Appendix 5B
Evaluation Methodology for FMPs

Appendix 5B. Project-Specific Evaluation Methodology for FMPs

This appendix explains sources of hydrologic and hydraulic models, mapping, and other information utilized to estimate pre-project and post-project benefits for specific FMPs evaluated in the Regional Flood Plan (RFP). Each of these Flood Mitigation Projects (FMPs) were analyzed to estimate potential flood benefits as well as demonstrate no negative impacts on neighboring areas. Methods and assumptions related to these evaluations are discussed for each FMP in the following sections.

5B-1. Modeling and Mapping Analysis for FMPs involving Detention/Retention Basins

Four of the FMPs discussed in this section are from the 2021 El Paso County SWMP, while the other two (EA10A and EA9A) are from the El Paso Water SWMP/Americas Ten Dam Study. All of the FMPs in this group of FMPs were modeled with HEC-HMS point discharge hydrographs applied to HEC-RAS 2D Hydraulic models. The first five projects listed below were prioritized and selected for evaluation by the Regional Flood Planning Group (RFPG) using the process for identifying potentially feasible FMPs, documented in *Chapter 4, Identification of Flood Mitigation Needs and Solutions*. The proposed EA9A project was later added to the list of evaluated FMPs by the RFPG, since it was adjacent to EA10A, it was included in the same Americas Ten Study hydrologic and hydraulic models, and it was also included in the El Paso Water SWMP. See the list of evaluated storage basin FMPs below, with corresponding Model IDs from *Chapter 2, Flood Risk Analyses*:

- **FMP ID: 143000011**, SSA4 – Proposed detention basin with sufficient hydrologic and hydraulic models and mapping available (see **Exhibit Map 20.11**)
  - Hydrologic Model ID: 140000000016 (Original Source: El Paso County SWMP)
  - Hydraulic Model ID: 140000000015 (Original Source: El Paso County SWMP)
- **FMP ID: 143000021**, SOC4 – Proposed sediment/detention basin with sufficient hydrologic and hydraulic models and mapping available (see **Exhibit Map 20.21**)
  - Hydrologic Model ID: 140000000017 (Original Source: El Paso County SWMP)
  - Hydraulic Model ID: 140000000018 (Original Source: El Paso County SWMP)
- **FMP ID: 143000024**, MON3 – Proposed sediment/retention basin with sufficient hydrologic and hydraulic models and mapping available (see **Exhibit Map 20.24**)
  - Hydrologic Model ID: 140000000019 (Original Source: El Paso County SWMP)
  - Hydraulic Model ID: 140000000020 (Original Source: El Paso County SWMP)
- **FMP ID: 143000025**, HAC3 – Proposed sediment/retention basin with sufficient hydrologic and hydraulic models and mapping available (see **Exhibit Map 20.25**)
  - Hydrologic Model ID: 140000000021 (Original Source: El Paso County SWMP)
  - Hydraulic Model ID: 140000000022 (Original Source: El Paso County SWMP)
- **FMP ID: 143000105**, EA10A – Proposed sediment/detention basin with sufficient hydrologic and hydraulic models and mapping available (see **Exhibit Map 20.105**)

  - Hydrologic Model ID: 140000000029 (Original Source: Americas Ten Study)
  - Hydraulic Model ID: 140000000028 (Original Source: Americas Ten Study)
- **FMP ID: 143000116**, EA9A – Proposed sediment/detention basin with sufficient hydrologic and hydraulic models and mapping available (see **Exhibit Map 20.116**)
  - Hydrologic Model ID: 140000000029 (Original Source: Americas Ten Study)
  - Hydraulic Model ID: 140000000028 (Original Source: Americas Ten Study)

Data Sources and FMP Extents

Individual mapbook figures displaying zoomed-in project locations and existing downstream flood risk areas are provided as part of **Exhibit Map 20** (see specified mapbook figure numbers listed above for each FMP). 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.

Pre-project and post-project conditions for the areas associated with the six proposed basins listed above were mapped based on the hydrologic HEC-HMS models and a 2D hydraulic HEC-RAS models listed above. Four of these project area models were originally developed as part of the 2021 El Paso County Interior Drainage Study and the other two (EA10A and EA9A) were developed as part of an unpublished feasibility study recently performed by AECOM for El Paso Water (2021). The proposed EA10A and EA9A sediment/detention basins were also included in the El Paso Water SWMP for the City of El Paso (2021).

All original models obtained were modified for the purposes of the RFP. The source models were set up with outflow hydrographs from the existing conditions HEC-HMS hydrologic models applied to the corresponding proposed 2D hydraulic model terrains in selected locations toward the downstream end of each contributing watershed. As part of the RFP, the existing and proposed condition HEC-HMS hydrographs were re-applied to the 2D hydraulic HEC-RAS models with modifications for the purposes of the RFP analysis, and to ensure that the latest hydrologic model output hydrographs are consistent with the hydraulic model inputs.

Pre- and Post- Project 1% Annual Chance Risk Analyses

The original post-project conditions hydraulic models obtained from the specified sources assume that all 1% annual chance flood risk upstream of the proposed basins are detained by the basin, resulting in no flow being discharged directly downstream of each proposed basin. All other subbasins affecting discharge downstream of the project, which are applied in the existing conditions models, are still applied in the proposed conditions hydraulic models. Pre- and post-project water surface elevation grids from the FMP analyses 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.

Pre- and Post- Project 0.2% Annual Chance Risk Analyses

The 0.2% annual chance events were not modeled as part of the original studies. Since this event is required for FMP evaluations in the RFP, meteorological models were added to the existing and proposed HEC-HMS hydrologic models for each project area. The 0.2% annual

chance rainfall parameters from the same data source locations as the 1% annual chance rainfall were utilized for the pre- and post-project hydrologic and hydraulic analyses.

