



CITY OF  
TUCSON

# FLOODPLAIN MANAGEMENT PLAN

Draft March 2016



## COUNCIL ADOPTION

On May 3, 2016, the Tucson City Council adopted the FMP under resolution **(insert resolution number here)**. The resolution is included in the Appendix of this report. The following officials were the city government leads at the time the FMP plan was adopted.

### **2016 Mayor & Council**

Jonathan Rothschild, Mayor  
Regina Romero, Ward 1  
Paul Cunningham, Ward 2  
Karin Uhlich, Ward 3  
Shirley Scott, Ward 4  
Richard Fimbres, Ward 5  
Steve Kozachik, Ward 6

### **2016 City Manager**

Michael Ortega

## COMMITTEE FORMATION DISCUSSION

Before delving into a detailed discussion of the Floodplain Management Plan (FMP) planning process and the ensuing results, the Tucson Floodplain Management Project team would like to thank the FMP committee members for their support and participation in the development of the plan. Over a five month period, the committee members met monthly in a progression of meetings designed to identify the flooding hazards Tucson faces while working towards defining an action plan to resolve those issues. The FMP committee worked diligently with the goal of protecting Tucson's citizens by using their expertise in planning, engineering, environmental sciences, and policy formation to inform the development of the FMP.

Elizabeth Leibold, P.E., CFM, Civil Engineer, in Tucson's Planning and Development Services Department (PDS) was the lead advocate for completing the FMP for Tucson and was assisted by Peter McGlaughlin, P.E. Fred Felix, Tucson City Engineer, serves as the city's Floodplain Administrator. At the beginning of the project, Ernie Duarte held the position of Director of PDS. At the time the FMP plan was completed and adopted in 2016, Nicole Ewing-Gavin served as the Interim Director of PDS. Robert Bezek, Regional Engineer, and Patricia Rippe, Natural Hazards Program Specialist, served as FEMA Region IX advisors while Maureen Towne, Risk MAP Coordinator for the Arizona Department of Water Resources (ADWR), also provided guidance during the FMP process. Sarah Houghland, BakerAECOM, prepared the 2016 FMP under contract as FEMA Region IX's Professional Technical Services (PTS) Contractor.

## COMMITTEE MEMBER LIST

A diverse group from different sectors of Tucson's population convened to form the committee. Those that diligently worked on the FMP include:

**Table 1. List of committee members involved in Tucson's floodplain management plan.**

Name	Organization	Title	FMP Committee Function/Role
Bill Zimmerman	Pima County Regional Flood Control District	Deputy Director	Public/Structural Flood Control Projects
B.J. Cordova	Tucson Clean & Beautiful	Membership & Communications Director	Tucson/Natural Resource Protection
Brent Borchers, P.E.	Terracon	Office Manager	Public/Property Protection
Claire Jean Prager	Coldwell Baker Residential Brokerage	Associate Broker	Public/Preventive Measures
Elizabeth Leibold, P.E., CPM, CFM	City of Tucson, PDS Engineering	Civil Engineer	Tucson/Preventive Measures
Joanne Hershenhorn	City of Tucson, Office of Integrated Planning	Project Coordinator	Tucson/Preventive Measures
Jim Robinson	City of Tucson, Transportation Dept. ITS Division	GIS Technician	Public/Property Protection
John Wise, P.E, CFM	Stantec	Managing Principal	Public/Property Protection
John Wood, P.E., LEED-AP	Presidio Engineering	President	Public/Preventive Measures
	SAHBA Representative		
Kieran Sikdar	Watershed Management Group	Program Manager	Public/Natural Resource Protection
Larry Roberts, P.E., MS	Arroyo Engineering	Principal Engineer	Public/Preventive Measures
Maureen Towne, CFM	ADWR	Risk MAP Coordinator	State/Public Information
Peter McLaughlin	City of Tucson, PDS Planning	Lead Planner	Tucson/Structural Flood Control Projects
Richard Remington	Logan Simpson	Senior Biologist	Public/Public Resource Protection
Rob Shand, P.E.	JE Fuller/Hydrology & Geomorphology, Inc.	Civil Engineer	Public/Emergency Services
Steve Tineo, P.E.	City of Tucson, TDOT	Engineering Project Manager	Tucson/Structural Flood Control Projects
Jim Vogelsberg	City of Tucson, PDS Engineering	Floodplain Administrator	Tucson/Structural Flood Control Projects

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## EXECUTIVE SUMMARY

The City of Tucson has proven to be an important study area for Floodplain Management and has great potential for increasing its resources and funding to improve community resilience. The City has endured sixteen (16) flooding and three (3) storm events from 1983 to 2012. Economic and environmental impacts of flooding events are severe, and could pose even more dangerous hazards in the future. The City of Tucson, along with support from FEMA Region IX, have created the City’s first Floodplain Management Plan to address community-wide floodplain hazards and mitigation measures.

During the FEMA Discovery Process, several areas in the Upper Santa Cruz watershed were identified, and community members and local agency representatives participated in discussions to address floodplain mitigation. By creating the City’s first Floodplain Management Plan (FMP), Tucson can better address floodplain management decisions, consider all mitigation alternatives or consequences, and improve their FEMA Community Rating System (CRS) standing. The FMP is considered an update to the Tucson Stormwater Management Study (TSMS), and the FMP will be Phase 5. It also formulates an action plan to best address the highest priority action items described by FMP Committee Members. The purpose of the FMP in Tucson is to prioritize actionable mitigation measures which will ultimately reduce the risk to life and property associated with flooding.

This plan provides guidance information for the City of Tucson to best assess their current floodplain hazards. It also catalogues many floodplain mitigation measures that are appropriate for the community, based on information gathered from community workshops. This plan should be used when referencing floodplain management requirements from federal, state, and local perspectives. It acts as an all-encompassing guide, while establishing strategies, measures, and priorities for the community.

Pima County has experienced 13 Major Disaster Declarations and 2 Emergency Declarations.

**Table 2. Tucson’s FEMA major disaster declarations.**

**Pima County Presidentially Declared Flood Disaster Events**

Major Disaster Declarations		
FEMA Disaster #	Date	Description
4203	11/5/2014	Severe Storms and Flooding*
1940	10/4/2010	Severe Storms and Flooding*
1888	3/18/2010	Severe Winter Storms and Flooding
1660	9/7/2006	Severe Storms and Flooding
1477	7/14/2003	Wildfire*
977	1/19/1993	Severe Storms, Tornadoes, Flooding
884	12/6/1990	Flooding, Severe Storm
691	10/5/1983	Severe Storms, Flooding
570	12/21/1978	Severe Storms, Flooding
551	3/4/1978	Severe Storms, Flooding
540	11/4/1977	Severe Storms, Flooding
343	7/3/1972	Severe Storms, Flooding
217	4/30/1966	Flooding
Emergency Declarations		
3307	1/24/2010	Severe Winter Storms and Flooding
3241	9/12/2005	Hurricane Katrina Evacuation

*\*Pima County included under statewide Hazard Mitigation Grant Program assistance.*

With Tucson currently being at CRS Level 6, this FMP process was more about building off the community's existing foundation by expanding available resources and utilizing them efficiently. In addition, the Plan provides tools to enhance the knowledge and skills of local and state officials who are responsible for floodplain management. Engaging the community in the process was also a key part in formulating the Plan. As summarized in Section iii, committee member meetings were held to garner feedback and coordination from local representatives. These helped to establish the project scope and specific goals for floodplain hazard mitigation. The FMP committee summarized Tucson's Floodplain Management Plan goals as:

### GOAL STATEMENT

Reduce flood and erosion hazards, damage, and associated costs by:

- **Identifying high-risk areas;**
- **Providing safe, efficient and balanced conveyance for stormwater runoff;**
- **Maintaining, enhancing and/or restoring riparian ecosystems and wildlife corridors;**
- **Increasing community awareness of water harvesting methodologies, floodplain preservation measures, and general flood and erosion information; and,**
- **Expanding incentives for private property owners and developers to implement sustainable flood and erosion hazard mitigation strategies.**



Figure 1: Panorama of the Rillito River

# Chapter 2

## PURPOSE AND INTENT OF THE FMP

### INTRODUCTION TO TUCSON

Tucson is part of Pima County and is located in the southeastern part of Arizona (Figure 2). Tucson experiences a desert climate with a monsoon season, and gets an average of twelve (12) inches of rain annually. While a majority of Pima County is considered rural or moderately developed, Tucson is decidedly an urban area so the challenges Tucson encounters differ and are more pronounced than what the other Pima County communities endure. Precipitation in Tucson is higher than most desert climates, which is cause for more flash flooding than in other parts of the state. Because many

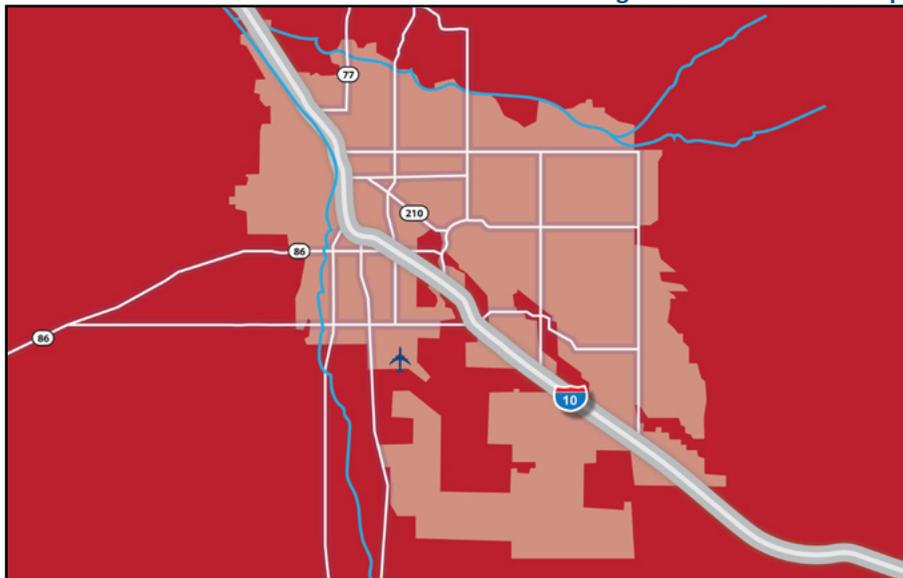
areas of the city do not have storm sewers, Tucson often times experiences flooding on the main thoroughfares. The most common flood risks identified within the City of Tucson are flooding and flash flood events.

