

Los Olmos HUC-8 Watershed, Texas Base Level Engineering (BLE) Results

MAS No. FY20-CTP-FRP-MAST #5 T.O. No. 11

Case No. 22-06-0047S

August 2022

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Executive Summary

The Texas Water Development Board (TWDB) contracted Halff Associates (Halff) to complete a Base Level Engineering (BLE) analysis for the HUC-08 watershed No. 13090001 – Los Olmos in South Texas, to support the U.S. Department of Homeland Security’s Federal Emergency Management Agency’s (FEMA) Discovery process and validation of effective Zone A Special Flood Hazard Areas (SFHAs). The BLE process involves using best available data and incorporating automated techniques with standard 2-dimensional (2D) model development procedures to produce regulatory-quality flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals.

The source digital terrain data used for surface model development in support of hydrologic and hydraulic analysis as well as mapping activities were leveraged from various local, State, and Federal partners. Details regarding the different datasets used are provided below in Section 2.1.

Precipitation depths for this study were established using NOAA Atlas 14 rainfall. An average precipitation depth was computed for the study area. The Hydrologic Engineering Center’s (HEC) Hydrologic Modeling System (HMS) was used to develop a simplified hydrologic model to compute excess rainfall which was then used in a rain-on-grid, 2D hydraulic model using HEC-RAS. The hydraulic model was used to compute flood depths and peak water surface elevations within the study area.

The stream mile network that was validated for this watershed was compiled using FEMA’s Community Needs Management Strategy (CNMS) inventory. CNMS is an inventory of flood hazard studies and flood hazard mapping needs for areas where a study is needed. This data is helpful for community officials in analyzing and depicting flood hazards to enhance the understanding of flood risk. Communities may use this information to make informed decisions on their planning and flood mitigation efforts. Table ES-1.1 lists the stream miles associated with this validation analysis.

Table ES-1.1: Summary of Stream Miles

Source	Los Olmos Stream Miles
CNMS	2,687

The full inventory of Zone A studies in the watershed were classified in CNMS. Total miles validated in CNMS are summarized in Table ES-1.2.

Table ES-1.2: Aggregated Zone A Validation Results

Validation Status	Status Type	Total Miles
VALID	BEING STUDIED	0.0
UNVERIFIED	BEING STUDIED	849.5

01 Introduction

Recent innovations and efficiencies in floodplain mapping have allowed the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) to develop a process called Base Level Engineering (BLE), which can be used to address current program challenges, including the validation of Zone A studies and the availability of flood risk data in the early stages of a flood risk project. The BLE process involves using best available data and incorporating automated techniques with standard 2-dimensional (2D) model development procedures to produce flood hazard boundaries for the 1-percent annual chance event as well as estimates of flood hazard boundaries for multiple recurrence intervals. The cost for developing the data and estimates resulting from the BLE process is lower than standard flood production costs. The BLE results may be used for eventual production of regulatory and non-regulatory products.

As described in Title 42 of the Code of Federal Regulations, Chapter III, Section 4101(e), once every five years, FEMA must evaluate whether the information on Flood Insurance Rate Maps (FIRMs) reflects the current risks in flood-prone areas. FEMA makes this determination of flood hazard data validity by examining flood study attributes and change characteristics, as specified in the Validation Checklist of the CNMS Technical Reference. The CNMS Validation Checklist provides a series of critical and secondary checks to determine the validity of flood hazard areas studied by detailed methods (e.g., Zone AE, AH, or AO). While the critical and secondary elements in CNMS provide a comprehensive method of evaluating the validity of Zone AE studies, a cost-effective approach for evaluating Zone A studies has been lacking.

In addition to the need for Zone A validation guidance, FEMA standards require flood risk data to be provided in the early stages of a flood risk project. FEMA Program Standard SID #29 requires that during Discovery, data must be identified that illustrates potential changes in flood elevation and mapping that may result from the proposed project scope. If available data does not clearly illustrate the likely changes, an analysis is required that estimates the likely changes. This data and any associated analyses should be shared, and results should be discussed with stakeholders.

An important goal of the BLE process is the scalability of the results. Scalability means that the results of a BLE analysis can not only be used for CNMS evaluations of Zone A studies but can also be leveraged throughout the Risk Mapping, Assessment, and Planning (Risk MAP) program. The data resulting from a BLE analysis can be updated as needed and used for the eventual production of regulatory and non-regulatory products, outreach and risk communication, and MT-1 processing. Leveraging this data outside the Risk MAP program may also be valuable to external stakeholders.

The Texas Water Development Board (TWDB) contracted Halff Associates (Halff) to complete a BLE analysis for the Los Olmos Watershed in South Texas to support FEMA's Discovery process and validation of effective Zone A Special Flood Hazard Areas (SFHA). The study extents include portions of Zapata, Jim Hogg, Starr, and Hidalgo Counties, and include the following communities: The Cities of Rio Grande, La Joya, Penitas, La Grulla, Sullivan, Escobares, and Roma. The study area consists of seven HUC-10 basins on the United States side: Las Escobas Creek, Remedura de Sandia Creek – Canada Honda, Las Blancas Creek – Los Olmos Creek, Los Olmos Creek – Rio Grande, Garcias Creek – Rio Grande, La Joya Creek – Rio Grande, and Arroyo Grande – Rio Grande. Figure 1.1 shows the orientation of the Los Olmos HUC-8 basin with respect to the Texas counties and Mexico.

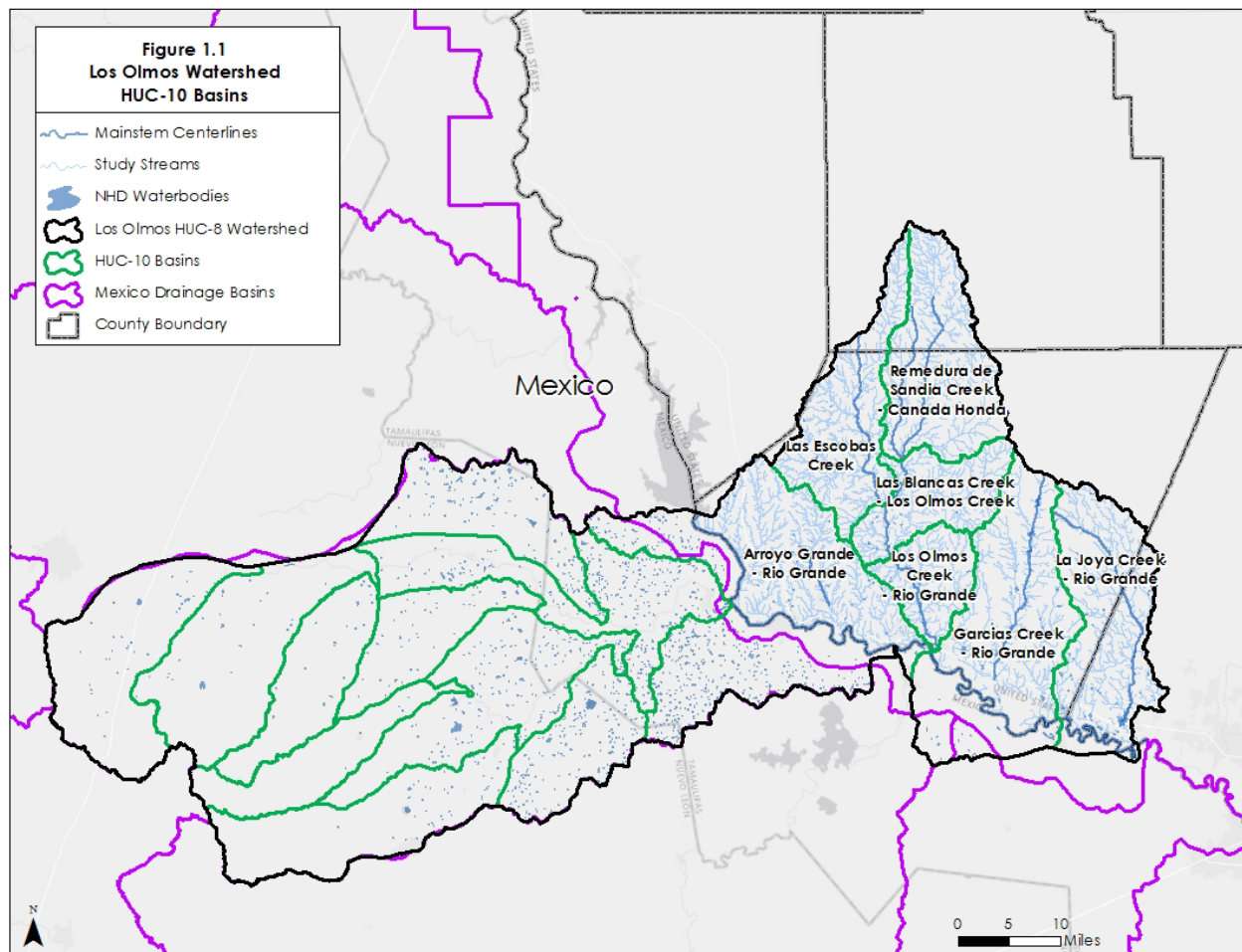


Figure 1.1: Los Olmos Watershed

02 2D BLE Modeling Inputs and Controls

Section 2 presents fundamental components required to execute a 2D hydraulic engineering analysis for the Los Olmos Watershed. Inputs such as elevation data, hydrology used to develop rain-on-grid data and inflow hydrographs, and hydraulic analyses and requisite model parameters are defined herein. HEC-RAS, Version 6.1 rain-on-grid utility was applied in the production of the 2D BLE products produced for this watershed.

2.1 Topographic Data

A high-resolution Digital Elevation Model (DEM) is a fundamental component for 2D engineering analyses by providing a detailed representation of the ground surface for hydraulic routing through the model area. As such, DEMs were developed for the Los Olmos BLE project by leveraging available high-resolution gridded elevation data derived from Light Detection and Ranging (LiDAR) collections throughout the entire State of Texas. The 10-foot DEM developed to support the 2D BLE modeling and analysis, within the Los Olmos Watershed, was executed using the following steps:

1. Available elevation data for the project area were inventoried and collected.
2. Leveraged elevation data were evaluated and prioritized based on source vertical accuracy, year of collection, and resolution.
3. Seamless DEMs were processed using GIS.
4. Quality was assured using quantitative and qualitative assessment.

Documentation regarding leveraged data including coverage, accuracy, acquisition dates, and source contact/agency are presented in the figures, tables and text within the following sections. All vertical accuracy specifications were obtained from the metadata or survey reports provided with the leverage datasets. All available metadata, survey reports, and other leverage documentation are included in the FEMA Data Capture Technical Reference compliant submittal content for the Los Olmos Watershed.

2.1.1 Inventory

An inventory of existing topographic data was conducted for the Los Olmos BLE project footprint. Figure 2.1 depicts the datasets identified and leveraged across the project area. FEMA, National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and other State and Federal agencies were queried to build the inventory with the most current and available data sources.