Diversions were set up in each applicable FMP proposed condition hydrologic models to divert all upstream runoff from the 0.2% annual chance event into a sink until the total inflow volume reached the capacity of each detention/retention structure. All excess runoff beyond the reported capacity of each structure was discharged downstream. The resulting discharge hydrograph was applied to the corresponding post-project 2D hydraulic model immediately downstream of each proposed structure.

Pre- and post- project water surface elevations were compared at downstream structures at risk to measure reductions in 0.2% annual chance flood risk. This approach assumed no outflow through a principal or auxiliary spillway. This is a conservative assumption, since outflow from principal and/or auxiliary spillways would likely limit the releases from the 0.2% annual chance flood.

However, even with the assumption noted above, FMPs for structures EA10A and EA9A from the El Paso Water SWMP (FMP IDs: 143000105 and 143000116) are estimated to have 0.2% annual chance flood capacity based on the design volumes included in the original 2009 City of El Paso SWMP. This is because existing upstream storage from both natural depressions and constructed features now contains a significant portion of the contributing watershed for each project. This existing upstream storage capacity was not accounted for when the projects were initially conceived in the 2009 SWMP.

No Negative Impact Analyses

The hydraulic analyses performed as part of the RFP demonstrated that post-project downstream water surface elevations extracted at building footprints are lower than or equal to pre-project water surface elevations. Similar positive benefits were observed throughout the study area, as would be expected since the projects add storage volume to reduce downstream flows. Therefore, there are no negative impacts estimated for the four FMPs listed above, from the El Paso County SWMP. The determination of no negative impact is based upon analysis of existing and proposed condition models, using the hydrologic HEC-HMS and hydraulic HEC-RAS models listed for each of the six FMPs referenced at the beginning of this section (Section 5B-1). The existing and proposed hydraulic model results showing depth of flooding at buildings relative to estimated Finished Floor Elevations (FFEs) are provided in **Appendix 5H** for reference. In addition, the spatial data (GIS building polygons) associated with the data table in **Appendix 5H** is provided in the "FPR14_Supplemental" geodatabase for the Region 14 RFP, named "Appendix_5H_FMP_Flooded_Structures.gdb."

Benefit Cost Ratio

Consistent with TWDB guidelines, benefits associated with FMPs considered in the evaluation process are based upon pre-project and post-project water surface elevations relative to estimated finished floor elevations, assumed to be raised 0.5 feet above existing ground. The existing ground elevation for each building was estimated by calculating the average ground level within each building footprint, based upon the same LiDAR data used to estimate water

surface elevations. Annual structural benefits were estimated for the 1% and 0.2% annual chance events by comparing the depth of water above each finished floor elevation to the residential and commercial building depth-structure damage curves and depth-content damage curves provided in the FEMA BCA toolkit 6.0 by TWDB.

Benefit Cost Analysis (BCA) methodology was adopted from the El Paso County SWMP 2021 methods with updates applied for the purposes of the RFP, including the use of the FEMA BCA toolkit 6.0 depth-damage and depth-content curves. Each detention/retention project noted above was assumed to have annual operation and maintenance (O&M) costs of $10,000 associated with sediment clearing. The sum of the annual structural and agricultural benefits was divided by the annualized project cost with a discount rate of 2.75% and a planning horizon of 50 years to obtain the Benefit Cost Ratio (BCR) for each project. Flooded roadways were not directly evaluated for benefits associated with the BCR, so it is anticipated that the projects will have higher BCRs than presented in the FMP evaluation table (**Appendix 4C**). A summary of the estimated BCR calculations for each of the six projects discussed in this section is provided below.

Table 5B.1. BCA Calculations for FMPs involving Detention/Retention Basins

FMP ID	**143000116**	**143000105**	**143000024**	**143000021**	**143000011**	**143000025**
FMP Name	**EA9**	**EA10**	**MON3**	**SOC4**	**SSA4**	**HAC3**
Total FMP Cost Sep (2020)	$11,897,000	$9,647,000	$27,033,000	$2,383,000	$14,744,000	$4,619,000
Discount Rate:	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%
Planning Horizon (years)	50	50	50	50	50	50
Annuity	0.037	0.037	0.037	0.037	0.037	0.037
Average Annual FMP Cost	$440,676	$357,334	$1,001,327	$88,269	$546,131	$171,092
Annual O&M	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
Total Annual Cost	**$450,676**	**$367,334**	**$1,011,327**	**$98,269**	**$556,131**	**$181,092**
Annual Benefit to Houses	$8,367	$8,367	$200,385	$5,828	$77,198	$1,704
Annual Benefit to Agriculture	$4,609	$4,609	$0	$1,303	$4,581	$2,181
Total Annual Benefit	**$12,976**	**$12,976**	**$200,385**	**$7,131**	**$81,779**	**$3,885**
BCR	**0.0**	**0.0**	**0.2**	**0.1**	**0.1**	**0.0**

5B-2. Modeling and Mapping Analysis for FMP ID: 143000100

The **FMP ID: 143000100** (NE3B) project in the El Paso SWMP (also known as Alcan Pond) is a proposed pond located in an highly developed area in northeast El Paso. This pond was originally conceived as part of a feasibility study (MCi, 2017) for El Paso Water entitled, "Northeast Sump Improvements – Hydrologic and Hydraulic Analysis" (Study ID: 89 from *Chapter 1*), where it was modeled with FLO2D software in conjunction with the Will Ruth Pond (Existing Project ID: 1400007), a proposed pond with contributing storm drain system located downstream of Alcan pond. Will Ruth Pond currently has the 100% final design plans completed, and committed funding by the Flood Infrastructure Fund.