Pima County was one of the hardest hit areas in the nation during the economic downturn in 2008, and has not experienced the population or development increase that was initially projected (the population rate has actually remained well below 1 percent). With the lack of funding and economic growth, it is essential to come up with a plan to mitigate floodplain hazards while taking into account the potential for public infrastructure deterioration. Also, with the potential for climate change conditions, communities are at risk for a higher potential for damage caused by natural disasters.

### INTRODUCTION TO THE FMP PROCESS

The FMP is an outcome from the Upper Santa Cruz Discovery process FEMA initiated in the fall of 2011. Discussions between FEMA and Tucson resulted in this plan being created in order to facilitate floodplain management activities in Tucson. FEMA's Risk Mapping, Assessment, and Planning, or (Risk MAP) program helps communities identify, assess, and reduce natural hazard risks. Through Risk MAP, FEMA provides information to enhance local mitigation plans, improve community outreach, and increase local resilience to hazards. The Upper Santa Cruz Discovery Report can be found in the Appendix of this report. For more information regarding the Discovery process you can go to FEMA's website [www.fema.gov](http://www.fema.gov) for more information. After the Discovery process came to a close, FEMA recognized that there is potential to expand on best management practices and encourage a more resilient community within Tucson. Flood risk products are created as a means to provide concrete evidence and reference materials to those who manage floodplain material data. With the development of a FMP, participants can create an action plan for floodplain management, and can ultimately reduce region-wide flood insurance rates.

Figure 2: Tucson aerial map.



## Chapter 2 Cont'd

This FMP process was unique in that FEMA mostly assisted with the project management, oversight, and production of final products, but the City of Tucson has been leading the effort and meetings. This has proved beneficial in getting the community's first-hand perspective and objectives. In creating Tucson's Floodplain Management Plan, the best assessment has been given for potential floodplain hazards, along with the most efficient mitigation actions for alleviating disaster potential. With the City's current CRS Rating, it's apparent that Tucson has already achieved major goals in regards to Floodplain Management. By going a step further in the Risk MAP process, this allows community representatives (and the public) to be able to have access to reference guides for floodplain management in the years to come.

As floodplain management increases overall, the flood risk potential for a community will decrease. It not only considers the well-being of the people, but also takes into consideration the natural and built environment. The intent of this product is to come up with an overarching report that discusses existing flood risks, areas of potential hazard, and ways to address these concerns. Having the FMP will allow for concrete and realistic flood risk products as it increases the public's awareness of flood risk potential. Having this report increases the region and its constituency's ability to adapt to hazards and risks that may arise. It allows committee participants to take part in a discussion of ongoing efforts and can be used for a more coordinated effort in case of emergencies. It also helps to increase federal funding for hazardous events and decreases insurance premiums for local residents.

The goal is to create an FMP that is unique to Tucson, and that outlines all of the issues the urban community contends with. A well-prepared plan will:

- Facilitate an update to the Tucson Stormwater Management Study (TSMS),
- Identify existing and future flood-related hazards and their causes,
- Ensure a comprehensive review of all possible activities and mitigation measures is conducted so that the most appropriate solutions will be implemented to address the hazard,
- Ensure the recommended activities meet the goals and objectives of the community, are in coordination with land use and comprehensive planning, do not create conflicts with other activities, and are coordinated so that the costs of implementing individual activities are reduced,
- Ensure the criteria used in community land use and development programs account for the hazards faced by existing and new development,
- Educate residents and property owners about the hazards, loss reduction measures, and the natural and beneficial functions of floodplain,
- Build public and political support for activities and projects that prevent new problems, reduce losses, and protect the natural and beneficial functions of floodplains,
- And, build a constituency that wants to see the plan's recommendations implemented.



**FEMA**

**RiskMAP**

Increasing Resilience Together

### QUICK RISK MAP PRODUCT DISCUSSION

Because flood hazards change over time, the Discovery process provides an opportunity to engage in a comprehensive review of activities that contribute to flood risk. Engaging local officials in this process increases their understanding of flood risk and gives them an active role in identifying proactive steps that can be implemented to protect the lives and property of community residents. Through Risk MAP, FEMA provides communities with information that can improve risk communication and enhance local mitigation plans, resulting in decreased flood risk. FEMA has developed a suite of multi-hazard risk assessment products, referred to as Flood Risk Products (FRPs), to assist with this endeavor. FRPs can help community officials assess, visualize, and communicate local flood risk. The FRPs developed as part of the overall project are included in the Appendix of this report.

As part of this project, the following FRPs were developed for Tucson:

- **Flood Risk Report** - The FRR provides community and watershed specific flood risk information extracted from the Flood Risk Database (FRD), explains the concept of flood risk and identifies useful tools and reference materials. The FRR, used in combination with the Flood Risk Map (FRM), is a good tool for communities to use for raising local flood risk awareness.
- **Flood Risk Database** (including Hazus-MH) - The FRD stores all of the flood risk assessment data which provides an valuation of potential financial consequences and other impacts associated with structures located in the SFHA. This data also enables communities to make informed decisions regarding future land development and community infrastructure
- **Flood Risk Map** - The FRM depicts flood risk data for a flood risk project area and is typically used to illustrate an overall picture of flood risk for the area.



Figure 3. Flood damage can be seen on Tucson streets.

# Chapter 3

## PLANNING PHASE

Before commencing the FMP process, a Working Group (WG) project team was established to determine how the planning process should go in order to meet the CRS requirements and to try to maximize the points that Tucson will receive as a result to go toward increasing the community CRS rating. Representatives from Tucson, ADWR, FEMA, and BakerAECOM (FEMA Region IX's Professional Technical Services contractor) were involved with the process. The WG began meeting on almost a weekly basis beginning in March 2015 to begin the process of identifying different stakeholders that should be invited to the FMP meetings along with discussions involving meeting format and potential outcomes. The WG continued to meet throughout the entire FMP process.

## TUCSON STAFF INVOLVEMENT

Per CRS requirements, the WG cited that it was very important to try to include stakeholders from as many departments within Tucson as possible to provide recommendations that can actually be supported and adopted by those departments. Having a wide range of participants will also allow the committee to have a fresh perspective of Tucson as a whole. Without the appropriate community backing, the recommendations and the FMP as a whole will not be successful. The different groups within Tucson's governmental structure include: TDOT, PDSD (includes engineering and planning), Office of Integrated Planning, Trees for Tucson, Tucson Clean & Beautiful, Tucson Airport Authority, Tucson City Council Ward 1 and 6 Offices, Tucson Police Department, Environmental Services.

Per the CRS Manual, the FMP committee included stakeholders that covered these seven categories that also reflect the possible activities to prevent or that can eliminate the problems caused by flood hazards:

1. Preventive measures (e.g., codes) (PDSD)
2. Property protection (e.g., elevation) (PDSD)
3. Natural resource protection (Tucson Clean & Beautiful)
4. Emergency services (Tucson Police Department)
5. Structural flood control projects (PDSD)
6. Public information (PDSD, Tucson City Council Ward Offices, PDSD)

The list of committee members that attended each committee meeting are included in the meeting minutes in the Appendix of this report.

## OTHER AGENCY COORDINATION

In addition to local Tucson staff, the project team also reached out to other agencies to participate in the process. Those agencies include: FEMA, ADWR, USACE, Pima County Regional Flood Control District, and the Arizona Floodplain Management Association, Southern Arizona Home Builders Association, and the Tucson Association of Realtors.

### REPORT REVIEW

The City of Tucson initiated the Tucson Stormwater Management Study (TSMS) in 1988 in order to develop a comprehensive stormwater management program. Fortunately for the FMP committee, Larry Roberts, Arroyo Engineering, was a member of the team that created the TSMS and Mr. Roberts provided the following TSMS description. The TSMS was planned as a multi-year project with the following four phases:

- Phase I:** Establish Framework, Goals, and Objectives
- Phase II:** Develop Stormwater Master Plan
- Phase III:** Prepare Implementation Program and Maintenance Management Program,  
Assess Institutional and Financial Elements
- Phase IV:** Implementation

Phase I of the TSMS was adopted by Mayor and Council in March 1990. The Phase I study utilized an extensive public participation program for soliciting citizen involvement. The Phase I study also redirected future stormwater management efforts toward an emphasis upon nonstructural approaches which maintain or enhance naturally vegetated watercourses.

Phase II of the TSMS was initiated in 1992 in order to develop a Stormwater Master Plan for controlling both stormwater quantity and quality. One of the primary purposes of Phase II of the TSMS was to expand on the results of the Phase I study and develop a Stormwater Master Plan that adequately and economically addresses City-wide stormwater management. The Stormwater Master Plan was prepared under the direction of the City of Tucson by a multi-disciplined consultant team with areas of expertise in water resources, stormwater quality, environmental aspects, public participation, and legal issues. The Stormwater Master Plan was approved by Mayor and Council in 1996.

The Final Report presented the recommended Stormwater Master Plan (Simons, Li & Associates, 1992). Seventeen additional key documents were also prepared as the foundation for the Stormwater Master Plan.

A major portion of Phase II of the TSMS was devoted to developing the Stormwater System Planner (SSP), a sophisticated software package used as a planning tool for developing the Stormwater Master Plan. The SSP was used to 1) manage an extensive database of physical parameters relating to watercourses and watersheds within the City, 2) perform hydrologic modeling for the 59 watersheds within the study area, 3) create summary reports for the database and the hydrologic modeling, and 4) prepare graphical presentations relating to watercourse and watershed data.

