

Appendix 5A

Hydrologic and Hydraulic Analysis of Project Specific FMSs

Appendix 5A. Project-Specific Evaluation Methodology for FMSs

This appendix explains sources of hydrologic and hydraulic models, mapping, and other information utilized to estimate pre-project and post-project benefits for specific FMSs evaluated in the RFP. Evaluations of all potential FMEs and most potentially feasible FMSs were performed at a reconnaissance or screening-level, unsupported by associated detailed hydrologic and hydraulic analyses. The exceptions were the following three FMSs which had specified hydrologic, hydraulic, and/or mapping information available which could be used to estimate proposed FMS benefits:

- FMS ID: 142000001, FEMA Levee Accreditation for All Rio Grande Levees at El Paso (see **Exhibit Map 21.01**)
 - Sufficient hydrologic and hydraulic models and mapping available
 - Hydrologic Model ID: 140000000011 (Preliminary FEMA)
 - Hydraulic Model IDs: 140000000001 (Preliminary FEMA) and 140000000003 through 140000000010 (El Paso County Interior Drainage 2021)
- FMS ID: 142000004, Coordination with Ft. Bliss for FMP Permitting and Maintenance Access (see **Exhibit Map 21.04**)
 - Sufficient hydrologic and hydraulic models and mapping available
 - Hydrologic Model IDs: 140000000011 (Preliminary FEMA) and 140000000019 [El Paso County Stormwater Master Plan (SWMP), Montana Sector]
 - Hydraulic Model ID: 140000000001 (Preliminary FEMA) and 140000000020 (El Paso County SWMP, Montana Sector)
- FMS ID: 142000008, Develop Certification Package for Cibolo Creek Channel and Levee (see **Exhibit Map 21.08**)
 - Sufficient mapping available
 - Existing conditions – RFP 1% annual chance flood risk boundary (*see Chapter 2, Flood Risk Analyses*)
 - Proposed conditions – Fathom 1% annual chance flood risk boundary (Model ID: 140000000038)

Individual mapbook figures displaying zoomed-in project locations and existing downstream flood risk areas are provided as part of **Exhibit Map 21** (see specified mapbook figure numbers listed above for each FMS). In addition, **Exhibit Map 22** shows a region-wide map of hydrologic and hydraulic model coverage extents, with coverage areas displayed according to the last two digits of the corresponding Model IDs.

Each of these three FMSs were analyzed to estimate potential flood benefits as well as demonstrate no negative impacts on neighboring areas. Methods and assumptions related to these detailed evaluations are provided in this appendix, along with discussion on the remaining FMSs which were not evaluated for 1% annual chance flood benefits.

5A-1. Mapping Analysis for FMS ID: 142000001

The RFPG has a short-term goal to accredit all levees in El Paso County by 2033 (Goal ID: 14004001). This FMS is associated with achieving that goal. Currently, only one Rio Grande levee is accredited by FEMA, extending through Central and East El Paso. All other existing levees are assumed to not be present in the 2019 Preliminary FEMA 1% annual chance mapping in El Paso County, based upon FEMA regulations. This mapping was also utilized in the RFP as it is a TWDB requirement to assume levees that are not accredited by FEMA are not present in RFP flood risk mapping.

Interior drainage studies are a requirement to certify and accredit levees with FEMA, which would remove areas protected by those accredited levees from the regulatory floodplain. An interior drainage study consists of hydrologic and hydraulic mapping performed to estimate 1% annual chance flood risk on the landward side of a levee. If a FEMA levee is accredited, FEMA will utilize results from the interior drainage analysis and mapping to establish regulatory flood risk inundation boundaries on the landward side of the levee.

Data Sources and FMS Extent

In locations where the levees are assumed not to be present, results from a natural valley flood analysis (2D hydraulic model, FLO-2D software) were utilized by FEMA to develop preliminary regulatory floodplain mapping extents as well as 1% annual chance depth and water surface grids. The National Levee Database, maintained by USACE, includes service area boundaries which can be downloaded as ArcMap (ESRI) GIS shp files for specific levees, where available. These service area boundaries represent locations where areas are protected from flooding due to existing levees.

The FMS boundary shown in **Exhibit Map 21.01** was derived for the RFP, using engineering judgment, to estimate areas at risk from a failure of the existing levees along the Rio Grande which affect flooding in El Paso and are not accredited by FEMA. The two primary flood extents utilized to develop this boundary were the 1% annual chance flood extents from the El Paso County Natural Valley Analysis Pre-LAMP Report (Study ID 41 in Appendix Table 1D from *Chapter 1*), and the service area boundaries for the Rio Grande levees through El Paso County, downloaded from the National Levee Database website.