Data Sources and FMP Extents

Exhibit Map 20.100 shows the proposed FMP extent as well as the proposed Will Ruth Pond location. The pre- and post-project conditions hydrologic HEC-HMS model (Model ID: 140000000031) and hydraulic FLO-2D model (Model ID: 140000000030) from the above-referenced feasibility study were provided by El Paso Water for the purpose of evaluating this FMP for the RFP. Consistent with the feasibility study, the post-project conditions hydraulic model for this FMP assumes that the proposed Will Ruth Pond, located downstream of Alcan pond, is constructed first. The pre-project hydraulic model assumes that neither Will Ruth Pond nor Alcan pond are constructed, and it is based upon a modified version of the model submitted to FEMA as part of the LOMR Case Number 18-06-0885P (published on June 12, 2018).

Pre- and Post- Project Risk Analyses

While Alcan pond would likely have flood risk benefits downstream of the proposed Will Ruth pond if the Will Ruth pond were not constructed, only the cost of Alcan pond, and the benefits associated with the flood risk area between Alcan pond and Will Ruth pond were considered in the BCR associated with this Project.

The pre-and post-project hydraulic models 2D models developed in FLO-2D software, with HEC-HMS point discharge hydrographs applied directly on the terrain surface, which was modified from existing conditions to represent the proposed pond in the proposed hydraulic model.

Water surface elevation grids from pre- and post-project hydraulic model results were extracted at building footprint polygons to compare depth inundation based on finished floor elevations. Finished floor elevations were assumed to be 0.5 ft above the average FLO-2D terrain elevation within the footprint of each building.

No Negative Impact Analyses

Pre- and post-project water surface elevation grids as well as depth grids were compared to assess potential negative impacts associated with the project. The comparison showed that the only locations where post project depths exceeded pre-project depths were in the location of the proposed pond. Buildings in the location of the proposed pond were not assumed to have negative impacts as the project would not be constructed if they remained in place. None of the buildings analyzed within the affected flood risk area between the two ponds were observed to have increased water surface elevations. Therefore, this FMP is estimated to have negative impacts.

The determination of no negative impact is based upon analysis of existing and proposed condition models, using the hydrologic HEC-HMS model (Model ID: 140000000031) and hydraulic FLO-2D model (Model ID: 140000000030) from the feasibility study entitled, "Northeast Sump Improvements – Hydrologic and Hydraulic Analysis" (Study ID: 89). The existing and proposed hydraulic model results showing depth of flooding at buildings relative to estimated Finished Floor Elevations (FFEs) are provided in **Appendix 5H** for reference. In addition, the spatial data (GIS building polygons) associated with the data table in **Appendix 5H** is provided in the "FPR14_Supplemental" geodatabase for the Region 14 RFP, named "Appendix_5H_FMP_Flooded_Structures.gdb."

Benefit Cost Ratio

Consistent with TWDB guidelines, benefits associated with FMPs considered in the evaluation process are based upon pre-project and post-project water surface elevations relative to estimated finished floor elevations, assumed to be raised 0.5 feet above existing ground. The existing ground elevation for each building was estimated by calculating the average ground level within each building footprint, based upon the same FLO-2D terrain used to estimate water surface elevations. Annual structural benefits were estimated for the 1% and 0.2% annual chance events by comparing the depth of water above each finished floor elevation to the residential and commercial building depth-structure damage curves and depth-content damage curves provided in the FEMA BCA toolkit 6.0 by TWDB.

Benefit Cost Analysis (BCA) methodology was adopted from the El Paso County SWMP 2021 methods with updates applied for the purposes of the RFP, including the use of the FEMA BCA toolkit 6.0 depth-damage and depth-content curves. The project was assumed to have annual operation and maintenance (O&M) costs of $5,000 associated with clearing the pond and contributing system of trash/sediment/debris. The sum of the annual structural benefits was divided by the annualized project cost with a discount rate of 2.75% and a planning horizon of 50 years to obtain the Benefit Cost Ratio (BCR) for each project. Flooded roadways were not directly evaluated for benefits associated with the BCR, so it is anticipated that the projects will have higher BCRs than presented in the FMP evaluation table (**Appendix 4C**). A summary of the estimated BCR calculations for FMP ID: 143000100 is provided below.

Table 5B.2. BCA Calculations for FMP ID: 143000100

FMP ID	**143000100**
FMP Name	**NE3B**
Total FMP Cost Sep (2020)	$21,234,000
Discount Rate:	2.75%
Planning Horizon (years)	50
Annuity	0.037
Average Annual FMP Cost	$786,527
Annual O&M	$5,000
Total Annual Cost	**$791,527**
Annual Benefit to Houses	$39,646
Annual Benefit to Agriculture	$0
Total Annual Benefit	**$39,646**
BCR	**0.1**

5B-3. Modeling and Mapping Analysis for FMPs Affecting Doniphan Drive

This subsection documents modeling and mapping assumptions for two FMPs (**FMP IDs: 143000111 and 143000113**), which both address flooding on Doniphan Drive in the cities of El Paso, Texas and Sunland Park, New Mexico. This area experiences repetitive localized flooding and sediment/debris damage to multiple buildings and major access road, Doniphan Drive. This is a high priority flood improvement area for El Paso Water. Both FMP IDs: 143000111 and 143000113 are included in the El Paso Water SWMP as NW3 and NW 26, respectively.