The City-wide database for the SSP was created for use by both City staff and water-resource professionals. The database included 1) physical information regarding watercourses such as lengths, widths, shapes, 2) environmental and cultural data regarding riparian habitat, archaeological resources, and watercourses regulated by the City's "ERZ" and "WASH" ordinances, and 3) watershed data such as size, percent impervious, and existing (and future) land uses.

As part of the hydrologic modeling for the Stormwater Master Plan, all available historic flow records were collected and used to calibrate the hydrologic model in order to provide more accurate design flow rates than those flow rates previously calculated using the existing City methodology. The resulting new "TSMS Hydrology" provided a comprehensive and accurate methodology to be used for floodplain management and the design of flood control facilities within the City of Tucson.

The Final Report the TSMS, Phase II, Stormwater Master Plan provided a 30-year framework for managing the surface water resources by integrating those technical, economic, social, and environmental factors which are essential for sound stormwater management. The comprehensive, watershed-based plan consisted of six major elements, described as follows:

### **1. Preservation of Naturally Vegetated Watercourses**

Riparian habitat was identified and classified along the naturally vegetated watercourses within the City of Tucson. Approximately 77 miles of these watercourses, representing 570 acres of riparian habitat, were recommended for preservation. This represented 98% of the riparian habitat that was identified.

### **2. Flood Hazard Studies**

Flood Hazard Studies were proposed for approximately 41 miles of watercourses where nonstructural stormwater management measures were recommended. These studies were designed to better define the extent of flooding risks and identify possible nonstructural management measures such as the purchase of flood insurance or floodproofing. Public education regarding the results of the Flood Hazard Studies was also recommended.

The Flood Hazard Studies were proposed to be prepared by the City of Tucson for local floodplain management, and not create any new regulatory floodplains under the jurisdiction of the Federal Emergency Management Agency (FEMA). However, some Flood Hazard Studies may result in the remapping of existing FEMA floodplains in order to provide more accurate information which may actually reduce the size of the regulatory FEMA floodplain.

### **3. Stormwater Quality Investigations**

Although no significant problems with the quality of stormwater runoff were documented, stormwater sampling was recommended to be initiated in order to obtain more reliable data. The new data were to be used by the City to determine whether additional studies were warranted.

### **4. Stormwater Capital Improvement Programs**

The major structural component of the Stormwater Master Plan was 47 capital improvement projects which generally involved channelization, bank protection, storm drains, or detention/retention facilities. The 47 projects, which were prioritized into a series of 5-year programs, would result in over 2,000 homes and 3 million square feet of commercial and industrial buildings protected from flooding.

### **5. Miscellaneous Capital Projects**

The need for various small, less costly projects was identified to address localized flooding problems throughout the City. These smaller projects generally consisted of roadway culverts, storm drains, channel improvements, and grade control structures.

### **6. Recommendations for Implementation**

Recommendations were prepared for new or revised City policies, regulations, standards, and practices which were necessary to fully implement the Phase II Stormwater Master Plan. The actual development of new or revised polices was completed as part of the TSMS, Phase III, Implementation Program.

The Phase III Implementation Program was initiated in 1996 to develop new or revised City policies, regulations, standards, and practices in order fully implement the Phase II Stormwater Master Plan. The key new or revised items are listed as follows:

1. Revised Drainage Standards Manual,
2. Draft Stormwater Quality Ordinance,
3. Implementation Plan for Preservation of Naturally Vegetated Watercourses,
4. Detailed Scope of Work for Flood Hazard Studies,
5. Detailed Scope of Work for Design Analyses of Capital Improvement Projects,
6. Identification of remapping needs for existing FEMA Flood Insurance Study,
7. Implementation Plan for Miscellaneous Capital Projects, and
8. Plan for Addressing Stormwater Quality and NPDES Requirements.

TSMS serves as the foundation for the FMP, and many reports listed below share the same goals as the TSMS. The reports include:

- 2012 Upper Santa Cruz Discovery Report (FEMA)
- 2012 Pima County Flood Insurance Study (June 16, 2011) (FEMA)
- 2008 Tucson Watercourse Maintenance Guidelines (Tucson)
- 2006 Water Harvesting Guidance Manual (Tucson)
- Pima County Multi-Jurisdictional Hazard Mitigation Plan (PCRFCDD)
- 2003 City of Tucson Habitat Conservation Plan (PCRFCDD)
- 2013 Pima County Community Wildfire Plan (Pima County)
- 2011-2015 Action Plan for Water Sustainability (Tucson)
- 2006 Tucson Parks & Recreation 10-Yr Strategic Plan (Tucson)
- Tucson Police Department Strategic Plan (2013-2018) (Tucson)
- Solving Flooding Challenges with Green Stormwater Infrastructure in the Airport Wash Area (2015) (Tucson Ward 1)
- Plan Tucson: City of Tucson General & Sustainability Plan (2013) (Tucson)
- 2013 City of Tucson Unified Development Code (Tucson)
- 2014 Tucson Emergency Operations Plan
- Multiple PCRFCDD Studies

### IN-PROGRESS /RECENTLY COMPLETED FLOODPLAIN MAPPING STUDIES OF MOST CONCERN FOR TUCSON

1. Arroyo Chico Multi-use Project (*see next page for project overview*)
2. Paseo de Las Iglesias Phase I: Santa Cruz River Bank Protection, Ecosystem Restoration, and Linear Parkway Project
3. Agua Caliente Physical Map Revision
4. Address the Zone A that was added along Pantano Wash due to an unaccredited levee in the June 2011 update to Tucson's Flood Insurance Rate maps.
5. Tucson Water's Re-alignment and Recharge Project.

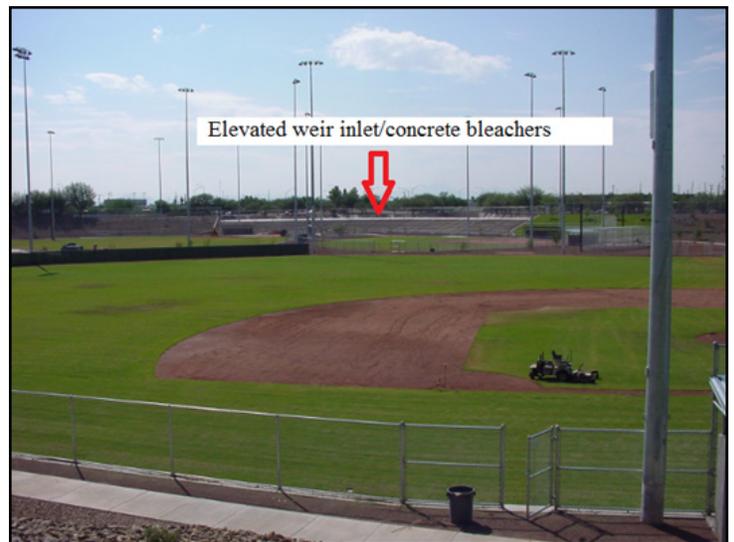
### OVERVIEW: ARROYO CHICO/TUCSON ARROYO FLOODPLAIN REDUCTIONS

The Federal Emergency Management Agency (FEMA) will soon issue a Letter of Map Revision (LOMR) for the remapping of the floodplains for the Tucson Arroyo, Arroyo Chico and High School washes to reflect the drainage improvements for the “Tucson Drainage Area/ Arroyo Chico Multi-Use Project”. This is a US Army Corp of Engineers (USACE) project, in partnership with the Pima County Regional Flood Control District (District) and the City of Tucson. The map revision impact portions of City of Tucson Wards 1, 5 and 6 and Board of Supervisors Districts 3 and 4. The District will be notifying approximately 600 property owners about the upcoming map revision that will be impacting their flood insurance rates. The new LOMR maps will reflect the reduced flood hazards as a result of the project. This is a multi-phase flood control project, and each phase of the project has provided additional benefits to the community and users beyond the direct flood control benefits.

The Tucson Arroyo and its tributaries -- High School Wash, Railroad Wash, Citation Wash, Paseo Grande Wash and Naylor Wash -- drain an area of 11.4 square miles located in central and downtown Tucson. The watershed is fully developed and contains a mix of residential, commercial and industrial areas. The downtown drainage infrastructure was originally constructed in the 1920s, 30's and 40's, which includes 1.7 miles of underground culverts. Because of the increased runoff due to urbanization the capacities of the existing drainage infrastructure was inadequate to convey the peak flows caused by intense thunderstorm events, resulting in frequent and severe flooding of residential, commercial and industrial areas along the entire length of the arroyo. Potential flood damages to both private properties and public infrastructure were estimated by the USACE at \$2.7 million (1998 prices) annually.



**Figure 4. Phase I: The fairways at Randolph South were reconstructed to be storm detention basins.**



**Figure 5. Phase 2A: Cherry Field is now a combination sports facility and a flood control reservoir.**



Figure 6. Phase 2B: Park Avenue Basin 2 Under Construction Storage Sept. 8, 2014.



Figure 7. Phase 2B: Basin 2 Flood.



Figure 8. Increment 4: Construction of High School Wash Storm Drain

### CITY OF TUCSON PARTICIPATION

The City of Tucson has played a major role in the overall Tucson Arroyo and Arroyo Chico improvements. They provided the land for Randolph South Detention Basin, participated in the design and were the contracting agency for the construction of the Randolph South Basins. They also donated a significant portion of the land needed for development of the Park Avenue Basins. The City also donated other lands to TUSD, provided improvements Tucson High School, and allowed temporary use of their parks to offset impact to TUSD during construction of Cherry Field as part of the IGA. The city has also replaced the Arroyo Chico storm drain along 8th street for future transportation improvements, and is planning further upgrades to the storm drain system downstream of Tucson Arroyo as part of with the future “Downtown Links” road improvements.

