	1073.68	1.8	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
164554	188	15-STIN-3	J9-15-A	1073.75	1.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
162614	115	15-STIN-53	J9-15-B	1070.94	4.9	2	3.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
161641	114	15-STIN-52	J9-15-C	1070.70	5.1	2	3.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
167484	110	15-STIN-45	J9-16-A	1072.33	2.7	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
168454	111	15-STIN-82	J9-16-B	1071.80	3.3	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
171395	213	16-STIN-23	J9-17-A	1071.74	3.5	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
173322	109	15-STIN-44	J9-18-A	1071.05	4.1	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
175266	108	15-STIN-43	J9-18-B	1069.09	6.3	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
193741	416	15-STIN-5	J9-19-A	1073.35	2.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
188876	494	15-STIN-67	J9-19-B	1072.25	3.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
187908	16	15-STIN-7	J9-19-D	1071.86	3.5	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
187909	189	15-STIN-4	J9-19-E	1073.25	2.1	3	3.50	1.50	1.2	0.00	3.00	Google Imagery (2013)
180144	104	16-STIN-35	J9-20-A	1073.14	2.7	2	3.50	2.00	1.6	0.42	2.30	Google Imagery (2013)
181113	63	15-STIN-59	J9-20-B	1071.73	3.8	3	6.16	4.66	3.7	0.00	3.00	Luke AFB Survey (Apr 2013)
182083	185	15-STIN-92	J9-20-C	1068.79	5.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
185005	105	15-STIN-61	J9-20-D	1072.02	4.1	2	3.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
192797*	394	16-STIN-22	J9-21-A	1070.54	6.4	3	6.28	3.14	2.5	0.00	3.00	Luke AFB Survey (Apr 2013)
197648	106	15-STIN-41	J9-22-A	1074.62	1.8	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
197646	107	15-STIN-42	J9-22-B	1073.26	3.2	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
200557	17	15-STIN-16	J9-23-A	1071.39	4.2	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
198615	322	15-STIN-1	J9-23-B	1070.77	4.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
213206	417	15-STIN-32	J9-24-A	1074.17	2.0	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
213207	471	15-STIN-37	J9-24-B	1073.00	3.1	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
214181	371	15-STIN-30	J9-24-C	1072.44	3.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
215157	418	15-STIN-20	J9-24-D	1071.86	3.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
241421	439	21-STIN-37	J9-26-A	1076.05	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
240451	343	21-STIN-51	J9-26-B	1074.36	3.8	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
240452	497	21-STIN-58	J9-26-C	1073.28	4.9	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
271594	402	21-STIN-38	J9-29-A	1078.51	1.3	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
281323	291	21-STIN-19	J9-30-A	1078.19	2.0	3	8.00	7.50	6.0	0.00	3.00	Google Imagery (2013)
268638	452	21-STIN-45	J9-31-A	1077.49	3.6	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
293942	299	21-STIN-43	J9-31-C	1077.47	2.5	3	8.82	9.31	7.4	0.00	3.00	Luke AFB Survey (Apr 2013)
311472	155	28-STIN-4	J10-1	1080.75	4.2	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
311468	154	28-STIN-3	J10-2	1081.33	2.8	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
309519	153	28-STIN-2	J10-3	1079.60	4.1	2	3.00	1.50	1.2	0.00	2.30	Google Imagery (2013)
180048	336	15-STIN-89	J11-1-A	1072.36	2.4	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
178103	335	15-STIN-90	J11-1-B	1072.57	2.2	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
177136	489	15-STIN-91	J11-2-A	1071.54	3.1	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
177140	82	15-STIN-39	J11-2-B	1071.64	3.1	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
181046	206	15-STIN-29	J11-3-A	1070.06	4.6	3	11.00	14.00	11.2	0.00	3.00	Luke AFB Survey (Apr 2013)
167449	249	15-STIN-55	J11-5-A	1072.22	2.8	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167448	202	15-STIN-2	J11-5-B	1071.71	3.2	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
177173	485	15-STIN-8	J11-5-D	1072.37	3.0	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
178152	203	15-STIN-27	J11-5	1068.78	6.1	3	11.00	14.00	11.2	0.00	3.00	Luke AFB Survey (Apr 2013)
166486	429	15-STIN-36	J11-6-A1	1070.56	4.5	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
166490	334	15-STIN-35	J11-6-A2	1071.14	3.7	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
172328	333	15-STIN-34	J11-6-B1	1070.64	4.5	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
175245	233	15-STIN-22	J11-6-C1	1069.71	5.8	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
175247	332	15-STIN-33	J11-6-C2	1072.21	2.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
178166	18	15-STIN-23	J11-7	1068.53	6.3	3	11.00	14.00	11.2	0.00	3.00	Luke AFB Survey (Apr 2013)
169361	430	15-STIN-15	J12-1	1072.82	2.4	3	5.50	3.50	2.8	0.00	3.00	Luke AFB Survey (Apr 2013)
168390	81	15-STIN-6	J12-2-A	1072.36	2.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
170336	205	15-STIN-17	J12-2-B	1072.44	2.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167426	488	15-STIN-14	J12-3-A	1072.41	2.8	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
170353	380	15-STIN-19	J12-5-A	1071.59	3.7	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
168407	251	15-STIN-13	J12-6-A	1070.80	4.2	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167434	204	15-STIN-12	J12-6-B	1070.28	4.9	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
167436	487	15-STIN-11	J12-6-C	1072.67	2.5	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
176192	486	15-STIN-10	J12-7-A	1072.25	2.7	3	5.42	3.42	2.7	0.00	3.00	Luke AFB Survey (Apr 2013)
176194	250	15-STIN-9	J12-7-B	1071.89	3.0	3	5.50	3.50	2.8	0.00	3.00	Based on Luke AFB Survey
189816	86	15-STIN-66	J13-1	1073.28	1.6	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
193714*	253	15-STIN-56	J13-2	1070.18	3.7	3	6.28	3.14	2.5	0.00	3.00	Google Imagery (2013)
189841	192	15-STIN-25	J13-4-A	1070.63	4.2	3	8.50	8.75	7.0	0.00	3.00	Based on Luke AFB Survey
188869	472	15-STIN-24	J13-4-B	1072.37	2.6	3	8.50	8.75	7.0	0.00	3.00	Luke AFB Survey (Apr 2013)
203401	173	15-STIN-98	J14-1-A	1070.86	2.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
203402	172	15-STIN-99	J14-1	1070.87	3.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
206321	174	15-STIN-100	J14-2-A	1070.56	3.2	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
209239	492	15-STIN-79	J14-3-A	1070.24	3.3	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
215078	337	15-STIN-80	J14-4-A	1070.65	3.2	3	11.00	15.00	12.0	0.00	3.00	Google Imagery (2013)
209248	32	15-STIN-77	J14-4-B	1070.57	3.7	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
216060	338	15-STIN-78	J14-4-C	1070.64	3.9	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
226762	393	21-STIN-29	J14-5-A	1072.18	2.8	3	8.00	8.00	6.4	0.00	3.00	Google Imagery (2013)
225791	294	21-STIN-28	J14-5-B	1071.88	3.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
227737	500	21-STIN-32	J14-5-D	1072.47	2.4	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
228709	41	21-STIN-31	J14-5-E	1071.87	3.0	3	9.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
228716	259	21-STIN-21	J14-5-F	1070.96	4.2	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
227745	212	21-STIN-25	J14-5-H	1071.99	3.1	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
228725	260	21-STIN-26	J14-6	1070.96	4.6	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
226781	443	21-STIN-22	J14-7-A	1072.66	2.3	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
229700	499	21-STIN-23	J14-7-B	1072.20	3.3	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
226784	391	21-STIN-7	J14-9-A	1072.68	3.1	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
227762	293	21-STIN-18	J14-10	1070.78	5.6	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
221940	90	21-STIN-50	J14-12-A	1073.58	2.3	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
226818	440	21-STIN-10	J14-13-A	1074.51	2.4	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
225856	290	21-STIN-52	J14-15-A	1073.12	3.8	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
225855	388	21-STIN-53	J14-15-B	1071.91	5.3	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
227802	256	21-STIN-56	J14-16-A	1072.93	4.2	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
227804	342	21-STIN-62	J14-16-B	1072.15	4.9	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
254028	149	21-STIN-47	J15-1-A	1075.23	2.6	2	3.50	1.00	0.8	0.42	2.30	Based on Luke AFB Survey
255976	150	21-STIN-46	J15-1	1075.70	2.8	2	3.50	1.00	0.8	0.42	2.30	Based on Luke AFB Survey
251109	223	21-STIN-48	J15-2-A	1075.55	2.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
250130	51	21-STIN-49	J15-4-A	1074.44	1.4	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
242346	347	21-STIN-30	J15-4-B	1072.81	2.8	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
235534	346	21-STIN-27	J15-5-A	1071.80	3.4	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
235536	345	21-STIN-36	J15-5-B	1072.12	4.1	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
205357	169	15-STIN-75	J16-1-A	1071.74	2.2	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
206328	168	15-STIN-76	J16-1-B	1070.02	3.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
203409	171	15-STIN-81	J16-1-D	1071.80	1.9	2	3.50	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
202438	170	15-STIN-74	J16-1-E	1071.52	2.4	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
205365	178	15-STIN-63	J16-2-A	1070.11	3.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
205364	177	15-STIN-95	J16-2-B	1071.12	3.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
202446	176	15-STIN-96	J16-2-C	1071.20	3.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
202445	175	15-STIN-97	J16-2-D	1071.75	2.4	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
201492	180	15-STIN-70	J16-5-A	1072.99	1.8	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
201491	179	15-STIN-71	J16-5-B	1072.83	1.9	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
203438	33	15-STIN-48	J16-6	1071.70	3.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
202458	381	15-STIN-46	J16-8-A	1072.20	2.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
207320	182	15-STIN-57	J16-10-A	1070.53	4.0	2	7.00	2.00	1.6	0.42	2.30	Luke AFB Survey (Apr 2013)
207322	181	15-STIN-21	J16-10-B	1070.55	4.0	2	7.00	2.00	1.6	0.42	2.30	Based on Luke AFB Survey
229707	442	21-STIN-20	J16-12-B	1073.74	2.5	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
229708	258	21-STIN-34	J16-12-D	1073.81	2.5	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
229723	210	21-STIN-60	J16-14-A	1073.66	3.1	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
229732	39	21-STIN-8	J16-15-A	1074.75	3.3	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
207328	85	15-STIN-68	J17-1	1072.31	2.8	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
207332	84	15-STIN-69	J17-2	1072.18	3.3	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
215114	432	15-STIN-58	J17-3	1071.83	3.3	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
214149	339	15-STIN-60	J17-5	1071.11	6.7	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
204423	35	15-STIN-64	J18-1	1073.85	1.5	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
207342	493	15-STIN-62	J18-2	1073.32	2.2	3	7.50	7.00	5.6	0.00	3.00	Luke AFB Survey (Apr 2013)
207344	34	15-STIN-72	J18-3-A	1071.83	3.7	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
225830	387	21-STIN-59	J18-5-A	1073.84	2.2	3	7.50	7.00	5.6	0.00	3.00	Based on Luke AFB Survey
203463	323	15-STIN-28	J19-1-A	1070.30	5.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
200544	419	15-STIN-26	J19-1-B	1072.24	3.1	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
201519	372	15-STIN-18	J19-1-C	1073.21	2.3	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
203465	191	15-STIN-38	J19-1-D	1072.54	2.9	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
211253	190	15-STIN-31	J19-2-A	1072.01	4.0	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
225843	441	21-STIN-11	J19-3-A	1073.12	3.0	3	11.00	14.00	11.2	0.00	3.00	Based on Luke AFB Survey
217089	91	15-STIN-83	J20-1	1074.76	2.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
219041	438	21-STIN-5	J20-2-A	1075.83	2.1	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
219038	289	21-STIN-55	J20-2-B	1075.73	2.6	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
219034	38	21-STIN-33	J20-2	1074.01	3.1	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221959	257	21-STIN-17	J20-3-A	1074.44	4.2	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
221957	40	21-STIN-16	J20-3-B	1074.06	4.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221956	344	21-STIN-15	J20-3-C	1074.20	4.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221954	211	21-STIN-14	J20-3-D	1073.26	4.7	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
221953	390	21-STIN-13	J20-3	1073.38	4.8	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
224873	498	21-STIN-12	J20-4	1071.97	4.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
324603	227	26-STIN-6	J21-1	1066.91	2.6	3	3.50	1.50	1.2	0.00	3.00	Google Imagery (2013)
329763	200	26-STIN-2	J22-1	1066.08	4.2	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
340165	366	26-STIN-5	J22-2	1066.83	2.8	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
334150	247	25-STIN-2	J23-1	1067.41	2.4	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
337865	29	25-STIN-1	J23-2	1066.34	3.0	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
354956	201	25-STIN-3	J23-4	1061.75	3.4	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
360904	483	30-STIN-3	J23-5-A	1064.26	2.6	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
370526	30	30-STIN-2	J24-1	1062.67	2.5	3	5.50	3.75	3.0	0.00	3.00	Google Imagery (2013)