Data Sources and FMP Extents

El Paso Water funded a feasibility study (URS, 2014) for FMP ID: 143000111 entitled, "Doniphan Storm Water Pump Stations PS1 and PS2 System Evaluation and Potential Improvements" (Study ID: 90). These pump station locations can be seen along with other relevant stormwater infrastructure in the area in **Exhibit Map 16.111.** The HEC-HMS hydrologic model associated with this study is identified as Model ID: 140000000035. The study recommends a proposed pump station replacement of PS1 with a new 110 cfs pump (1% annual chance capacity) and proposed storm drain system to relieve flooding in localized ponding areas on Doniphan, also shown in **Exhibit Map 16.111**. The hydrologic modeling analysis from the feasibility study considers the following drainage components:

- Existing overland drainage for Doniphan Drive;
- Channel routing for Doniphan Ditch;
- Contributing flows to existing Pump Station, PS1;
- Contributing flows to existing Pump Station, PS2; and
- Storm drain routing of principal spillway outfall for Keystone Dam, a 96-inch diameter RCP connected to Pump Station 1, which discharges to the Rio Grande.

A later feasibility study (AECOM, 2016) for FMP ID: 143000113 entitled, "Technical Memorandum with Project Recommendation, Montoya Drain H&H Analysis" (Study ID: 38) was also performed for El Paso Water to further investigate alternative improvements for flooding along Doniphan Drive with a proposed pond and a constructed wetland (a nature-based solution). The proposed pond and conduit/channel routing flow to it are depicted in **Exhibit Map 16.113**. The hydrologic and storm drain routing HEC-HMS model from the initial feasibility study (Study ID: 90, discussed above) was used as the base model for existing conditions, and it was refined as part of the 2016 study (Model ID: 140000000034).

The 2016 feasibility study defines existing 1% annual chance flood risk based upon the 2013 Courchesne Interior Drainage Study (Study ID: 91). However, since 2013, a more recent interior drainage study has been completed in the area, which is the Doniphan Corridor Interior Drainage Study (Study: ID 64). Mapping from the Doniphan Corridor study is partially incorporated in both the 2019 Preliminary FEMA (Study ID: 21) mapping for El Paso County, as well as the recent 2021 El Paso County Interior Drainage Study (Study: ID 24).

Pre- and Post- Project Risk Analyses

Based upon the history of hydrologic and hydraulic models discussed above, the most updated hydrologic model available for specific design purposes related to these two FMPs is the hydrologic model associated with the 2016 feasibility study (Model ID: 140000000034). Since the Preliminary FEMA mapping in this area is based upon the Natural Valley Analysis (Study ID 41), which assumes there are no Rio Grande levees in place, the most appropriate existing conditions hydraulic model for the 1% AC risk mapping in this area is estimated to be the 2021 El Paso County Interior Drainage Study (Study ID: 24, Model ID: 140000000004), which is a FLO-2D hydraulic model with point discharges applied from a corresponding HEC-HMS model. **Exhibit Maps 16.111** and **16.113** both depict existing 1% annual chance flood risk in this area, which is based upon Study ID: 24 and the following assumptions:

- The existing Rio Grande levees (which are not accredited by FEMA in this area) are in place;
- Tailwater of the interior drainage outfalls to the Rio Grande in the area are associated with typical base flow in the river, and not the 1% annual chance flood in the Rio Grande. This assumption was applied in the El Paso County Interior Drainage study based upon a coincident flooding analysis of the Rio Grande with local interior flooding.

In the pre-project conditions evaluation for both FMP IDs: 143000111 and 143000113, the 1% annual chance water surface elevation raster associated with the El Paso County Interior Drainage Study (Study ID: 24, Model ID: 140000000004) was compared to finished floor elevations extracted from the associated FLO-2D model terrain (assuming finished floor elevations are 0.5 ft higher than existing ground) at intersecting building footprint locations. This comparison was used to estimate the number of existing structures and population at risk.

The Doniphan Pump Station 2014 feasibility study assumes a storm drain system and pump station with 1% annual chance capacity would be installed along repetitive flooding locations of Doniphan and the surrounding area. Therefore, the post-project conditions for FMP ID: 143000111 (Doniphan Pump Station 1 Reconstruction Project, NW3) assume that all the localized 1% annual chance flood risk areas shown in **Exhibit Maps 16.111** are mitigated.

Based upon the information available from the 2016 feasibility study (Study ID: 38) and the recently updated El Paso Water SWMP, the proposed FMP ID: 143000113 (the Montoya Pond/Wetland Project, NW26) is only anticipated to relieve localized flooding coming from the northwest along Doniphan, which does not inundate any buildings according to the pre-project 1% annual chance risk mapping. Therefore, no buildings are anticipated to be removed from flood risk for this FMP.

However, the FMP ID: 143000113 is expected to reduce flooding coming from the northwest on Doniphan toward the buildings that are estimated to be removed from flooding in the post-project conditions for FMP ID: 143000111. Therefore, the number of structures removed from flood risk in FMP ID: 143000111 was estimated to be equal to the number of structures with reduced 1% annual chance flooding in FMP ID: 143000113. Based upon vicinity of the project to the Rio Grande levees, which are not designed for the 0.2% annual chance flood, there are no 0.2% annual chance flood risk benefits assumed for either of the FMPs.

No Negative Impact Analyses

Based upon the modeling and information available about **FMP ID: 143000111**, a new storm drain system along Doniphan Drive is proposed to route 1% annual chance runoff to a proposed reconstructed pump station with additional capacity relative to the existing Pump Station 1, discharging directly to the Rio Grande. This is expected to improve the performance of the Keystone Dam 96-inch RCP outfall conduit, which currently routes stormwater through the existing Pump Station 1. At this conceptual phase of design, and since the nature of flooding in this area is associated with localized flooding, there are no project components or modeling results which are anticipated to have negative impacts on neighboring areas.