### PROJECT WEBSITE AND EDUCATION TOOLS

An important component of the FMP process is encouraging community participation in the development of the FMP. A project specific webpage was created on FEMA Region IX's website prior to the first FMP committee meeting. The FMP meeting logistical information was posted to the [www.R9map.org](http://www.R9map.org) webpage for the duration of the project. In addition, meeting minutes and other pertinent information was posted to this location. This information was also posted to Tucson's project webpage [www.tucsonaz.gov/pdsd/floodplain-information](http://www.tucsonaz.gov/pdsd/floodplain-information).

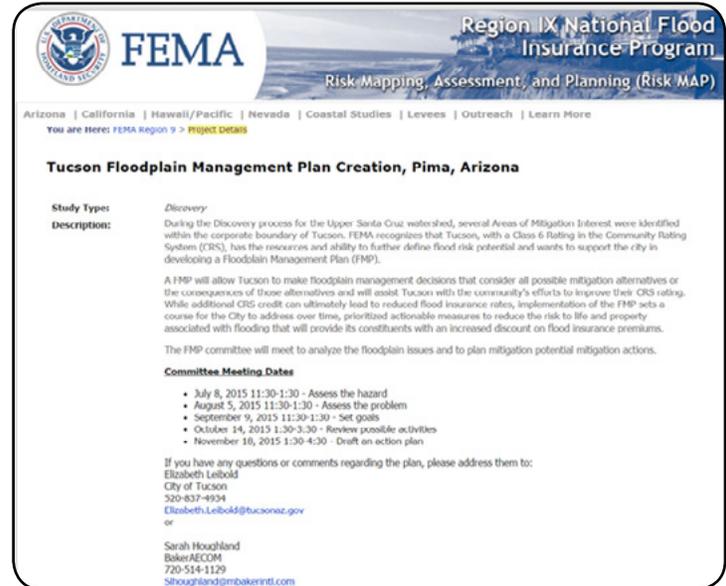


Figure 9. FEMA's Tucson FMP website.

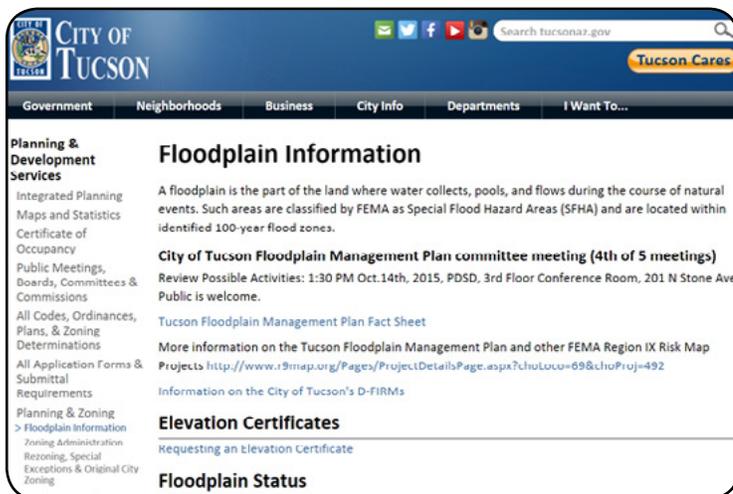


Figure 10. The City of Tucson's FMP information website.

### PUBLIC INVOLVEMENT

#### Planning Process Conducted Through a Planning Committee

In addition to representatives from Tucson's local government, the WG solicited participation from the public and other stakeholders that do not hold positions in any capacity within Tucson's local government were included in the FMP process. As part of the planning process, Tucson residents as well as individuals from local consulting engineering and planning firms, the Pima County Regional Flood Control District, the University of Arizona, and the Tucson of Realtors lent their time and expertise in order to create a robust FMP that will guide Tucson's future project planning.

The committee lists and meeting attendee lists are located in the Appendix of this report.

### Public Meetings Held on Draft Plan/Other Public Information to Encourage Input

On Monday, March 7, 2016, Tucson hosted a public meeting from **5:00 pm to 7:00 pm in the Children's Conference Room at the Joel D. Valdez Main Library, 101 North Stone Avenue, Tucson, AZ 85701**. Members of the Tucson FMP working group presented the draft of the FMP to the community with the intent of soliciting review comments to improve the report's content. A FMP Fact Sheet was also presented at the meeting. In addition to the FMP plan, the City also took this opportunity to present the draft floodplain ordinance to Tucson's residents. Tucson advertised the Open House in The Daily Territorial on February 19, 2016, on the Tucson website at [www.tucsonaz.gov/pdsd/floodplain-information](http://www.tucsonaz.gov/pdsd/floodplain-information) beginning February 17, 2016, and on the FEMA Region IX website [www.R9map.org](http://www.R9map.org) beginning February 17, 2016. The Open House meeting notice, attendee list, and comments are included in the Appendix of this report.

While hard copies of the FMP report were available to review at the Open House, attendees were encouraged to access the project website [www.R9map.org](http://www.R9map.org) and download a digital copy of the report. A Fact Sheet with an executive summary of the FMP and directions to download the report was available at the Open House in case attendees preferred to review a digital copy of the report. The public comment period closed on Monday, March 21, 2016.

The screenshot shows the City of Tucson website interface. At the top left is the City of Tucson logo. To the right are social media icons for email, Twitter, Facebook, YouTube, and Instagram, followed by a search bar for [tucsonaz.gov](http://tucsonaz.gov) and a "Tucson Cares" button. Below the navigation bar are tabs for Government, Neighborhoods, Business, City Info, Departments, and I Want To... The main content area is titled "Floodplain Information" and includes a definition of a floodplain, an announcement for an Open House on March 7, 2016, at the Joel D Valdez Main Library, and links to a fact sheet and more information on the project. A sidebar on the left lists various services under "Planning & Development Services".

**CITY OF TUCSON**

Search [tucsonaz.gov](http://tucsonaz.gov)

Tucson Cares

Government Neighborhoods Business City Info Departments I Want To...

**Planning & Development Services**

- Integrated Planning
- Maps and Statistics
- Certificate of Occupancy
- Public Meetings, Boards, Committees & Commissions
- All Codes, Ordinances, Plans, & Zoning Determinations
- All Application Forms & Submittal Requirements

## Floodplain Information

A floodplain is the part of the land where water collects, pools, and flows during the course of natural events. Such areas are classified by FEMA as Special Flood Hazard Areas (SFHA) and are located within identified 100-year flood zones.

Public is welcome to the Open House for the Tucson Floodplain Management Plan and the Tucson Floodplain Ordinance Update, on Monday, March 7, 2016, from 5 PM to 7 PM at the Joel D Valdez Main Library, 1st floor Children's Conference Room, 101 N Stone Av, Tucson, Arizona, 85701.

[Tucson Floodplain Management Plan Fact Sheet](#)

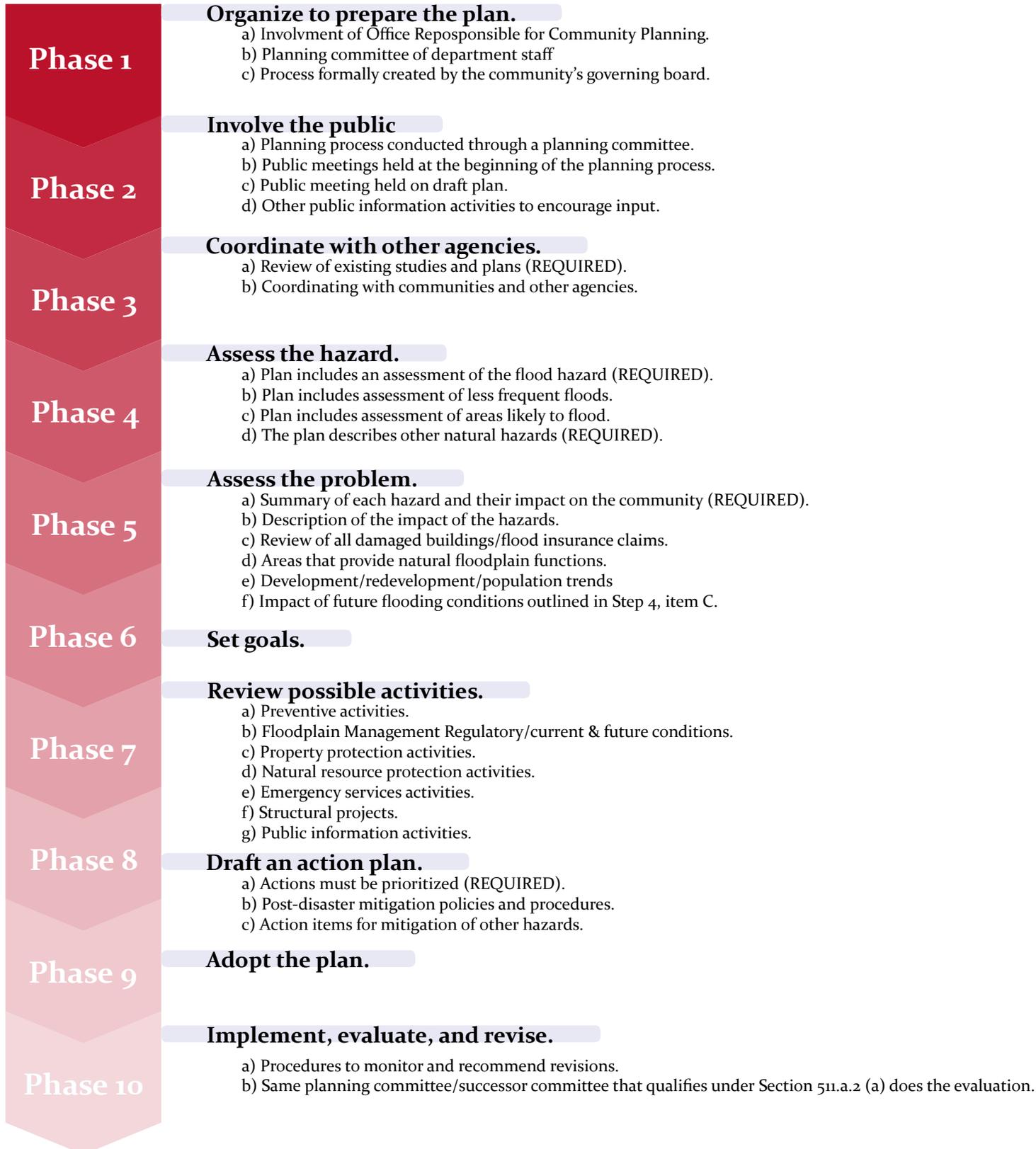
More information on the Tucson Floodplain Management Plan and other FEMA Region IX Risk Map Projects <http://www.r9map.org/Pages/ProjectDetailsPage.aspx?choLoco=69&choProj=492>

[Information on the City of Tucson's D-FIRMs](#)

Figure 11. Public outreach announcement on the City's website.