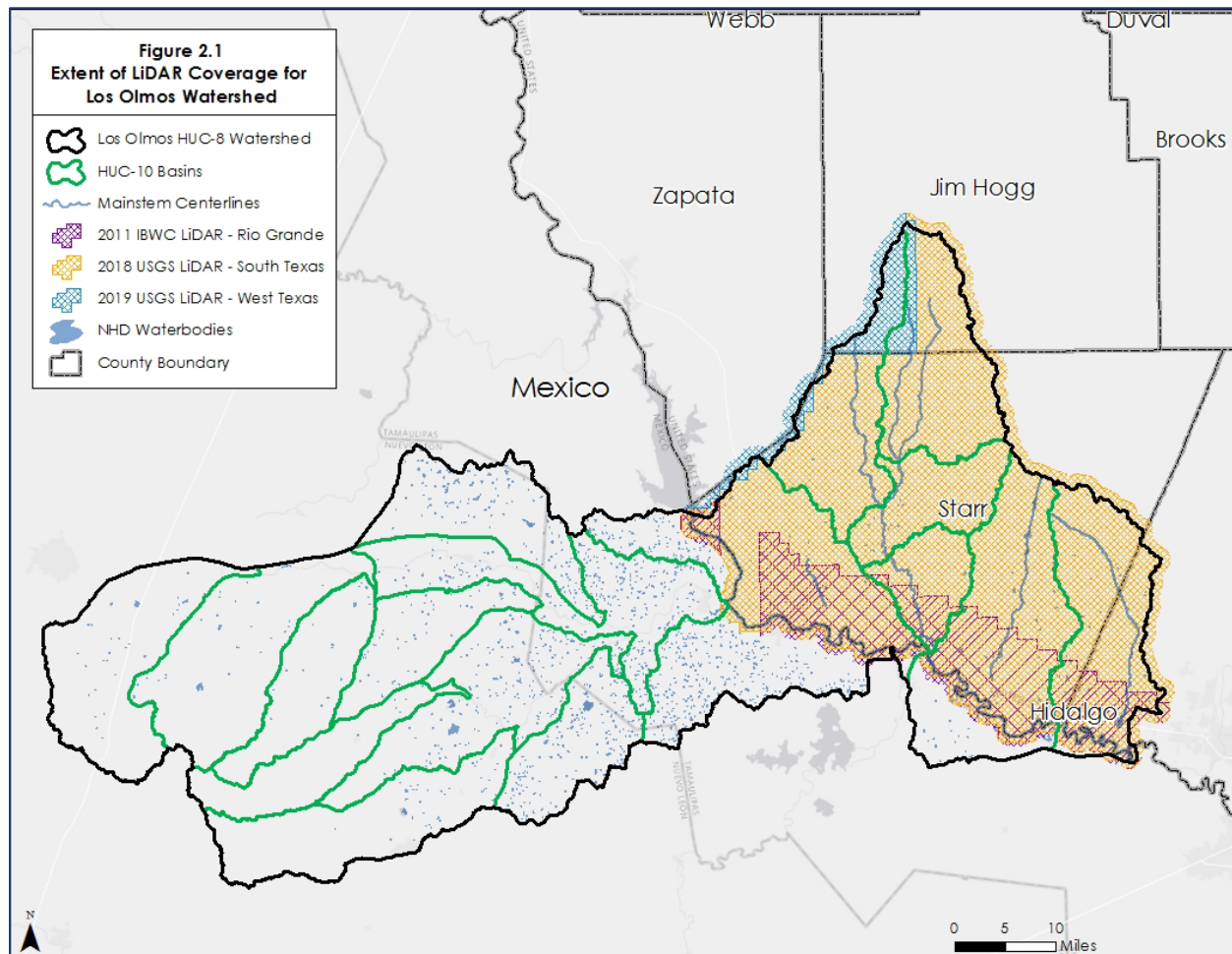


Figure 2.1: Los Olmos Watershed BLE Source Terrain Data

2.1.2 Evaluation

A data coverage assessment was conducted to check for data gaps, extent, accuracy, and completeness. A review of related documentation, reports, indexes, and metadata associated with the leveraged datasets ensured each dataset meets FEMA accuracy requirements for topographic data. Decisions to leverage or exclude a dataset (or portion of it), were based generally on the following criteria coupled with engineering judgment:

- Data meet FEMA vertical accuracy standards (Table 2.1)
- Date of origination
- Data density and coverage

Table 2.1 depicts the Risk Map SID 43 vertical accuracy requirements based on flood risk and terrain slope within the floodplain being mapped.

Table 2.1: FEMA Vertical Accuracy Requirements for Leveraged Data

Level of Flood Risk	Typical Slopes	Specification Level	Vertical Accuracy*	LiDAR Nominal Pulse Spacing (NPS)
High (Deciles 1,2,3)	Flattest	Highest	24.5 cm / 36.3 cm	≤ 2 meters
High (Deciles 1,2,3)	Rolling or Hilly	High	49.0 cm / 72.6 cm	≤ 2 meters
High (Deciles 2,3,4,5)	Hilly	Medium	98.0 cm / 145 cm	≤ 3.5 meters
Medium (Deciles 3,4,5,6,7)	Flattest	High	49.0 cm / 72.6 cm	≤ 2 meters
Medium (Deciles 3,4,5,6,7)	Rolling	Medium	98.0 cm / 145 cm	≤ 3.5 meters
Medium (Deciles 3,4,5,6,7)	Hilly	Low	147 cm / 218 cm	≤ 5 meters
Low (Deciles 7,8,9,10)	All	Low	147 cm / 218 cm	≤ 5 meters

*Vertical Accuracy at 95% Confidence Level (FVA or NVA)/(CVA or VVA)

Table 2.2 depicts the complete list of source elevation data and attributes leveraged for the Los Olmos Watershed BLE project. All datasets used for hydraulic analyses and mapping meet the highest specification level defined in Table 2.1. Further explanation of the Table 2.2 datasets can be referenced in section 2.1.2.1.

Table 2.2: Source Topographic Data Available for the Los Olmos Watershed

Year	Description	Data Type	RMSE	Source/Owner
2011	2011 IBWC Rio Grande LiDAR	Airborne LiDAR	NVA 0.03m	IBWC
2018	2018 USGS South TX LiDAR (Aransas, Dewitt, Calhoun, Goliad, Karnes, Refugio, Victoria)	Airborne LiDAR	NVA 0.0089m	USGS
2018	2018 Mexico	Airborne LiDAR	Best Available	Mexico
2019	2019 USGS West Texas LiDAR	Airborne LiDAR	Less than 10 cm	USGS

2.1.2.1 Los Olmos Watershed Source Terrain Data

The source elevation data for the Los Olmos Watershed are DEMs derived from USGS and IBWC LiDAR data. Preprocessed bare-earth hydro-enforced DEMs from the acquiring entity (via TNRIS) were projected and adjusted as needed into one seamless. Bare-earth LiDAR data are typically made by filtering non-ground returns (e.g. buildings, vegetation, etc.) from the processed LiDAR returns with hydro-lines and other LiDAR derived breaklines enforced. Brief descriptions of each LiDAR source are provided below. For more detailed information, the LiDAR project report for each dataset is included in the XXX submittal.

2011 IBWC LiDAR– The 2011 IBWC LiDAR was acquired from December 2010 to August 2011. The measured RMSE was documented at 0.03m Non-Vegetated Accuracy.

2018 Mexico– The best available LiDAR for Mexico is from 2018 and was used in the digital elevation model. Project and LiDAR quality specifics can be found at the Spanish Language site at the link provided: <https://www.inegi.org.mx/temas/relieve/continental/#Mapa>

2018 USGS South TX LiDAR, Aransas, Dewitt, Calhoun, Goliad, Karnes, Refugio, Victoria– The 2018 USGS LiDAR was acquired from January 2018 to February 2019 and was collected with a point spacing of 70 cm. The measured RMSE was documented at 0.0089m Non-Vegetative Accuracy. The reported Z (vertical) Accuracy meets the 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using $RMSE(z) \times 1.9600$ as defined by the National Standards for Spatial Data Accuracy (NSSDA) and was assessed and reported following National Digital Elevation Program (NDEP)/ASRPS Guidelines.

2019 USGS West Texas LiDAR– The 2019 USGS West Texas LiDAR was acquired from February 2019 to April 2019. The measured RMSE was documented at less than 10 cm. The reported Z (vertical) Accuracy meets the 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using $RMSE(z) \times 1.9600$ as defined by the National Standards for Spatial Data Accuracy (NSSDA) and was assessed and reported following National Digital Elevation Program (NDEP)/ASRPS Guidelines.

2.1.3 Data Development Methodology

The source topographic data were processed for an area covering the Los Olmos Watershed and contributing drainage areas for the Los Olmos BLE modeling efforts. The topographic data for Los Olmos Watershed was projected horizontally, as needed, to North American Datum of 1983 (NAD83), State Plane Coordinate System (SPCS) Texas South in feet (4205-SPC83). All topographic data were adjusted vertically, as needed, to NAVD88 in feet. Halff used a combination of ArcGIS and other software tools to apply any vertical datum shifts and/or any horizontal projection transformations to the topographic data.

2.1.4 DEM QA/QC

DEMs developed for use in the Los Olmos Watershed BLE analysis were developed using a controlled process, evaluated, and assured by a topographic data development team and were evaluated and assured by the engineering team to meet the quality standards of the project. Quality assurance during the data development process includes, but is not limited to the following QC checks:

- Horizontal Projection Check
- Vertical Datum Check
- Resolution Check
- Format Check
- Seamless Data Check to ensure the DEM files are consistent and seamless along source data edges

The quality control after the development process by the topographic data development team included visual observations using hillshade, contouring, color rendering, and/or other visual aids to review and identify potential impactful anomalies within the DEM surface. This QC step included, but were not limited to the following QC checks:

- Seamless Data Check to ensure no voids along the edges and between the prioritized datasets
- NoData Value Check to ensure no null values
- Manual Elevation Check using hillshade rasters to find erroneous elevation issues
- Unit Consistency Check
- Legacy Cell Value Anomalies

Quality assurance conducted after the seamless DEM development conducted by the engineering team included visual and automated assessments to identify potentially impactful anomalies or slope changes that may adversely impact hydraulic computations.

The final DEM data developed for the Los Olmos Watershed are assured to meet FEMA standards and present a representative surface developed from leveraged elevation data for the purposes of this BLE project.

2.2 2D BLE Methods

The following sections describe the 2D computational mesh and program setting considerations, followed by discussion and tabulation of hydrologic and hydraulic engineering methods and model inputs.

2.2.1 2D Computational Mesh and Settings

The HEC-RAS 2D computational mesh defines the extents of the 2D flow and can affect the accuracy of the 2D calculations. A denser mesh may provide more accurate results, but it can dramatically increase model run times. The original 2D mesh for the model was established as evenly spaced cells at approximately 200 feet. The mesh was further refined by placing breaklines along roads, berms, ridges, and other high ground that can impede the flow as well as stream centerlines to allow flow conveyance. To ensure the entire Los Olmos Watershed, including adjacent inflows, was represented, a 1-mile buffer was added to the HUC boundary.

The HEC-RAS 2D computational mesh was created for Los Olmos Watershed based on the USGS HUC boundaries using ArcGIS toolsets, such as smoothing and simplification routines, significantly reducing the need for manual edits to mesh cells within HEC-RAS. The 2D mesh consists of 1,003,362 cells with a 200-foot nominal mesh cell size. Factors that could result in either larger or smaller cell sizes including included:

- Proximity to the edge of the 2D mesh
- Presence of breaklines
- Refinement of mesh for significant flood control features (levees, dams, etc.).

A 30-second time step was used in the HEC-RAS model, applying the Diffusion Wave (simplified Full Momentum) equations.

2.2.2 Model and Boundary Condition Setup

Using HEC-RAS rain-on-grid modeling requires establishing a 2D computational mesh boundary as discussed previously, and often requires defining inflow boundary conditions in addition to excess precipitation applied to the mesh. For the Los Olmos Watershed, inflow hydrographs from two inflow points along the Mexico border and three inflow hydrographs from International Falcon Reservoir HUC were used, along with excess precipitation applied to the mesh. The three inflow hydrographs from International Falcon Reservoir include two outflows at the base of the dam and one hydrograph for the spillway. Figure 2.2 shows the 2D computational mesh for the Los Olmos Watershed, along with USGS peak streamflow gages pertinent to the study area.