This determination of no negative impact for **FMP ID: 143000111** is based upon engineering judgment after reviewing the feasibility study entitled, "Doniphan Storm Water Pump Stations PS1 and PS2 System Evaluation and Potential Improvements" (Study ID: 90) and analysis of existing condition models, using the hydrologic HEC-HMS model (Model ID: 140000000035) and the hydraulic FLO-2D model (Model ID: 140000000004) discussed in this section (Section 5B-3).

For **FMP ID: 143000113**, runoff coming from the northwest, along Doniphan is proposed to be routed to a proposed pond by channel or storm drain. The proposed pond will add storage capacity to the system, and discharge from the pond is proposed to be pumped into the Rio Grande with a new pump station. A series of new pump stations are also proposed to control groundwater levels in the area, creating more additional storage volume, and benefitting the Montoya Drain outfall to the Rio Grande which has historically reported issues related to high groundwater tables in the area. At this conceptual phase of design, and since the nature of flooding in this area is associated with localized flooding, there are no project components or modeling results which are anticipated to have negative impacts on neighboring areas.

This determination of no negative impact for **FMP ID: 143000113** is based upon engineering judgment after reviewing the feasibility study entitled, "Technical Memorandum with Project Recommendation, Montoya Drain H&H Analysis" (Study ID: 38) and analysis of existing condition models, using the hydrologic HEC-HMS model (Model ID: 140000000034) and the hydraulic FLO-2D model (Model ID: 140000000004) discussed in this section (Section 5B-3).

Benefit Cost Ratio

Consistent with TWDB guidelines, benefits associated with FMPs considered in the evaluation process are based upon pre-project and post-project water surface elevations relative to estimated finished floor elevations, assumed to be raised 0.5 feet above existing ground. The existing ground elevation for each building was estimated by calculating the average ground level within each building footprint, based upon the same FLO-2D terrain used to estimate water surface elevations. Annual structural benefits were estimated for the 1% and 0.2% annual chance events by comparing the depth of water above each finished floor elevation to the residential and commercial building depth-structure damage curves and depth-content damage curves provided in the FEMA BCA toolkit 6.0 by TWDB.

Benefit Cost Analysis (BCA) methodology was adopted from the El Paso County SWMP 2021 methods with updates applied for the purposes of the RFP, including the use of the FEMA BCA toolkit 6.0 depth-damage and depth-content curves. Each project was assumed to have annual operation and maintenance (O&M) costs of $5,000 associated with maintaining the pumps and

stormwater conveyance systems. The sum of the annual structural benefits was divided by the annualized project cost with a discount rate of 2.75% and a planning horizon of 50 years to obtain the Benefit Cost Ratio (BCR) for each project. Flooded roadways were not directly evaluated for benefits associated with the BCR, so it is anticipated that the projects will have higher BCRs than presented in the FMP evaluation table (**Appendix 4C**). A summary of the estimated BCR calculations for FMP ID: 143000100 is provided below.

Table 5B.3. BCA Calculations for FMPs Affecting Doniphan Drive

FMP ID	**143000111**	**143000113**
FMP Name	**NW3**	**NW26**
Total FMP Cost Sep (2020)	$16,132,000	$35,568,000
Discount Rate:	2.75%	2.75%
Planning Horizon (years)	50	50
Annuity	0.037	0.037
Average Annual FMP Cost	$597,544	$1,317,471
Annual O&M	$5,000	$5,000
Total Annual Cost	**$602,544**	**$1,322,471**
Annual Benefit to Houses	$2,307	$506
Annual Benefit to Agriculture	$0	$0
Total Annual Benefit	**$2,307**	**$506**
BCR	**0.0**	**0.0**

5B-4. Modeling and Mapping Analysis for FMP ID: 143000097

The El Paso Water SWMP identifies **FMP ID: 143000097** as a channel improvement project in northwest El Paso city limits, named NW16. The channel segment is also known as the Upper White Spur Drain, which extends from Village Court to Doniphan Drive. The downstream channel segment on the west side of the Doniphan Drive crossing has been widened; however, the FMP area is identified to be undersized in the SWMP (see FMP area identified in **Exhibit Map 20.97)**. The existing concrete-lined channel has a depth of 3 feet (ft) with side slopes of 1.25 horizontal (H) : 1 vertical (V), and a bottom width of 6 ft. The proposed channel is designed to be 4.5 ft deep with side slopes of 1.25H: 1V, and a bottom width of 6 ft..

Data Sources and FMP Extents

Due to the significant portion of drainage area contributing to this channel from SH20 (Mesa Street), the most appropriate base hydrologic model was assumed to be from the 2019 TXDOT feasibility study for SH20 (Study ID: 59, Model ID: 140000000002), entitled "Drainage Study for SH 20 (Mesa Street) From Doniphan Drive to Texas Avenue." Spatial hydrologic modeling layers such as drainage areas and longest flowpaths, as well as the applicable hydrologic HEC-HMS model were obtained from the SH20 study and were modified for the purposes of the RFP evaluation of FMP ID: 143000097. The base hydrologic model was modified in the RFP to create an updated hydrologic HEC-HMS model (Model ID: 140000000033) to estimate flows contributing to the White Spur Drain.

The most appropriate hydraulic model identified as the base model for this FMP (before modifications) is the 2019 Preliminary FEMA hydraulic 2D HEC-RAS model (Model ID: 140000000001). As part of the evaluation of FMP ID: 143000097 for the RFP, the base hydraulic model was modified to develop a pre-project and post-project conditions 2D hydraulic HEC-RAS model (Model ID: 140000000032).

