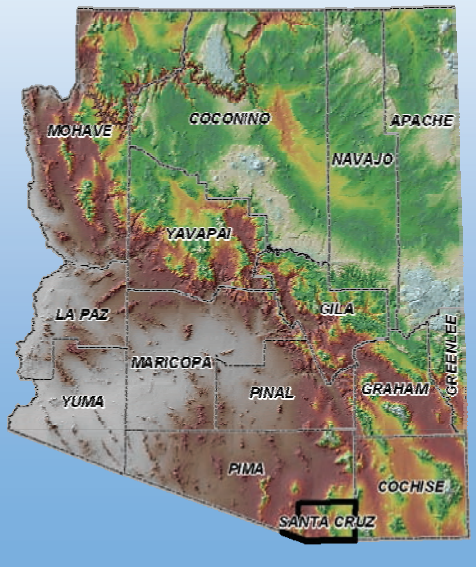
# Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan 2011



# EXECUTIVE SUMMARY

Across the United States, natural and human-caused disasters have led to increasing levels of death, injury, property damage, and interruption of business and government services. The toll on families and individuals can be immense and damaged businesses cannot contribute to the economy. The time, money and effort to respond to and recover from these emergencies or disasters divert public resources and attention from other important programs and problems. With 36 federal or state declarations, 98 other significant events, and a combined total of 134 disaster events recorded, the three jurisdictions within Santa Cruz County, Arizona participating in this planning effort, recognize the consequences of disasters and the need to reduce the impacts of natural and human-caused hazards. The county and jurisdictions also know that with careful selection, mitigation actions in the form of projects and programs can become long-term, cost effective means for reducing the impact of natural and human-caused hazards.

The elected and appointed officials of Santa Cruz County, Nogales, and Patagonia demonstrated their commitment to hazard mitigation in 2005-2006 by preparing the first Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan (2006 Plan). The 2006 Plan was approved by FEMA on March 23, 2006 and now requires a full, FEMA approved, update due to its five year expiration.

In response, the Arizona Division of Emergency Management (ADEM) secured a federal planning grant and hired JE Fuller/ Hydrology & Geomorphology, Inc. to assist the county and participating jurisdictions with the update process. Santa Cruz County reconvened a multi-jurisdictional planning team comprised of veteran and first-time representatives from each participating jurisdiction, various county and local departments and organizations, and ADEM. The Planning Team met four times during the period of October 2010 to April 2011 in a collaborative effort to review, evaluate, and update the 2006 Plan. The resulting Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan (Plan) will continue to guide the county and participating jurisdictions toward greater disaster resistance in full harmony with the character and needs of the community and region.

The Plan has been prepared in compliance with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 U.S. C. 5165, enacted under Sec. 104 the Disaster Mitigation Act of 2000, (DMA 2000) Public Law 106-390 of October 30, 2000, as implemented at CFR 201.6 and 201.7 dated October, 2007. The Plan identifies hazard mitigation measures intended to eliminate or reduce the effects of future disasters throughout the county, and was developed in a joint and cooperative venture by members of the Santa Cruz County Planning Team.

# TABLE OF CONTENTS

**SECTION 1: JURISDICTIONAL ADOPTION AND FEMA APPROVAL ..... 1**
**1.1 DMA 2000 Requirements ..... 1**
1.1.1 General Requirements ..... 1
1.1.2 Update Requirements ..... 1
**1.2 Official Record of Adoption ..... 2**
**1.3 FEMA Approval Letter ..... 2**

**SECTION 2: INTRODUCTION ..... 5**
**2.1 Plan History ..... 5**
**2.2 Plan Purpose and Authority ..... 5**
**2.3 General Plan Description ..... 5**
**2.4 Overall Plan Update Process ..... 5**

**SECTION 3: PLANNING PROCESS ..... 9**
**3.1 Planning Process Description ..... 9**
**3.2 Previous Planning Process Assessment ..... 9**
**3.3 Primary Point of Contact ..... 9**
**3.4 Planning Teams ..... 10**
3.4.1 Planning Team Assembly ..... 10
3.4.2 Planning Team Activities ..... 11
3.4.3 Agency/Organizational Participation ..... 13
**3.5 Public Involvement ..... 14**
3.5.1 Previous Plan Assessment ..... 14
3.5.2 Plan Update ..... 15
**3.6 Reference Documents and Technical Resources ..... 15**

**SECTION 4: COMMUNITY DESCRIPTIONS ..... 19**
**4.1 General ..... 19**
**4.2 County Overview ..... 19**
4.2.1 Geography ..... 19
4.2.2 Climate ..... 23
4.2.3 Population ..... 25
4.2.4 Economy ..... 26
**4.3 Jurisdictional Overviews ..... 29**
4.3.1 Nogales ..... 29
4.3.2 Patagonia ..... 31

**SECTION 5: RISK ASSESSMENT ..... 33**
**5.1 Hazard Identification and Screening ..... 33**
**5.2 Vulnerability Analysis Methodology ..... 36**
5.2.1 General ..... 36
5.2.2 Calculated Priority Risk Index (CPRI) Evaluation ..... 36
5.2.3 Asset Inventory ..... 37
5.2.4 Loss Estimations ..... 40
5.2.5 Development Trend Analysis ..... 41
**5.3 Hazard Risk Profiles ..... 41**
5.3.1 Dam Failure ..... 43
5.3.2 Drought ..... 51
5.3.3 Extreme Temperature ..... 59
5.3.4 Flood / Flash Flood ..... 63
5.3.5 Hazardous Materials Incidents ..... 71
5.3.6 Severe Wind ..... 77
5.3.7 Wildfire ..... 81
**5.4 Risk Assessment Summary ..... 88**

**SECTION 6: MITIGATION STRATEGY** ..... **89**
**6.1 Hazard Mitigation Goals and Objectives** ..... **89**
**6.2 Capability Assessment** ..... **92**
6.2.1 Jurisdictional Capabilities ..... 93
6.2.2 Previous Mitigation Activities ..... 101
6.2.3 National Flood Insurance Program Participation ..... 103
**6.3 Mitigation Actions/Projects and Implementation Strategy** ..... **104**
6.3.1 Previous Mitigation Actions/Projects Assessment ..... 104
6.3.2 New Mitigation Actions / Projects and Implementation Strategy ..... 116