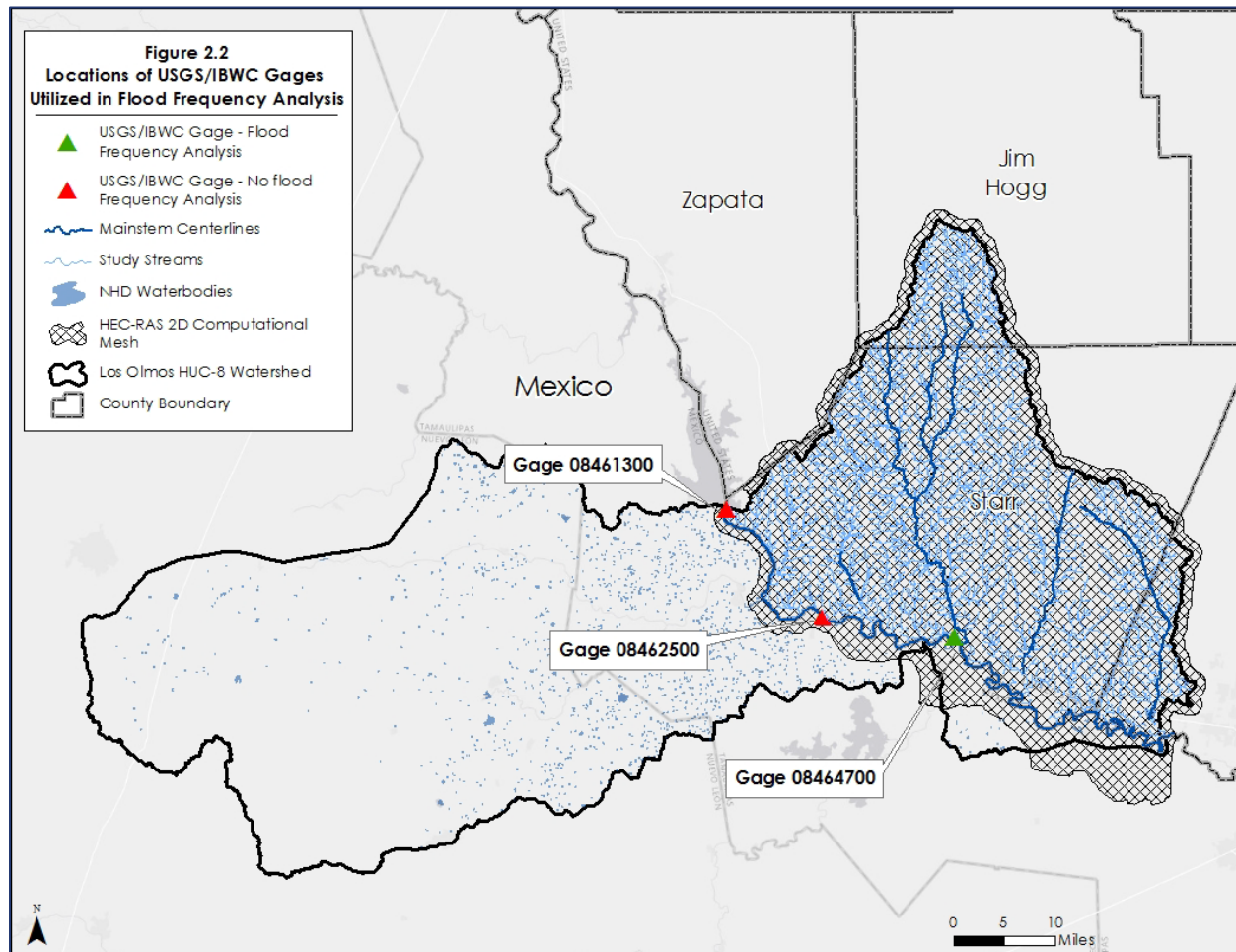


Figure 2.2: HEC-RAS 2D Computational Mesh and USGS/IBWC Peak Streamflow Gages

Figure 2.3 shows the inflow boundary condition locations for the Los Olmos Watershed. The development of the inflow hydrographs, and excess precipitation hyetographs for the 2D mesh, is described in Section 2.2.3.1.1.

Three flow hydrographs representing outflow from the upstream International Falcon Reservoir RAS model was used for the boundary conditions along the Rio Grande. The remaining boundaries on the U.S side were defined as continuous boundaries to allow drainage from adjacent basins to leave the model area freely. Normal depth was used for non-unique outflow boundary conditions using approximate energy grade-line slopes estimated from the LiDAR terrain data.

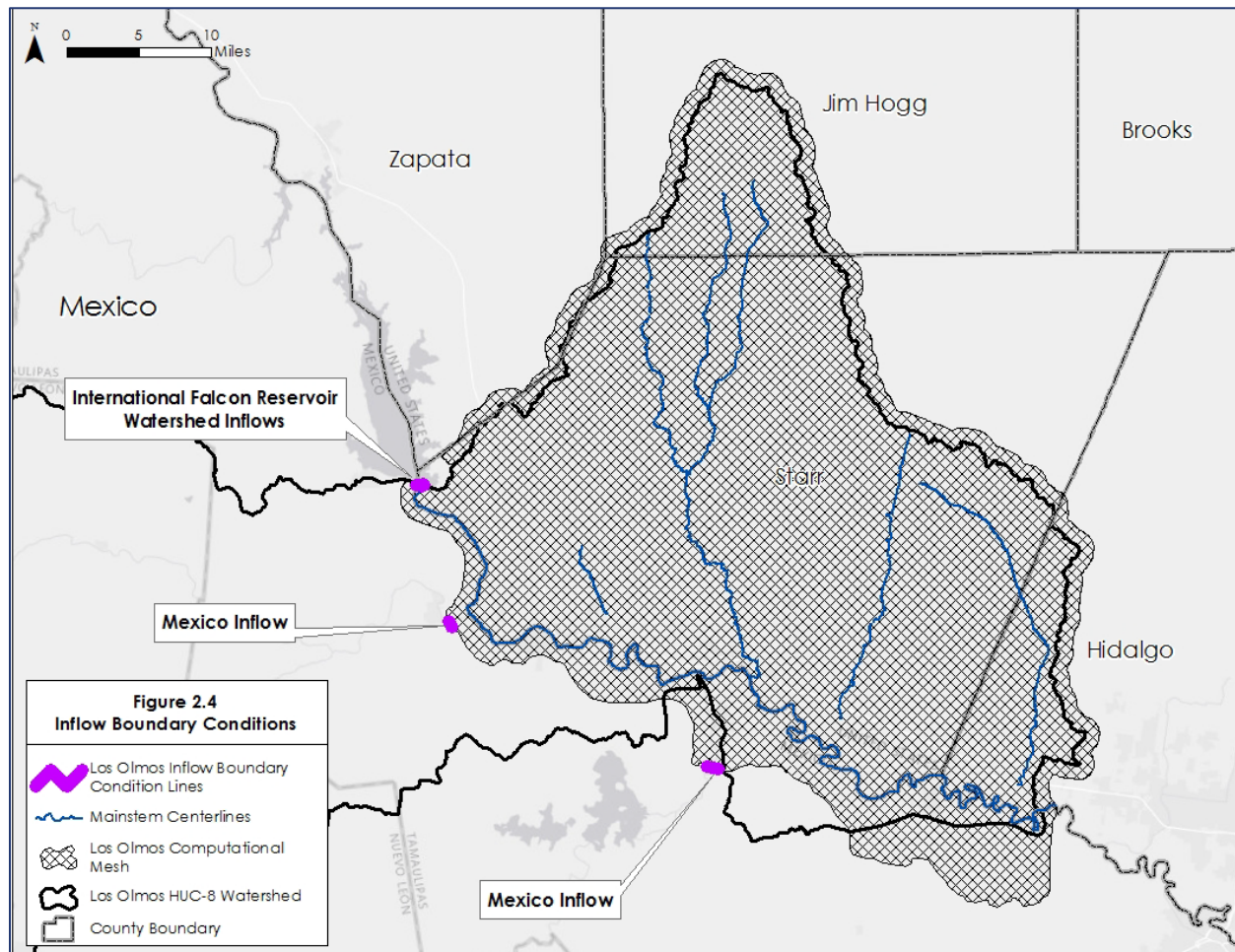


Figure 2.3: HEC-RAS 2D Computational Mesh and Inflow Boundary Conditions for Los Olmos Watershed

2.2.3 Hydrology

The Los Olmos Watershed contains the Rio Grande with contributing drainage area from both the United States and Mexico, with the greater portion from Mexico. The following sections discuss the approach for the hydrologic modeling in the United States and in Mexico.

2.2.3.1 United States Hydrology

HEC-HMS, Version 4.3, was used for the development of excess precipitation hyetographs which were applied to the 2D mesh in the United States. Precipitation frequency data published in NOAA Atlas 14, Volume 11 Version 2.0 (NOAA, 2018) were used for this study. These data were obtained from NOAA's Precipitation Frequency Data Server (PFDS) (<http://hdsc.nws.noaa.gov/hdsc/pfds/index.html>). The 10-, 4-, 2-, 1-, and 0.2-percent annual chance 24-hour precipitation depths for the watershed were determined by area-weighted intersection of gridded PFDS data within the study area. Excess precipitation for the 2D mesh was developed as described in Section 2.2.3.1.1.

Inflow hydrograph boundary conditions for the 2D mesh were derived from the upstream model for the International Falcon Reservoir hydraulic model and from the Mexico hydrology model (discussed in Section 2.2.3.2).

USGS streamflow gage data were leveraged to estimate peak flows for gages within the Los Olmos Watershed for model validation purposes, as discussed in Section 2.3.1. The gages utilized for this study are presented in Table 2.3.

Table 2.3: USGS/IBWC Peak Streamflow Gages

Gage ID	Flooding Source and Location	Published Drainage Area (mi ²)	Period of Record
08464700	Rio Grande at Ft. Ringgold, Rio Grande City, TX	174,362	1954-2000

Annual chance peak flows were calculated at each gage using USGS Bulletin 17C methodology. Calculated discharges for the 1-percent, 1-percent plus, and 1-percent minus events are presented in Table 2.4 for the gage utilized in this study.

Table 2.4: USGS/IBWC Peak Streamflow Gage Analysis Results

Gage ID	Flooding Source and Location	1% Peak Q (cfs)	1%- Peak Q (cfs)	1%+ Peak Q (cfs)
08464700	Rio Grande at Ft. Ringgold, Rio Grande City, TX	294,120	214,421	474,204

2.2.3.1.1 Excess Precipitation for 2D Computational Mesh

HEC-HMS, Version 4.3 was used to apply the SCS Curve Number method to calculate losses and define excess precipitation for each watershed. Temporal distributions of point rainfall totals were defined using frequency storm distributions. The plus and minus standard error for the 1-percent annual chance precipitation depths were determined as the upper and lower 84% confidence limits on the nominal 1-percent depth, assuming a normal distribution of the logarithms for the precipitation depths.

In addition to recurrence interval precipitation estimates, NOAA Atlas 14 provides 90% confidence intervals of reported precipitation values. On a normal distribution curve, 90% confidence intervals (i.e. the upper and lower 95% confidence limits) correspond to ± 1.645 standard deviations. The 1% plus and minus events are defined to be one standard deviation above and below the 1% event.

Curve Numbers were computed by intersecting the National Land Cover Dataset (NLCD) 2016 coverage and NRCS soils data based on the matrix presented in Table 2.5. A portion of the modeled area was outside the coverage of the NLCD, and these areas were assumed to be NLCD classification of 11 (open water) since they were located in and near the Rio Grande.

Table 2.5: Land Use-Soils-CN Matrix for Computing Initial Curve Numbers

LU_GridCode	NLCD LU Description	Hydrologic Soil Group			
		A	B	C	D
11	Open Water	99	99	99	99
21	Developed Open Space	49	69	79	84
22	Developed Low Intensity	61	75	83	87
23	Developed Medium Intensity	81	88	91	93
24	Developed High Intensity	89	92	94	95
31	Barren Land	39	61	74	80
41	Deciduous Forest	30	55	70	77
42	Evergreen Forest	30	55	70	77
43	Mixed Forest	30	55	70	77
52	Shrub Scrub	30	48	65	73
71	Herbaceous	49	62	74	85
81	Hay Pasture	39	61	74	84
82	Cultivated Crops	51	67	76	80
90	Woody Wetlands	72	80	87	93
95	Emergent Herbaceous Wetlands	72	80	87	93

The time of concentration (in hours) for the study area was approximated as the square root of the drainage area (in square miles). Time of concentration was multiplied by 0.6 to compute the lag time. The lag time does not impact the excess rainfall hyetograph, so it was not necessary to compute a more accurate basin travel time. The table below shows the curve number and lag time values used in this study.

Table 2.6: U.S. Rainfall-Runoff Parameters (Curve Number, Lag Time)

Sub-basin Description	CN	Lag Time (min)
Los Olmos	65	1,222

NRCS rainfall-runoff methods were used to define excess precipitation applied to the 2D mesh, including curve numbers for defining rainfall losses and lag time for transforming the runoff temporally. No routing was considered in the rainfall-runoff modeling. Frequency storm distributions were used for defining

temporal distributions of point rainfall totals. Weighted average rainfall depths were calculated for the 10-, 4-, 2-, 1-, and 0.2-percent ACEs. The weighted average rainfall depths for 1-percent plus and 1-percent minus rasters were also calculated using the upper and lower confidence intervals for the 1-percent event. These steps were performed for durations of 5-min, 15-min, 1-hr, 2-hr, 3-hr, 6-hr, 12-hr, and 24-hr. The weighted average rainfall depths were used to determine the excess precipitation in the HEC-HMS model. Areal reduction was not applied to the US portion of the watershed based on the sensitivity analysis described in Section 2.3.1. Table 2.7 provides the rainfall depths for a 24-hour storm duration used for determining excess precipitation.