Pre- and Post- Project Risk Analyses

Output point discharge hydrographs from the modified HEC-HMS model were released onto the HEC-RAS 2D hydraulic model terrain within the White Spur Drain channel. The Preliminary FEMA hydraulic model terrain was developed by FEMA to allow flow to pass through the downstream Doniphan Drive culvert crossing and subsequent downstream crossings with the placement of breaklines rather than the use of 2D connections for detailed culvert hydraulic analyses. As part of the RFP analysis, the 2D hydraulic model mesh was modified with revised breaklines around the White Spur Drain, and the Doniphan Drive culvert crossing was modeled as a 2D connection. The hydraulic model results in the FMP area showed that the upstream portion of the White Spur Drain is undersized, resulting in out of bank flooding affecting commercial buildings adjacent to the channel. However, the model shows flow eventually draining back into the channel further downstream, just upstream of the Doniphan Drive crossing.

Due to limitations associated with 2D models simulating channelized flow, and since survey data were not available for channel flowlines or downstream crossing dimensions, a field visit was conducted to measure relevant channel, culvert, and headwall dimensions. Then, additional CulvertMaster and Flowmaster models were developed to check capacities of existing and

proposed channel dimensions, as well as the downstream crossings. Since proposed channel and culvert dimensions were estimated to contain existing 1% AC flows based on the different hydraulic modeling analyses performed, the buildings adjacent to the existing channels were estimated to be removed from flood risk in post-project conditions. Due to the uncertainties associated with capacities of contributing storm drains conveying the 0.2% annual chance runoff into the channel from the various inlets and pipe networks draining to the channel, this event was not modeled in detail, and the FMP was assumed to have no benefits for the 0.2% annual chance flood.

No Negative Impact Analyses

Channel widening projects can sometimes present an increased risk to downstream properties if out of bank flooding from pre-project conditions is contained in post-project conditions, and the channel is undersized further downstream. This FMP is not estimated to have that issue, as the downstream channel segment is already significantly wider (~13 ft bottom width, 6ft depth) than the upstream segment being widened from a bottom width of 3ft to 6ft, with 4.5 ft depth, and flow from the channel is allowed to interact with flow in the adjacent pond downstream and northwest of the channel. Furthermore, pre-project out of bank flooding was observed to re-enter the channel further downstream in the 2D hydraulic model results, which indicates the total flow in the channel is not increasing. As an additional test, the full flows estimated to enter the upper channel segment based on the hydrologic modeling results were released downstream of the Doniphan crossing, and results showed the same flood extents as pre-project conditions. Based upon the analyses described above, it is estimated that this FMP would cause no negative impacts on neighboring areas.

The determination of no negative impact is based upon analysis of existing and proposed condition models, using the hydrologic HEC-HMS model (Model ID: 140000000033) and hydraulic HEC-RAS 2D model (Model ID: 140000000032) described in this section. The existing and proposed hydraulic model results showing depth of flooding at buildings relative to estimated Finished Floor Elevations (FFEs) are provided in **Appendix 5H** for reference. In addition, the spatial data (GIS building polygons) associated with the data table in **Appendix 5H** is provided in the "FPR14_Supplemental" geodatabase for the Region 14 RFP, named "Appendix_5H_FMP_Flooded_Structures.gdb."

Benefit Cost Ratio

Consistent with TWDB guidelines, benefits associated with FMPs considered in the evaluation process are based upon pre-project and post-project water surface elevations relative to estimated finished floor elevations, assumed to be raised 0.5 feet above existing ground. The existing ground elevation for each building was estimated by calculating the average ground level within each building footprint, based upon the same FLO-2D terrain used to estimate water surface elevations. Annual structural benefits were estimated for the 1% and 0.2% annual chance events by comparing the depth of water above each finished floor elevation to the residential and commercial building depth-structure damage curves and depth-content damage curves provided in the FEMA BCA toolkit 6.0 by TWDB.

Benefit Cost Analysis (BCA) methodology was adopted from the El Paso County SWMP 2021 methods with updates applied for the purposes of the RFP, including the use of the FEMA BCA

toolkit 6.0 depth-damage and depth-content curves. The project was assumed to have annual operation and maintenance (O&M) costs of $1,000 associated with trash and debris removal from the channel and contributing storm drain systems. The sum of the annual structural benefits was divided by the annualized project cost with a discount rate of 2.75% and a planning horizon of 50 years to obtain the Benefit Cost Ratio (BCR) for each project. Flooded roadways were not directly evaluated for benefits associated with the BCR, so it is anticipated that the projects will have higher BCRs than presented in the FMP evaluation table (**Appendix 4C**). A summary of the estimated BCR calculations for FMP ID: 143000097 is provided below.

Table 5B.3. BCA Calculations for FMP ID: 143000097

FMP ID	**143000097**
FMP Name	**NW16**
Total FMP Cost Sep (2020)	$1,570,000
Discount Rate:	2.75%
Planning Horizon (years)	50
Annuity	0.037
Average Annual FMP Cost	$58,154
Annual O&M	$1,000
Total Annual Cost	**$59,154**
Annual Benefit to Houses	$2,826
Annual Benefit to Agriculture	$0
Total Annual Benefit	**$2,826**
BCR	**0.0**

5B-5. Modeling and Mapping Analysis for FMP ID: 143000003

The City of San Elizario has communicated to the RFPG several flooding issues associated with their historic district. A 2021 feasibility study was identified, entitled, "Drainage Feasibility Study, Socorro Rd. Intersections with San Antonio St. & Main St." (Study ID: 49). The feasibility study used TXDOT aerial imagery and topography to delineate a 48-acre drainage area, and used the Rational Method to estimate a proposed 1% annual chance runoff volume of 10.4 ac-ft. The study identified three alternatives for flooding locations in San Elizario:

- Alternative 1 - An 11.5 ac-ft regional pond with contributing storm drain system ($758,493);
- Alternative 2 - A series of park ponds with a total capacity of 6.7 ac-ft ($910,391); and
- Alternative 3 - A small pond with a 0.34 ac-ft capacity ($192,375)

The recommended alternative from the feasibility study is the Alternative 1; however, **FMP ID: 143000003** is associated with Alternative 3 from the feasibility study. The approximate localized flooding extent estimated from the feasibility study is shown in **Exhibit Map 20.03**.