415681	484	30-STIN-1	J25-1	1064.15	3.0	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
263972	74	23-STIN-8	J26-1	1075.82	10.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
260081	422	23-STIN-6	J26-2	1075.71	11.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
255216	239	23-STIN-5	J26-3	1075.20	10.5	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
249376	72	23-STIN-1	J26-5	1075.34	8.0	3	4.00	2.00	1.6	0.00	3.00	Google Imagery (2013)
244513*	195	23-STIN-18	J26-6	1074.99	9.3	3	9.42	7.07	5.7	0.00	3.00	Google Imagery (2013)
241588	117	23-STIN-24	J26-8-A	1077.60	4.7	2	2.50	2.50	2.0	0.42	2.30	Google Imagery (2013)
237701	325	23-STIN-19	J26-8	1074.51	9.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
231864	421	23-STIN-10	J26-10	1074.31	8.7	3	7.50	6.25	5.0	0.00	3.00	Google Imagery (2013)
228942	116	23-STIN-17	J26-11-A	1077.17	4.5	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
227972	193	23-STIN-25	J26-12	1074.30	8.4	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
224076	19	23-STIN-14	J26-13-A	1074.13	7.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
223098	376	23-STIN-9	J26-13-B	1074.15	8.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
223094	375	23-STIN-12	J26-13-C	1074.78	8.1	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
223106	20	23-STIN-16	J26-13	1073.81	9.8	3	7.85	4.91	3.9	0.00	3.00	Google Imagery (2013)
216232*	136	16-STIN-48	J26-14-A	1079.69	2.7	2	3.00	2.00	1.6	0.42	2.30	Google Imagery (2013)
217252	70	17-STIN-6	J26-14-D	1073.77	9.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
211434	420	17-STIN-7	J26-16	1073.75	9.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
200731	69	17-STIN-13	J26-17	1075.34	7.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
191001	374	17-STIN-9	J26-18	1074.13	8.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
181271	324	17-STIN-4	J26-19	1074.33	7.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
169596	236	17-STIN-1	J26-20	1074.42	6.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
158893	235	17-STIN-3	J26-22	1074.08	6.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
149165	473	17-STIN-8	J26-24	1073.92	5.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
139436	373	17-STIN-5	J26-25	1073.84	5.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
129702	234	11-STIN-4	J26-26	1074.42	4.7	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
128729	451	11-STIN-2	J26-27	1077.09	2.1	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
260043*	77	22-STIN-9	J27-1	1077.38	5.4	3	9.42	7.07	5.7	0.00	3.00	Google Imagery (2013)
261993	427	22-STIN-5	J27-2	1077.44	5.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262971	426	23-STIN-26	J27-3	1077.06	7.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262976	198	23-STIN-30	J27-4	1076.66	6.7	3	4.50	2.50	2.0	0.00	3.00	Google Imagery (2013)
262980	25	23-STIN-31	J27-5	1076.73	8.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262985	423	23-STIN-43	J27-6	1076.59	8.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
262989	240	23-STIN-36	J27-7	1076.42	8.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
263966	475	23-STIN-28	J27-8	1076.13	10.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
246428	164	23-STIN-29	J28-1-A	1077.05	4.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
241569	378	23-STIN-34	J28-1-B	1076.73	5.0	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
242540	479	23-STIN-35	J28-1	1076.82	2.9	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
246433	244	23-STIN-33	J28-2	1076.61	3.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
250327	245	23-STIN-32	J28-4	1076.43	3.4	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
248391	118	23-STIN-42	J28-5-A	1079.98	4.6	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
248390	119	23-STIN-41	J28-5-B	1079.92	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
252287	196	23-STIN-4	J28-6-A	1075.78	9.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
249369	73	23-STIN-3	J28-6	1073.85	9.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
251319	474	23-STIN-2	J28-7	1075.38	9.8	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
234780	238	23-STIN-20	J29-1	1074.37	7.8	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
236722	71	23-STIN-22	J29-2-A	1074.47	6.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
234777	194	23-STIN-21	J29-2	1074.66	6.3	3	5.00	3.00	2.4	0.00	3.00	Google Imagery (2013)
237688	120	23-STIN-40	J29-3-A	1079.59	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
237687	121	23-STIN-39	J29-3-B	1079.69	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
234758	122	23-STIN-38	J29-4	1077.60	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
237668	243	22-STIN-12	J29-5-A	1077.88	2.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
227943	241	23-STIN-37	J29-5-B	1077.53	4.9	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
226975	424	23-STIN-13	J29-5-C	1077.83	4.6	3	10.50	12.25	9.8	0.00	3.00	Google Imagery (2013)
227953	237	23-STIN-11	J29-5-D	1079.13	3.4	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
233779	476	23-STIN-27	J29-5	1075.53	5.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
261010	330	22-STIN-6	J30-1	1077.82	3.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
258091	26	22-STIN-7	J30-2	1077.51	5.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
254198	124	22-STIN-15	J30-3-A	1077.56	4.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
248364	22	22-STIN-17	J30-3-C	1077.43	5.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
245446	329	22-STIN-11	J30-3-D	1077.28	4.4	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
240586	24	22-STIN-13	J30-3-E	1077.04	3.9	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
253225	123	22-STIN-16	J30-3	1077.07	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
247388	478	22-STIN-18	J30-5	1076.08	5.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
242525	425	22-STIN-22	J30-6	1075.69	3.9	3	9.50	10.50	8.4	0.00	3.00	Google Imagery (2013)
236688	21	22-STIN-19	J30-8	1075.56	4.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
234747	76	22-STIN-10	J30-9	1075.22	5.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
233776	242	22-STIN-1	J30-10	1074.95	5.1	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
227938	377	22-STIN-2	J30-12	1074.28	5.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
223072	75	22-STIN-4	J30-13-A	1073.94	7.8	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
223069	477	22-STIN-3	J30-13-B	1074.48	7.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
223063	78	22-STIN-29	J30-13-C	1075.99	6.5	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
259059	379	22-STIN-8	J31-1	1078.15	3.9	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
256134	428	22-STIN-25	J31-2	1077.34	3.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
249323	79	22-STIN-33	J31-3	1076.82	4.1	3	9.00	10.00	8.0	0.00	3.00	Google Imagery (2013)
244458	28	22-STIN-23	J31-4	1076.65	4.8	3	10.00	12.00	9.6	0.00	3.00	Google Imagery (2013)
222079	480	22-STIN-28	J31-5-A	1077.88	4.5	3	8.00	7.50	6.0	0.00	3.00	Google Imagery (2013)
230836	27	22-STIN-26	J31-5-B	1076.83	5.5	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
239593	482	22-STIN-24	J31-5	1076.42	5.4	3	8.50	8.75	7.0	0.00	3.00	Google Imagery (2013)
239597	42	22-STIN-21	J31-6	1076.22	5.4	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
238626	165	22-STIN-32	J31-7	1076.41	4.2	2	1.50	1.50	1.2	0.42	2.30	Google Imagery (2013)
128692	450	10-STIN-7	J32-1	1074.39	2.5	3	6.50	5.25	4.2	0.00	3.00	Google Imagery (2013)
139397	297	11-STIN-3	J32-2	1073.28	2.9	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
143286	49	16-STIN-37	J32-3	1072.79	4.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
148150	140	16-STIN-45	J32-4	1071.78	5.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
149123	139	16-STIN-44	J32-5	1071.84	5.7	2	3.00	1.50	1.2	0.00	2.30	Google Imagery (2013)
158854	400	16-STIN-50	J32-6	1071.59	4.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
164692	271	16-STIN-51	J32-7	1071.88	5.0	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
169555	353	16-STIN-53	J32-8	1071.70	6.3	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
156883	143	16-STIN-47	J32-9-C	1073.60	3.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
155909	144	16-STIN-40	J32-9-D	1074.68	2.5	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
180257	352	16-STIN-55	J32-10	1071.77	6.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
189986	270	16-STIN-56	J32-11	1072.26	7.6	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
199715	269	16-STIN-57	J32-12	1072.65	8.1	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
209446	398	16-STIN-54	J32-13	1073.25	8.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
137465	356	11-STIN-1	J33-1	1075.24	2.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
142326	148	17-STIN-10	J33-2	1074.79	2.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
142325	147	17-STIN-18	J33-3	1074.72	2.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
143291	401	17-STIN-11	J33-5	1074.61	2.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
141328	145	16-STIN-39	J33-6	1073.95	2.7	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
142302	146	16-STIN-38	J33-7	1073.60	3.1	2	3.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
156924	448	17-STIN-14	J33-10	1076.71	1.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
157892	138	17-STIN-15	J33-12	1075.41	2.4	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
157891	137	17-STIN-16	J33-13	1075.50	2.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
153993	354	17-STIN-17	J33-14-A	1076.30	1.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
156911	48	17-STIN-12	J33-14	1074.70	3.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
157864	141	16-STIN-30	J33-15	1074.34	2.1	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
157865	142	16-STIN-43	J33-16	1073.93	2.5	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
154953	222	16-STIN-34	J33-17-A	1074.48	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
163709	355	16-STIN-41	J33-17-B	1074.62	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
158845	449	16-STIN-42	J33-17	1073.12	3.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
209399	447	16-STIN-36	J34-1	1072.01	7.5	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
198696	267	16-STIN-15	J34-2	1071.26	7.1	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
188965	221	16-STIN-14	J34-3	1070.95	6.7	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)
178262	220	16-STIN-1	J34-4	1070.68	6.2	3	6.00	4.50	3.6	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
Max Depth - Distance from inlet invert to ground surface
* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
168534	503	16-STIN-9	J34-6	1070.27	5.6	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
157836	103	16-STIN-8	J34-7-A	1073.35	3.1	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
157834	102	16-STIN-7	J34-7-B	1073.84	2.7	2	4.00	1.50	1.2	0.00	2.30	Google Imagery (2013)
157833	446	16-STIN-16	J34-7	1070.60	5.6	3	7.50	7.00	5.6	0.00	3.00	Google Imagery (2013)
148103	47	16-STIN-6	J34-8	1071.17	4.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
142266	101	16-STIN-5	J34-9-A	1072.82	3.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
143237	100	16-STIN-4	J34-9	1072.69	3.3	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
128649	92	10-STIN-2	J35-3-A	1071.66	5.0	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
121822	98	10-STIN-13	J35-4-A	1073.08	3.4	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
170449	219	16-STIN-10	J36-1	1073.45	1.8	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
151964	445	16-STIN-31	J36-2-A	1074.13	2.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
156828	266	16-STIN-26	J36-2-B	1074.25	2.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
152926*	262	16-STIN-19	J36-2-C	1073.36	2.5	3	4.71	1.77	1.4	0.00	3.00	Google Imagery (2013)
146111	214	16-STIN-18	J36-2-D	1074.28	1.2	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
151962	444	16-STIN-24	J36-2	1069.92	6.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
148068	218	16-STIN-29	J36-3-A	1073.86	2.0	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
144177	265	16-STIN-12	J36-4-A	1074.16	2.1	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
141259	502	16-STIN-27	J36-5	1070.49	6.4	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
123742	46	10-STIN-16	J36-6-A	1075.32	1.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
122771	95	10-STIN-17	J36-6	1073.56	3.6	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
121788	96	10-STIN-12	J36-7-A	1074.27	2.9	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
120814	97	10-STIN-15	J36-7-B	1074.50	2.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
120825	94	10-STIN-18	J36-7	1072.46	4.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
161677	1158		J37-1	1072.75	3.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
155839	1159		J37-2	1072.74	3.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
155835	348	16-STIN-21	J37-3-A	1073.40	2.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
152917	43	16-STIN-3	J37-3-B	1071.88	3.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
151940	295	16-STIN-2	J37-4	1071.63	6.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
N/A	44	16-STIN-32	J37-5	1071.03	6.5	3	*Not an Inlet in FLO-2D*		0.0		3.00	
145124	395	16-STIN-25	J37-6-A	1073.04	3.9	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
145126	349	16-STIN-17	J37-6	1070.56	6.6	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
139285	501	16-STIN-28	J37-8-A	1069.90	6.3	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet

3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet

Max Depth - Distance from inlet invert to ground surface

* indicates the inlet is circular in shape

Appendix 3 - Inlet Data for FLO-2D (SWMMFLO.DAT)

FLO-2D CELL#	GIS OBJECTID	LUKE AFB INLET_ID	SWMM NAME	INVERT_ELV	MAX DEPTH	INLET TYPE	LENGTH[2] OR PERIMTER[3]	WIDTH[2] OR AREA[3]	WIDTH[2] OR AREA[3] (80%)	HEIGHT	WEIR COEFF	Source of Storm Drain Measurements
133450*	215	10-STIN-6	J37-9	1069.08	6.8	3	4.71	1.77	1.4	0.00	3.00	Google Imagery (2013)
127619	216	10-STIN-8	J37-10-A	1072.95	2.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
118858	217	10-STIN-9	J37-10	1073.78	3.7	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
115941	93	10-STIN-11	J37-11	1074.02	3.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
137333	263	10-STIN-3	J38-1	1073.68	4.0	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
131495	350	10-STIN-4	J38-3-A	1072.54	4.4	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
130525	45	10-STIN-1	J38-3-B	1071.94	5.4	3	6.00	4.00	3.2	0.00	3.00	Google Imagery (2013)
130526*	351	10-STIN-5	J38-3	1071.19	6.0	3	4.71	1.77	1.4	0.00	3.00	Google Imagery (2013)
122742	264	10-STIN-10	J38-4	1069.99	6.9	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
114950	134	9-STMH-27	J38-6-A	1073.93	3.2	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
113394	132	9-STMH-25	J38-6-B	1075.73	3.5	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
117871	60	9-STMH-28	J38-6	1069.55	6.5	3	4.50	2.25	1.8	0.00	3.00	Google Imagery (2013)
118840	133	9-STMH-26	J38-7-A	1072.04	5.7	2	4.00	1.50	1.2	0.42	2.30	Google Imagery (2013)
122729	61	9-STMH-29	J38-8	1071.01	4.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
129540	462	9-STMH-30	J38-9	1073.32	3.5	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
137324	7	9-STMH-31	J38-10	1074.31	2.4	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
102794	363	9-STMH-24	J42-1	1076.04	2.2	3	7.00	6.00	4.8	0.00	3.00	Google Imagery (2013)
102052	319	9-STMH-22	J42-2	1076.07	2.7	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)
101308	11	9-STMH-23	J42-3	1075.98	3.4	3	9.00	9.00	7.2	0.00	3.00	Google Imagery (2013)

2. Inlet Type 2 uses Length and Width of inlet
3. Inlet Type 3 uses Perimeter (L + 2W) and Area of inlet
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APPENDIX 4

District Quality Control (DQC)

Comments and Responses from Dr. Checks

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

CESPL-ED 20 May 2013

MEMORANDUM FOR CESPL-PM-M, Attn.: Joe Derungs

Subject: Transmittal of Flood Investigation Study for Luke Air Force Base, Maricopa County, Arizona.

1. References

a. EC 1165-2-209, "Civil Works Review Policy", dated 31 January 2012.

2. Enclosed is the Flood Investigation Study for Luke Air Force Base, Maricopa County, Arizona along with Engineering Division DQC Certification.

3. The Engineering Division District Quality Control Process has been completed for this work product in accordance with reference 1 a. During the DQC, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. All important comments resulting from the DQC have been resolved.

4. This work product may be incorporated into the associated draft report and may be submitted to the ATR Leader for review.

5. If you have any questions or concerns, the Engineering Division point of contact is Cuong Ly (Chief, Hydrology and GIS Section) at extension 3566.

RICHARD J. LEIFIELD, P.E.
Chief, Engineering Division

CESPL-ED

Subject: Transmittal of Flood Investigation Study for Luke Air Force Base, Maricopa County, Arizona.

CF:
CESPL-ED
CESPL-ED-H
CESPL-ED-HH

LEIFIELD
CESPL-ED

VERMEEREN RV
CESPL-ED-H 5/23/13

LY CTL 5/23/13
CESPL-ED-HH

VC 5/23/13
CRISOSTOMO
CESPL-ED-HE

5/23/13
CASEY
CESPL-ED-HE

AB 5/23/2013
BIER
CESPL-ED-HH

COMPLETION OF ENGINEERING DIVISION DQC

The Engineering Division District Quality Control (DQC) Process has been completed for the Flood Investigation Study at Luke Air Force Base, Maricopa County, Arizona. The DQC was conducted as defined in the project's Review Plan to comply with the requirements of EC 1165-2-209. During the DQC, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. All important comments resulting from the DQC have been resolved.

5/23/2013

Adam Bier, P.E. *Date*
Hydraulic Engineer, Hydraulic Section
CESPL-ED-HH

5/23/2013

Kerry Casey *Date*
Hydrologic Engineer, Hydrology & GIS Section
CESPL-ED-HE

5/23/13

Van Crisostomo, P.E. *Date*
Chief, Hydraulics Section
CESPL-ED-HH

5/23/13

Cuong Ly, P.E. *Date*
Chief, Hydrology & GIS Section
CESPL-ED-HE

29 May 2013

Rene Vermeeren, P.E. *Date*
Chief, Hydrology and Hydraulics Branch
CESPL-ED-H

CERTIFICATION OF ENGINEERING DIVISION DQC

As noted above, Engineering Division DQC has been conducted for this work product and all resulting concerns have been fully resolved.

5/28/13

Richard J. Leifield, P.E. *Date*
Chief, Engineering Division
CESPL-ED

DQC Comments - Luke Air Force Base Luke Air Force Base

Comments by Cuong Ly (17 May 2013)

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Cuong Ly
Comment: The purpose should read, "The purpose of this report is to document the existing conditions of the storm drain system and to provide the hydrologic and hydraulic analysis of the existing condition at Luke AFB."			
			Evaluator: Adam Bier
Evaluation: Concur; the purpose has been updated in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Cuong Ly
Comment: Regarding the use of FLO-2D, text should read, "The existing condition hydrologic and hydraulic analysis for surface flows was performed using FLO-2D modeling software.			
			Evaluator: Adam Bier
Evaluation: Concur; the purpose has been updated in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Cuong Ly
Comment: Add Appendix 2 (original PMP for this study) and include a reference in section 1.1			
			Evaluator: Adam Bier
Evaluation: Concur, the original PMP for this study was added as Appendix 2 and a reference was added to Section 1.1.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.3 Mapping	**Reviewer:**	Cuong Ly
Comment: Be consistent with the acronym referencing the Flood Control District of Maricopa County as the District.			
			Evaluator: Adam Bier
Evaluation: Concur; the Flood Control District of Maricopa County will be referred to as the District.			
Back-check: Concur			
Status: Closed			

Comment Location:	2.1 SWMM Overview	**Reviewer:**	Cuong Ly
Comment: Add that the SWMM model was requested by the Flood Control District of Maricopa County (the District)			
			Evaluator: Adam Bier
Evaluation: Concur, text has been added to the report regarding SWMM being requested by Luke AFB and the District.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.1 FLO-2D Introduction	**Reviewer:**	Cuong Ly
Comment: Add that the FLO-2D model was requested by the District and Luke AFB.			
			Evaluator: Adam Bier
Evaluation: Concur, text has been added to the report regarding FLO-2D being requested by Luke AFB and the District.			
Back-check: Concur			
Status: Closed			