**SECTION 7: PLAN MAINTENANCE PROCEDURES** ..... **121**
**7.1 Monitoring and Evaluation** ..... **121**
**7.2 Plan Update** ..... **122**
**7.3 Incorporation into Existing Planning Mechanisms** ..... **122**
**7.4 Continued Public Involvement** ..... **123**

**SECTION 8: PLAN TOOLS** ..... **125**
**8.1 Acronyms** ..... **125**
**8.2 Definitions** ..... **126**

## LIST OF MAPS

**Maps 1A and 1B – Dam Failure Hazard Map(s) – County Wide**

**Maps 1C – Dam Failure Hazard Maps – Nogales**

**Map 2A – Flood Hazard Map – County Wide**

**Maps 2B and 2C – Flood Hazard Maps – Nogales and Patagonia**

**Maps 3A – HAZMAT Hazard Map – County Wide**

**Maps 3B and 3C – HAZMAT Hazard Maps – Nogales and Patagonia**

**Maps 4A – Wildfire Hazard Map – County Wide**

**Maps 4B and 4C – Wildfire Hazard Maps – Nogales and Patagonia**

## LIST OF FIGURES

**Figure 4-1: Vicinity Map** ..... **20**

**Figure 4-2: Transportation Routes Map** ..... **21**

**Figure 4-3: Terrestrial Ecoregions Map** ..... **22**

**Figure 4-4: Daily Temperatures and Extremes for Nogales 6N, Arizona** ..... **24**

**Figure 4-5: Daily Temperatures and Extremes for Canelo 1 NW, Arizona** ..... **24**

**Figure 4-6: Monthly Climate Summary for Nogales 6N, Arizona** ..... **25**

**Figure 4-7: Monthly Climate Summary for Canelo 1 NW, Arizona** ..... **25**

**Figure 4-8: 2010 Land Ownership Map for Santa Cruz County** ..... **28**

**Figure 4-9: City of Nogales Land Ownership and Location Map** ..... **30**

**Figure 4-10: Town of Patagonia Land Ownership and Location Map** ..... **32**

**Figure 5-1: Nogales, Sonora dam locations** ..... **46**

**Figure 5-2: Average statewide precipitation variances from a normal based on 1971-2000 period ..... 52**

**Figure 5-3: Average statewide precipitation variances from a normal based on 1998 - 2009 period ..... 52**

**Figure 5-4: U.S. Drought Monitor Map for July 26, 2011 ..... 53**

**Figure 5-5: U.S. Seasonal Outlook, July to October, 2011 ..... 54**

**Figure 5-6: Arizona short term drought status map as of July 26, 2011 ..... 55**

**Figure 5-7: Arizona long term drought status map for April 2011 ..... 56**

**Figure 5-8: National Weather Service Heat Index Chart ..... 61**

**Figure 5-9: Murphy Complex Fire Burn Severity Map ..... 82**

**Figure 6-1: Past Mitigation Projects in Arizona ..... 101**

## LIST OF TABLES

**Table 2-1: 2006 Plan review and 2011 Plan correlation ..... 6**

**Table 3-1: List of jurisdictional primary points of contact ..... 10**

**Table 3-2: Multi-jurisdictional planning team participants ..... 11**

**Table 3-3: Planning meetings convened as part of the plan update process ..... 12**

**Table 3-4: Comparative summary of agency/organization participation in the plan update process ..... 14**

**Table 3-5: List of resource documents and references reviewed and incorporated in the plan update process ..... 16**

**Table 4-1: Jurisdictional population estimates for Santa Cruz County ..... 26**

**Table 5-1: Initial hazard identification lists ..... 34**

**Table 5-2: State and Federally Declared Natural Hazard Events That Included Santa Cruz County – January 1966 to August 2010 ..... 35**

**Table 5-3: State and Federally Declared Natural Hazard Events That Included Santa Cruz County – January 1966 to August 2010 ..... 35**