Table 2.7: Precipitation Rainfall Depths for Estimating Excess Precipitation for HEC-RAS 2D Computational Mesh

Sub-basin Description	Percent Annual Chance Exceedance	Rainfall Duration (in)							
		5 min	15 min	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr
Los Olmos	10%	0.78	1.55	2.84	3.52	3.93	4.61	5.26	5.92
	4%	0.96	1.91	3.50	4.41	4.97	5.89	6.75	7.60
	2%	1.11	2.21	4.04	5.15	5.85	7.00	8.02	9.03
	1%	1.26	2.51	4.61	5.97	6.83	8.24	9.46	10.63
	1% minus	0.97	1.93	3.55	4.62	5.31	6.45	7.45	8.43
	1% plus	1.55	3.09	5.68	7.31	8.35	10.03	11.46	12.82
	0.2%	1.63	3.23	6.04	8.12	9.51	11.69	13.46	15.00

Figure 2.4 shows the hyetographs applied to the 2D computational mesh.

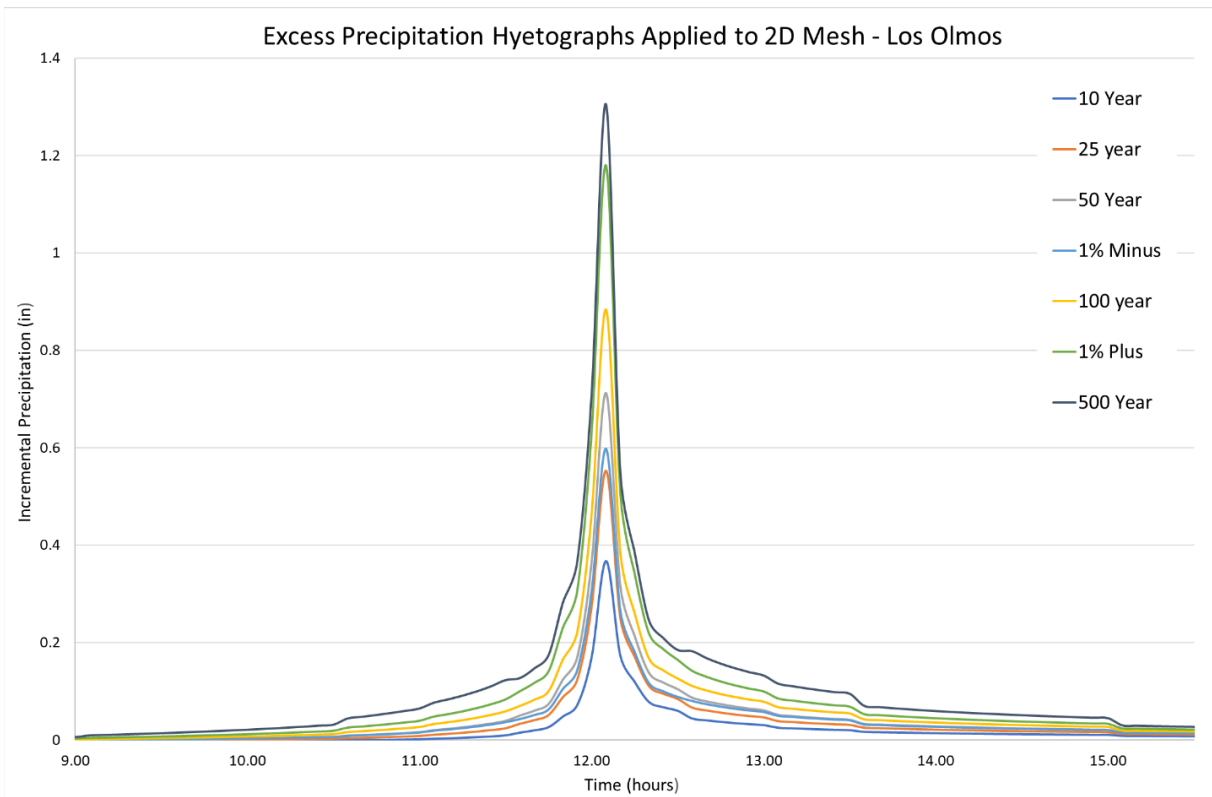


Figure 2.4: Precipitation Hyetographs Applied to the Computational Mesh

2.2.3.2 Mexico Hydrology

The hydrology in Mexico utilized drainage areas obtained from the *Instituto Nacional de Estadística, Geografía y Informática* (INEGI) website, specifically, the “*Simulador de Flujos de Agua de Cuencas Hidrograficas*”. These basins were merged or adjusted based on location and engineering judgement.

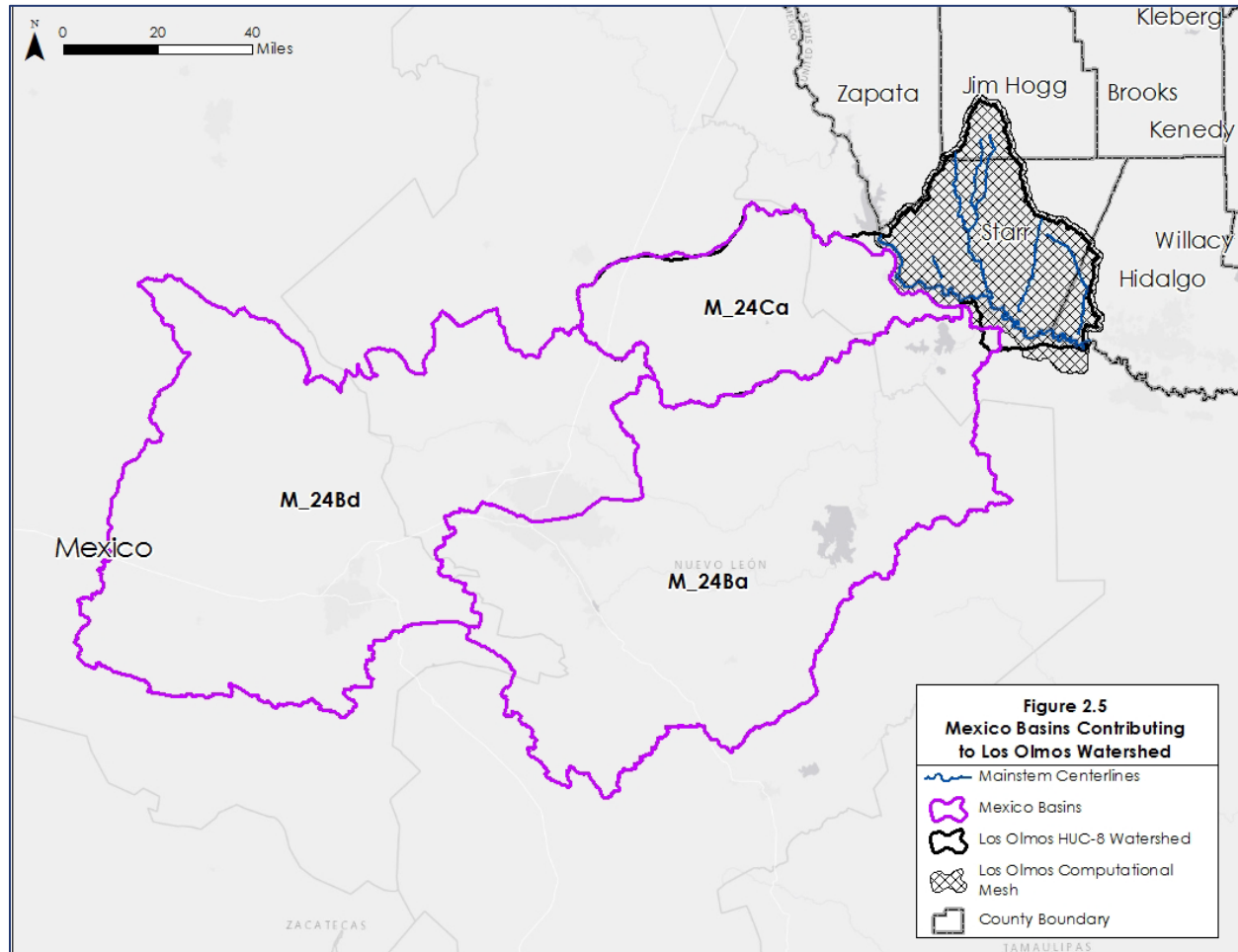


Figure 2.5: Mexico Basins Contributing to Los Olmos Watershed

Mexico land use data was based on the North American Land Change Monitoring System (NALCMS) 2015 land cover 30-meter resolution map. The NALCMS land cover categories were converted to NLCD codes according to Table 2.8 below.

Table 2.8: Mexico Landcover

NALCMS 2015 Land Cover Values and Description		NLCD Code	NLCD Description
Value 1	Temperate or sub-polar needleleaf forest	42	Evergreen Forest
Value 2	Sub-polar taiga needleleaf forest	42	Evergreen Forest
Value 3	Tropical or sub-tropical broadleaf evergreen forest	42	Evergreen Forest
Value 4	Tropical or sub-tropical broadleaf deciduous forest	41	Deciduous Forest
Value 5	Temperate or sub-polar broadleaf deciduous forest	41	Deciduous Forest
Value 6	Mixed forest	43	Mixed Forest
Value 7	Tropical or sub-tropical shrubland	52	Shrub Scrub
Value 8	Temperate or sub-polar shrubland	52	Shrub Scrub
Value 9	Tropical or sub-tropical grassland	71	Herbaceous
Value 10	Temperate or sub-polar grassland	71	Herbaceous
Value 14	Wetland	95	Emergent Herbaceous Wetlands
Value 15	Cropland	82	Cultivated Crops
Value 16	Barren lands	31	Barren Land
Value 17	Urban	23	Developed Medium Intensity
Value 18	Water	11	Open Water

The time of concentration for the Mexico sub-basins was calculated using velocity-based methods. The flow was split into five major categories: overland flow, shallow concentrated flow, channel – mountainous, channel – hills, and channel – plains. Each of the channel sections were drawn and had an estimated slope. The velocities for channel sections were calculated using the open channel sections in Bentley’s FlowMaster software. Table 2.9 shows the curve number and lag time values used in this study.

Table 2.9: Mexico Rainfall-Runoff Parameters (Curve Number, Lag Time)

Sub-basin Description	CN	Lag Time (min)
M_24Ba	75	1,851
M_24Bd	72	1,948
M_24Ca	73	1,746

Precipitation data for Mexico was obtained from Centro Nacional de Prevención de Desastres in Mexico (<http://www.atlasmnacionalderiesgos.gob.mx/portal/fenomenos>). Isohyets were available for the 24-hr storm event and treated like contours to create a precipitation raster. Rainfall depths were available only for 1-hour and 24-hour storm durations, so depths for the other durations (5-min, 15-min, 2-hr, 3-hr, 6-hr, and 12-hr) were computed based on average ratios established from the depth-durations in the U.S.

hydrology. Additionally, rainfall depths were not available for the 4%, 1% plus, and 1% minus frequency events, so depths were interpolated based on ratios established from the U.S. hydrology.

Areal reduction was applied to the Mexico subbasins using the USGS areal reduction curves (USGS WRI Report 99-4267). Areal reduction was applied to the Mexico basins and not the U.S. basins in order to align with the gage analyses on the Rio Grande and to ensure that the International Falcon Reservoir stage did not exceed the top of the dam in the 0.2-percent storm event.

2.2.3.2.1 El Azucar – Marte R Gomez Dam

The Marte R Gomez Dam resides in the Mexico contributing drainage area that inflows into the Rio Grande along the Los Olmos Watershed boundary. This reservoir provides significant flood control and thus required inclusion in the Mexico hydrology model. Data for the reservoir and dam was obtained from “Sistema Nacional de Información del Agua Monitoreo de las Principales Presas de México” (conagua.gob.mx). The principal spillway crest elevation is 250.5 ft (76.34 m) and the emergency spillway elevation is 272.3 ft (83.00 m), with a top of dam elevation of 282.2 ft (86.00 m). A discharge rating curve was developed for the principal spillway using the weir equation with a known maximum discharge of approximate 459,090 cfs (13,000 m³/s). Additional information on the emergency spillway was not available to include discharges in this analysis. The elevation – storage curve was established using published known storage at key elevation points. The remaining data points on the curve were linearly interpolated between the known values.

2.2.3.3 Rainfall-Runoff Hydrograph Boundary Conditions

This section discusses the drainage areas for which inflow hydrographs, developed from rainfall-runoff modeling, were used as boundary conditions to the 2D computational mesh. The following figures show the inflow hydrographs for each contributing flooding source applied to the 2D computational mesh. Figure 2.6, Figure 2.7, and Figure 2.8 include the International Falcon Reservoir drainage area contributing inflow hydrograph to Los Olmos. Figure 2.9 and Figure 2.10 includes the Mexico drainage area contributing inflow hydrograph Los Olmos.