Pre- and Post- Project Risk Analyses

Original source models were not modified as part of the analysis for this FMS. To estimate existing conditions for this FMS, 1% annual chance inundation extent boundaries and water surface elevation rasters resulting from the hydrologic and hydraulic models associated with the 2019 Preliminary FEMA Mapping study for El Paso County (Model IDs 140000000001 and 140000000011 from Table 2.1 in *Chapter 2*) were utilized. To estimate proposed conditions for this FMS, 1% annual chance inundation extent boundaries and water surface elevation rasters resulting from the hydrologic and hydraulic models developed as part of the 2021 El Paso

County Interior Drainage Study (Model IDs 140000000003 through 140000000010 in Table 2.1 from *Chapter 2*) were utilized.

Pre- and post-project water surface elevations intersecting building footprints within the FMS extent were compared to estimated finished floor elevations, which were assumed to be 0.5 ft higher than the average ground elevation from the terrain used in the Preliminary FEMA models. Structures at risk were assumed for buildings with finished floor elevations lower than pre- or post-project water surface elevations. No flood benefits were assumed for the 0.2% annual chance flood event, since levee accreditation does not require analysis of the 0.2% annual chance flooding.

No Negative Impact Analyses

The potential for this FMS to negatively impact neighboring areas depends upon specific requirements needed for individual levee segments to meet FEMA certification standards. For levee segments which have already been constructed to FEMA standards, but which lack continuous interior drainage studies along the entire levee segment, there are no additional proposed flood infrastructure improvements associated with this FMS. The benefits of accrediting those levee segments are associated with updated flood risk mapping only; therefore, an impact analysis is not required to confirm that this FMS would not negatively impact neighboring areas.

For levee segments which may require various infrastructure improvements to be certified by project sponsors and accredited by FEMA, the necessary improvements should be identified early in the scope of work associated with performing this FMS. Any potential negative flood impacts associated with proposed levee improvements or the construction process for levee improvements, which may be needed to certify existing levees, should be identified by project sponsors early in the design phases of each specific levee project.

5A-2. Modeling and Mapping Analysis for FMS ID: 142000004

This FMS is primarily associated with facilitating coordination between El Paso Water and the U.S. Army to allow for necessary access on Fort Bliss property to maintain two existing dams (Fusselman and Northgate) by removing sediment regularly, and to eventually perform final design and construct two proposed sediment/detention basins. The two proposed basins are NE7 from the El Paso Water SWMP (Study ID: 13) and MON1 from the El Paso County SWMP (Study ID: 26).

Data Sources and FMS Extent

Existing dams and proposed basin areas are identified in **Exhibit Map 21.04**, along with existing downstream areas at risk of 1% annual chance flooding (shown in purple). The flood risk areas downstream of Northgate and Fusselman dams, as well as downstream of the proposed NE7 basin were delineated based upon 2019 Preliminary FEMA 1% annual chance flood extents. Proposed conditions were not modeled for the existing dams since the amount of sediment to be removed and additional storage volume which may become available is unknown at this time. Proposed conditions were not modeled for NE7 because hydrologic and hydraulic models were not available for this proposed project.

Pre-project and post-project conditions for the area associated with the proposed basin, MON1 were mapped based on a hydrologic HEC-HMS model and a 2D hydraulic HEC-RAS model developed for the MON1 project as part of the 2021 El Paso County SWMP (Study ID: 26). The source models were set up with outflow hydrographs from the existing conditions HEC-HMS hydrologic model applied to the proposed 2D hydraulic model terrain in selected locations toward the downstream end of each contributing watershed. As part of the RFP, the existing condition HEC-HMS hydrographs were re-applied to the 2D hydraulic HEC-RAS model to ensure that the latest hydrologic model output hydrographs are consistent with the hydraulic model inputs. The proposed condition model was not modified as part of the RFP.

Pre- and Post- Project Risk Analyses

The 2019 Preliminary FEMA 1% annual chance water surface elevation grids were compared to finished floor elevations to estimate pre- and post-project conditions for the two existing dams and proposed basin NE7.