Comments by Kerry Casey (16 May 2013)

Comment Location:	Title Page	**Reviewer:**	Kerry Casey
Comment: Remove FLO-2D floodplain from Luke AFB aerial and move "SOUTH PACIFIC DIVISION" above "LOS ANGELES DISTRICT" on the title block			
			Evaluator: Adam Bier
Evaluation: Concur; the title page has an updated aerial without the FLO-2D floodplain displayed. Additionally, the title block was adjusted to have South Pacific Division listed above Los Angeles District.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.1 Study Purpose and Scope	**Reviewer:**	Kerry Casey
Comment: Add "for surface flows" when mentioning that FLO-2D was used for the hydrologic and hydraulic analysis.			
			Evaluator: Adam Bier
Evaluation: Concur, the text "for surface flow" has been added to the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.2 Mapping	**Reviewer:**	Kerry Casey
Comment: Add "and mapping" to the first sentence after mentioning aerial photography.			
			Evaluator: Adam Bier
Evaluation: Concur, the text now reads "Aerial photography and mapping collected in…"			
Back-check: Concur			
Status: Closed			

Comment Location:	1.4 Site Investigation	**Reviewer:**	Kerry Casey
Comment: Add the following sentences before paragraphs 1 and 2 before mentioning the purpose of visit. Paragraph 1: "An initial meeting and field investigation was held 6-8 November 2012." Paragraph 2: A follow up site visit was held 11-13 December 2012."			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been added to the beginning of each paragraph.			
Back-check: Concur			
Status: Closed			

Comment Location:	1.5 Data Sources	**Reviewer:**	Kerry Casey
Comment: Change shape file to one-word "shapefile". Applies throughout report.			
			Evaluator: Adam Bier
Evaluation: Concur; the report now refers to shapefile as one word.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.1 FLO-2D Introduction	**Reviewer:**	Kerry Casey
Comment: Change FLO-2D components to "surface water" components in the first sentence.			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been modified to reflect this change			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.2 Roughness Coefficients	**Reviewer:**	Kerry Casey
Comment: Move the first two sentences to after the bullet list of Manning's values.			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been moved and added as paragraph 2 in this section.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.3 Infiltration and Abstraction	**Reviewer:**	Kerry Casey
Comment: Change "global assumptions" to "global values" when discussing global values used in the INFIL.DAT			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been modified.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.3 Infiltration and Abstraction	**Reviewer:**	Kerry Casey
Comment: Please revise the fifth paragraph beginning "In FLO-2D, TOL (in the TOLER.DAT file) represents…"			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been revised to the following: "In FLO-2D, TOL (in the TOLER.DAT file) represents the minimum water depth necessary to initiate sharing of volume between grids. Depression storage (TOL) is an initial loss from the potential surface flow. According to the District, it functions as a surface detention and should be set to a value less than 0.03 feet. The District has been using a value of 0.004 feet (equivalent to 0.048 inches), based on the smallest value of IA in Table 6.5 in the *Drainage Policies and Standards for Maricopa County, Arizona.* The initial abstraction (IA) calculated by the GDS when assigning infiltration data to each grid cell represents the total initial abstraction (which includes the TOL value of 0.048 inches). However, the IA in the INFIL.DAT file should not include the TOL value since FLO-2D adds it when running a simulation. Consequently, the IA value initially assigned by the GDS should be adjusted such that the TOL plus IA equals the total initial abstraction."			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.4 Rainfall and Inflow	**Reviewer:**	Kerry Casey
Comment: Change "a rain storm" to "precipitation" Change "discharge a" 100-year storm event" to "convey the" 100-year storm event. Change "west" of the airfield to "east"			
			Evaluator: Adam Bier
Evaluation: Concur, the text changes have been made in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.8 Hydraulic Structures	**Reviewer:**	Kerry Casey
Comment: Be consistent in referencing the Los Angeles District, either COE or LAD			
			Evaluator: Adam Bier
Evaluation: Concur; the report has been updated to refer to the LA District with COE.			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.10 SWMM – FLO-2D Interface	**Reviewer:**	Kerry Casey
Comment: Add FLO-2D Interface to the title to differentiate from previous section on SWMM			
			Evaluator: Adam Bier
Evaluation: Concur, the title has been updated to SWMM – FLO-2D Interface			
Back-check: Concur			
Status: Closed			

Comment Location:	3.3 Analysis Results	**Reviewer:**	Kerry Casey
Comment: Change "without project condition" to "Existing conditions"			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been modified.			
Back-check: Concur			
Status: Closed			

Comments by Van Crisostomo (17 May 2013)

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Overall a good report considering we have very little experience using SWMM and FLO-2d in combination. This should provide good experience in the future for urban drainage type of floodplain analyses.			
			Evaluator: Adam Bier
Evaluation: Thank you.			
Back-check: Concur			
Status: Closed			

Comment Location:	Appendix 2	**Reviewer:**	Van Crisostomo
Comment: Appendix 2 is missing			
			Evaluator: Adam Bier
Evaluation: Appendix 2 will be included in future submittals			
Back-check: Concur			
Status: Closed			

Comment Location:	Storm Drain Profiles	**Reviewer:**	Van Crisostomo
Comment: Storm Drain Profiles 1-3 - Unclear as to where these are located. Suggest a figure similar to Figure 4 that includes all these. Are these the only storm drains of concern?			
			Evaluator: Adam Bier
Evaluation: A Figure will be added to show the storm drain system. The figure will identify the storm drain lines. The three storm drain profiles provided are the storm drains directly affecting the parking ramp (critical) area. Other storm drain lines (not in the parking ramp) may have drainage problems as well. The following text has been added to Section 2.4 of the report: "Three storm drain lines in the parking ramp area were identified as possible systems to be improved. Storm drain lines elsewhere on Luke AFB may also cause flooding problems; however, an emphasis was placed on the storm drains that directly affect the parking ramps for this analysis. See Figure 3 for an aerial showing the storm drain system in the parking ramp area which highlights the three storm drain lines discussed below."			
Back-check: Concur			
Status: Closed			

Comment Location:	3.2.4 (page 7)	**Reviewer:**	Van Crisostomo
Comment: Should the last sentence refer to Figure 2 not Figure 1			
			Evaluator: Adam Bier
Evaluation: Concur; text has been changed to reference Figure 2.			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Any data available for calibration, i.e. past flooding history? Looks like there may be some historical photos of flooding.			
			Evaluator: Adam Bier
Evaluation: Concur. The following text was added to Section 3.4 Historical flood depths were not available to calibrate the floodplain produced in this analysis; however, the FEMA 100-year floodplain was used for comparison. Furthermore, Alan Thomas from Luke AFB, upon viewing the initial floodplain map, provided reasonable verification that the flooded areas represent areas where flooding has been observed.			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Any recommendations, i.e. are there obvious major contributors to flooding? This would help out the local sponsors when doing their alternatives.			
			Evaluator: Adam Bier
Evaluation: Concur. A conclusion & recommendations section was added at the end of the report. See Section 4.0			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: How long would the flooding last (hours, days, etc.)?			
			Evaluator: Adam Bier
Evaluation: Concur. Text has been added to the report in Section 3.4 regarding the length of significant (0.5 feet) flooding.			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Van Crisostomo
Comment: Is the video camera inspection still part of the scope of work?			
			Evaluator: Adam Bier
Evaluation: Do Not Concur. The video camera inspection was replaced by SWMM storm drain profiles. The profiles were used in the critical parking ramp area to see if there are inconsistencies in the storm drain system which could potentially be a cause for flooding. Text has been added to Section 1.1 to discuss.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 4	**Reviewer:**	Van Crisostomo
Comment: Table 4 - Add (NAVD 1988) to the invert elevation column headings.			
			Evaluator: Adam Bier
Evaluation: Concur, the reference will be added to Table 4			
Back-check: Concur			
Status: Closed			

Comments by Rene Vermeeren (20 May 2013)

Comment Location:	Section 1.3	**Reviewer:**	Rene Vermeeren
Comment: Delete in the parenthesis the word "The" and leave the word "District".			
			Evaluator: Adam Bier
Evaluation: Concur, "The" was removed from the parenthesis.			
Back-check: Concur			
Status: Closed			

Comment Location:	Title Page	**Reviewer:**	Rene Vermeeren
Comment: Reformat the title page to present more as an A-E document for a client. Include the same project name, project number, and order number as part of the page. Follow examples from A-E submittals or even some of the models studies ERDC has produced.			
			Evaluator: Adam Bier
Evaluation: Concur. The title page has been reformatted. Megan Craig provided a sample cover page of the template she is working on for Engineering Division. I added project number and project order number per your request.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table of Contents	**Reviewer:**	Rene Vermeeren
Comment: Include "List of Acronyms" after APPENDICES in preface page. Suggest adding a Coordination page to list individuals associated with the study from the Corps, Luke AFB, and Maricopa County FCD.			
			Evaluator: Adam Bier
Evaluation: Concur, a "List of Acronyms" has been included and follows after the Table of Contents, List of Tables, and List of Figures. A listing of project team members was added to a preface which was inserted between the title page and the table of contents. Team member names and agency are listed as well as DQC reviewers. ATR reviews will be added prior to final submittal of report after the ATR process.			
Back-check: Concur			
Status: Closed			

Comment Location:	Add Executive Summary	**Reviewer:**	Rene Vermeeren
Comment: This document if very technical in text. Add "Executive Summary" page to highlight the study scope of work, general procedures used, and study results.			
			Evaluator: Adam Bier
Evaluation: An executive summary was added after the table of contents.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 1.1, Study Purpose and Scope	**Reviewer:**	Rene Vermeeren
Comment: Expand the discussion to explain what items in this report are covered and what items if any are not covered with respect to Section 3.0, Key Deliverables in the PMP. Add discussion on local agency relationship. What is their role and why?			
			Evaluator: Adam Bier
Evaluation: Section 1 "General Description of Study" was expanded to include the following subsections which discussed the PMP and added more overall project detail. Study Purpose and Scope Study Goals Deliverables Study Area Topographic Survey Field Investigation Data Collection Coordination Previous Studies			
Back-check: Concur			
Status: Closed			

Comment Location:	General Comment	**Reviewer:**	Rene Vermeeren
Comment: Add a section "Previous Studies and Study Procedure" between 1.0 General Description and Section 2.0 Storm Drain Conditions to describe previous H&H work in the area and analysis procedure for this study and how the application of the non-Corps models was applied. It is confusing to state an EPA model that does rainfall runoff analysis and then describe FLO-2D that also does some form of rainfall run-off analysis. Has the combined model of FLO-2D and the EPA SWMM been Corps approved? In addition, include a subsection on results of any other related studies and how they were incorporated in this study.			
			Evaluator: Adam Bier