**Table 5-4: Santa Cruz County Undeclared Historic Hazard Events – September 1960 to January 2011 ..... 35**

**Table 5-5: Calculated Priority Risk Index (CPRI) categories and risk levels ..... 38**

**Table 5-6: Asset inventory structure counts by category and jurisdiction as of April 2011 ..... 40**

**Table 5-7: ADWR safety categories ..... 44**

**Table 5-8: Downstream hazard potential classes for state regulated dams ..... 45**

**Table 5-9: NID and ADWR dams by hazard classification ..... 45**

**Table 5-10: CPRI results by jurisdiction for dam failure ..... 47**

**Table 5-11: Asset inventory losses due to dam failure flooding ..... 48**

**Table 5-12: Population sectors exposed to dam failure flooding ..... 48**

**Table 5-13: Santa Cruz County HAZUS building exposure to dam failure ..... 49**

**Table 5-14: City of Nogales HAZUS building exposure to dam failure ....49**

**Table 5-15: Town of Patagonia HAZUS building exposure to dam failure ....50**

**Table 5-16: Unincorporated Santa Cruz County HAZUS building exposure to dam failure ....50**

**Table 5-17: CPRI results by jurisdiction for drought ....55**

**Table 5-18: CPRI results by jurisdiction for extreme temperature ....60**

**Table 5-19: CPRI results by jurisdiction for flooding ....65**

**Table 5-27: Repetitive Loss property statistics for Santa Cruz County jurisdictions ....66**

**Table 5-20: Asset inventory exposure to high and medium hazard flooding and corresponding loss estimates ....67**

**Table 5-21: Population sectors exposed to high and medium hazard flooding ....67**

**Table 5-22: Santa Cruz County HAZUS building exposure flooding ....68**

**Table 5-23: City of Nogales HAZUS building exposure flooding ....68**

**Table 5-24: Town of Patagonia HAZUS building exposure flooding ....69**

**Table 5-25: Unincorporated Santa Cruz County HAZUS building exposure flooding ....69**

**Table 5-28: CPRI results by jurisdiction for flooding ....72**

**Table 5-29: Asset inventory exposure to high and medium hazard HAZMAT and corresponding loss estimates ....74**

**Table 5-30: Population sectors exposed to high and medium hazard HAZMAT ....74**

**Table 5-31: Santa Cruz County HAZUS building exposure to HAZMAT ....75**

**Table 5-32: City of Nogales HAZUS building exposure to HAZMAT ....75**

**Table 5-33: Town of Patagonia HAZUS building exposure to HAZMAT ....76**

**Table 5-34: Unincorporated Santa Cruz County HAZUS building exposure to HAZMAT ....76**

**Table 5-36: Fujita Tornado Scale ....78**

**Table 5-37: CPRI results by jurisdiction for severe wind ....79**

**Table 5-38: CPRI results by jurisdiction for wildfire ....84**

**Table 5-39: Asset inventory exposure to high and medium hazard wildfire and corresponding loss estimates ....85**

**Table 5-40: Population sectors exposed to high and medium hazard wildfire ....85**

**Table 5-41: Santa Cruz County HAZUS building exposure wildfire ....86**

**Table 5-42: City of Nogales HAZUS building exposure wildfire ....86**

**Table 5-43: Town of Patagonia HAZUS building exposure wildfire ....87**

**Table 5-44: Unincorporated Santa Cruz County HAZUS building exposure wildfire ....87**

**Table 5-45: Hazards to be mitigated by each participating jurisdiction ....88**

**Table 6-1-1: Legal and regulatory capabilities for Santa Cruz County ....93**

**Table 6-2-1: Technical staff and personnel capabilities for Santa Cruz County ....94**

**Table 6-3-1: Fiscal capabilities for Santa Cruz County ....95**

**Table 6-1-2: Legal and regulatory capabilities for Nogales ..... 96**

**Table 6-2-2: Technical staff and personnel capabilities for Nogales ..... 98**

**Table 6-3-2: Fiscal capabilities for Nogales ..... 98**

**Table 6-1-3: Legal and regulatory capabilities for Patagonia ..... 99**

**Table 6-2-3: Technical staff and personnel capabilities for Patagonia ..... 100**

**Table 6-3-3: Fiscal capabilities for Patagonia ..... 100**

**Table 6-4: Previous mitigation activities for Santa Cruz County jurisdictions ..... 102**

**Table 6-5: Previous projects in Santa Cruz County jurisdictions receiving federal mitigation grant funding ..... 103**

**Table 6-6: NFIP status and statistics for Santa Cruz County and participating jurisdictions as of March 22, 2011 ..... 103**

**Table 6-7-1: Santa Cruz County assessment of previous plan cycle mitigation actions/projects ..... 105**

**Table 6-7-2: Nogales assessment of previous plan cycle mitigation actions/projects ..... 111**

**Table 6-7-3: Patagonia assessment of previous plan cycle mitigation actions/projects ..... 114**

**Table 6-8-1: Mitigation actions and projects and implementation strategy for Santa Cruz County ..... 117**

**Table 6-8-2: Mitigation actions and projects and implementation strategy for Nogales ..... 119**

**Table 6-8-3: Mitigation actions and projects and implementation strategy for Patagonia ..... 119**

**Table 7-1: Past and proposed continued public involvement activities or opportunities identified by Santa Cruz County jurisdictions ..... 124**

## LIST OF APPENDICES

**Appendix A: Official Resolution of Adoption**

**Appendix B: Planning Process Documentation**

**Appendix C: Public Involvement Records**

**Appendix D: Detailed Historic Hazard Records**

**Appendix E: Plan Maintenance Review Memorandums**

# SECTION 1: JURISDICTIONAL ADOPTION AND FEMA APPROVAL

**Requirement §201.6(c)(5):** *[The local hazard mitigation plan shall include…] Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted*.

**Requirement §201.6(d)(3):** *A local jurisdiction must review and revise its plan to reflect changes in development ,progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five (5) years in order to continue to be eligible for mitigation project grant funding.*

## 1.1 DMA 2000 Requirements

### *1.1.1 General Requirements*

The Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan (the Plan) has been prepared in compliance with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (Stafford Act), 42 U.S.C. 5165, as amended by Section 104 of the Disaster Mitigation Act of 2000 (DMA 2000) Public Law 106-390 enacted October 30, 2000. The regulations governing the mitigation planning requirements for local mitigation plans are published under the Code of Federal Regulations (CFR) Title 44, Section 201.6 (44 CFR §201.6). Additionally, a DMA 2000 compliant plan that addresses flooding will also meet the minimum planning requirements for the Flood Mitigation Assistance program as provided for under 44 CFR §78.

DMA 2000 provides requirements for States, Tribes, and local governments to undertake a risk-based approach to reducing risks to natural hazards through mitigation planning[1]. The local mitigation plan is the representation of the jurisdiction's commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. Local plans will also serve as the basis for the State to provide technical assistance and to prioritize project funding.

Under 44 CFR §201.6, local governments must have a Federal Emergency Management Agency (FEMA)-approved local mitigation plan in order to apply for and/or receive project grants under the following hazard mitigation assistance programs:

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)
- Severe Repetitive Loss (SRL)

FEMA, at its discretion, may also require a local mitigation plan under the Repetitive Flood Claims (RFC) program as well.

### *1.1.2 Update Requirements*

DMA 2000 requires that existing plans be updated every five years, with each plan cycle requiring a complete review, revision, and re-approval of the plan at both the state and FEMA level.. Santa Cruz County and the incorporated communities of Nogales and Patagonia are all included in a FEMA approved multi-jurisdictional hazard mitigation plan. The Plan is the result of an update process performed by the Santa Cruz County jurisdictions to update the multi-jurisdictional plan developed in late 2005 and early 2006.

[1] FEMA, 2008, *Local Multi-Hazard Mitigation Planning Guidance*

## 1.2 Official Record of Adoption

Adoption of the Plan is accomplished by the governing body for each participating jurisdiction in accordance with the authority and powers granted to those jurisdictions by the State of Arizona. The officially participating jurisdictions in the Plan include:

| County | Cities | Towns |
|---|---|---|
| • Santa Cruz | (none) | • Town of Patagonia |

The City of Nogales also participated in the planning effort, but did not complete several of the required planning elements. In the following Plan sections, tables for the City of Nogales have been retained as appropriate, to serve as placeholders should the City choose to participate in future planning efforts. At this time, however, the City of Nogales is not considered to be an official participant in this Plan.

Each jurisdiction will keep a copy of their official resolution of adoption located in Appendix A of their copy of the Plan.