Data Sources and FMP Extents

An analysis performed as part of the RFP, reviewing 2D Preliminary FEMA and Fathom hydraulic model results. In addition, the 2014 LiDAR topography data associated with the Preliminary FEMA study was analyzed in the area, along with aerial imagery to estimate existing flow patterns. A copy of the Preliminary FEMA hydrologic HEC-HMS model (Model ID: 140000000011) for Work Area 7 (WA7) was utilized as the hydrologic model for this FMP (Model ID: 140000000037). Similarly, a copy of the Preliminary FEMA 2D hydraulic HEC-RAS model (Model ID: 140000000001) for WA7 was utilized as the hydraulic model for this FMP (Model ID: 140000000036).

Pre- and Post- Project Risk Analyses

The analysis did not agree with the extent of the drainage area delineated in the feasibility study, which prevented the RFPG from recommending Alternative 1. It is anticipated that in order for the Alternative 1 pond to provide flood benefits for a drainage area of the size estimated in the feasibility study (48 acres), a more extensive storm drain network than the one proposed would be necessary, which was not reflected in the proposed cost for the alternative.

However, through continued coordination with local stakeholders at the City of San Elizario, specific known localized flooding areas near the proposed Alternative 3 small pond location were identified (circled in **Exhibit Map 20.03**). In reference to Alternative 3, the feasibility study states, "This alternative was identified by the City of San Elizario officials due to its practical and close proximity location to the flooding intersections."

A small local drainage area that could be captured by Alternative 3 without an extensive storm drain network was delineated at approximately 3 acres. City of San Elizario utilizes the City of El Paso Drainage Design Manual (COEP, 2008) to regulate stormwater design. The feasibility study utilized "El Paso Design Standards for Construction," dated June 2008 (COEP-DSC) to estimate the 1% annual chance volume required for retention basins such as the Alternative 3 pond. These standards require a 4-inch rainfall depth for the 1% annual chance event, which is

between the 12-hour and 24-hour duration rainfall depth in this area according to NOAA Atlas 14 rainfall. Assuming the reduced drainage area of approximately 3 acres results in a 1% annual chance volume of 0.65 acre-feet.

Since the proposed Alternative 3 volume is 0.34 acre-feet, it is not anticipated to contain the 1% annual chance event based on these standards. Assuming a similar storm duration as the design standards (between 12-hour and 24-hour) results in the proposed pond having an estimated capacity to contain an event between the 20% and 10% annual chance storm. Since a minimum time of concentration is assumed for a drainage area of 3 acres, a shorter duration storm intensity is more applicable to the site; so it is estimated that the pond would relieve localized flooding in this known ponding area for approximately the 10% annual chance level of service. This is in alignment with the RFPG goal to remove 40% of the low water crossings from 10% annual chance floodplain by 2033, and to remove 90% of low water crossings in the region from 10% annual chance floodplain by 2053.

This Alternative 3 pond location could intercept runoff draining toward one of the repetitive ponding areas through curb cuts or minimal storm drain infrastructure. Therefore, with approval from the RFPG and local City of San Elizario stakeholders, Alternative 3 was selected for evaluation as part of the RFP.

Since the Preliminary FEMA 2D hydraulic model (Model ID: 140000000001) is considered the best available model in this location, and it does not delineate significant flood depths in the repetitive flooding locations, there are no structures estimated to be removed from flooding due to the FMP.

No Negative Impact Analyses

Since this a small-scale project to alleviate localized road flooding, and it adds storage volume to the project area, there are estimated to be no negative impacts on neighboring areas associated with this FMP. This determination of no negative impact is based upon engineering judgment after reviewing the feasibility study entitled, “Drainage Feasibility Study, Socorro Rd. Intersections with San Antonio St. & Main St.” (Study ID: 49) and analysis of existing condition runoff patterns in the contributing drainage area, using a copy of the Preliminary FEMA 2D hydraulic model for WA7 (Model ID: 140000000036).

Benefit Cost Ratio

Since there were no 1% or 0.2% annual chance benefits associated with this project, a BCA of 0 was assumed for the FMP.

5B-6. Modeling and Mapping Analysis for FMP ID: 143000005

The 2019 TXDOT feasibility study for **FMP ID: 143000005** (SH 20 Drainage improvements) is entitled "Drainage Study for SH20, from Doniphan Drive to Texas Avenue" (Study ID: 59). The report documents a hydrologic HEC-HMS (Model ID: 140000000002) and hydraulic EPA SWMM (Model ID: 140000000012) modeling analysis of 39 culvert/storm drain crossings on SH20 (Mesa Street) on the Westside of the City of El Paso. The capacity of each crossing was analyzed and reported for roadway gutter/inlet level of service as well as crossing capacity level of service.