# COMMUNITY RATING SYSTEM FMP STEPS

The FMP planning process is based on hazard mitigation planning steps and are summarized below:



# Chapter 4

## ASSESSING THE HAZARD

To the credit of the diverse participants, the hazard brainstorming session included a wide array of hazards Tucson faces. The hazards were identified by participants based on experiences and known issues caused by the hazard that have been assessed either via technical data: Discovery Process, Existing Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS), Tucson data studies, PCRFCFCD data studies. Also, public complaints were registered to inform the hazards. The Special Flood Hazard Areas (SFHA) shown on the FIRMs generally formed the basis of the assessment, but Tucson and the PCRFCFCD also have conducted studies that have not been included on the FIRMs and FIS to date that had to be considered. In addition, the four (4) repetitive loss properties were also evaluated. As the committee progressed through the brainstorming session, they also considered areas not mapped on the FIRM that experience flooding either due to riverine flooding or die to a localized flooding problem.

It is important to note that while TSMS is organized on a watershed basis, the FMP will consider Tucson as a whole. The FMP committee decided that the FMP should be more broadly based than TSMS. Since this FMP will be the first for Tucson, the FMP document will be considered a higher level planning document for now. During the 5 year review of the plan, the FMP committee can evaluate whether they want to change the format to being watershed based or if they prefer to continue to look at Tucson as a whole.

The FMP committee brainstorming session produced so many hazards, the WG decided that it would be beneficial to group the hazards into 7 main categories. After reviewing the brainstorming results, 7 overarching categories became apparent. These hazard categories are listed below along with the hazards that were identified. Not all hazards listed in the groupings carry the same weight, but for the sake of this report they will all be discussed in terms of the main category subject. In addition, some hazards are listed in multiple categories.

## FLOOD AREAS WITH UTILITY/MUNICIPAL STRUCTURES

This hazard statement describes the types of structures that are at risk during flooding events for the 1-percent-annual-chance flood event or perhaps for an even lower frequency flooding event. These structures include the different types of utility and municipal structures that are at risk from the SFHA.

- Buildings with sensitive storage
- Critical facilities
- Dams
- Emergency Management buildings
- Existing underground contamination plume areas
- Groundwater contamination
- Land subsidence
- Landfills
- Nursing homes
- Overhead utility lines
- Police/Fire Stations
- Railroads
- Sand & Gravel operations
- Underground utility lines
- Undersize drainage structures
- Wastewater/Effluent Discharge
- Wells

### GEOMORPHOLOGIC FLOOD HAZARDS

This group of hazards designate the multitude of different geomorphological hazards result from flooding. Debris flow is defined in this grouping consists of debris on steep terrain like what is seen in canyon areas.

- Channel headcutting
- Contamination plumes
- Debris flows
- Erosion zone setbacks – mostly an issue in older neighborhoods
- Groundwater contamination
- Land subsidence
- Lateral erosion
- Mud flows
- Natural earth fissures
- Sand and gravel operations
- Sedimentation
- Septic tanks
- Uncertain flow paths
- Wells

### NATURAL FLOODPLAINS

This hazard grouping involved all potential hazards associated with floodplains.

- Alluvial fans
- Bajadas – not as steep as alluvial fans
- Braided flows
- Buffel grass
- City of Tucson Flood Hazard Areas – jurisdictional floodplains
- FEMA floodplains
- ERR floodplain areas
- Environmental Resource Zone floodplain areas
- Flood Hazard Areas
- Habitat issues
- Invasive species
- Monsoons
- Post-wildfire areas
- Regional Watercourses
- Riparian habitat issues
- Sedimentation
- Sheet Flows
- Uncertain flow paths
- Vados
- W.A.S.H. Ordinance watercourses
- Watershed boundaries
- Watersheds

### PRIVATE DRAINAGE INFRASTRUCTURE

This hazard subset is the most difficult to regulate since the hazards occur on private property.

- Channel headcutting
- Detention
- Drywells
- Green infrastructure
- LID
- Lowflow crossing
- Ponding
- Retention
- Riparian habitat issues
- Sedimentation
- Standing water
- Waterharvest areas - techniques should not cause adverse impacts

### PUBLIC INFRASTRUCTURE CONVEYANCE

The hazards in this grouping encompass all potential hazards that arise in the public infrastructure domain.

- Bridges
- Channel headcutting
- Dams
- Detention
- Dip crossings
- Green infrastructure
- Levees
- LID
- Lowflow crossing
- Maintenance of Drainage Facilities
- Non-levee embankments
- Ponding
- Railroads
- Retention
- Riparian habitat issues
- Sedimentation
- Standing water
- Under sized drainage systems
- Undersize drainage structures
- Waterharvest areas - techniques should not cause adverse impacts

### VEGETATION ASSOCIATED FLOOD HAZARDS

This category highlights potential flood hazards that are a result of vegetation in the floodplain.

- Buffel grass
- Debris flows
- Habitat issues
- Illegal dumping
- Invasive species
- Lightning
- Ponding
- Riparian habitat issues
- Standing water

### URBAN HIGH-DENSITY FLOOD AREAS

Tucson is primarily an urban setting so it is not like PCRFC urban watercourse and due to higher population density, encroachment is an issue. As land becomes more scarce, people are being pushed into the floodplain. Floodplain preservation and safety concerns result due to the encroachment.

- Buffel grass
- Channel headcutting
- Critical facilities
- Development
- Drywells
- Erosion zone setbacks
- FEMA flood plain
- Flood Hazard Areas
- Green infrastructure
- Illegal dumping
- Invasive species
- LID
- Lowflow crossing
- MH parks
- Ponding
- Railroads
- Riparian habitat issues
- Sedimentation
- Septic tanks
- Standing water
- Urban agricultural areas in floodplain
- Waterharvest areas – techniques should not cause adverse impacts

The committee then prioritized the hazards according to the group consensus regarding Tucson's overall vulnerability to each hazard. The results were as follows where 1 is the hazard Tucson is most vulnerable to and 7 is the least hazard Tucson is most vulnerable to.

### Tucson's Hazard Vulnerability Assessment:

- 1 Public Infrastructure Conveyance
- 2 Flood Areas with Utility/Municipal Structures
- 3 Urban High-Density Flood Areas
- 4 Private Drainage Infrastructure - The Committee
- 5 Natural Floodplains
- 6 Vegetated Associated Flood Hazards
- 7 Geomorphological Flood Hazards

### OTHER HAZARDS IN TUCSON

In addition to flood hazards, Tucson is also vulnerable to a variety of other natural and man-made hazards. A review of the 2012 Pima County Multi-Jurisdiction Hazard Mitigation Plan (HMP) showed that while Tucson is generally affected by all risk hazard profiles, there is only significant risk from the following hazards (in addition to flood):

- Drought
- Earthquake
- Severe Wind
- Subsidence

### LESS FREQUENT FLOOD HAZARDS

An investigation of the numerous hazards that were identified showed that, somewhat surprisingly, Tucson is not seriously vulnerable by the hazards listed below:

Alluvial Fans: Despite being located in the desert, where conditions are favorable, there are no known alluvial fans in Tucson. A majority of Tucson is located in the valley and not in the foothills or mountains where alluvial fan occurrence makes more sense. Although there are no formal alluvial fans, there are areas throughout the City that exhibit similar characteristics.

Dams: For Tucson, there are 2 dams in the city with one being located in Kennedy Park, and the dams do not pose a significant danger to the community.

Levees: Levees also do not present a significant hazard to Tucson either. The only FEMA accredited levee segments occur along the Santa Cruz River on FIRM panels 04019C1666L, 04019C1667L, 04019C1669L, 04019C1688L, and 04019C2276L for two separate levee segments in northwestern Tucson. Additionally, there is an unaccredited levee along Pantano Wash on FIRM panel 04019C1713L in the northeastern part of the city.

### FUTURE CONDITION CONSIDERATIONS AND THEIR POTENTIAL IMPACT TO FLOODPLAINS

Population: Since the last Census in 2010, the Pima Association of Government (PAG) estimates Tucson's population has grown at a steady, but slow, pace from 0.13% to 1.48%. In the PAG's 2013-2050 Incorporated Places Population Projects for Pima County and incorporated areas, Tucson's population is expected to grow by approximately 1% per year through 2050. Since the population growth isn't expected to increase rapidly and is expected to be on a steady projection, Tucson can take this opportunity to get out ahead of future development in areas where the floodplain mapping is outdated or non-existent.

Development/Redevelopment: Since Tucson is largely developed, new development will occur mostly on the outskirts of the city which also correlates to the more rural areas in the city where the SFHAs are likely old or non-existent. Also, redevelopment in Tucson is likely to occur to replace aging infrastructure. Tucson's floodplain ordinance addresses development issues by defining setbacks along watercourses, outlining other subdivision and development project requirements, and outlining detention and retention system constraints.