## 1.3 FEMA Approval Letter

The Plan was submitted to the Arizona Division of Emergency Management (ADEM), the authorized state agency, and FEMA for review and approval. FEMA's approval letter is provided on the following page.

***[Insert FEMA Approval Letter Here]***

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# SECTION 2: INTRODUCTION

## 2.1 Plan History

In 2005 and 2006, Santa Cruz County and the incorporated communities of Patagonia and Nogales participated in a mitigation planning process that resulted in the development of the *Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan*, which will be referred to herein as the 2006 Plan. The 2006 Plan received official FEMA approval on March 23, 2006, and is currently expired, having reached the end of the 5-year planning cycle.

## 2.2 Plan Purpose and Authority

The purpose of the Plan is to identify natural hazards and certain human-caused hazards that impact the various jurisdictions located within Santa Cruz County, assess the vulnerability and risk posed by those hazards to community-wide human and structural assets, develop strategies for mitigation of those identified hazards, present future maintenance procedures for the plan, and document the planning process. The Plan is prepared in compliance with DMA 2000 requirements and represents a multi-jurisdictional update of the 2006 Plan listed in Section 2.1.

Santa Cruz County, Nogales, and Patagonia are all political subdivisions of the State of Arizona and are organized under Title 9 (cities/towns) and Title 11 of the Arizona Revised Statutes (ARS). As such, each of these entities are empowered to formally plan and adopt the Plan on behalf of their respective jurisdictions.

Funding for the development of the Plan was provided through a PDM planning grant obtained by the State of Arizona from FEMA. JE Fuller/ Hydrology & Geomorphology (JE Fuller) was retained by Arizona Division of Emergency Management (ADEM) to provide consulting services in guiding the planning process and Plan development.

## 2.3 General Plan Description

The Plan is generally arranged and formatted to be consistent with the 2010 State of Arizona Multi-Hazard Mitigation Plan (State Plan) and is comprised of the following major sections:

**Planning Process** – this section summarizes the planning process used to update the Plan, describes the assembly of the planning team and meetings conducted, and summarizes the public involvement efforts.

**Community Description** – this section provides an overall description of the participating jurisdictions and the County as a whole.

**Risk Assessment** – this section summarizes the identification and profiling of natural and human-caused hazards that impact the County and the vulnerability assessment for each hazard that considers exposure/loss estimations and development trend analyses.

**Mitigation Strategy** – this section presents a capability assessment for each participating jurisdiction and summarizes the Plan mitigation goals, objectives, actions/projects, and strategy for implementation of those actions/projects.

**Plan Maintenance Strategy** – this section outlines the proposed strategy for evaluating and monitoring the Plan, updating the Plan in the next 5 years, incorporating plan elements into existing planning mechanisms, and continued public involvement.

**Plan Tools** – this section includes a list Plan acronyms and a glossary of definitions.

## 2.4 Overall Plan Update Process

The Plan is the result of a thorough update process that included a section by section review and evaluation of the 2006 Plan by the planning participants.

At the onset of the planning process, ADEM printed a copy of the 2006 Plan and provided a copy to each respective jurisdiction as a working document for their review and use during the planning process. This way the jurisdictions could keep their original 2006 Plan intact and unmarked. Digital versions of the Santa Cruz County 2006 Plan were made available to planning team members not directly associated with a specific jurisdiction. The Planning Team performed a cursory overview each section of the 2006 Plan during the first meeting, wherein the plan purpose was explained, sections were discussed, and the plans' relation to the DMA 2000 requirements were summarized. The existing Plan was used as a basis for discussions on how to update and improve the Plan. Planning participants were requested bring their working copy to every meeting as the team stepped through each stage of the update process. Table 2.1 summarizes the review and analysis of each section of the 2006 Plans and generally describes what changes were or were not made and why. Additional details of that process are also discussed in the Plan sections as well.

**Table 2-1: 2006 Plan review and 2011 Plan correlation**

| 2006 Plan Section | 2011 Plan Section | Review and Changes Description (2006 Plan to the 2011 Plan) |
|---|---|---|
| 1 | 1, 2, and 4 | • Plan format changes were made to make the Plan more compatible with the 2010 State Plan format.<br>• General plan descriptions were changed to reflect the update process, the new plan format, and authorizations<br>• Community descriptions were compiled to provide both a county-wide and jurisdiction specific depiction. Much of the original text was kept. Time sensitive data such as demographics, climate statistics, and incorporated community boundaries were updated with the latest information available.<br>• Descriptions of development history were updated to reflect the last five years. |
| 2 | 3 | • The 2006 Plan contacts were updated as necessary and recompiled into Section 3 of the 2011 Plan. The review concluded that the original Section 2 data did not warrant a separate section and it could be added to Section 3. |
| 3 | 3 | • Section 3 was expanded to include evaluation summaries and to better describe the planning team development.<br>• Added a column to the table listing the planning team participants to describe their roles<br>• Decided to keep the table format summarizing the planning team meetings and agendas, but provide supplemental meeting minutes in an Appendix<br>• Provided a new section to address agency/organization participation and changes between the 2006 Plan and 2011 Plan participation |
| 4 | 5 | • Risk Assessment changed from Section 4 to Section 5<br>• The whole structure of the risk assessment was revised to provide a hazard based approach to the subsections. The planning team felt this would make the plan easier to understand and follow.<br>• Each hazard profile and vulnerability analysis was carefully updated to reflect either more current or totally new data.<br>• Asset inventories were updated and refined to make them more complete and current. |