Data Sources and FMP Extents

Eight drainage improvement projects are proposed in the feasibility study (all of which were evaluated for inclusion in this FMP) to increase roadway drainage levels of service from less than the 20% annual chance in pre-project conditions to the 10% annual chance level of service in post-project conditions. The projects are identified and prioritized with documented cost estimates in the feasibility study (Study ID: 59). Descriptions of the proposed improvements are documented in the FMP narratives in **Appendix 4D** of *Chapter 4*, and the locations of each improvement are shown in **Exhibit Map 20.05**, along with relevant existing inlet and conduit locations. A summary of the proposed projects is below:

- Six projects include expanding the capacity of existing inlets and/or adding new inlets and connecting them to existing crossings;
- One project includes lengthening a weir that conveys flow to an existing crossing; and
- One project includes increasing the capacity of inlets and increasing the capacity of the existing crossing to which they are connected.

Pre- and Post- Project Risk Analyses

Since all of the projects are proposed to only increase levels of service for roadway flooding to the 10% annual chance, this FMP was estimated to have no 1% annual chance benefits affecting buildings or roadways. While this outcome does not achieve a 1% annual chance level of service at each crossing, it is in alignment with the RFPG goal of removing 40% of low water crossings from the 10% annual chance floodplain in the region by 2033, and removing 90% of low water crossings from the 10% annual chance floodplain by 2053.

No Negative Impact Analyses

All of the proposed projects would increase runoff to existing crossings, but only one project includes expanding the crossing which receives the additional runoff. To investigate potential negative impacts related to the eight proposed projects, the level of service of each existing crossing that is proposed to receive increased runoff due to the projects was reviewed. Based on the EPA SWMM hydraulic model results, two of the crossings that are proposed to receive increased runoff have less than the capacity needed to convey the 1% annual chance flood:

- Crossings 9A and 9B, a 36" Steel pipe and a 36" Reinforced Concrete Pipe (RCP) located near the intersection of Vin Granada and SH20
  - Associated with Improvement 10-3 to "Increase the capacity of the inlets and crossing at 9A & 9B by 30 cfs"

- Crossing 18, a 48" RCP located near the Baltimore Avenue/SH20 intersection
  - Associated with Improvement 10-7 to "Add inlets at the sag near crossing 18. Connect the inlets to crossing 18. Estimated capacity: Approximately 50 cfs"

At the locations listed above, the following data were reviewed to assess potential negative impacts associated with increasing conveyance to crossings that are undersized for the 1% annual chance flood:

- Existing drainage infrastructure;
- HEC-HMS and EPA SWMM inputs/results;
- Existing downstream flood risk boundaries based on Preliminary FEMA 1% annual chance floodplains; and
- Overflow flooding patterns and contributing drainage areas based on 2014 LiDAR topography associated with the Preliminary FEMA 2D hydraulic model

At the location of proposed Improvement 10-3, the two drainage areas contributing to the inlets that are proposed to have increased capacity/conveyance (C_9A_1 and C_9B_1) are significantly smaller (~52 acres and ~19 acres, respectively) than the drainage area of Flowpath No. 20A (C_8_1, ~588 acres), which would receive the increased runoff due to the improvements. As expected, based on the difference in drainage area sizes, there are significant differences in lag times/timing of peak flows (6.7 minutes for C_9A_1 and 6 minutes for C_9B_1 vs. 17.2 minutes for C_8_1). Therefore, the anticipated increased runoff associated with the 30 cfs increased capacity of the inlets and crossing at Improvement 10-3 is expected to arrive much sooner than the approximate 1,768 cfs peak flow of the receiving stream (Crossing 8, Flowpath No. 20A), and any impact to the peak flow of the receiving stream is expected to be negligible. In addition, the 1% annual chance floodplain is contained within the banks of the channel of the receiving stream for more than 2,000 feet downstream of the outfall location from Improvement 10-3. Based on the information above, the project Improvement 10-3 is not estimated to cause negative impacts on neighboring areas.

At the location of proposed Improvement 10-7, the pre-project 1% annual chance event is currently estimated to cause 120 cfs to overflow at Crossing 18, with overflow draining downstream (southwest) down Baltimore Avenue. By installing new inlets at the sag located on East Baltimore Avenue, where there is currently a grate inlet, any existing overflows associated with the 1% annual chance event are not expected to change since there is no new flow being directed into the drainage area, and the roadway inlets are not designed to convey the 1% annual chance flood. Based on the information above, the project Improvement 10-3 is not estimated to cause negative impacts on neighboring areas.

Based on the analyses of the two projects above, and since the other 6 proposed projects are estimated to improve 10% annual chance conveyance to crossings which are reported to have capacity for greater than the 1% annual chance flood, there are estimated to be no negative impacts on neighboring areas associated with this FMP. This determination of no negative impact is based upon engineering judgment after reviewing the feasibility study entitled, "Drainage Study for SH20, from Doniphan Drive to Texas Avenue" (Study ID: 59) and analysis of existing condition models, using the hydrologic HEC-HMS (Model ID: 140000000002) and hydraulic EPA SWMM (Model ID: 140000000012).

Benefit Cost Ratio

Since there were no 1% or 0.2% annual chance benefits associated with this project, a BCA of 0 was assumed for the FMP.

5B-7. Non-structural FMPs that were not Analyzed

The two remaining FMPs are non-structural FMPs, and were not analyzed with modeling or mapping data.

FMP ID: 143000007 (flood gage and flood gates for low water crossings in Marfa) was not analyzed for 1% annual chance flood benefits or impacts, since there is no flood infrastructure proposed which would have a measurable effect on flood conditions. The determination of no negative impact is based upon engineering judgment.

Since the **FMP ID: 143000009** is a non-structural FMP associated with Hudspeth County developing and implementing a floodplain ordinance to regulate development, a hydrologic and hydraulic analysis was not performed, and the post-project level of service is not applicable. The determination of no negative impact is based upon engineering judgment.