Evaluation: Section 1.9 was added to discuss previous studies. The results from the previous studies are discussed in Section 2.0 Hydrology. Discussion was added to Section 1.9 regarding the use of FLO-2D and EPA-SWMM to complete the H&H analysis. The combination of FLO-2D and EPA-SWMM is not a Corps approved model, but was used at the request of Luke AFB and Maricopa County.
Back-check: Concur
Status: Closed

Comment Location:	General Comment	**Reviewer:**	Rene Vermeeren
Comment: In the EPA and FLO-2D analysis, there seems to be a lot of information provided on modeling input parameters and files used. Appendix 1 provides a summary of input data, but I don't see a reference to any plates or diagrams from which to view this information. Suggest adding a section where reference to back-up electronic data for this analysis can be found.			
			Evaluator: Adam Bier
Evaluation: Added a new section 4.5 FLO-2D and SWMM Output – The output for the FLO-2D and EPA-SWMM model is provided in electronic format. The EPA-SWMM model output is provided as "SWMM.rpt". The FLO-2D output is provided electronically in various ".OUT" text files, including SUMMARY.OUT. Other important output files include those for levees, hydraulic structures, floodplain cross sections, Manning's n-values, infiltration, and flood depths.			
Back-check: Concur			
Status: Closed			

Comment Location:	Figures	**Reviewer:**	Rene Vermeeren
Comment: Although the background showing an aerial photo is interesting to look at, it makes it difficult to view the key purpose of the Figure and items on the legend. a. Figure 3 is hard to detect the yellow shade. b. Add asterisk to the word Levee in Figure 3 and define in legend. c. Figure 4 shows both the study boundary and cross sections in Red. The cross sections have no alignment tie nor are they labeled. d. On Figure 5, why is the FEMA flood boundary shown on Government land? The FEMA flood boundaries in some areas are difficult to view the flooded area and the flooding limits.			
			Evaluator: Adam Bier
Evaluation: Concur. The figures were re-arranged and some were added. Some changes are mentioned below: a. A grey background was added to the legend to help the legend items to stand out.) b. An asterisk was added to the legend before the word levees. A description was also added. c. The color representing the project boundary has been changed to purple.			

d. The existing FEMA floodplain was provided by Luke AFB and is shown as a comparison to the FLO-2D floodplain results. The goal of the final product of this study (not this phase) is to produce an updated FEMA floodplain. The FEMA floodplain has been edited to just show the extents of the flooding. See updated Figure 7.
Back-check: Concur
Status: Closed

Comment Location:	Section 1.5 last paragraph and section 2.4 Storm Drain Profile Analysis	**Reviewer:**	Rene Vermeeren
Comment: Add a figure (?) to just show all exiting flood control features related to the base before the Profiles. Suggest labeling the "Profiles" as Figures, Exhibits or Plates. Profiles show both plan view and profile – should they be re-titled as such? Re-label section 2.4 to "Existing Flood Control Features" and then use subheadings to describe (1) Detention Basins, (2) Storm Drains (both open and closed), (3) Storm drain inlets, (4) Culverts, and any other appurtenant flood control structures (pumps).			
			Evaluator: Adam Bier
Evaluation: Concur. Two figures were added (Figures 5 and 6). Figure 5 shows the storm drain system for the main base area. Figure 6 shows a detail of the parking ramp area. Figure 6 was included per DQC comment from Van to highlight the storm drain profiles. The storm drain profiles have been re-named Plates 1-3. These will be placed after the figures and before the appendices. The Plates were renamed "Plan and Profile". Section 3.1 was labeled to "Existing Flood Control Features", and sub headings with the appropriate sections were added as requested.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 2.2	**Reviewer:**	Rene Vermeeren
Comment: "What method was used to calculate hydraulics for the storm drain? Why are Green Ampt and Dynamic Wave mentioned here relative to storm drain hydraulics?			
			Evaluator: Adam Bier
Evaluation: Concur. The FLO-2D model uses the momentum and continuity equations to calculate hydraulics. Text was added to section 4.1. The Green-Ampt method and dynamic wave were mentioned because those methods are also used in the FLO-2D and SWMM modeling for the purposes stated in the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2	**Reviewer:**	Rene Vermeeren
Comment: Suggest subsections to Components such as (a) Hydrology (infiltration, rainfall and inflow, etc.,) (b) Geometric Features (Elevations, Streets, Buildings, Levees, etc.,) and (c) Model Application (Models, x- sections, "n" values, inlets, and outflows).			
			Evaluator: Adam Bier
Evaluation: Concur, the FLO-2D Components section was split into three sections (4.2 Hydrology Components, 4.3 Geometric Components, and 4.4 Model Components.			
Back-check: Concur			
Status: Closed			

Comment Location:	Hydrology	**Reviewer:**	Rene Vermeeren
Comment: Hydrology: There is not a separate section. a. What is the drainage area of the upstream watershed? b. What are the impacts of upstream drainage on the study area? c. Suggest adding figure on the watershed drainage area. d. Are there any stream systems entering the base and what are the systems within the base? e. What are exit points on the downstream end of the base and do they impact any downstream developed areas? f. What are the configuration /characteristics of detention basins? g. There are no hydrologic results presented in terms CPs, discharges, storm drain discharges (both inlet and outlet at peak of event.) h. Why was study only done for 100-year? Should other events be studied to present a broader view of flood risk?			
			Evaluator: Adam Bier
Evaluation: A Hydrology Section was added to the report a. The upstream watershed drainage area is approximately 2800 square miles (added to report) b. Added to report, see Section 2.2 c. A Vicinity Map was created which shows a portion of the watershed surrounding Luke AFB. d. Yes there are stream systems entering the base, text added in Section 2.2. Figure 3 created to show existing facilities. Figure 4 created to show Capital Improvement Projects based on the 2009 Hydrologic Report. e. Text has been added to Section 2.4 to discuss the exit points from the base. f. The Dysart Detention Basin is discussed in Section 2.4.1 and the on base basins in 3.1.1 g. Hydrology was completed using FLO-2D. Storm drain discharges will be added to the final June 14 report. h. The project goal is to get updated FEMA 100-year floodplain, so all analysis was done using the 100-year event.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2.2	**Reviewer:**	Rene Vermeeren
Comment: Manning's "n" values seem inconsistent with other published data or seem not appropriate for given condition. a. "n" value for swimming pools appears high for a water body. b. "n" value for concrete appears high at "n" equal to 0.02 c. What "n" value was used to represent highly developed areas (housing tracts, buildings, etc.)?			
		Evaluator: Adam Bier	
Evaluation: Do not concur. It was agreed upon within the PDT that we would use the shapefiles already developed for Luke AFB by Maricopa County at the November 2012 meeting.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2.7 Levees and Section 3.2.4	**Reviewer:**	Rene Vermeeren
Comment: Is Loop 303 a block wall and is it structurally fortified to divert upstream flood flows around the base?			
		Evaluator: Adam Bier	
Evaluation: Loop 303 is not a block wall. This description was provided by Maricopa County and has been inserted into the report. See Section 4.2.2 "Each roadway project (Loop 303 and Northern Parkway) includes a corresponding drainage project with facilities that will intercept, detain, and convey the 100-year peak flows. Since the Northern Parkway is currently under construction and ADOT identifies 2014 as the completion date of the Loop 303, base improvements will be designed based upon those roadways being in place. The submittal to FEMA for re-delineation of the floodplain will not occur before both roadway projects are completed."			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.2.10	**Reviewer:**	Rene Vermeeren
Comment: State reference for storm drain curb inlets and storm drain drop inlets.			
		Evaluator: Adam Bier	
Evaluation: Concur. A reference to the FLO-*2D Pro Model and EPA SWMM Model Integration* manual was added to the end of the paragraph preceding the discussion on curb and drop inlets. See Section 3.4.3.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 3.3	**Reviewer:**	Rene Vermeeren
Comment: No hydraulic results are shown for the storm drains and detention basins. a. It would be useful to know where and what discharges enter and exit storm drain system and what flows by-pass the system and stay overland. Do any of the inlets have flow exiting out under peak flow conditions? b. What impact do on-site detention basins have on flood attenuation?			
			Evaluator: Adam Bier
Evaluation: Concur. At this time, the SWMM model has not been fully integrated into the FLO-2D model. We have been working with FLO-2D to get the SWMM subsurface model to work with our surface flow model. The results provided include only surface flow at this time. It is anticipated that the SWMM model will be integrated prior to final submission on June 14. Results will be added to the report.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 2 Classification	**Reviewer:**	Rene Vermeeren
Comment: The "MUkey" is not shown or reference to anything else. The impervious values are all 100%. What is the purpose of having this table?			
			Evaluator: Adam Bier
Evaluation: Concur. This table has been removed.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 1-3 Rainfall Hydrograph	**Reviewer:**	Rene Vermeeren
Comment: Is this the correct label for a table? A hydrograph refers to an x-y graphic relationship. Was the Pattern 1 distribution varied to produce the worst case scenario for the areas of interest?			
			Evaluator: Adam Bier
Evaluation: Concur. The name of the table has been changed to "Rainfall Distribution". The pattern 1 distribution was not varied to produce the worst case scenario for the areas of interest. Maricopa County recommended we use the pattern 1 distribution.			
Back-check: Concur			
Status: Closed			

Comment Location:	Profiles	**Reviewer:**	Rene Vermeeren
Comment: Add legend to identify features on profile.			
			Evaluator: Adam Bier
Evaluation: Concur. Legend added to Plates 1-3.			
Back-check: Concur			
Status: Closed			

Comment Location:	Figure 5	**Reviewer:**	Rene Vermeeren
Comment: Encircle the areas shown on the following figures for ease of viewing problem areas.			
			Evaluator: Adam Bier
Evaluation: Concur See Updated Figure 7			
Back-check: Concur			
Status: Closed			

Comments by Rene Vermeeren (23 and 28 May 2013)

Comment Location:	Figure 5	**Reviewer:**	Rene Vermeeren
Comment: Editorial comments and report organization suggestions			
			Evaluator: Adam Bier
Evaluation: Additional editorial comments provided by Rene Vermeeren from 23 May and 28 May 2013 have been incorporated into the report. Some of the editorial comments include the following: 1. A sentence regarding Maricopa County's role and relationship has been added to the Executive Summary. 2. Editorial changes were made regarding the Preface, Executive Summary, 1.1 Study Purpose and Scope, 1.9 Previous Studies, 1.10 Modeling Procedure, 2.4 Existing Facilities, 4.1 FLO-2D Introduction. 3. Sections on EPA-SWMM modeling were moved from Sections 3.2 - 3.5 to Section 4.6 - 4.9 to follow the discussion on FLO-2D modeling. 4. List of Acronyms moved to a separate page from table of contents.			
Back-check: Concur			
Status: Closed			

APPENDIX 5

Agency Technical Review (ATR)

Comments and Responses from Dr. Checks

LUKE AIR FORCE BASE
FLOOD CONTROL INVESTIGATION STUDY
JUNE 2013

COMPLETION OF AGENCY TECHNICAL REVIEW

The Agency Technical Review (ATR) has been completed for the Flood Control Investigation Study for Luke Air Force Base, Maricopa County, Arizona. The ATR was conducted as defined in the project's Review Plan to comply with the requirements of EC 1165-2-214. During the ATR, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing U.S. Army Corps of Engineers policy. The ATR also assessed the District Quality Control (DQC) documentation and made the determination that the DQC activities employed appear to be appropriate and effective. All comments resulting from the ATR have been resolved and the comments have been closed in DrChecks[sm].