**Table 2-1: 2006 Plan review and 2011 Plan correlation**

| 2006 Plan Section | 2011 Plan Section | Review and Changes Description (2006 Plan to the 2011 Plan) |
|---|---|---|
| 5 | 6 | • Mitigation Strategy changed from Section 5 to Section 6<br>• A review of the goals and objectives subsection resulted in a significant change to much simpler goals and objectives. Reasoning for the changes are summarized in Section 6.1<br>• Tables 5.1 and 5.4 of the capability assessment were compiled into one table to provide an "at-a-glance" summary of these elements. The details of the old Table 5.4 were relegated to the reference lists provided at the end of each hazard subsection of the new Plan Section 5.3 and at other locations throughout the Plan where the documents are referenced.<br>• Tables summarizing previous mitigation activities for each jurisdiction were provided to document past mitigation activities<br>• Section addressing the NFIP program was added in compliance to requirement changes from the 2006 Plan to the 2011 Plan<br>• Each mitigation action/project in the 2006 Plan were reviewed and assessed by the respective jurisdiction. Tables summarizing the results are provided<br>• Planning team chose to combine the old tables 5.5 and 5.6 into one table to have all the details of the new mitigation actions/projects in one table. |
| 6 | 7 | • Plan Maintenance Procedures changed from Section 6 to Section 7.<br>• In general, the review of this section highlighted the lack of plan maintenance actually performed and forced a better definition of future efforts. It is anticipated that a multi-jurisdictional plan will provide the platform for a more regular review.<br>• Added text to discuss review past plan maintenance activities and reasons for successes/failures.<br>• Identified the need to expand Section 7.3 to provide a better explanation of plan incorporation by each of the jurisdictions.<br>• Identified a need to provide more definition and specificity to the approach in Section 7.4. Revised to be more specific in the types and schedules of future public involvement opportunities. |

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# SECTION 3: PLANNING PROCESS

***§201.6 (b):*** *Planning process. An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:*
*(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;*
*(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and*
*(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.*

***§201.6(c)(1)****: [The plan shall include…] (1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

This section includes the delineation of various DMA 2000 regulatory requirements, as well as the identification of key stakeholders and planning team members within Santa Cruz County. In addition, the necessary public involvement meetings and actions that were applied to this process are also detailed.

## 3.1 Planning Process Description

ADEM applied for and received a PDM planning grant to fund a multi-jurisdictional effort to review, update and consolidate the 2006 Plan. Once the grant was received, ADEM then selected JE Fuller to work with the participating jurisdictions and guide the planning process. An initial project kick-off meeting between JE Fuller and ADEM was convened in September 2010 to begin the planning process, outline the plan objectives, outline the anticipating meeting agendas for the planning efforts, and to discuss the new plan format and other administrative tasks. Initial points of contact were also established between ADEM, JE Fuller, and Santa Cruz County. A total of four Planning Team meetings were conducted over the period of October 2010 through April 2011. The first Planning Team meeting was convened on October 19, 2010. Subsequent to that meeting, changes in personnel caused a delay in the planning process. A new primary point of contact was established for the Planning Team and the process was restarted with a repeat of the first meeting on February 23, 2011. Throughout that period of time, all the work required to collect, process, and document updated data and make changes to the plan was performed, culminating in a draft of the Plan. Details regarding key contact information and promulgation authorities, the planning team selection, participation, and activities, and public involvement are discussed in the following sections.

## 3.2 Previous Planning Process Assessment

The first task of preparation for this Plan, was to evaluate the process used to develop the 2006 Plan. This was initially discussed by ADEM and JE Fuller prior to the county planning team kickoff meeting. The previous planning approach included a blended use of multi-jurisdictional planning team meetings and individual local planning team meetings within each jurisdiction, all facilitated by JE Fuller. The culmination of the effort was the production of a multi-jurisdictional plan. The process worked well, but required a tremendous amount of time and budget that is not available for this planning process. A conclusion of the 2006 Plans process assessment was that the new planning process would substantially mimic the prior process, except that no individual jurisdictional meetings would be convened, and that the effort would again result in a true multi-jurisdictional plan.

The planning process was presented and discussed at the first multi-jurisdictional planning team meeting and was contrasted to the 2006 Plan approach. Only a few of the planning team members were involved with the development of the 2006 Plan, so there was some institutional knowledge of the prior process.

## 3.3 Primary Point of Contact

Table 3-1 summarizes the primary points of contact identified for each participating jurisdiction.

**Table 3-1: List of jurisdictional primary points of contact**

| Jurisdiction | Name | Department / Position | Address | Phone | Email |
|---|---|---|---|---|---|
| Santa Cruz County | Mary Dahl | Community Development / Director | 2150 N. Congress Dr. Suite 117 Nogales, AZ 85621 | 520-375-7930 | mdahl@co.santa-cruz.az.us |
| Santa Cruz County | John Hays | Public Works / Manager & Safety Officer | 2150 N. Congress Dr. Suite 117 Nogales, AZ 85621 | 520-375-7830 | jhays@co.santa-cruz.az.us |
| City of Nogales | Jesus Gomez | Fire Department / Division Chief – Terrorism Liaison Officer | 777 North Grand Ave. Nogales, AZ 85621 | 520-285-5692 | jgomez@nogalesaz.gov |
| Town of Patagonia | David Teel | Administration / Town Manager | 310 McKeown Avenue Patagonia, AZ 85624 | 520-723-5361 | patagoniagov@qwestoffice.net |

## 3.4 Planning Teams

Two levels of planning teams were organized for the development of this Plan. The first was a Multi-Jurisdictional Planning Team (Planning Team) that was comprised of one or more representatives from each participating jurisdiction. The second level planning team was the Local Planning Team.

The role of the Planning Team was to work with the planning consultant to perform the coordination, research, and planning element activities required to update the 2006 Plan. Attendance by each participating jurisdiction was required for every Planning Team meeting as the meetings were structured to progress through the planning process. Steps and procedures for updating the 2006 Plan were presented and discussed at each Planning Team meeting, and assignments were normally given. Each meeting built on information discussed and assignments given at the previous meeting. The Planning Team also had the responsibility of liaison to the Local Planning Team, and were tasked with:

- Conveying information and assignments received at the Planning Team meetings to the Local Planning Team
- Ensuring that all requested assignments were completed fully and returned on a timely basis.
- Arranging for review and official adoption of the Plan.

The function and role of the Local Planning Team was to:

- Provide support and data
- Assist the Planning Team representative in completing each assignment
- Make planning decisions regarding Plan components
- Review the Plan draft documents

### *3.4.1 Planning Team Assembly*

At the beginning of this planning process, Santa Cruz County organized and identified members for the Planning Team by initiating contact with, and extending invitations to all incorporated communities within the county limits, as well as the Arizona Division of Emergency Management and JE Fuller. Other entities that were subsequently invited to participate are discussed in Section 3.4.3. The participating members of the Planning Team are summarized in Table 3-2. Returning planning team members are highlighted.