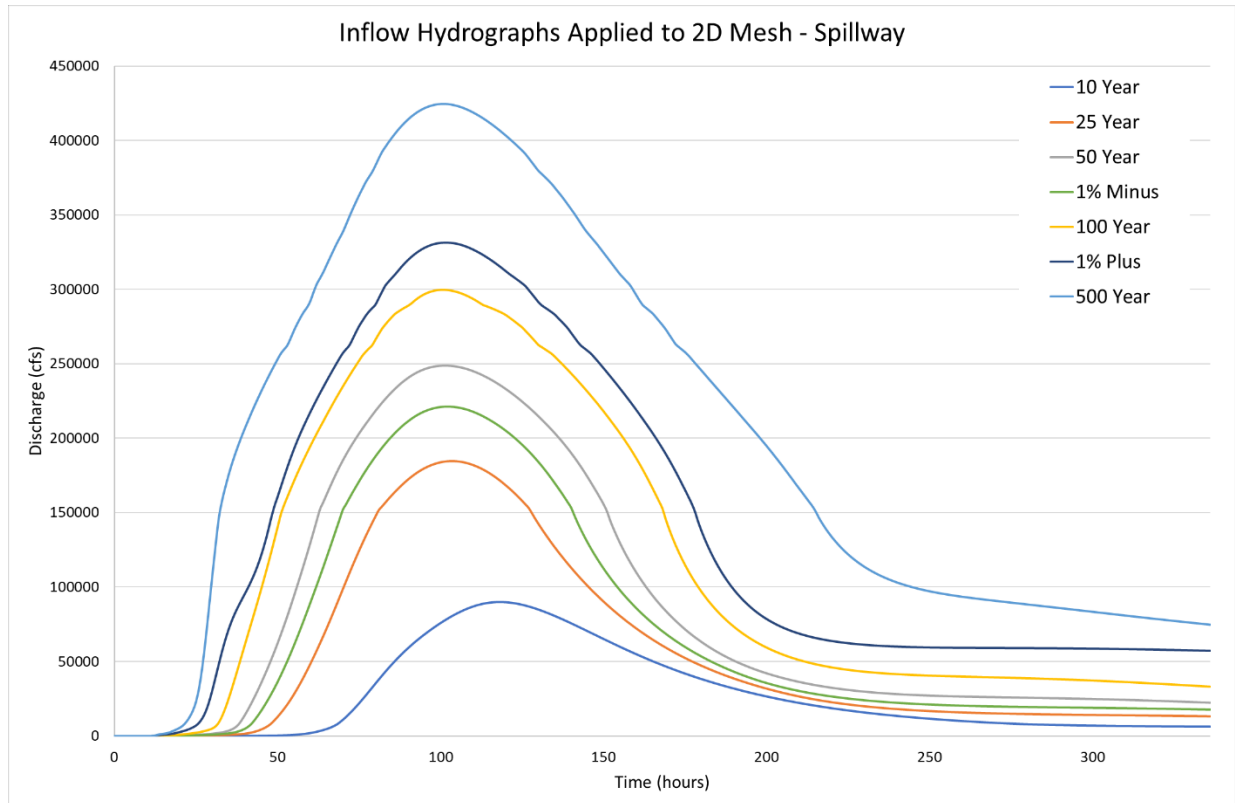


Figure 2.6: International Falcon Reservoir Spillway Inflow Hydrographs

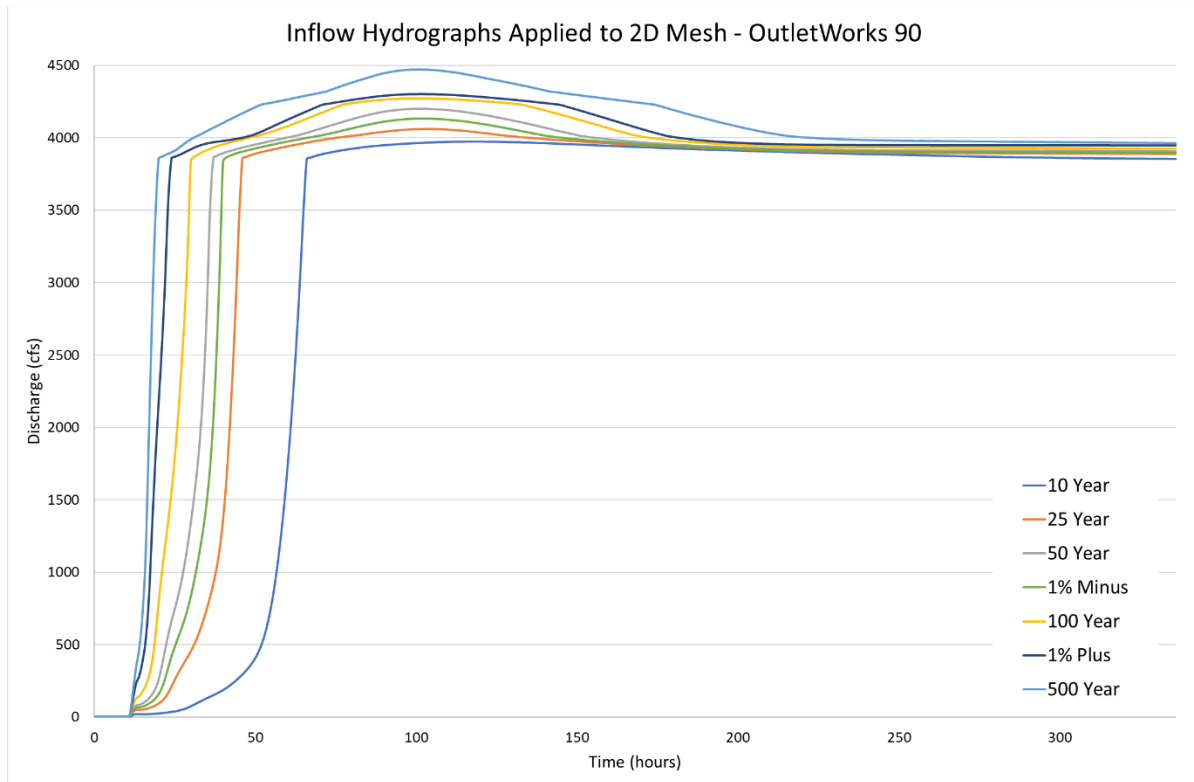


Figure 2.7: International Falcon Reservoir Outlet Works 90 Inflow Hydrographs

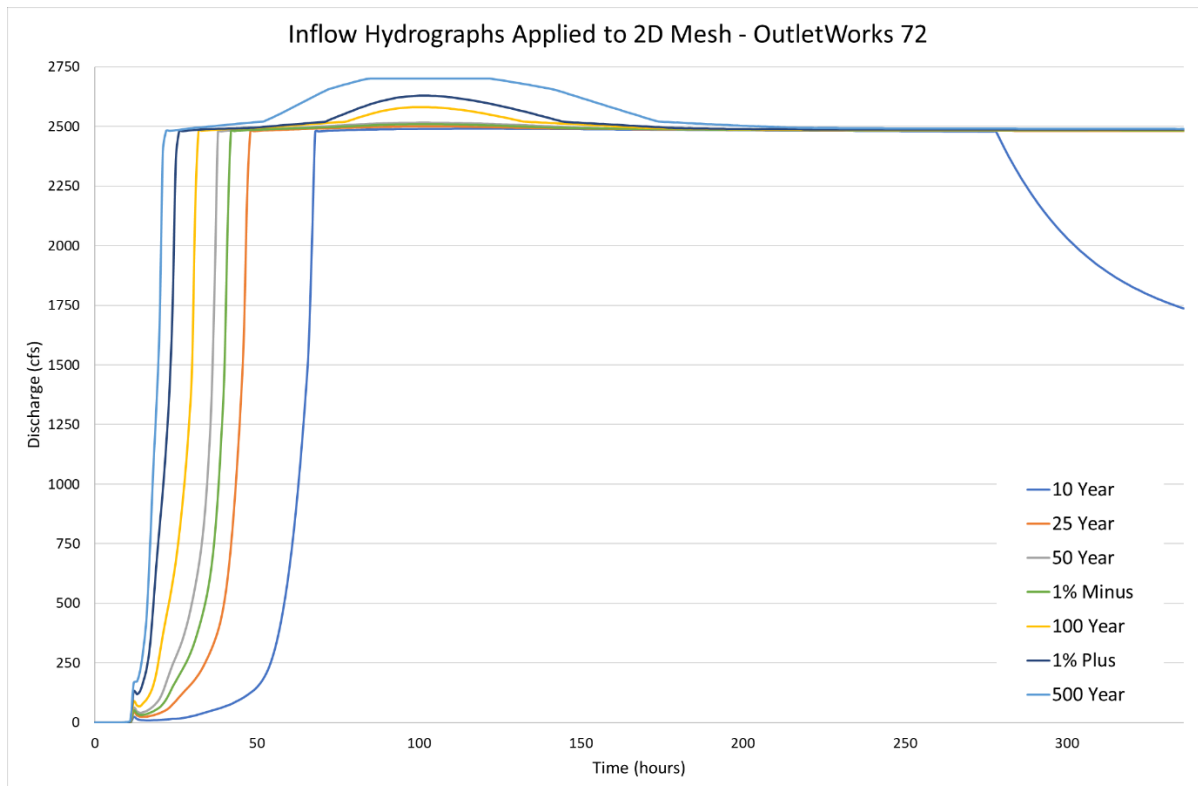


Figure 2.8: International Falcon Reservoir Outlet Works 72 Inflow Hydrographs

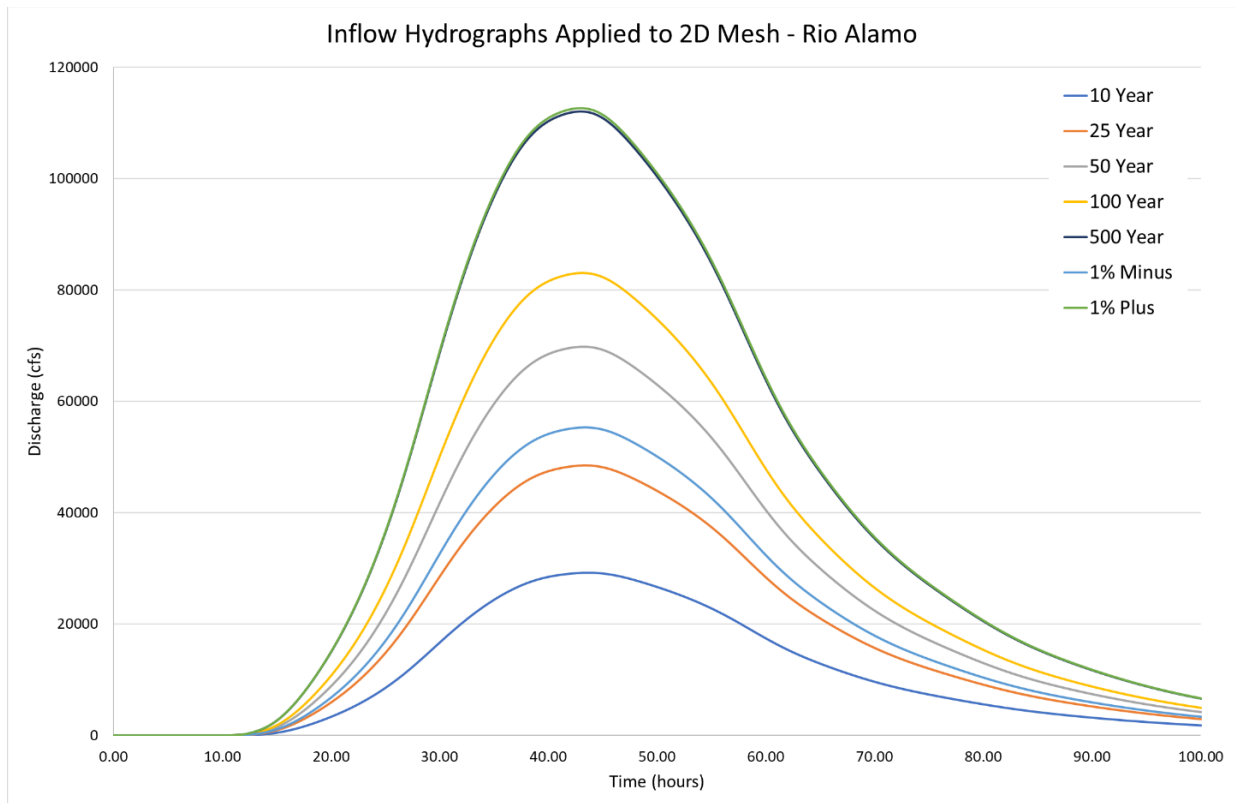


Figure 2.9: M_24Ca Basin - Rio Alamo Contributing Drainage Area Inflow Hydrographs