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Mike Lin — Date
Senior Hydraulic Engineer
CESPK-ED-HD

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Date: 2013.06.25 13:57:04 -07'00'

Stephen Graff, P.E. — Date
Chief, Hydraulic Design Section
CESPK-ED-HD

06.25.13
Tony Beuche, P.E. — Date
Project Manager, Project Management Branch
Flood Control District of Maricopa County

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Adam Bier, P.E. — Date
Hydraulic Engineer
CESPL-ED-HH

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Kerry Casey — Date
Senior Hydrologic Engineer
CESPL-ED-HG

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Cuong Ly, P.E. — Date
Chief, Hydrology & GIS Section
CESPL-ED-HG

CERTIFICATION OF AGENCY TECHNICAL REVIEW

As noted above, all concerns resulting from the ATR of the project have been fully resolved.

27 JUNE 13
Richard J. Leifield, P.E. — Date
Chief, Engineering Division
CESPL-ED

ATR Comments - Luke Air Force Base

Comments from Pedro Melo Rodriguez and Richard Waskowski from the Flood Control District of Maricopa County (FCDMC) - 03 June 2013

Comment Location:	Section 1.3 Deliverables, Page 2	**Reviewer:**	FCDMC
Comment: On page 2, please specify a reason why the pump capacity was not necessary (e.g. the peak flow was negligible, neglecting the pump gives the worst case scenario, etc.)			
			Evaluator: Adam Bier
Evaluation: Concur; data was not available regarding the specific pump capacity. If such data were available it could be added to the report. The following text was added to Section 1.2 Deliverables. "An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis. However, a pump was included in the EPA-SWMM model using the default parameters assuming an ideal pump curve."			
Back-check: 1) Section 1.3 Deliverables, Page 2 - Please change "An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis. However, a pump was included in the EPA-SWMM model using the default parameters assuming an ideal pump curve" to "An evaluation of pumping capacity and operation of storm drain pumping systems was included in the scope of work, but was determined not to be needed to complete the analysis because the data for specific pump capacity was not available. However, a pump that used default parameters assuming an ideal pump curve was included in the EPA-SWMM model as an estimate until better data is obtained" 2) Section 4.9, Page 19 - Please add some discussion to the report that documents the 80% reduction in the area of the inlet.			
Evaluation: Concur. The text in section 1.3 Deliverables was changed to the recommended text.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 1.6, Page 3	**Reviewer:**	FCDMC
Comment: In Section 1.6, page 3, please add that these structures were surveyed to obtain a representative sample of the total number of structures.			
			Evaluator: Adam Bier
Evaluation: Concur, the following was added to Section 1.6 (Now Section 2.2), "The structures were surveyed to obtain a representative sample of the total number of structures in the study area."			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 1.7 Data Collection	**Reviewer:**	FCDMC
Comment: Please add a note to the Jersey Barriers and Walls shapefile explanation that these are only the 'major' ones.			
			Evaluator: Adam Bier
Evaluation: Concur, the following was added to the descriptions: Jersey Barriers: "Only the major Jersey Barriers were included in the shapefile (i.e. the barriers surrounding the parking ramps)." Walls: "Only the major walls were modeled in FLO-2D. Major walls include security boundary walls, walls surrounding parking areas, and walls surrounding buildings and yards."			
Back-check: Concur			
Status: Closed			

Comment Location:	Subsection 3.1.3, Page 10	**Reviewer:**	FCDMC
Comment: In Sub-Section 3.1.3, page 10; were the invert elevations that were provided part of the surveyed ones? Please clarify whether these elevations were part of the original GIS database or the subsequent survey.			
			Evaluator: Adam Bier
Evaluation: Concur, the following text was added to the report in previous section 3.1.3 (new section 4.2.3), "Of the 435 inlet invert elevations obtained from the Luke AFB GIS geodatabase, 43 of those were surveyed by the COE. The invert elevations surveyed by the COE were used in lieu of the elevations provided by Luke AFB for the respective inlets."			
Back-check: Concur			
Status: Closed			

Comment Location:	Figure 6	**Reviewer:**	FCDMC
Comment: In Figure 6, culverts are hard to see on the map as lines, is there any better way of displaying these? Maybe thicker lines?			
			Evaluator: Adam Bier
Evaluation: Concur; a thicker line will be used in an attempt to make the culverts more visible.			
Evaluation: Concur, the structures were difficult to see on Figure 6, so additional detailed maps were created. See Plates 10-14 for detailed hydraulic structure locations.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 4.1, Page 11	**Reviewer:**	FCDMC
Comment: In Section 4.1, page 11, please list the exact number (551,096) of cells as this will help to make sure that the FLO2D files are the right ones, based on grid numbers.			
			Evaluator: Adam Bier
Evaluation: Concur, the exact number of grid cells (551,096) was added to the text.			
Back-check: Concur			
Status: Closed			

Comment Location:	Sub-section 4.2.1, Page 11	**Reviewer:**	FCDMC
Comment: In Sub-Section 4.2.1, page 11, was the GDS interface used to calculate the Green-Ampt parameters or was this done outside of GDS? If so, please add a sentence that indicates GDS was used.			
			Evaluator: Adam Bier
Evaluation: Concur, text was added to the first sentence of section 4.2.1 (now Section 5.3.1) indicating that GDS was used to calculate the Green-Ampt parameters. The following text was added, "The Green-Ampt method was used to simulate infiltration using FLO-2D GDS Pro."			
Back-check: Concur			
Status: Closed			

Comment Location:	Page 12 & List of Acronyms	**Reviewer:**	FCDMC
Comment: At the top of page 12 and the "List of Acronyms", "SOLID" should be "SOILD".			
			Evaluator: Adam Bier
Evaluation: Concur, the text and list of acronyms were corrected to say "SOILD"			
Back-check: Concur			
Status: Closed			

Comment Location:	Subsection 4.3.5, Page 15	Reviewer:	FCDMC
Comment: In Sub-Section 4.3.5, page 15, were all the hydraulic structures surveyed? For example, HS-8 was added after the survey was performed. Were other structures surveyed from the initial survey? Why does page 15 of the report indicate that 7 culvert locations are modeled, but 17 locations are shown on Figure 9? Please clarify this section.			
			Evaluator: Adam Bier
Evaluation: Concur. The following text was clarified in new Section 5.4.5, "There are approximately 40 culvert locations within the project study area, consisting of approximately 80 individual culverts. The culverts vary in size, shape, and material but typically are constructed of either reinforced concrete or corrugated metal. Twenty seven culvert locations were judged to significantly impact the hydraulic results and were chosen to be incorporated into the FLO-2D model." Table 3 now provides a column listing the source of the culvert information regarding culvert size, inlet invert elevations, outlet invert elevation. In particular, HS-8 was measured in the field on June 5, 2013 but the upstream and downstream invert elevations are based on the TIN surface elevation. Additionally, 27 culvert locations are now included in the model.			
Back-check: Concur			
Status: Closed			

Comment Location:	Table 3	Reviewer:	FCDMC
Comment: In Table 3, are the elevations from survey and/or from the TIN surface? For example, HS-8 was added after the survey was performed and there was talk about using the elevations from the TIN surface. Please add a column that lists the source of the elevation, whether it was from field survey or the TIN.			
			Evaluator: Adam Bier
Evaluation: Concur, a column was added to Table 3 showing the source of the elevation data.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 4.8, Page 18	Reviewer:	FCDMC
Comment: In Section 4.8, page 18, please add Storm Drain Profile 1, 2 or 3 after the reference to Plates 1, 2 or 3 so there is a direct correlation between those references, Figure 7, Section 5.0 and the Plates. Also, Plate 3 should reference Storm Drain profile 3 rather than 5.			
			Evaluator: Adam Bier
Evaluation: Concur, the Storm Drain Profiles (Plates) will be presented after the Figures. The reference to Plate 3 has been corrected.			
Back-check: Concur			
Status: Closed			

Comment Location:	Section 4.9, Page 19	**Reviewer:**	FCDMC
Comment: In Section 4.9, page 19, the area of the inlets is the actual open available area for water to flow through. The size of the inlet grate openings affects this. The area should be calculated based on the total open area, and not just by multiplying the width times the length (or using just the radius).			
			Evaluator: Adam Bier
Evaluation: Concur. For all the drop inlets in the model, the area of the inlet will be reduced by 80% in the SWMMFLO.DAT.			
Back-check: 2) Section 4.9, Page 19 - Please add some discussion to the report that documents the 80% reduction in the area of the inlet.			
Evaluation: Concur, the following text was added to former section 4.9, now section 5.10). "After calculating the total area of each drop inlet, the area was reduced to 80 percent of the total area for the SWMMFLO.DAT to account for the area of inlet obstructed by the metal bars of the inlet grate. Since Luke AFB has a variety of grate types and a complete inlet survey has not been completed, COE and District personnel decided to globally assume 80 percent open area for water to flow through for each inlet. Furthermore, to account for the reduction in available area for water to flow into curb inlets, the inlet width was reduced by 80 percent."			
Back-check: Concur			
Status: Closed			

Comment Location:	Page 20, Section 4.9	**Reviewer:**	FCDMC
Comment: At the top of page 20, "SMM" should be "SWMM".			
			Evaluator: Adam Bier
Evaluation: Concur, the text has been corrected to "EPA-SWMM"			
Back-check: Concur			
Status: Closed			

Comment Location:	Appendix 1	**Reviewer:**	FCDMC
Comment: In Appendix 1, please add comments to the Note column that will indicate how (or if) the inlet was field verified. For example, some comments could be "Field verified by Luke personnel" or "Estimated from Google imagery" or "Needs additional survey".			
			Evaluator: Adam Bier
Evaluation: Concur. A column has been added to Appendix 1 to indicate the source of the data.			
Back-check: Concur			
Status: Closed			

Comment Location:	Figure 4 – Existing Features	**Reviewer:**	FCDMC
Comment: On Figure 4, the Reems Road Channel and Basin are now existing features.			
			Evaluator: Adam Bier
Evaluation: Concur, Reems Road Channel and basin were added to Figure 3 "Existing Features" and shown on Figure 4 as existing features.			
Back-check: Concur			
Status: Closed			

Comments from Tony Beuché from the Flood Control District of Maricopa County - 04 June 2013

Comment Location:	General Comments	**Reviewer:**	Tony Beuché

Comment:

The following are comments from review of the draft report of the Luke AFB Flood Control Investigation submitted to FCDMC on 05.28.13. Please review the comments and respond with any questions that you may have.