**Table 3-2: Multi-jurisdictional planning team participants**

| Name | Jurisdiction / Organization | Department / Position | Planning Team Role |
|---|---|---|---|
| John Ashcroft | Town of Patagonia | Fire Department / Fire Chief | Secondary Community Point of Contact<br>Planning Team participant |
| Mike Burns | Rio Rico Fire District | Fire Department / Battalion Chief | Planning Team participant |
| Les Caid | Rio Rico Fire District | Fire Department / Fire Chief | Interim Primary Point of Contact<br>Planning Team participant |
| Louis Chaboya | Tubac Fire District | Fire Department / Project Manager | Planning Team participant |
| Patty Conger | Tubac Fire District | Fire Department | Planning Team participant |
| Mary Dahl | Santa Cruz County | Community Development Department / Director | Co-Jurisdictional Point of Contact<br>Lead coordinator for LPT<br>Planning Team participant |
| Gilbert Escobar | City of Nogales | Fire Department / Captain | Planning Team participant |
| Alfonso Flores | City of Nogales | Police Department / Detective | Planning Team participant |
| Jesus M. Gomez | City of Nogales | Fire Department / Division Chief | Jurisdictional Point of Contact<br>Lead coordinator for LPT<br>Planning Team participant |
| Frank Granadis | Tubac Fire District / Santa Cruz County | Fire Department / Emergency Planner | Planning Team participant |
| John Hays | Santa Cruz County | Public Works Department – Flood Control District / Floodplain Coordinator | Co-Jurisdictional Point of Contact<br>Planning Team participant |
| George X. Lineiro | City of Nogales | Planning and Zoning Department / Director | Planning Team participant |
| Carlos Mendoza | Nogales Suburban Fire District | Fire Department / Battalion Chief | Planning Team participant |
| W. Scott Ogden | JE Fuller/ Hydrology & Geomorphology, Inc. | Project Manager / Sr Civil Engineer | Planning Team Lead Consultant<br>Preparation and presentation of plan update elements |
| Carlos Parra | Nogales Suburban Fire District | Fire Department / Fire Chief | Planning Team participant |
| Shelly Patton | Santa Cruz County | Health and Human Services Department - Health Services / Program Coordinator | Planning Team participant |
| Genaro Rivera | Tubac Fire District | Fire Department / Battalion Chief | Planning Team participant |
| David Teel | Town of Patagonia | Administration / Town Manager | Jurisdictional Point of Contact<br>Lead coordinator for LPT<br>Planning Team participant |
| Sue Wood | Arizona Division of Emergency Management | Program Manager | Planning Team participant<br>Project/Grant Manager<br>State reviewer |
| Jose Yanez | City of Nogales | Public Works Department - Utilities / Pretreatment Officer | Planning Team participant |

Lists of Local Planning Team members and their respective roles, for each jurisdiction, are provided in Appendix B.

### *3.4.2 Planning Team Activities*

The Planning Team met for the first time on October 19, 2010 to begin the planning process. Subsequent to that meeting, changes in personnel caused a delay and a new primary point of contact was established for the Planning Team. The process was restarted with a repeat of the first meeting on February 23, 2011. Two more meetings were convened on about a monthly basis to step through the

plan review and update process. Planning Team members used copies of the 2006 Plan for review and reference. Following each Planning Team meeting, the Point of Contact for each jurisdiction would convene meetings with the Local Planning Team as needed to work through the assignments. Table 3-3 summarizes the Planning Team meetings along with a brief list of the agenda items discussed. Detailed meeting notes for all of the Planning Team meetings are provided in Appendix B. There are no details of the Local Planning Team meetings.

**Table 3-3: Planning meetings convened as part of the plan update process**

| Meeting Type, Date, and Location | Meeting Agenda |
|---|---|
| Planning Team Meeting No. 1<br><br>October 19, 2010<br><br>Santa Cruz County Emergency Operations Center<br><br>Nogales, AZ | • INTRODUCTIONS / GREETING<br>• MITIGATION PLANNING OVERVIEW<br>• CURRENT MITIGATION PLAN REVIEW<br>• PLANNING PROCESS<br>  o MJ Planning Team Roles<br>  o Public Involvement Strategy<br>• RISK ASSESSMENT<br>  o Hazard Identification / Profiling<br>  o Asset Inventory<br>• PREVIOUS MITIGATION PROJECTS<br>• OTHER DATA NEEDS<br>• NEXT MEETING DATES<br>• ACTION ITEM SUMMARY |
| Planning Team Meeting No. 2 (Repeat of First Meeting)<br><br>February 23, 2011<br><br>Nogales Fire Station No. 2<br><br>Nogales, AZ | • INTRODUCTIONS / GREETING<br>• MITIGATION PLANNING OVERVIEW<br>• CURRENT MITIGATION PLAN REVIEW<br>• PLANNING PROCESS<br>  o MJ Planning Team Roles<br>  o Public Involvement Strategy<br>• RISK ASSESSMENT<br>  o Hazard Identification / Profiling<br>  o Asset Inventory<br>• PREVIOUS MITIGATION PROJECTS<br>• OTHER DATA NEEDS<br>• NEXT MEETING DATES<br>• ACTION ITEM SUMMARY |

**Table 3-3: Planning meetings convened as part of the plan update process**

| Meeting Type, Date, and Location | Meeting Agenda |
|---|---|
| Planning Team Meeting No. 3<br><br>March 22, 2011<br><br>Rio Rico Fire Station No. 3<br><br>Rio Rico, AZ | • ACTION ITEM STATUS REVIEW<br>• CAPABILITY ASSESSMENT<br>  o Jurisdictional Capabilities<br>  o Prior Mitigation Activities<br>  o NFIP Participation and Status<br>  o Repetitive Loss Properties<br>• GOALS & OBJECTIVES REVIEW/UPDATE<br>• PLAN MAINTENANCE PROCEDURES<br>  o Monitoring and Evaluation<br>  o Plan Update<br>  o Plan Incorporation<br>  o Continued Public Involvement<br>• MEETING ENDING<br>  o Review of action items<br>  o Next meeting reminder/verification<br>• ACTION ITEM SUMMARY |
| Planning Team Meeting No. 4<br><br>April 27, 2011<br><br>Rio Rico Fire Station No. 3<br><br>Rio Rico, AZ | • ACTION ITEM REVIEW/STATUS<br>• VULNERABILITY ANALYSIS REVIEW<br>• MITIGATION ACTION/PROJECT FORMULATION AND IMPLEMENTATION STRATEGY<br>• END OF MEETING DISCUSSION |