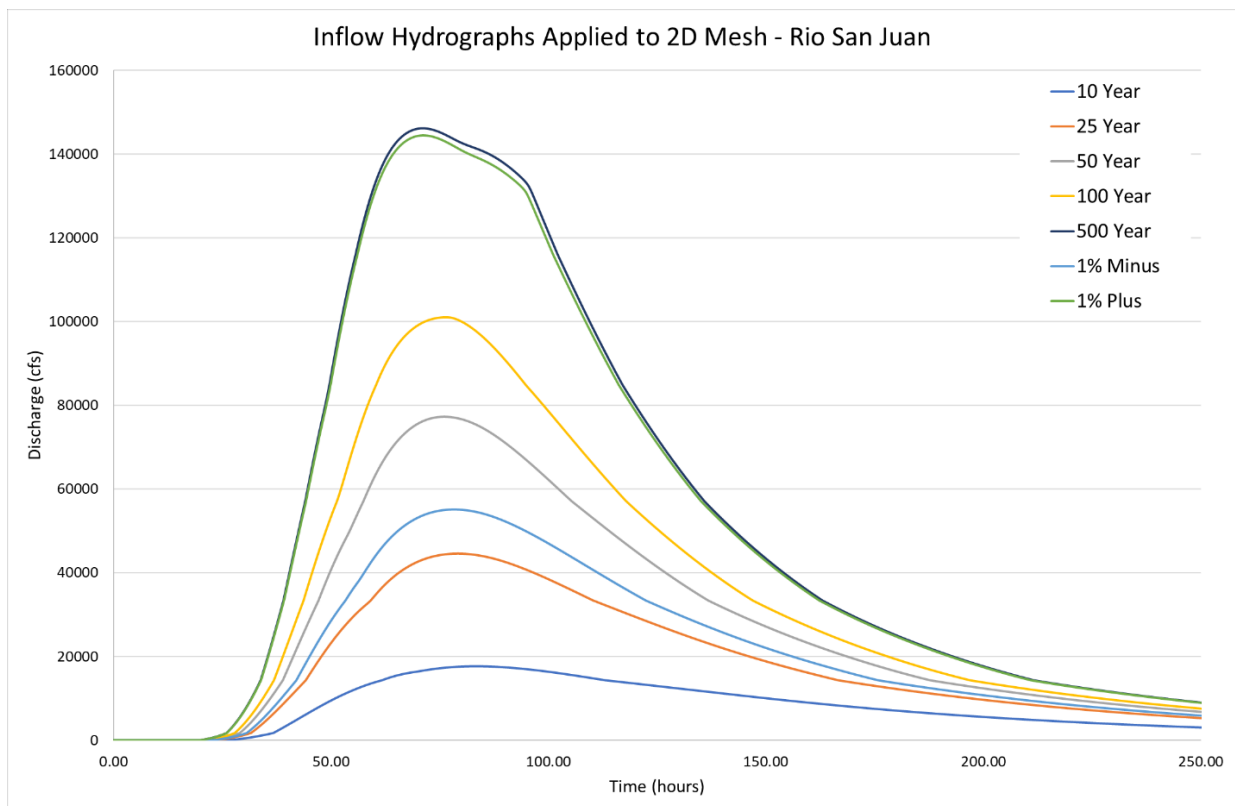


Figure 2.10: Rio San Juan Junction 1 – Rio San Juan Contributing Drainage Area Inflow Hydrographs

2.2.4 Hydraulics

This section describes the remaining hydraulic modeling considerations, including implementation of Manning's roughness values, breaklines, and hydraulic structures within the 2D computational mesh.

2.2.4.1 Roughness Coefficients

A Manning's n roughness coverage was developed for the 2D computational mesh using typical values for roughness for given NLCD land classifications. In several areas, the channel section land use indicated a Manning's n-value inappropriate for channel conveyance. A 20-foot buffer zone was created by automated processes around each stream centerline (mainstems and tributaries) to create a main channel roughness zone. The channel roughness zone was given a Manning's n value of 0.045, obtained from the HEC-RAS User's Manual, to ensure the channel 2D cells have appropriate conveyance. The table below shows a typical land use-roughness matrix used in defining the roughness coverage for the study area.

Table 2.10: NLCD 2016-Manning's N Roughness Matrix

NLCD Classification	Manning's N	Minimum	Normal	Maximum
Open Water	0.030	0.025	0.038	0.050
Developed, Open Space	0.040	0.030	0.040	0.050
Developed, Low Intensity	0.060	0.060	0.090	0.120
Developed, Medium Intensity	0.080	0.080	0.120	0.160
Developed, High Intensity	0.120	0.120	0.160	0.200
Barren Land	0.030	0.023	0.025	0.030
Deciduous Forest	0.120	0.100	0.150	0.200
Evergreen Forest	0.120	0.080	0.120	0.160
Mixed Forest	0.120	0.080	0.140	0.200
Scrub/Shrub	0.060	0.070	0.115	0.160
Grassland/Herbaceous	0.030	0.025	0.038	0.050
Pasture/Hay	0.040	0.025	0.038	0.050
Cultivated Crops	0.040	0.020	0.035	0.050
Woody Wetlands	0.100	0.045	0.098	0.150
Emergent Herbaceous Wetland	0.080	0.050	0.068	0.085
Main Channel ¹	0.045			

Source: HEC-RAS 2D Modeling User's Manual

¹ Clean, winding, some pools and shoals, some weeds and stones, lower stages, more ineffective slopes and sections

2.2.4.2 Breaklines

Breaklines align grid cell faces and were used within the 2D mesh area to define prominent features including road embankments and hydraulic structures as well as stream centerlines. Road embankments were identified in ArcGIS and imported into HEC-RAS as breaklines to ensure that water was not routed past roads until it was deep enough to overtop the road. County, interstate, state recognized, and U.S. roads were incorporated for road breaklines from the ESRI North America Detailed Streets layer. The stream centerlines were input as breaklines to ensure cells lined up perpendicular to the stream and to capture stream conveyance. Stream centerlines were simplified to speed up editing and run times in HEC-RAS. Levees from the National Levee Inventory, and railroads from the TIGER Railroads layer were also incorporated. Additionally, several private dams and embankments were added as breaklines to better represent flow patterns through and around these structures.

2.2.4.2.1 Roads

Culvert crossings specifically were identified by intersections of the stream centerlines and road lines by automated processes and were modeled by burning channels through the embankment in the DEM to prevent unnecessary impoundment of water. This approach was used for most hydraulic structures because it could be implemented in ArcGIS on a large scale with much less effort than alternative methods. Since this an automated process, it was not possible to isolate specific culverts to burn through the DEM, thus conservative assumptions on width of opening were applied to not overestimate the release of water through the crossing.

Culvert crossings that were not processed out of the terrain data were modeled by inserting v-notches into the road breaklines at the points of intersection with the Culvert crossings. The v-notches cause the grid cells to realign around the embankment and allow water to be routed across the embankment without creating artificial backwater. An example of the v-notch breakline approach is shown below.

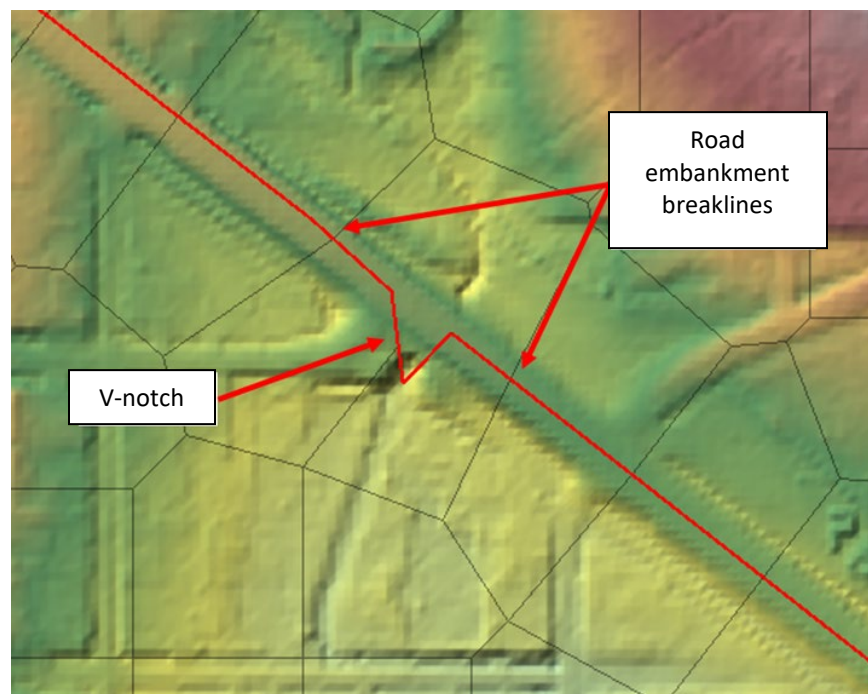


Figure 2.11: V-Notch Breakline Approach at Culvert Crossing

2.2.4.3 Initial Conditions

Initial conditions were not used in the Los Olmos 2D BLE model.

2.2.5 Special Assumptions

Different from the other Rio Grande Valley BLE studies, the Los Olmos Watershed was not split into North and South models. This resulted in a larger model cell mesh count as compared to the other model domains.

Additionally, the modeling of the Mexico hydrology with the inclusion of Marte R Gomez Dam was based on the best available data that could be obtained for the dam and reservoir. Future updates to the modeling should include additional information on the flood control structure modeling of this dam and reservoir.

2.3 Model Results

The 2D BLE results for the study provides estimated flood risk in areas that do not currently have an SFHA mapped. Additionally, the application of rain-on-grid modeling allowed for the identification of localized flood risk beyond the extents of the traditional SFHAs. There was no effective BFE data available in the Los Olmos HUC-8. The validity of the 2D BLE results should be verified through community work map meetings before being applied as a regulatory product.

2.3.1 Model Validation & Sensitivity Analysis

Known USGS and IBWC gages within the model area with more than 20 years of flow record were used for validation of the 1-percent ACE. Peak flows within the model were compared with Bulletin 17C analyses of the gage data using HEC-SSP, Version 2.2. Results of the flow comparisons are presented in Table 2.11.

There are three USGS/IBWC gages in the Los Olmos Watershed. Of these gages, only one, 08464700, was used for calibration of the hydraulic model. USGS/IBWC gage 08461300 was not used for calibration due to its location directly downstream of one of the Outlet Works channels at the International Falcon Reservoir Dam. USGS/IBWC gage 08462500 was not used for calibration due to having a period of record of only 11 years after dam construction in 1968.

Table 2.11: 1-Percent Annual Chance Reasonability Comparisons

Flooding Source	USGS/IBWC Gage Used for Verification	HEC-RAS 6.1 (2D)		Gage Analysis	
		WSEL (ft)	Discharge (cfs)	WSEL (ft) ¹	Discharge (cfs)
Rio Grande	08464700	170.3	350,030	171.9	294,120

¹ Water surface elevation is approximate based on HEC-SSP input data and adjusted to NAVD 88 Datum.

To determine which factors were significantly impacting the model results, a sensitivity analysis was run to evaluate the impact of three specific parameters: hydrologic losses, computation interval, and boundary conditions. Further discussion of the roughness coefficients can be found in Section 2.2.4.1. It was determined that no areal reduction should be applied to the precipitation within the US but was applied to the subbasins within Mexico. Table 2.12 summarizes the results of each run at the USGS/IBWC gage.