1. Section 1.4, third sentence – The Gila River is located due south of LAFB (the confluence of the Salt and Gila is three miles east of Litchfield Road).
2. Section 2.1, third sentence – The Agua Fria River Watershed is approximately 238 squares miles in area.
3. Section 2.2, first paragraph, third sentence – Add as follows: "…west side of Reems Road ***and*** lies west…"
4. Section 2.2, second paragraph, first sentence – Add as follows: "…Parkway Drainage Improvement***s***…"
5. Section 2.2, second paragraph, fifth sentence – Replace as follows: "…and their drainage facilities ***are*** included…"
6. Section 2.2, second paragraph – In clarification, the Northern Parkway, the Loop 303 and their associated drainage improvements are currently under construction.
7. Section 2.3 – Note that the Dysart Drain adjacent to the north boundary of the base was improved in 1994 to address adverse slope caused by ground subsidence.
8. Section 2.4.2, third sentence – Note that the existing culvert under Camelback Road at Bullard Wash was designed to have capacity for the 100-year peak flow.
9. Section 2.4.3, second sentence – The final design of the Loop 303 drainage improvements has been completed and construction of those improvements is underway.
10. Section 3.1.2, first and second paragraphs, last sentences – Add as follows: "See Figure 6 ***for***…"
11. Section 4.4.3, first and second sentences – Correct font size.
12. Section 5.0 – Can any conclusions and recommendations be made regarding the performance of the existing drainage channels located south of Super Saber Street and east of the airfield or for the infield detention basins (Airfield North Detention Basin and Airfield South Detention Basin)?
13. Figure 1 – Label for Agua Fria River is misspelled.
14. Figure 4 – Note that some of the Future Detention Basins shown adjacent to the Loop 303 and Northern Parkway are either currently under construction or will be constructed with roadway projects. The Loop 303 is an ADOT project and the final locations and configurations of the basins may not correspond directly to what is depicted on the figure.

Evaluator: Adam Bier
Evaluation: Concur; The following are responses to the comments above. 1. The text was corrected to reference the Gila River being south of Luke AFB. (Section 1.4) 2. The Agua Fria River watershed area was revised to say 238 square miles. (now Section 3.1) 3. The text correction was made. (now Section 3.2) 4. The text correction was made. (now Section 3.2) 5. The text correction was made. (now Section 3.2) 6. The text was clarified to report that the Northern Parkway and Loop 303 drainage facilities are currently under construction. (now Section 3.2) 7. Text was added to the Dysart Drain section to note that the channel was improved in 1994 to address adverse ground slope. (now Section 4.1.1) 8. Text was added to the Bullard wash Section to discuss the design capacity and to give the culvert dimensions. (now Section 4.1.2) 9. Text was added to the section regarding the final design of the Loop 303 drainage improvements being completed and that construction is underway (now Section 4.1.3). 10. "For" was added to the respective sentences (now Section 4.2.1). 11. The font size was corrected in Section 4.5.3 (now 5.4.3). 12. Discussion regarding the performance/capacity of existing features will be added to the report based on the SWMM results. 13. The label was corrected for Agua Fria River in Figure 1. 14. A Note was added to Figure 4 regarding the final locations and configurations of the basins. Additionally, the following text was added to Section 3.2 "Some of the future detention basins shown adjacent to the Loop 303 and Northern Parkway are either under construction or will be constructed with roadway projects. The Loop 303 is an ADOT project and the final locations and configurations of the basins may not correspond directly to what is depicted on the on Figure 4."
Back-check: Concur
Status: Closed

Comments from Pedro Melo Rodriguez and Richard Waskowski from the Flood Control District of Maricopa County (FCDMC) - 04 June 2013

Comment Location:	FLO-2D – Hydraulic Structures	**Reviewer:**	FCDMC

Comment:

1) After reviewing the hydraulic structures file along with the grid elevations, there are some adjustments needed. The following Figure 1 represents Hydraulic Structure 1 – Headwall with Flared Wing Walls. The top half of the figure shows the current condition in FLO2D, where the hydraulic structure's invert elevation is below the grid elevation. The same thing happens at the downstream, where the hydraulic structure is below the grid cells. After checking all of the 17 hydraulic structures in the model, all of these have the same issue as hydraulic structure 1.

   When FLO2D is calculates the flow using the head, it uses the grid elevation to the water surface elevation. When the hydraulic structure is below the grid cell, the flow is under estimated and can cause instabilities in the model.

   The bottom half of the figure shows how the hydraulic structures should look like in the model. The grid elevations must be adjusted to the invert elevations of the hydraulic structures upstream and downstream. The elevation adjustment must continue to other grid elements upstream and downstream from the hydraulic structure (shown with blue grids in Figure 2).

   Figure 2, shows an aerial of Hydraulic Structure 1. As shown on the aerial, due to the grid cells size, the grids that represent the channel (Shown with blue Grid) are an average of top of bank and channel bottom. When these grids are averaged the channel bottom is raised, these elevations need to be adjusted to maintain continuity in the model with a positive slope.

Evaluator: Adam Bier

Evaluation: Concur, the grid elevations have been adjusted according to the TIN upstream and downstream from the culverts. The inlet and outlet grid elevations were based on the source of the elevation (COE Survey, Luke AFB GIS Geodatabase, or TIN). A positive slope was maintained as found according to the TIN and available data; however, there were a few locations that do not have a positive slope according to the TIN.

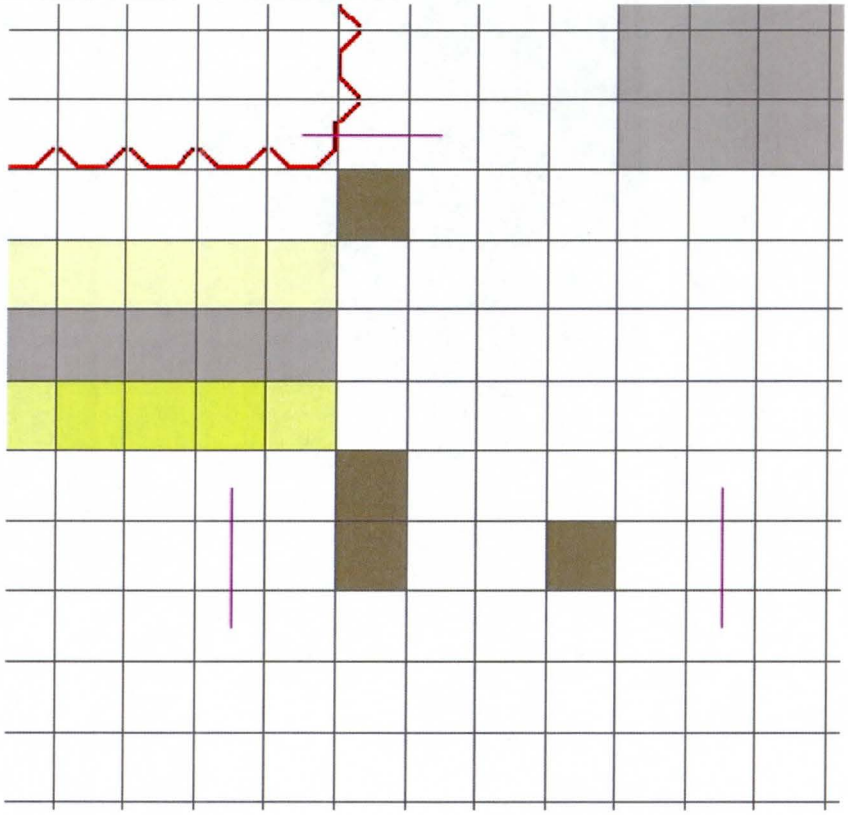
Back-check: Concur

Status: Closed

Comment Location:	FLO-2D Hydraulic Structures	Reviewer:	FCDMC

Comment:

2) Figure 3 shows structure 13 & 14. To avoid possible instabilities structure 13 and 14 can share the same outlet – Grid number 311408.



Evaluator: Adam Bier

Evaluation: Concur, hydraulic structures 13 and 14 have been revised to share the same outlet – Grid Cell Number 311408.

Back-check: Concur

Status: Closed

Comment Location:	Section 1.3 Deliverables, Page 2	**Reviewer:**	FCDMC
Comment: 3) Some floodplain cross-sections do not contain much flow. It is recommended that some cross-sections be removed, but some cross-sections be added at other locations of interest, e.g. upstream of the Bullard Wash culvert at Camelback Road and upstream of the flow breakout near the golf course at the end of the runway.			
			Evaluator: Adam Bier
Evaluation: Concur, floodplain cross-sections that do not contain much flow will be removed from the model and additional floodplain cross sections will be added to the model.			
Evaluation: Concur; low flow floodplain cross sections were removed and additional floodplain cross sections were added at Bullard Wash, Northern Litchfield Drainage Channel, the channel/swale that begins on the east side of the runway and eventually runs north of the golf course, and at the breakout location at the northwest corner of the golf course. A table was created to better explain the floodplain cross section locations and the cross sections are now shown on the new hydraulic structure figures.			
Back-check: Concur			
Status: Closed			

Comments from Mike Lin, Corps of Engineers, Sacramento District - 11 June 2013

Comment Location:	1) Contents in 1.0 General Description of Study	**Reviewer:**	Mike Lin, SPK

Comment: Recommend to include in "1.0 General Description of Study" only subjects which are general in nature, such as Objectives, Study Area, Previous Studies and Coordination.

Recommend:

(1) Combine 1.1 Study Purpose and Scope and 1.2 Study Goals into a single sub-section – Study Objectives

(2) Move 1.5 Topographic Survey, 1.6 Field Investigation and 1.7 Data Collection into a new section 2.0 Data Collection

(3) Delete 1.3 Deliverables and present contents of this sub-section in various respective sections.

(4) Move 1.10 Modeling Procedures to Section 4.0.

(5) Refer to file attached to this comment named "Recommended Revised Table of Contents" for application to Sections 1.0 through 4.0)

Evaluator: Adam Bier

Evaluation: Check and Resolve

First of all, thank you for the suggestions on reorganizing the report. Many of the suggested comments have been implemented in the Final Report; however, a few of the suggestions were not and reasons will be given in the respective ATR comment sections.