### *3.4.3 Agency/Organizational Participation*

In addition to the adopting jurisdictions listed in Section 1.2, several agencies and organizations that operate within or have jurisdiction over small and large areas of Santa Cruz County were invited to participate in the planning process. As a part of organizing the first and second Planning Team meetings, invitations were extended to several entities via both email and letter, to provide an opportunity for participation in the planning process. Copies of the various email and letter invitations are provided in Appendix B. The following is a partial list of the various agencies/organizations invited:

- Arizona Department of Water Resources
- Arizona Division of Emergency Management
- Arizona Red Cross
- City of Nogales
- J.E. Fuller/ Hydrology & Geomorphology, Inc.
- Nogales Chanber of Commerce
- Nogales Suburban Fire District
- Nogales Unified School District
- Rio Rico Fire District
- Santa Cruz County Chamber of Commerce
- State Climatologist Office – Arizona State Universtity
- Town of Patagonia
- Tubac Fire District
- U.S. Border Patrol
- Unisource Energy

Table 3-4 summarizes the organizations and agencies that participated in the 2006 Plan and those that participated in the 2010-2011 Plan update process. An explanation of the differences between the two lists is also provided where appropriate.

**Table 3-4: Comparative summary of agency/organization participation in the plan update process**

| Agency / Organization | Participation | | Explanation |
|---|---|---|---|
| | 2006 Plan | 2011 Plan | |
| Arizona Division of Emergency Management | yes | yes | |
| City of Nogales – Police Department | yes | yes | |
| City of Nogales – Public Works Department | yes | yes | |
| City of Nogales – Fire Department | yes | yes | |
| International Boundary and Water Commission | yes | no | No invitation extended. Local position for IBWC was not filled at the time and nearest rep was in El Paso, TX |
| Nogales Suburban Fire District | yes | yes | |
| Rio Rico Fire District | yes | yes | |
| Santa Cruz County – Office of Emergency Management | yes | yes | |
| Santa Cruz County – Public Works Department – Flood Control Division | yes | yes | |
| Santa Cruz County Sheriff's Office | yes | no | Did not respond to invitation |
| Santa Cruz County – Community Development Department | yes | yes | |
| Santa Cruz County – Public Health Services | yes | yes | |
| Town of Patagonia – Water Department | yes | no | Town was represented by Town Manager and Fire Chief |
| Town of Patagonia – Fire Department | yes | yes | |
| Town of Patagonia | yes | yes | |
| Tubac Fire District | yes | yes | |
| U.S. Department of Homeland Security – U.S. Customs and Border Protection | yes | no | Did not respond to invitation |

An integral part of the planning process included coordination with agencies and organizations outside of the participating jurisdiction's governance to obtain information and data for inclusion into the Plan or to provide more public exposure to the planning process. Much of the information and data that is used in the risk assessment is developed by agencies or organizations other than the participating jurisdictions. In some cases, the jurisdictions may be members of a larger organization that has jointly conducted a study or planning effort like the development of a community wildfire protection plan or participation in an area association of governments. Examples of those data sets include the FEMA floodplain mapping, the community wildfire protection plans, USFS wildfire data, severe weather statistics and incidents, and the South Eastern Arizona Governments Association. A summary of the resources obtained, reviewed and compiled into the risk assessment are summarized at the end of each subsection of Section 5.3 and in Section 3.6. Jurisdictions needing these data sets obtained them by either requesting them directly from the host agency or organization, downloading information posted to website locations, or engaging consultants.

## 3.5 Public Involvement

### *3.5.1 Previous Plan Assessment*

The pre-draft public involvement strategy for the 2006 Plan development used:

- Posting of an informational brochure on the Santa Cruz County website.
- Distribution of an informational brochure as an insert with utility bills and newsletters.
- Press releases that were picked up and run in several local newspapers and radio stations
- Standing agenda and discussion items in the publicly announced and attended LEPC meetings.

No pre-draft comments were received during the 2006 Plan process.

The post-draft strategy included the formal council and board of supervisors meeting processes wherein the 2006 Plans were presented and promulgated. The details of the meeting process varied from jurisdiction to jurisdiction, but typically included some form of advertisement of the meeting agenda two to four weeks in advance of the council/board meeting. In most cases, an informal, pre-adoption presentation of the 2006 Plan was made during a working session of the council/board. The final adoption of the resolutions were almost unanimously done as part of a consent agenda at a formal council/board meeting. There were no records of any public comment on the 2006 Plan adoption process.

The Planning Team discussed the prior public involvement actions and concluded that it provided adequate public exposure to the mitigation planning process. The Planning Team also concluded that more web-based technology should be used for the update. Also, since any formal council/board action has a built-in public notification and comment opportunity, the Planning Team chose to continue using this process as one of the post-draft mechanisms for getting the Plan before the public.

### *3.5.2 Plan Update*

Public involvement and input to the planning process was encouraged cooperatively among all of the participating jurisdictions using several venues throughout the course of the pre-draft planning. The planning team discussed various options for pre-draft public involvement including a repeat of using the press releases/public service announcements, newspaper articles, general public announcements or meetings, council/board briefings at a working session, and web page postings. The following strategy was formulated and implemented:

- A public notice will be posted on all three jurisdictions' websites
- Include an agenda item on the next LEPC meeting announcing the mitigation planning and update process and extending an invitation for participation.
- Develop and issue a press release and monitor the media sources to see who runs an article.
- Once the draft plan is ready, the website notices will be revised accordingly and a second press release will be issued. The draft plan itself, will be posted to the Santa Cruz County website for public review and comment prior to final adoption.

All of the notices, postings, and articles encouraged review and comment of the draft Plan by the public. Interested citizens were also encouraged to participate in the local community adoption process which, depending upon the jurisdiction, may have included a public meeting and a formal public hearing. Copies of the pre- and post-draft public notices, web pages, and newspaper notices are provided in Appendix C.