Table 2.12: Sensitivity Analysis Results at USGS/IBWC Gage 08464700

Iteration	Manning's N Zones	Breaklines	Hydrologic Losses	Initial Conditions/ Computational Interval	Boundary Conditions	Peak Flow (cfs)	Peak Elevation (ft)
1	Original Land Use	Major Roads w/Centerlines Enforced - Simplified	Excess Precipitation, No AR ³	Dry / 1 min	Normal Depth	185,832	162.21
2	Original Land Use	Major Roads w/Centerlines Enforced - Simplified	Excess Precipitation, No AR in US, AR in MX, NHO ⁴	Dry / 30 sec	Normal Depth	362,710	170.34
3	Land Use with Shrub/Scrub 0.07	Major Roads w/Centerlines Enforced - Simplified	Excess Precipitation, No AR in US, AR in MX, NHO	Dry / 30 sec	Normal Depth	361,418	170.18
4	Land Use with Shrub/Scrub 0.07, Hay/Pasture 0.05, and Cultivated Crops 0.045	Major Roads w/Centerlines Enforced - Simplified	Excess Precipitation, No AR in US, AR in MX, NHO	Dry / 30 sec	Normal Depth	358,819	170.20
5	Original Land Use	Major Roads w/Centerlines Enforced - Simplified	Excess Precipitation, No AR in US, AR in MX, NHO	Dry / 30 sec, IFR Dam at 90% Gate Openings	Normal Depth	344,654	170.34
6 ¹	Original Land Use	Major Roads w/Centerlines Enforced - Simplified	Excess Precipitation, No AR in US, AR in MX, NHO	Dry / 30 sec, 90% Gate Openings w/ Updated MX and US Inflows	Normal Depth	350,030	170.34
					Gage Analysis:	294,120	171.89 ²

¹ Parameters from Iteration 6 were used for the final model, however additional computational mesh was implemented following the results of the sensitivity analysis.

² Water surface elevation is approximate based on HEC-SSP input data.

³AR – areal reduction

⁴NHO – no hydrologic overlap

2.3.2 Comparison to Existing Studies

The 2D base level engineering study of South Laguna Madre, located just downstream of Los Olmos, was completed in October 2021 (Compass PTS JV, “South Laguna Madre Watershed, Texas 2D Base Level Engineering Methods and Results”). This study used Rio Grande inflows into South Laguna Madre from the USIBWC-provided peak design flows which were based on the 1967 Hurricane Beulah event. This event resulted in a maximum discharge of 220,000 cfs at Rio Grande City and was determined to be 60 to 80 percent of the maximum probable precipitation, thus resulting in the adoption of a new design flow of 250,000 cfs at Rio Grande City. The USIBWC-provided flows were designated and approved in Minute No. 238 in September 1970 and were used directly in this study. No detailed hydrology was developed as part of this study. The South Laguna Madre study identified that additional detailed hydrologic study may update flood risk for the South Laguna Madre watershed.

Compared to the flows developed as part of the study presented herein, an estimated 1-percent ACE discharge of approximately 382,400 cfs is anticipated at the downstream end of the Los Olmos watershed. This is approximately 74% greater than the maximum discharge of 220,000 cfs (1-percent ACE) provided by the USIBWC. This is based on traditional hydrology for the contributing drainage area from Mexico which is approximately 45,615 square miles contributing to the Rio Grande. While our study flows produce a higher peak discharge, we are within the confidence band of the USGS Gage No. 08464700 – Rio Grande at Ft Ringgold, Rio Grande City, TX and are off from our 1-percent ACE gage analysis by 19%.

The differences in flows along the Rio Grande between this study and the South Laguna Madre BLE study can be attributed to the differences in methodology used to determine the flows, incorporation of Atlas 14 rainfall data, updated topographic data, dam operations, and international treaty agreements. Future considerations outside the scope of this BLE study for model refinement may include incorporating detailed hydrologic modeling, coordination with USIBWC, and incorporation of dam operation procedures. Further model refinement may reconcile the differences between the flows of these BLE studies, yielding smoother model tie-ins.

2.4 Challenges

Major challenges included a lack of peak streamflow records on the Mexico side of the HUC, though sufficient data was available in the US to provide confidence in the results.

The Mexico hydrology was established using best available soils and land use data as well as topographic information. Runoff estimates were not able to be validated for the Mexico hydrology.

Structures have not been added to the BLE model despite evidence of cross structures which allow the streams to convey water through numerous structures. In these locations, the model may be overestimating the water surface elevation upstream of the road until the road is overtopped and underestimating the water surface elevation downstream of the road.

HEC-RAS, Version 6.1, has an apparent bug that was identified in reviewing isolated areas of flooding. In these areas, the lower frequency events (ex. 10-percent) showed higher water surface elevations than the higher frequency events (ex. 0.2-percent). This was reviewed in multiple versions of HEC-RAS and was confirmed to occur in Version 5.7, 6.1 and 6.2. It is unknown why this may occur; however, the model does not experience instabilities and the mainstem floodplains have not shown this occurring when reviewing profile lines. In review of the model setup, stability and results, the flood extent results appear appropriate and impacts due to the bug are likely negligible.

HEC-RAS, Version 6.1 has a known error in the rain on mesh interpolation of flood depths between adjacent cells in the overbank area. This error produces artificially higher depths of flooding on the flood fringe referred to as cupping. Since this is a known issue in HEC-RAS and HEC is working on a solution, effort to remove these errors from the flood extents was not performed. Figure 2.12 below provides an example of cupping for reference. Once a solution is provided by HEC, it may be possible to update mapping to reduce and/or remove the cupping effects on the fringe of the floodplains.

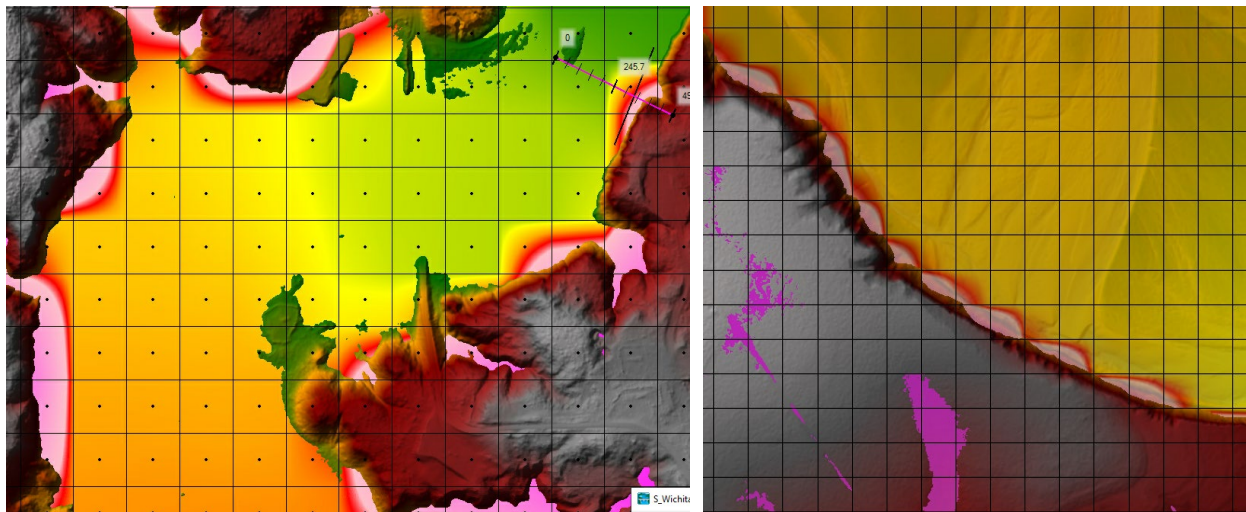


Figure 2.12: Cupping Examples

2.5 Recommendations

This study provides significant information useful for flood identification and communication among those affected. The study is highly scalable, and stakeholder input and further analysis would enhance the product and inform implementation of regulatory flood hazard areas. In addition, the validity of the 2D BLE results should be verified through community work map meetings before being applied as a regulatory product.

03 Floodplain Mapping and Effective Zone A Validation

The following sections provide a synopsis of how raw modeled depths were translated into SFHAs. In addition to developing a new SFHA, the BLE model data was leveraged to validate the effective zone A studies within the project footprint. The results of the validation effort can be found below in section 3.2.

3.1 Special Flood Hazard Area

3.1.1 Model Outputs

The floodplains are derived from the raw modeled depth grids using the maximum value. These depth grids are exported from HEC-RAS as TIFF format rasters with an interpolated rendering that slope values at the center and along the faces/edges of the computational mesh cells. Using GIS, the TIFF rasters are post processed into a 10-percent non-regulatory feature class, 1-percent ACE SFHAs, and 0.2-percent shaded X polygons.

3.1.2 Methodology

The use of 2D modeling methods results in water surface elevation values at every cell in the model's computational mesh. In order to represent the desired model results and eliminate extraneous disconnected cells, post processing of the depth grids is required. For the purposes of the Los Olmos BLE study, floodplain mapping delineation was completed using connected raster cells at the extent of the CNMS mapped and unmapped features in the project footprint. Converting the raster data to polygon features enabled an intersection of modeled results to the CNMS and effective zones to create the SFHA and 0.2-percent shaded X features. Because the new mapping, based on gridded engineering, retains the blocky shape of a raster, a simplification process was applied using GIS to smooth the boundaries using a 10-foot smoothing threshold. These processes remove unnecessary points, bends, and angles while preserving the natural shape of the polygon. Furthermore, small voids, or "holes" inside of the floodplain were aggregated with the larger surrounding polygons to merge them and make the floodplain complete. In alignment with the TWDB's 2D BLE Guidelines (May 2022) floodplain polygons were cleaned against the criteria provided below in Table 3.1 which provides thresholds for mapping removal based on depth and area of flood risk.

Table 3.1: Mapping Threshold Matrix

Area (ac)	Depth (ft)
< 0.33	-
0.33 - 0.5	< 0.33
0.5 - 1.0	< 0.25
1.0 - 2.0	<0.1

For example, if flooding polygons were disconnected from a flooding source and less than two acres in area and 0.1 feet of depth, the polygon was removed from the SFHA. These edits align to the mapping standards adopted by the TWDB and those required by FEMA.

In addition to the SFHA, all other flooding associated with the 1- and 0.2-percent raw results were retained as "on the shelf" data that may be leveraged for future needs and analysis. This information is available in the included Supplemental Data associated with this study.

3.1.3 Flood Hazard Area Layer

Special Flood Hazard Areas (SFHA), as noted above, were developed to at least the extent of the CNMS features and up to 1 square mile drainage area and effective zone A study locations. The Regional CNMS database, National Flood Hazard Layer, and paper inventory were used as reference data to ensure extent of the BLE results represents appropriate current flooding extent coverage, at a minimum.

The 0.2-percent flood areas were produced using the same methods as the 1-percent SFHA. After both layers were developed, a union of the two products was performed to develop the deliverable format EBF_E_FLD_HAZ_AR.

3.1.4 Mapping Considerations

3.1.4.1 Ponds

Numerous ponds exist throughout the Los Olmos Watershed. Due to the nature of 2D BLE and the large mesh cells used for modeling, the entire extent of smaller, isolated ponding areas is not always fully mapped in the raw model output. To identify flood risk in these areas, the pond footprints were merged in by automated processes using the best available National Hydrography Dataset. This dataset has its own limitations in that it is not current to current topography or LiDAR and may not align completely to the present-day pond footprints. However, it was used as the best available at the time of the study. A nominal depth of 0.1-foot was used for any areas merged into the floodplain that were not in the raw model results and the water surface elevation was interpolated. The water surface elevations in these areas should not be considered correct and would require further study to refine the correct water surface elevation based on detailed modeling.

3.1.4.2 Mapping Tie-Ins

As discussed in Section 2.3.2, a significant tie-in occurs between the Los Olmos and South Laguna Madre watersheds. Due to modeling differences between the two studies, a reasonable tie-in was not feasible. Future model refinement may reconcile the differences between the flows of the two BLE studies, yielding smoother model tie-ins.

Minor fringe watershed tie-ins to adjacent HUCs were checked to ensure they met the 0.5-foot tie-in requirement. These areas were modeled using overlapping meshes between adjacent HUCs and then clipped to the USGS HUC boundaries. These HUC boundaries resulted in minor discrepancies in the mapping extent and water surface elevations, however, no differences exceeded the 0.5-foot mapping tolerance.

3.1.4.3 Centerline Alignment

After completion of the FLD_HAZ_AR, the S_WTR_LNs (centerlines) were reviewed for containment within the 1-percent ACE floodplain. Any centerlines that were 50 feet or greater in length outside of the 1-percent floodplain extent were realigned for containment.

3.2 Validation of Effective Zone A SFHA

The following summarizes the results of the CNMS validation assessments for the effective Zone A studies in the Los Olmos Watershed.