The post-project conditions hydraulic model obtained from the El Paso County SWMP assumes that all 1% annual chance flood risk upstream of the proposed basin is detained by the basin, resulting in no flow being discharged directly downstream of the proposed basin. All other subbasins affecting discharge downstream of the project, which are applied in the existing conditions model, are still applied in the proposed conditions hydraulic model. Pre- and post-project water surface elevation grids from the MON1 analysis were exported from the 2D hydraulic model results and compared to finished floor elevations of buildings within building footprint areas to estimate structures at risk.

Since proposed conditions were not modeled for the two existing dams or proposed NE7 basin, there were no structures downstream of these project areas anticipated to be removed from 1% annual chance flooding as part of the FMS risk analyses. However, downstream structures

with finished floor elevations impacted by 1% annual chance water surface elevations are anticipated to have reduced flood risk, due to the creation of additional flood storage volume upstream. Therefore, these structures were included, along with structures measured to be benefited by the MON1 project, in the reported number of structures with reduced 1% annual chance flood risk in the FMS evaluation table shown in **Appendix 4F**. There were no benefits assumed for the 0.2% annual chance flood.

No Negative Impact Analyses

While proposed condition modeling was not performed for the proposed maintenance of the two existing dams (Northgate and Fusselman) or for the proposed NE7 basin, results of the MON1 analysis showed that post-project downstream water surface elevations are lower than or equal to pre-project water surface elevations. Similar positive benefits would be expected if the two existing dams were maintained by clearing out sediment (because more storage volume would be available), and if the proposed basin NE7 were constructed (it would capture and detain runoff, reducing flows downstream). Therefore, there are no negative impacts estimated for this FMS.

5A-3. Mapping Analysis for FMS ID: 142000008

The RFPG has a long-term goal of accrediting all levees in Region 14 by 2053 (Goal ID: 14004002). In alignment with that goal, this FMS is associated with accrediting the “Presidio, TX, Cibolo Creek Left Levee” as identified in the National Levee Database, maintained by USACE. The extent of the FMS study area is shown on **Exhibit Map 21.08**.

Data Sources and FMS Extent

The National Levee Database includes a service area boundary for this levee, which can be downloaded as an ArcMap (ESRI) GIS shp file. The National Levee Database service area boundary was used as the FMS extent, and represents the area protected from flooding due to the existing Cibolo Creek levee. The 1% annual chance risk boundary developed for the RFP in this location includes a merged inundation extent consisting of the 1% annual chance Fathom flood risk boundary combined with the FAFDS boundary, which assumes the unaccredited Cibolo Creek levees are not in place. This mapping was utilized in the RFP flood risk layer because it is a TWDB requirement to assume levees that are not accredited by FEMA are not present in RFP flood risk mapping.

Interior drainage studies are a requirement to certify and accredit levees with FEMA. The certification and accreditation of a levee would remove areas protected by those accredited levees from the regulatory floodplain. An interior drainage study consists of hydrologic and hydraulic mapping performed to estimate 1% annual chance flood risk on the landward side of a levee. If a FEMA levee is accredited, FEMA will utilize results from the interior drainage analysis and mapping to establish regulatory flood risk inundation boundaries on the landward side of the levee.

An associated FME, to be completed prior to this FMS, is the development of hydrologic and hydraulic models for Cibolo Creek and interior drainage as part of the SWMP for the City of Presidio (FME ID: 141000002). It is expected this interior drainage analysis would be relatively straight forward, since topography does not drain toward the Cibolo Creek levee, but rather, it drains south, toward the Rio Grande. Therefore, significant ponding against the levee from the landward side is not anticipated.

Pre- and Post- Project Risk Analyses

The developers of the Fathom flood risk boundaries were interviewed as part of the regional flood planning process to understand assumptions and modeling methods related to levees in the 2D hydrologic and hydraulic modeling and mapping software. According to the Fathom modelers/developers, the assumptions related to levee protection in the software are consistent with flood protection service areas and information regarding frequency of overtopping included in the National Levee Database (which gets updated periodically as new information becomes available). If the information is not available for a specific levee, the model and mapping results are based upon the quality and resolution of the terrain used in that area, which may or may not capture the continuous raised ground elevations associated with a levee, depending on the height and extent of the levee.

Where the information is available, a National Levee Database field named, “Incipient Overtopping Annual Exceedance Probability (AEP)” specifies the frequency of flood event

contained by a levee before it is overtopped. For the Cibolo Creek Left and Right levees, the National Levee Database specifies this AEP as 0.001 (or the 1,000-year return period). Based on the information provided, it is assumed that the Fathom risk layer incorporates levee protection from the 1% annual chance Cibolo Creek riverine flooding within the associated service area obtained from the National Levee Database. Inspection of the Fathom 1% annual chance flood risk layer in this area (shown in purple on **Exhibit Map 21.08**) demonstrates that minimal flood extents are inundated within the FMS extent, which is consistent with the assumptions communicated to the RFPG by the Fathom modelers/developers.