## Chapter 4 Cont'd

Climate Change: Currently, Tucson does not have regulations to address climate change outside of the conditions prescribed in Executive Order 13677, *Climate-Resilient International Development*, that was released on September 23, 2014. To meet the requirements in the Executive Order, federally-funded floodplain management projects and activities will be required to include evaluations of potential climate change impacts in Tucson as part of the analysis. The climate change assessment will consider if there are noticeable changes to weather patterns and if there are side effects caused by these changes. The evaluations may have an impact on Tucson's floodplain management practices by influencing regulations, maintenance practices, and hydrologic and hydraulic analysis methodologies.



Figure 12. Climate change will be considered for future federally-funded flood risk projects.

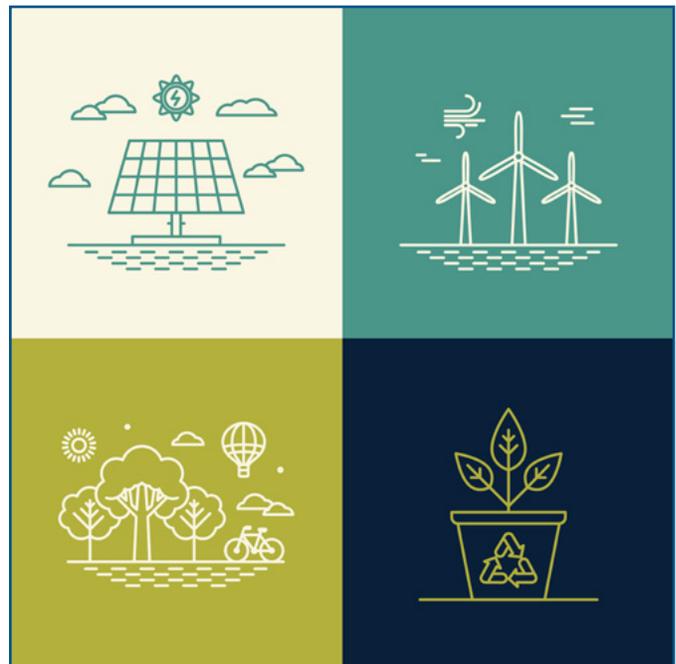


Figure 13. Sustainable practices create vibrant communities.

# Chapter 5

## ASSESSING THE PROBLEM

Seven (7) main hazards were identified and sub-groups were formed based on these hazards which included the following:

1. Public Infrastructure Conveyance
2. Flood Areas with Utility/Municipal Structures
3. Urban High-Density Flood Areas
4. Private Drainage Infrastructure
5. Natural Floodplains
6. Vegetated Associated Flood Hazards
7. Geomorphological Flood Hazards

For each of the 7 main hazard groupings, the problems were assessed according to these criteria that are a description of the impact of the hazards on:

- i. Life, safety, health, procedures for warning and evacuation
- ii. Public health including health hazards to floodwaters/mold
- iii. Critical facilities and infrastructure
- iv. The community's economy and tax base
- v. Number and type of affected buildings

Questionnaires were provided during these breakout sessions to help the committee members organize their thoughts. In the end, the top five (5) problems caused by their assigned hazards were listed.

1. Public Infrastructure Conveyance
  - a. Ingress/egress for access and evacuation
  - b. Inundation, etc., from embankment breach
  - c. Swept away hazard at low water, etc.
  - d. Drowning hazard for ponding
  - e. Loss of utility service
2. Flood Areas with Utility/Municipal Structures
  - f. Emergency response plans are current and active
  - g. Inadequate access to hospitals and emergency resources during a flood event
  - h. Impacts to the cost of developing and attracting new businesses
  - i. Hazards from contamination and debris
  - j. Loss of tax base due to disruptions
3. Urban High-Density Flood Areas
  - k. Erosion
  - l. Contamination of stormwater
  - m. Standing water/ponding – mobility (car, bike, ped., etc.) and West Nile
  - n. Wash clogging (debris, vegetation) – maintenance
  - o. Unplanned historic growth

4. Private Drainage Infrastructure
  - p. Access – ensuring community flow during all issues that may arise with varying problems
  - q. Contamination of groundwater & natural facilities near or adjacent to properties. Be able to make proper notification of hazards whether private or public contaminants
  - r. Erosion and sediment from basins
  - s. Ponding water in all areas & the hazards that may be produced. Public/private notifications.
  - t. West Nile Virus/mosquito transference of unhealthy viruses throughout the neighborhoods and surrounding communities.
5. Natural Floodplains
  - u. Access
  - v. Utilities
  - w. Flood warning program and process
  - x. Pre-1980 structures not compliant
  - y. Regulations & enforcement – keep development out of natural floodplains which poses a challenge and an opportunity for the community
6. Vegetated Associated Flood Hazards
  - z. Debris flows – naturally generated vegetation debris that blocks flows, water conveyance, etc.
  - aa. Invasive species – Buffelgrass and Salt Cedar fire effects & intensity, power poles, utility structures
  - bb. Riparian habitat – human occupancy within the riparian corridor, notification and evacuation of occupants when events occur
  - cc. Ponding – mosquito breeding, public use, potential issues with health
  - dd. Riparian habitat – lack of mapping of what vegetation is actually in the floodplain, where are concentrations of invasive species/good native habitats, etc.
7. Geomorphological Flood Hazards
  - ee. Groundwater contamination – runoff from auto service industry & airport related facilities (surface contamination leading to groundwater contamination); landfills & sand and gravel operations
  - ff. Channel headcutting & erosion – loss of taxable land; economic hardships on the community, property owners; the general public
  - gg. Subsidence – leads to property damage & economic hardship-condemned facilities & structure collapse; leads to fissures/roads & structure damage; alters flow paths
  - hh. Mud flows – road & structure/property damage; infrastructure/facility damage
  - ii. Wells – impacted groundwater; monitoring wells; flumes



Figure 14. Flooding can easily damage city infrastructure.

### REVIEW OF ALL DAMAGED BUILDINGS/FLOOD INSURANCE CLAIMS (HAZUS)

Hazus, FEMA's loss estimation and hazard modeling software, was used to conduct a flood risk analysis based on the 1-percent-annual chance flood event for structures within Tucson. This enhanced analysis leveraged locally managed inventory, hazard, and terrain data.

Parcel boundaries were used in conjunction with assessor data tables to create building centroids representing structure types and values. A comprehensive 1-percent-annual-chance flood event floodplain was developed by combining FEMA and local data sources, and a flood depth grid was developed using a citywide elevation surface derived from Tucson's LiDAR data. These enhanced data inputs were modeled in two Hazus scenarios in order to estimate damages to structures and aggregated census block data within the city.

Tucson has 1,783 flood insurance policies as of February 2016. The policies account for \$1,623,950 in total premiums that represent \$387,788,700 in total coverage. There have been 620 claims in the community. This information was taken from FEMA's Community Information System (CIS) database.

### REPETITIVE LOSS PROPERTY

There are only 4 properties in Tucson that are considered Repetitive Loss Properties. At this time, Tucson has been looking into mitigation actions for the property owners. One of the property owners has taken steps to hire a civil engineer to prepare a drainage report to look at floodproofing to physically help protect the home from flooding from Christmas Wash. Two of the properties are located along Bronx Wash, and the other property is located along Navajo Wash.

# Chapter 6

## SETTING GOALS

Working on the Action Plan as a group included prioritizing actions items and making recommendations as to which actions would be included in the report. Time was also utilized to discuss post-disaster mitigation policies and procedures and action items of mitigation of other hazards. The goals the committee identified align with Tucson's overall goals, and they support the FMP committee's vision for how Tucson can address flood hazards in the future. The goals can be directly correlated to the community's hazard mitigation activity strategies, and a brief discussion of how each goal furthers Tucson's objectives has been included below the goal statement.

THE CITY OF TUCSON FLOODPLAIN MANAGEMENT PLAN GOAL IS TO;

**Reduce flood and erosion hazards, damage, and associated costs by:**

- Identifying high-risk areas.
- Providing safe, efficient, and balanced conveyance for stormwater runoff.
- Maintaining, enhancing and/or restoring riparian ecosystems and wildlife corridors.
- Increasing community awareness of water harvesting methodologies, floodplain preservation measures, and general flood and erosion information.
- Expanding incentives for private property owners and developers to implement sustainable flood and erosion hazard mitigation strategies.

1. Identifying high-risk areas. While many flooding sources in Tucson have been mapped and officially recognized by FEMA, the city acknowledges that some flooding sources are in need of restudies due to development and other pressures. In addition, determining the locations of the high-risk areas will help inform capital improvement plans, outreach strategies, and emergency management plans in addition to having many other purposes.
2. Providing safe, efficient, and balanced conveyance for stormwater runoff. Whether this goal is referring to capital improvement projects or to restoring natural watercourses, the intent is for Tucson to address areas where stormwater runoff causes an issue for its residents in the manner described by the goal statement.
3. Maintaining, enhancing and/or restoring riparian ecosystems and wildlife corridors. This goal is important to Tucson because the community is proud of and protective of its natural resources. Tucson is a unique desert community, and its natural features make it a desirable place to explore. Protecting the natural habitat while balancing the pressures an urban community faces is of the highest importance.
4. Increasing community awareness of water harvesting methodologies, floodplain preservation measures, and general flood and erosion information. Enhancing and diversifying community outreach activities will be a focus for Tucson. It is important to understand your community prior to formulating an outreach plan. For Tucson, a systematic and targeted approach to disseminate information is likely the best way to deliver the messages regarding the topics listed in the goal statement.
5. Expanding incentives for private property owners and developers to implement sustainable flood and erosion hazard mitigation strategies. The intent of this goal is to foster community support and awareness of flood hazards. By providing incentives to property owners, Tucson will likely be more successful in achieving its floodplain management objectives.



Figure 15. Sandbagging is an easy and cost-effective technique to battle flooding.