3.2.1 Initial Assessment A1 – Significant Topography Update Check

The significant topography update check determines whether a topographic data source is available that is significantly better than what was used for the effective Zone A modeling and mapping. For this study of the Los Olmos Watershed the topographic data source for the BLE analysis was derived from the best available LiDAR data, as discussed in Section 2.1. This elevation data provides quality LiDAR data coverage for the entire study area, therefore, this check is set to PASS.

3.2.2 Initial Assessment A2 – Check for Significant Hydrology Changes

The significant hydrology changes check determines whether new regression equations have become available from the USGS since the date of the effective Zone A study. If newer regression equations exist for the area of interest, then an engineer must determine whether these regression equations would significantly affect the 1-percent ACE flow. It is unknown if regression methods were used in the effective studies, therefore, this element was set to FAIL for newly added streams and left PASS if already attributed as such in previous CNMS.

3.2.3 Initial Assessment A3 – Check for Significant Development

The significant development check, using the National Urban Change Indicator (NUCI) dataset, assesses increased urbanization in the study watershed. If the percentage of urban area within a HUC-12 watershed containing the effective Zone A study is 15 percent or more and has increased by 50 percent or more since the effective analysis, the study would fail this check. The check for significant development in the Los Olmos Watershed was completed by evaluating percentage of urban change at the HUC-12 level. The entire watershed is classified as rural and all reaches were set to PASS for this assessment.

Table 3.2 presents the summarized results of checks A1 through A3.

Table 3.2: A1-A3 Validation Results

Assessment Checks	Pass / Fail	Notes
A1 – Topography	Pass	LiDAR significantly better than effective USGS topo source/Effective mapping leveraged LiDAR data.
A2 – Hydrology	Pass/Fail	Effective hydrology methods are unknown
A3- Development	Pass	Less than 15% of study area is under urban cover/>50% increase in urban area in an urban HUC-12

3.2.4 Validation Check A4 – Check of Studies Backed by Technical Data

Zone A studies that pass all initial assessment checks described above may be categorized as “Valid” in the CNMS Inventory only if the effective Zone A study is supported by modeling or sound engineering judgment and all regulatory products are in agreement. If the effective Zone A study passes all initial assessment checks, but is not supported by modeling, or if the original engineering method used is unsupported or undocumented, a comparison of the BLE results and effective Zone A’s is performed. Due to lack of documentation of the original engineering methods in the Los Olmos Watershed, check A4 has been marked as FAIL for most parts of this study and left as PASS if it was already identified as such in previous CNMS.

3.2.5 Validation Check A5 – Comparison of BLE and Effective Zone A

The effective Zone A comparison was performed at the full extent of the Los Olmos Watershed. The validation of the effective Zone A boundaries using 2D flood hazard products differ from the standard 1D methods due to the lack of cross sections and their use with standard FBS methodology. For this 2D study, the effective A zone boundaries were compiled using the National Flood Hazard Layer and Core Logic effective digital uplift product. These data were dissolved to one continuous A-zone layer, which then had test points placed along its perimeter every 200 feet.

For each test point, a 75-foot buffer was created. Using this buffer, the minimum and maximum values of the DEM were extracted, as a proxy for the effective base flood elevation. The minimum value of the 1% minus raster, and the maximum value of the 1% plus raster are also extracted. These 1% plus maximum and 1% minus minimum values are products of the new 2D BLE study and act as the vertical tolerance. The test point passes if the DEM maximum value is less than or equal to the 1% plus maximum value and the DEM minimum value is greater than or equal to the 1% minus minimum value. This can be visualized as a short 75-foot radius cylinder, with a height of 1% plus maximum – 1% minus minimum. This test verifies that at least one point from the ground surface (i.e. proxy BFE) falls both vertically and horizontally within this range.

3.2.6 Validation Results

All 849.5 total miles of available CNMS features representing the effective Zone A studies were categorized as shown in Table 3.3 and illustrated in Figure 3.1 below. Table 3.4 summarizes the validation results based on the individual HUC 12 watersheds within Los Olmos Watershed.

Table 3.3: Aggregated Zone A Validation Results

Validation Status	Status Type	Total Miles
VALID	BEING STUDIED	0
UNVERIFIED	BEING STUDIED	849.5

Table 3.4: HUC-12 Zone A Validation Results

HUC-12 Watershed		Total FBS Points	Fail	Pass	%Pass	BLE Comparison Pass? (>85%)
Watershed Name	Watershed Number					
Arroyo Morteros-Rio Grande	130900011102	1,752	801	951	54.3	FAIL
Arroyo la Minta	130900011103	2,811	732	2,079	74.0	FAIL
Ramirez Creek-Rio Grande	130900011107	1,338	655	683	51.0	FAIL
Arroyo Garceno-Arroyo Grande	130900011108	2,993	732	2,261	75.5	FAIL
Arroyo Morenos-Rio Grande	130900011109	1,401	485	916	65.4	FAIL
Arroyo Quiote	130900011110	1,335	255	1,080	80.9	FAIL
Kelsey Lake-Rio Grande	130900011112	1,247	489	758	60.8	FAIL
Upper Remadura de Sandia Creek	130900011201	491	261	230	46.8	FAIL
Middle Remadura de Sandia Creek	130900011202	1,368	467	901	65.9	FAIL
Lower Remadura de Sandia Creek	130900011203	1,210	564	646	53.4	FAIL
Canda Honda	130900011204	1,349	294	1,055	78.2	FAIL
Upper Las Escobas Creek	130900011301	2,124	961	1,163	54.8	FAIL
Del Puerto Creek-El Chapote Creek	130900011302	1,474	599	875	59.4	FAIL
Lower Las Escobas Creek	130900011303	748	297	451	60.3	FAIL
EL Sauz Creek	130900011304	933	533	400	42.9	FAIL
El Negro Ranch	130900011401	895	435	460	51.4	FAIL
El Leoncito Tank	130900011402	754	535	219	29.0	FAIL
Las Blancas Creek	130900011403	1,542	601	941	61.0	FAIL
Lake Kimberly-Los Olmos Creek	130900011501	1,686	799	887	52.6	FAIL
Rio Grande City-Los Olmos Creek	130900011502	1,777	747	1,030	58.0	FAIL
Olmitos Creek-Rio Grande	130900011601	1,503	707	796	53.0	FAIL
Headwaters Garcias Creek	130900011603	1,377	660	717	52.1	FAIL
Boyle Oil Field	130900011604	923	209	714	77.4	FAIL
Barbacoas Oil Field-Garcias Creek	130900011605	1,062	345	717	67.5	FAIL
Salado Creek	130900011606	731	200	531	72.6	FAIL
Garcias Creek-Rio Grande	130900011607	1,062	530	532	50.1	FAIL
Hinde Oil Field	130900011701	437	321	116	26.5	FAIL
Upper La Joya Creek	130900011702	709	265	444	62.6	FAIL
Town of Rincon	130900011703	596	200	396	66.4	FAIL
Middle La Joya Creek	130900011704	1,203	631	572	47.5	FAIL
Lower La Joya Creek	130900011705	1,442	554	888	61.6	FAIL
La Burrita Creek-Rio Grande	130900011706	982	281	701	71.4	FAIL

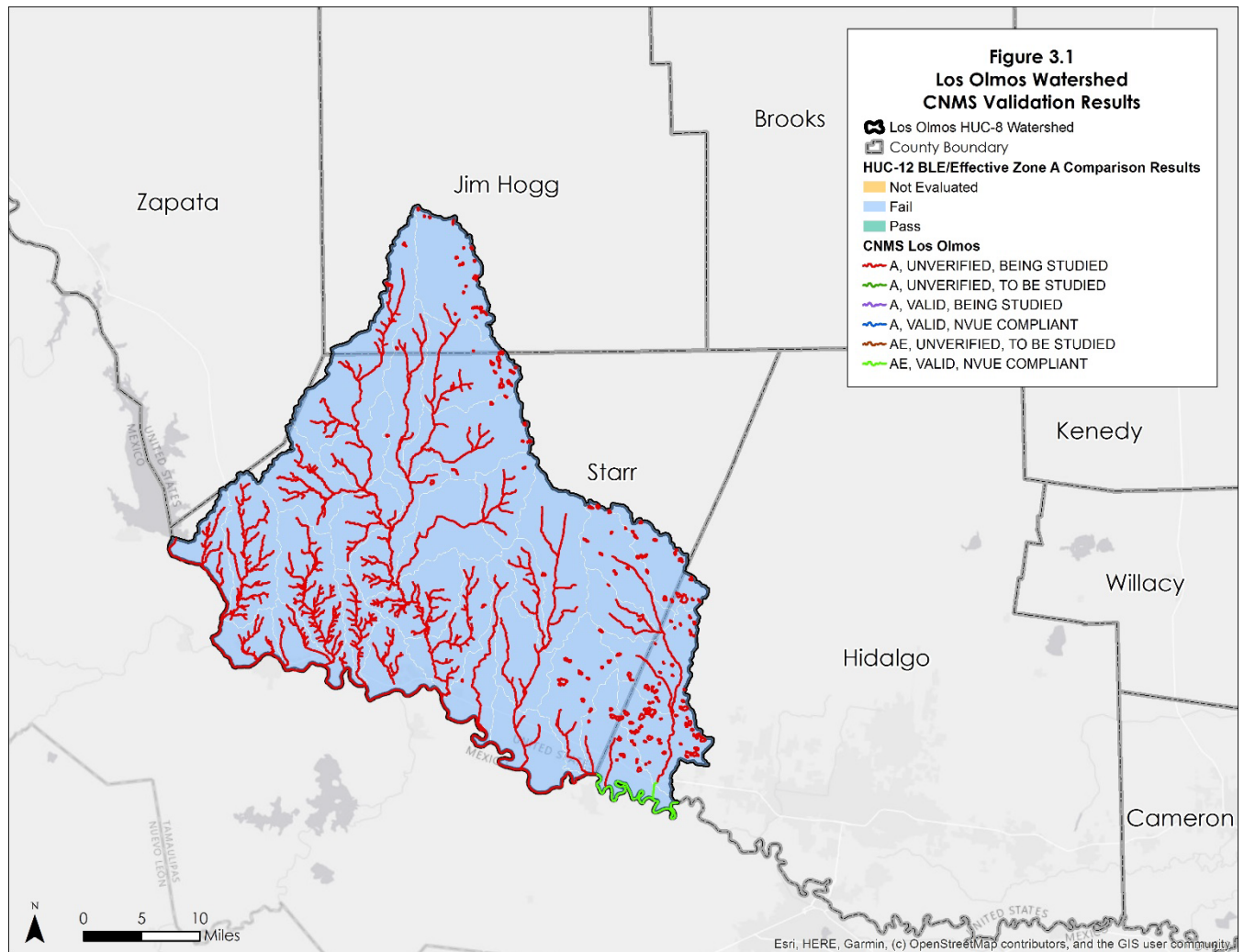


Figure 3.1: Los Olmos Watershed CNMS Validation Results

3.3 Flood Risk Analysis

A flood risk analysis was performed for this project. The updated 1-percent ACE depth grid was used to calculate the potential flood losses. The loss results are stored in the S_FRAC_AR spatial file within the FRD geodatabase. All results are reported in whole dollar values.

Hazus Version 5.1 (SP02) was used for the basic and refined loss analysis.

The losses are reported via census blocks. It is important to note that Hazus Version 5.1 (SP02) uses dasymetric census blocks. Dasymetric mapping removes undeveloped areas (such as areas covered by bodies of water, wetlands, or forests) from the census blocks, changing their shape and reducing their size in these areas. For more information on dasymetric data visit FEMA's Media Library for the Hazus-MH Data Inventories: Dasymetric vs. Homogenous, or Hazus 3.0 Dasymetric Data Overview.

Hazus analysis was performed by county within the project watershed extents for the 1-percent return period to ensure proper model processing. A summary of results per county for the 1-percent ACE scenario is shown in Table 3.5.

Table 3.5: Hazus 5.1 (SP02) Results for 1-percent-annual-chance (100 year) scenario for Los Olmos Watershed, Texas

County	Full Replacement – Total Loss	Dollar Exposure (Replacement Value) - Buildings	Dollar Exposure (Replacement Value) - Contents
Hidalgo	\$192,580,000.00	\$559,007,000.00	\$367,302,000.00
Jim Hogg	\$19,000.00	\$3,286,000.00	\$2,110,000.00
Starr	\$910,901,000.00	\$2,789,879,000.00	\$1,590,056,000.00
Zapata	-	\$232,000.00	\$116,000.00
Total	\$1,103,500,000.00	\$3,352,404,000.00	\$1,959,584,000.00

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