Therefore, to estimate post-project flood risk, it was estimated that the building polygons that intersect the Fathom 1% annual chance risk boundary within the National Levee Database service area are approximately the same number of buildings that would remain in the 1% annual chance flood risk area if a detailed interior drainage analysis were performed, and the levee was accredited by FEMA.

Furthermore, since the RFP 1% annual chance flood risk boundary does not consider the left or right Cibolo Creek levees to be in place, the pre-project flood risk boundary for this FMS was assumed to match the RFP flood risk boundary within the study limits of the National Levee Database service area for the levee. Pre-project flood risk was then estimated by performing a spatial analysis in ArcMap (ESRI) to intersect the building footprint polygons and road layers, documented in *Chapter 2*, with the RFP 1% annual chance flood risk boundary. There were no benefits assumed for the 0.2% annual chance event, due to the high level of uncertainty associated with the capacity and performance of the Cibolo Creek levees relative to the 0.2% annual chance flood.

No Negative Impact Analyses

The potential for this FMS to negatively impact neighboring areas depends upon specific requirements that must be met for the levee segment to meet FEMA certification standards. If the existing left Cibolo Creek levee is already constructed to FEMA certification standards, there would be no proposed flood infrastructure improvements associated with this FMS. The levee accreditation benefits would be associated with updated flood risk mapping only, and an impact analysis would not be required to confirm that the FMS does not negatively impact neighboring areas.

If various infrastructure improvements are required for the levee segment to be certified by project sponsors and accredited by FEMA, the necessary improvements should be identified early in the scope of work associated with performing this FMS. Any potential negative flood impacts associated with proposed levee improvements or the construction process for levee improvements, which may be needed to certify existing levees, should be identified by project sponsors early in the design phases of each specific levee project.

5A-4. FMSs not analyzed for flood risk benefits

The only other FMSs involving potential infrastructure improvements are FMS IDs: 142000002 and 142000003 (discussed in the following subsections), which both involve more conceptual level planning before specific flood benefits can be quantified. The remaining FMSs are non-structural strategies involving early warning systems with recurring costs, developing regulatory standards to be applied by multiple entities, complex stakeholder coordination, or other associated FMEs, FMSs, or FMPs required to be completed prior to implementation. Since these FMSs are not estimated to have a direct effect on 1% annual chance flooding due to the nature of the FMS or the early conceptual phase, no flood benefits are reported, and it is estimated there will be no negative impacts to neighboring areas.

Discussion of FMS ID: 142000002

FMS ID: 142000002 (Irrigation and Recharge Application of Captured Rainwater Runoff at Alpine) involves landscaping design and minor street runoff diversions into rainwater harvesting catchment areas in Kokernot Park in the City of Alpine. Hydrologic calculations were performed as a donation from project supporters to quantify annual water supply benefits (discussed in *Chapter 6*). However, hydrologic and hydraulic models were not available, nor were spatial files defining specific watersheds or project components. This project was selected for evaluation as a strategy since it includes multiple project locations and phases, with some portions already constructed, and others still in need of funding and design.

The strategy is primarily associated with water quality benefits and groundwater infiltration, since the proposed curb cut openings for roadway runoff diversions would only have the capacity to divert very high frequency/low intensity rain events, such as the 50% annual chance event. Since, this strategy is supported by volunteers, including the City of Alpine Street Department, who are in favor of diverting local street runoff into the City park for landscaping and infiltration purposes, this strategy was not evaluated for 1% annual chance flood risk benefits, and it is estimated to cause no negative impacts on neighboring areas.

Discussion of FMS ID: 142000003

FMS ID: 142000003 includes implementing a colonia-wide drainage system and maintenance and outreach program for roadside swales and driveway culverts at Fort Hancock. However, it first requires associated FME ID: 141000014, to be performed, which includes a SWMP for Fort Hancock. The designs developed as part of the SWMP would be used to implement this strategy in a second phase. This strategy also involves a public education and outreach component to inform residents of the importance of maintaining drainage systems. This outreach component of the strategy has a recurring cost. Since the FME ID: 141000014 is required before any proposed designs can be conceptualized, this FMS was not analyzed for flood risk benefits, and it is estimated to cause no negative impacts on neighboring areas.