## REVIEWING POSSIBLE ACTIVITIES

All major problems caused by the hazards were assessed by reviewing them in consideration to the possible activities that can be implemented to address the hazards and further Tucson's FMP goals. The possible activity topics included:

- i. Preventive activities
- ii. Floodplain management regulatory/current & future conditions
- iii. Property protection activities
- iv. Natural resource protection activities
- v. Emergency services activities
- vi. Structural projects
- vii. Public information activities

The committee considered all possible activities as potential mitigation measures, noting which ones were valid and which ones should not be considered. The problem statements were arranged in matrices according to hazard, and the top five problems caused each problem were listed so that they could be assessed in regards to the potential mitigation activities in a systematic way. Blanks in the matrices mean that the activities were considered, but the FMP committee did not deem them applicable. The full spreadsheets are located in the Appendix of this report. As the committee filled out the matrices, they were asked to highlight the activities the committee recommended most for those problem statements. Although not all activities were selected for inclusion in the action plan, the City will catalogue all responses to consider for future updates to the FMP.



Figure 16. Tucson's landscape in bloom.

# Chapter 8

## ACTION PLAN

Building on the work completed by reviewing the potential mitigation activities, the committee then reviewed the activities that were considered valid and then recommended 3 to 5 that could be implemented for each of the 7 major hazard groups. Projects in the 2012 Pima County Hazard Mitigation Plan are also identified in this report.

**These four (4) questions were evaluated for each recommendation, and these items must be identified in the Action Plan:**

- 1** Who is responsible for implementing the action?
- 2** When it will be completed?
- 3** How it will be funded?
- 4** What goal does the action support?

## MITIGATION ACTIVITY SUMMARY PRIORITIZATION

The following flooding projects were included in the 2012 Pima County HMP:

**Table 3. Actions for Flood Hazards Listed in the HMP**

Mitigation Action/Project	Hazard(s) Mitigated	Estimated Cost/Funding Source	Completion Date	Responsible Agency
Identify funding source and construct two bridges and 50 box culverts with 380 back-up power units for signalized intersections at high flood hazard crossings in City of Tucson limits in accord with the COT Department of Transportation 5year plan. If a box culvert cannot be constructed an automated warning device, consisting of a barricade, signs and flashing lights would be installed.	Flood, Severe Wind	\$100 million, Staff Time Grant Funds	Ongoing effort with long-term horizon. Schedule dependent upon funding.	Department of Transportation/Streets Administrator and Streets Chief Engineer
Promote Disaster-resistant water delivery system by constructing redundant water transmission lines (e.g. The Utility and the community will be less susceptible to loss of water delivery due to natural or manmade disasters).	All	7.9 million Operations Budget	Ongoing with full completion by 2020.	Water Department/Water Administrator Maintenance & Operations
Re-direct drainage canal at Barrio Viego to prevent continued repetitive losses.	Flood	\$425,000 Grant Funds, General Fund, PCRFCF	2013	Transportation Dept/Project Administrator
In compliance with the NFIP, the City of Tucson will continue to require the preparation and submittal of a CLOMR or CLOMRF for all proposed development within FEMA delineated SFHAs The Town of Tucson will maintain compliance with NFIP regulations by enforcement of the current floodplain management ordinance through review of new development located in the floodplain and issuance of floodplain use permits.	Flood	Staff Time	Annual - Ongoing	Development and Planning Services Department/Director
Improve floodplain administration under the NFIP program by sending inspectors into the field when we receive a flood warning from the National Weather Service, to assess bridges, washes and other critical infrastructures within the City of Tucson.	Flood	Staff Time	Annual - Ongoing	Development and Planning Services Department/Director

### POST-DISASTER MITIGATION POLICIES AND PROCEDURES (2014 TUCSON)

The 2014 Tucson Emergency Operations Plan defines activities that need to be conducted following a disaster. The Emergency Operations Plan lists organizations that take part of the emergency response and the different roles the organizations are responsible for during a disaster. The Tucson Office of Emergency Management and Homeland Security and the Emergency Support Function Leaders Group are the main organizations responsible for coordinating policy and the different groups within Tucson that are in charge of the management of the Emergency Operations Plan. Multiple support agencies participate in long-term incident management and recovery operations. The plan also specifies the information that is required in the After-Action Report (AAR) that summarizes emergency response successes along with recommendations for future improvements.

### ACTION ITEMS FOR MITIGATION OF OTHER HAZARDS

The following mitigation actions and projects summaries were taken from the 2012 Pima County HMP. This project list only contains action items for hazards other than flood. All flood hazard projects have been included in the recommendation matrices listed in a previous section.

**Table 4. HMP Action for other Hazards**

Mitigation Action/Project	Hazard(s) Mitigated	Estimated Cost/Funding Source	Completion Date	Responsible Agency
Tucson Water, a division of the Utility Services Department, will secure its assets and facilities by implementing actions as identified in the Federally mandated Water System Vulnerability Assessment completed in October 2002.	Terrorism, Vandalism	\$20 million Operations Budget	On-going with full completion by 2020	Water Department/Water Engineer & Operations
Work with the Arizona Geological Society and USGS on projects that mitigate geo-hazards (e.g. Continue the feasibility study with the AZGS and USGS Water Plan 2000-2050. Construct second recharge facility to be known as the Southern Avra Valley Recharge and Recovery Project (SAVSARP). The utility could then use its entire allotment of Central Arizona Project water and provide capacity for recharging additional water supplies. Construction will take 5 years.)	Drought, Earthquake, Subsidence, other geo-hazards	\$51.2 million Operations Budget	Ongoing effort with long term horizon. Schedule dependent upon funding	Water Department/Staff

## PLAN ADOPTION AND FMP MAINTENANCE STRATEGY

### ADOPTION BY TUCSON CITY COUNCIL

Tucson Mayor and Council adoption information will be added following plan adoption.

### FMP MAINTENANCE STRATEGY

The FMP committee will convene on a yearly basis to monitor and assess the action plan implementation process. The committee will prepare an evaluation report to submit with Tucson's annual CRS recertification documentation. Per CRS guidelines, the report "must be submitted to the governing body, released to the media, and made available to the public."

In 2020, the Tucson FMP committee will convene to review the 2016 FMP and to make updates by October 1, 2020, or four years after the plan was adopted. Following the initial update, the FMP evaluation and updates can be scheduled to occur concurrently with the community's normal 5-year CRS review cycle for the other CRS activities. In addition, it would be beneficial if the FMP and CRS review cycles synched up with the Pima County HMP process so that the project lists in the FMP and HMP match. The FMP review cycle tasks should include at a minimum:

1. Convene the same committee that prepared the plan or one that meets the criteria identified in the CRS manual.
2. Hold a public meeting to review the updated report.
3. Review new studies and information that was completed after the FMP was created.
4. Review the hazard and problem assessments and update if necessary.
5. Review goals and update if necessary.
6. Review the action plan and update to account for actions that were completed, ones that are no longer necessary, and to add in new actions.
7. Adoption by Mayor and Council.

During the 5 year plan review, the FMP committee can evaluate whether they want to change the format of the report to being watershed based off if they prefer to continue to view Tucson as a whole.

## REFERENCES

- 2010 Census [www.factfinder.census.gov](http://www.factfinder.census.gov)
- 2013 Community Rating System Manual (FEMA)
- 2012 Upper Santa Cruz Watershed Discovery Report (FEMA)
- Pima County Flood Insurance Study (June 16, 2011) (FEMA)
- Tucson Stormwater Management Study (Tucson)
- 2008 Tucson Watercourse Maintenance Guidelines (Tucson)
- 2006 Water Harvesting Guidance Manual (Tucson)
- 2012 Pima County Multi-Jurisdictional Hazard Mitigation Plan (PCRFCFCD)
- 2003 City of Tucson Habitat Conservation Plan (PCRFCFCD)
- 2013 Pima County Community Wildfire Plan (Pima County)
- 2011-2015 Action Plan for Water Sustainability (Tucson)
- 2006 Tucson Parks & Recreation 10-Yr Strategic Plan (Tucson)
- Tucson Police Department Strategic Plan (2013-2018) (Tucson)
- Solving Flooding Challenges with Green Stormwater Infrastructure in the Airport Wash Area
- ERZ and WASH Ordinances Watercourse Analysis: Southeast Region & TSMS Recommendations (Tucson, Department of Transportation)
- Sustainability Tools for Assessing & Rating Communities/STAR (Tucson Office of Integrated Planning)
- Plan Tucson: City of Tucson General & Sustainability Plan (2013) (Tucson)
- Arroyo Chico Post Project Conditions Map (PCRFCFCD)
- ALERT System Map & Rain Gauge Data (PCRFCFCD)
- Solving Flooding Challenges with Green Stormwater Infrastructure in the Airport Wash Area (PCRFCFCD, Tucson Ward 1)
- Take Back Our Parks (Tucson Ward 4)
- Lee Moore Wash Basin Management Study (PCRFCFCD/Tucson)
- Ruthruaff Basin Management Plan (PCRFCFCD)
- Arroyo Chico Multi-Use Project (PCRFCFCD)
- Pantano Wash Bank Protection & River Park: Craycroft Road to Tanque Verde Road (PCRFCFCD)
- Paseo de las Iglesias Phase I: Santa Cruz River Bank Protection, Ecosystem Restoration, and Linear Parkway, Ajo Way to Silverlake Road (PCRFCFCD)
- Green Valley Drainageway #6 Improvements (PCRFCFCD)
- Mission View Wash Drainage Improvements (PCRFCFCD)
- Pantano Wash Bank Protection - Speedway Blvd. to Tanque Verde Rd (PCRFCFCD)
- Airport Wash South Basin Management Study (PCRFCFCD)
- Green Valley Hydrology Study (PCRFCFCD)
- Agua Caliente Wash Letter of Map Revision (PCRFCFCD)
- Santa Cruz River at Grant Road Floodplain Study (PCRFCFCD)
- PAG's 2013-2050 Incorporated Places Population Projects for Pima County and incorporated areas
- FEMA's Community Information System
- 2014 Tucson Emergency Operations Plan

# Appendices

## APPENDICES

The full report can be downloaded at [www.R9map.org](http://www.R9map.org). The appendices to this report include information regarding:

- Tucson City Council Adoption Resolution
- Open House Notice, Attendee List, and Public Comment Summary
- Project Fact Sheet
- FMP Committee Meeting Minutes & Attendance Tracking
- Action Plan Potential Activities List
- 510 FMP Checklist
- Risk MAP Products

# Action Plan

The Tucson FMP committee came up with one defining Action Plan Goal that aligns with Tucson's overall goals. This goal can be directly correlated to the community's hazard mitigation activity strategies, and a brief discussion of how each goal furthers Tucson's objectives has been included below the goal statement.