1) Concur; the sections 1.1 and 1.2 have been combined to be a new section titled 1.1 Study Objectives.
2) Concur, the sections regarding survey, field investigation, and data collection has been moved to a new 2.0 Data Collection Section.
3) Non-concur, the deliverables section was added after DQC comments received from the H&H Branch Chief. The goal of this section is to clearly present the deliverables that were included in the PMP.
4) Concur, Modeling Procedures has been moved to Section 5.0 (Now Section 5.1)
5) Thank you for providing the revised Table of Contents.

Back-check: Concur

Status: Closed

Comment Location:	2) Previous Studies	**Reviewer:**	Mike Lin, SPK
Comment: The following sub-sections under Section 2.0 EXISTING HYDROLOGIC DATA: 2.1 Watershed 2.2 Existing Conditions 2.3 Subsidence Discuss in length about the previous study "Loop 303 Hydrologic Report". All of the contents in the above 3 sub-sections should be placed under Previous Studies in Section 1.0 GENERAL DESCRIPTION OF STUDY.			
			Evaluator: Adam Bier
Evaluation: Non- Concur, the three sections discuss the previous report's hydrologic data, and a separate section was requested via DQC comments from the H&H Branch Chief. The sections have been moved to become Section 3.1, 3.2, and 3.3 (after creating a new section for Section 2.0 Data Collection). A reference to the hydrologic data section (now 3.0) was added to the short Section 1.4 Previous Studies.			
Back-check: Concur			
Status: Closed			

Comment Location:	3) Watershed Boundary vs. Study Boundary	**Reviewer:**	Mike Lin, SPK
Comment: The study area is a small part of a large watershed. Despite storm water conveyance elements along the periphery of the study area, storm water generated from upstream areas of the watershed could potentially become overland flow into the study area. Revise the Report to clarify that the study includes only flows generated from the rainfall within the study area.			
			Evaluator: Adam Bier
Evaluation: Concur, the following text was added to the report in new Section 3.2 Existing Storm Water Conveyance Features (3rd paragraph), "The study includes only flows generated from the rainfall within the study area and does not include potential overland flows from the Loop 303 and Northern Parkway Drainage Improvements from the west and north, respectively. See Section 5.3.2 for further discussion regarding rainfall and inflows."			
Back-check: Concur			
Status: Closed			

Comment Location:	4) Section 3.0 Existing Storm Drain System	**Reviewer:**	Mike Lin, SPK

Comment:

Change the title "EXISTING STORM DRAIN SYSTEM" to "EXISTING STORM WATER DRAINAGE SYSTEM"
Move sub-sections 2.4.1, 2.4.2 and 2.4.3 to Section 3.0 under a sub-section name "3.1 Storm Water Conveyance System"
Call the local storm water drain system as sub-section "3.2 Storm Water Sewer System"
Re-name all current sub-sections 3.1.1, 3.1.2, 3.1.3 ...3.1.7 as 3.2.1...3.2.7.

Evaluator: Adam Bier

Evaluation: Check and Resolve
Concur, the title of new Section 4.0 was renamed "EXISTING STORM WATER DRAINAGE SYSTEM." Previous Section 2.4.1, 2.4.2 and 2.4.3 were moved to new Section 4.1 under Section 4.0 "Existing Storm Water Conveyance System". Now 4.1.1, 4.1.2, 4.1.3 and 4.1.4.

Non-concur with proposed title to new Section 4.2. We decided to use the title "Existing Storm Water Drainage System Components." It was requested by Branch Chief DQC to not refer to the storm drains as storm sewers for this project. The component sections were renamed 4.2.1, 4.2.2...4.2.7

Back-check: Concur

Status: Closed

Comment Location:	5) Existing Conditions Flows	**Reviewer:**	Mike Lin, SPK

Comment:

Existing condition flows were cited for Dysart Drain, Bullard Wash and other existing facilities. State in the Report how the existing condition flows were defined.

Evaluator: Adam Bier

Evaluation: Concur, a paragraph was added under new Section 4.1 Existing Storm Water Conveyance System.

"The Loop 303 Hydrologic Report from September 2009 presented information on existing storm water conveyance features in the study area. The results presented in this section were obtained from the HEC-1 model completed as part of the September 2009 Hydrologic Report."

Back-check: Concur

Status: Closed

Comment Location:	6) Floodplain Analysis Using FLO-2D and EPA-SWMM	Reviewer:	Mike Lin, SPK
Comment: Move sub-section 1.10 Modeling Procedure to the beginning Section 4.0 as Modeling Procedures			
			Evaluator: Adam Bier
Evaluation: Concur, previous section 1.10 was moved to section 5.1 to precede discussion regarding the FLO-2D and SWMM discussions.			
Back-check: Concur			
Status: Closed			

Comment Location:	7) FLO-2D Justification	Reviewer:	Mike Lin, SPK
Comment: *a.* In second paragraph, Section 4.1 the sentence "Because the overland flooding is not limited by significant topographic changes (i.e. flat areas) in terms of flow directions FLO-2D was selected to analyze the flooding at Luke AFB" is not a true statement and it should be deleted and/or replaced with something more objective as to why Flo-2d is an appropriate analysis tool for this study. b. Revise the last sentence in the 1st paragraph of Section 4.1 from "FLO-2D is a COE approved model for surface water hydraulic applications." to "FLO-2D is a USACE approved model for surface water hydraulic applications and was selected to analyze the flooding at Luke AFB."			
			Evaluator: Adam Bier
Evaluation: **a.** Concur, the sentence from previous section 4.1 (now 5.2) was removed from the report. **b.** Concur, the sentence (in new section 5.2) was revised to read, "FLO-2D is a USACE approved model for surface water hydraulic applications and was selected to analyze the flooding at Luke AFB."			
Back-check: Concur			
Status: Closed			

Comment Location:	8) Storm Water System: accuracy of SWMM model profiles and pipe sizes	Reviewer:	Mike Lin, SPK

Comment:
The Report cited a few questionable segments, however, a cursory check of approximately 1/3 of the drain system data indicates many potentially erroneous pipe profiles and pipe sizes in the EPA SWMM model (see file attached to this comment "Profile_Check.pdf" submitted as preliminary review comment May 22, 2013). Experience indicates that GIS data often contains numerous errors, and is more appropriate for use as an O&M management tool than as a foundation for hydraulic modeling. Addressing this issue requires much more effort than simply adjusting a few profiles identified to-date, and should be well documented for future information and recommendation.

Therefore, the Report should be revised to better document this situation, specifically as regards: a) the model is based on potentially erroneous GIS data (for example, due to incorrect input of field survey data, vertical datum discrepancies, etc); b) whether or not potentially erroneous data has been confirmed; c) the extent of such erroneous data; d) whether or not any erroneous data was corrected; e) potential significance and consequences of such discrepancies to the analysis (assuming it was overlooked in the current analysis); f) how future effort to correct these discrepancies might be significant (i.e. securing accurate as-built drawings, performing additional field surveys, etc); and g) how such effort must be expended prior to future use of the model to simulate actual alternatives for improvement.

Evaluator: Adam Bier

Evaluation: Concur. The following text was added to the introduction of the GIS data, "Some of the elevations for the GIS data points appeared to be consistent with the TIN described below. A select set of inlets were field surveyed, which verified that adverse slopes do occur in the system. The GIS data was used as provided by Luke AFB, but it is recommended that the remainder of the inverts and culverts be re-surveyed to verify the data."

Back-check: Concur

Status: Closed

Comment Location:	9) Infrequent Flood Event	**Reviewer:**	Mike Lin, SPK

Comment:

In general practice, storm water system is analyzed for a minimum of two rainfall events:

(1) 1/10 or 1/15annual chance exceedance event to evaluate the average and more frequent conditions for minimum functionality; and
(2) 1/100 annual chance exceedance event to assess a larger design objective for overall system storage (detention/retention basins) and conveyance capacity.

For infrequent flood events, temporary storage on the streets is considered as an accepted practice if it does not constitute loss of life or significant property damage. Revise the Report to recommend future modeling consider this modeling approach.

Evaluator: Adam Bier

Evaluation: Non- concur. This was a specific study to evaluate the existing flood problems for the 100-year flood event as requested by Luke AFB. There is no intent to provide design information regarding the storm drain system.

Back-check: Concur

Status: Closed

Comment Location:	10) Frequent Flood Event	**Reviewer:**	Mike Lin, SPK

Comment:

The activities at AFB have a much higher probability to be impacted by more frequent flooding than the 1/100 annual chance exceedance event. Experience indicates it is often not cost effective to implement flood protection for the 1/100 event based solely infrequent events for the overall system. The storm water sewer system is therefore, commonly designed to function best for the more frequent flood event. Therefore, to ensure a feasible baseline condition and minimum level of functionality, this study and Report should be revised include the 10- or 15-year rainfall events.

Evaluator: Adam Bier

Evaluation: Non- concur. This was a specific study to evaluate the existing flood problems for the 100-year flood event as requested by Luke AFB. There is no intent to provide design information regarding the storm drain system.

Back-check: Concur

Status: Closed

Comment Location:	11) Maximum Water Depth	**Reviewer:**	Mike Lin, SPK
Comment: Revise titles in Figures 10 through 14 to indicate that the floodplain shown in each of the figure was the maximum water depth for the design 1/100 event (not the depth at any given time).			
			Evaluator: Adam Bier
Evaluation: Concur, the titles of the Figure 10 has been revised to Maximum Flood Depth of 100-Year Design Event vs. FEMA Floodplain. Figures 11-14 have been revised to Maximum Food Depth of 100-Year Design Event.			
Back-check: Concur			
Status: Closed			

Comment Location:	12) Maximum Depth	**Reviewer:**	Mike Lin, SPK
Comment: Define "MAX_Depth" in Column 6, Appendix 1.			
			Evaluator: Adam Bier
Evaluation: Concur, Max_Depth and the other table headings are defined on the page preceding Appendix 1, but a note defining Max_Depth will also be added at the base of each page in the table.			
Back-check: Concur			
Status: Closed			

Comment Location:	13) Assumptions in Boundary Conditions	**Reviewer:**	Mike Lin, SPK
Comment: Report needs to document important assumptions regarding boundary conditions, especially the western boundary (future raised freeway assumed to be raised), and golf course development on the north side assumed to intercepts ALL overland flow from entering the model domain.			
			Evaluator: Adam Bier
Evaluation: Non- Concur, the third paragraph in the section discussing Rainfall and Inflow (new Section 5.3.2) discusses the assumptions regarding the Loop 303 and Northern Parkway drainage improvements as well as the Falcon Dunes Golf Course having a design capacity to convey a 100-year event. Furthermore, discussion regarding the boundary conditions is discussed in section titled Existing Storm Water Conveyance Features (new section 3.2).			
Back-check: Concur			
Status: Closed			