THE CITY OF TUCSON FLOODPLAIN MANAGEMENT PLAN GOAL IS TO;

**Reduce flood and erosion hazards, damage, and associated costs by:**

- Identifying high-risk areas.
- Providing safe, efficient, and balanced conveyance for stormwater runoff.
- Maintaining, enhancing and/or restoring riparian ecosystems and wildlife corridors.
- Increasing community awareness of water harvesting methodologies, floodplain preservation measures, and general flood and erosion information.
- Expanding incentives for private property owners and developers to implement sustainable flood and erosion hazard mitigation strategies.

Table 5. Action Plan

Problem Statement	Recommended Activity	Responsible Party	Target Completion Date	Goal Activity Supports				
				1	2	3	4	5
Public Conveyance Infrastructure	Research high-risk dip crossing locations and look into replacing dip crossings with 100-year drainage structures.	City Engineer, TDOT, Floodplain Manager, Permits Manager. Planning & mapping in progress.	On-going effort with long-term horizon. Schedule dependent upon funding.	X	X		X	
	Map all-weather access routes in the City.		2017	X	X		X	
	Map areas where barricades are used for low water crossing. Assess / expand Operation Splash. (TDOT Engineer)		2017	X	X		X	
	Assure Utilities are obtaining required permits.		Annual - On-going		X		X	
	Provide one-hundred year conveyance structures.		On-going effort with long-term horizon. Schedule dependent upon funding.	X	X		X	
Utility Municipal Structures	Annual Plan and Implement: Educate crews. Encourage consistency between agencies/jurisdiction. Have Operations & Maintenance Forces remove trash, debris, landscaping clippings from public ROW. Promote Routine Maintenance with a plan for crew / educate crews.	Operations & Maintenance	Annual - On-going	X			X	
	Meetings on a "Annual" Basis, Educate & Outreach, Open Houses/PSA's/HOA's, Newsletters, Annual Outreach to the Public and share the Emergency Response Plan(s)	Floodplain Manager, Public Information Office	Annual - On-going			X	X	X
	Map water lines and note condition of lines that run under flood retarding structures such as UPRR and ADOT embankments. Prepare for All Utilities	TDOT, Floodplain Manager	2017	X				
Urban High Density	Identify locations along stormwater conveyance system that are at high risk of erosion; and routinely monitor at least annually and especially after major flow events	TDOT Stormwater Management	2017 and monitor on an annual basis	X	X			
	Provide routine maintenance to prevent and remove accumulation of debris; and provide public information on how to prevent clogging and obstruction of stormwater conveyance system	TDOT	Annual - On-going	X			X	X
	Include policy in Stormwater Management Plan to update plan every 5 to 10 years or as reasonable to address population migration and annexations	TDOT Stormwater Management	On-going effort to be revisited every 5 to 10 years.	X	X			
	Coordinate with ecologist/biologists ramification of standing water in natural resource areas and implement acceptable mitigation practices	TDOT Stormwater Management	On-going effort with long-term horizon. Schedule dependent upon funding.	X		X	X	X
	Comply with MS4 permit requirements	TDOT Stormwater Management	Annual - On-going	X	X	X	X	X
Private Drainage Infrastructure	Create list and obtain focused flood hazard studies to rank areas that need to be addressed. Create map of high incident of access issues for emergency response activities.	TDOT/Dev. Services with funding from RFCD	2017 and monitor on an annual basis	X			X	
	Educate property owners, HOA's, realtors, insurance agents, landlords, and general public.	Environmental Services	Annual - On-going				X	X
	Incorporate proper sediment traps, utilize water harvesting to minimize sediment from unstable soil.							
	Establish positive drainage during construction & maintain throughout life of facility.							
	R & D BMP to improve soil infiltration & minimize compaction utilizing native grasses/trees/organic desert mulch.	Development Services	Annual - On-going					X

Table 5. Action Plan

Problem Statement	Recommended Activity	Responsible Party	Target Completion Date	Goal Activity Supports				
				1	2	3	4	5
Natural Floodplains	Produce overlays of priority areas where known roadway, infrastructure, structure areas have had flooding issues from vegetative debris flow - City of Tucson to map and describe flood plain road crossing (bridge span, culvert crossing, low water hardened crossing) and rate the effectiveness of flood water conveyance, ad structure integrity ( <u>High Impact: in channelized waterways - not going in for natural areas?</u> )	TDOT Stormwater Management	2016 and monitor on an annual basis	X	X	X		
	City of Tucson will develop habitat management plans that include and are complimentary to WASH ordinance requirements, ERZ code (restricting development within the flood plain), the ERR reporting requirements for proposed floodplain disturbance and all other applicable local, state, and federal codes, ordinances or regulations ( <u>High Impact</u> )	TDOT Stormwater Management	2017		X	X		
	City of Tucson to work with Tucson Clean and Beautiful to delineate target areas for intense public outreach on managing flood waters and family safety tips during floods ( <u>Maintenance Practices, flood prevention, opportunities, involvement</u> )	Tucson Clean & Beautiful	2017 and monitor on an annual basis				X	
	City of Tucson to locate, map and prioritize areas of significant channel head cutting adjacent to private property	TDOT Stormwater Management	2016	X				
	City of Tucson will develop recommendation for acquisition, relocations or additional flood protective measures for at-risk properties ( <u>TCB Involvement</u> )	Tucson Clean & Beautiful	2016 and monitor on an annual basis	X	X			X
	City of Tucson would work with Tucson Clean and Beautiful and Southern Arizona Buffelgrass Coordination Center in producing information brochures designed for city elected officials, administrator and additional information for the general public informing of the value of healthy riparian corridors within the City of Tucson and planned management activities to maintain and enhance riparian corridors for the City resident's quality of life ( <u>TCB Involvement</u> )	Tucson Clean & Beautiful, South Arizona Buffelgrass Coordination Center	2017 and monitor on an annual basis				X	
	Multi-jurisdictional Flood Panel - for Realtors - floodplain info outreach activity. City of Tucson to develop informational pamphlets, bulletins and other communication to be delivered to transient encampment warning of dangers of occupancy in the flood plain due to potential flood and fire	Tucson Realtors Association, TDOT Stormwater Management	2016 and monitor on an annual basis	X			X	
	City of Tucson to produce geo-database of all critical structure infrastructure within flood plain and flood prone areas by September 2016	TDOT Stormwater Management	2016 and monitor on an annual basis	X			X	
	City of Tucson to review ERZ code, WASH ordinance, ERR standards to develop vegetation management guidelines including trimming woody vegetation to 6 feet above ground, describe seed mix for herbaceous understory of perennial grasses for soil stabilization within 0.5 miles upstream of priority water conveyance impact areas	TDOT Stormwater Management	2017	X				

Table 5. Action Plan

Problem Statement	Recommended Activity	Responsible Party	Target Completion Date	Goal Activity Supports				
				1	2	3	4	5
Vegetated Hazards	City of Tucson will map and describe vegetative associations to the alliance level within watercourses using Manning n values, hydraulic vegetation density ( <u>COT GIS - COT Engineering</u> )	TDOT GIS	GIS shapefiles 1st qtr 2016, vegetation mapping 2nd 3rd qtr 2016 and 2017 priority HUCs, density calculations find mapping 4th qtr 2016, COT Engineering appropriate funds, FEMA grant 2017 pre disaster grant	X	X	X		
	City of Tucson will work with the Southern Arizona Buffelgrass Coordination Committee to develop (or expand) and recommend incentives for private land owners and developers to implement programs to reduce invasive species within flood prone areas - and assist in riparian habitat restoration	TDOT Stormwater Management	3rd qtr 2017 after #1 vegetation and density mapping completed Funding - SABCC, COT Engineering appropriated funds				X	X
	City of Tucson to review ERZ code, WASH ordinance, ERR standards to develop vegetation management guidelines including trimming woody vegetation to 6 feet above ground, describe seed mix for herbaceous understory of perennial grasses for soil stabilization within 0.5 miles upstream of priority water conveyance impact areas	TDOT Stormwater Management	2017			X		
Geomorphological	Watershed management planning that includes restrictions for retention systems where groundwater contamination occurs. Onsite Containment (require properties with hazardous materials to construct basins to store and treat runoff) Contamination Hotline	TDOT Stormwater Management	2017 and monitor on an annual basis	X	X		X	
	Inspection & Maintenance program. Also, map locations of high-risk erosion hazard areas. Inspection & Maint. Program. Erosion Damage Hotline (where residents can call a central phone # to report erosion risk or damage to infrastructure like roads and utilities).	TDOT Stormwater Management	Annual - On-going	X		X	X	
	Emergency Service & Utility Notification Hotline	TDOT Stormwater Management	2017 and monitor on an annual basis				X	
	Bank Stabilization. Revegetation of Slopes. Post-fire reseeding programs to help reduce soil transport after storm events in rural areas.	TDOT Stormwater Management	Annual - On-going		X	X		
	Erosion Hazard setback regulations - update to reflect higher risk areas. Mapping Risk Areas ( <u>PCFCD</u> )	TDOT Stormwater Management	Annual - On-going		X	X		
	PSAs, public information through utility bills and building permits. Explain what is practical for erosion prevention for desert climate area.	TDOT Stormwater Management	Annual - On-going				X	