## 3.6 Reference Documents and Technical Resources

Over the course of the update planning process, numerous other plans, studies, reports, and technical information were obtained and reviewed for incorporation or reference purposes. The majority of sources referenced and researched pertain to the risk assessment and the capabilities assessment. To a lesser extent, the community descriptions and mitigation strategy also included some document or technical information research. Table 3-5 provides a reference listing of the primary documents and technical resources reviewed and used in

the Plan. Detailed bibliographic references for the risk assessment are provided at the end of each hazard risk profile in Section 5.3. Other bibliographic references are provided as footnotes.

**Table 3-5: List of resource documents and references reviewed and incorporated in the plan update process**

| Referenced Document or Technical Source | Resource Type | Description of Reference and Its Use |
|---|---|---|
| Arizona Department of Commerce | Website Data and Community Profiles | Reference for demographic and economic data for the county. Used for community descriptions |
| Arizona Department of Emergency Management | Data and Planning Resource | Resource for state and federal disaster declaration information for Arizona. Also a resource for hazard mitigation planning guidance and documents. |
| Arizona Department of Water Resources | Technical Resource | Resource for data on drought conditions and statewide drought management (AzGDTF), and dam safety data. Used in risk assessment. |
| Arizona Geological Survey | Technical Resource | Resource for earthquake, fissure, landslide/mudslide, subsidence, and other geological hazards. Used in the risk assessment. |
| Arizona Model Local Hazard Mitigation Plan | Hazard Mitigation Plan | Guidance document for preparing and formatting hazard mitigation plans for Arizona. |
| Arizona State Land Department | Data Source | Source for statewide GIS coverages (ALRIS) and statewide wildfire hazard profile information (Division of Forestry). Used in the risk assessment. |
| Arizona Wildland Urban Interface Assessment (2004) | Report | Source of wildfire hazard profile data and urban interface at risk communities. Used in the risk assessment. |
| Arizona Workforce Informer | Website | Source for employment statistics in Arizona. |
| Bureau Net (2010) | Website Database | Source for NFIP statistics for Arizona. |
| City of Nogales General Plan | General Plan | Source for history, demographic and development trend data for the city. |
| Earth Fissure Risk Zone Investigation Report (AMEC, 2006) | Hazard Data | Source of fissure risk data and historic fissure and subsidence events. Used in the risk assessment. Used in the risk assessment. |
| Environmental Working Group's Farm Subsidy Database (2011) | Website Database | Source of disaster related agricultural subsidies. Used in the risk assessment. |
| Federal Emergency Management Agency | Technical and Planning Resource | Resource for HMP guidance (How-To series), floodplain and flooding related NFIP data (mapping, repetitive loss, NFIP statistics), and historic hazard incidents. Used in the risk assessment and mitigation strategy. |
| HAZUS-MH | Technical Resource | Based data sets within the program were used in the vulnerability analysis. |
| National Climatic Data Center | Technical Resource | Online resource for weather related data and historic hazard event data. Used in the risk assessment. |
| National Integrated Drought Information System (2011) | Technical Resource | Source for drought related projections and conditions. Used in the risk assessment. |
| National Inventory of Dams (2009) | Technical Resource | Database used in the dam failure hazard profiling. Used in the risk assessment. |
| National Response Center | Technical Resource | Source of traffic related HAZMAT incidents and rail accidents. Used in the risk assessment. |
| National Weather Service | Technical Resource | Source for hazard information, data sets, and historic event records. Used in the risk assessment. |
| National Wildfire Coordination Group (2011) | Technical Resource | Source for historic wildfire hazard information. Used in the risk assessment. |
| Office of the State Climatologist for Arizona | Website Reference | Reference for weather characteristics for the county. Used for community description. |
| Santa Cruz County Comprehensive Plan (2005) | Comprehensive Plan | Source for history, demographic and development trend data for the unincorporated county. |
| Santa Cruz County Flood Control District | Technical Resource | Resource for floodplain, levee, and dam failure data. Used in the risk assessment. |
| South-Eastern Arizona Governments Association (2011) | GIS and Demographic Data | Source for GIS data and countywide demographic projections and development data. |
| Standard on Disaster/Emergency Management and Business Continuity Programs (2000) | Standards Document | Used to establish the classification and definitions for the asset inventory. Used in the risk assessment. |

**Table 3-5: List of resource documents and references reviewed and incorporated in the plan update process**

| Referenced Document or Technical Source | Resource Type | Description of Reference and Its Use |
|---|---|---|
| State of Arizona MHMP (2007 - 2010) | Hazard Mitigation Plan | The state plan was used a source of hazard information and the state identified hazards were used as a starting point in the development of the risk assessment. |
| Town of Patagonia General Plan (2009) | General Plan | Source for history, demographic and development trend data for the city. |
| USACE Flood Damage Report (1978) | Technical Data | Source of historic flood damages for 1978 flood. Used in the risk assessment. |
| USACE Flood Damage Report (1994) | Technical Data | Source of historic flood damages for 1993 flood. Used in the risk assessment. |
| U.S. Forest Service | Technical Data | Source for local wildfire data. Used in the risk assessment. |
| U.S. Geological Survey | Technical Data | Source for geological hazard data and incident data. Used in the risk assessment. |
| Western Regional Climate Center | Website Data | Online resource for climate data used in climate discussion of Section 4 |
| World Wildlife Fund (2010) | GIS Data | Terrestrial ecoregions database used in the general county description. |

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# SECTION 4: COMMUNITY DESCRIPTIONS

## 4.1 General

The purpose of this section is to provide updated basic background information on Santa Cruz County as a whole and includes information on geography, climate, population and economy. Abbreviated details and descriptions are also provided for each participating jurisdiction.

## 4.2 County Overview

### *4.2.1 Geography*

Santa Cruz County is located in south central Arizona, as illustrated by Figure 4-1. It is bordered by Pima County on the north and west, Cochise County on the east and the State of Sonora, Mexico on the south. Two incorporated communities, Nogales and Patagonia, and 15 unincorporated communities are located within the County. The City of Nogales serves as the county seat.

The county encompasses approximately 1,236 square miles and is generally bounded on the east and west by longitudes 110.46 and 111.37 degrees west, and on the south and north between latitudes 31.33 to 31.73 degrees north. Major transportation routes through the area are shown on Figure 4-2 and include Interstate 19, State Highways 82, 83 and 289. A branch line of the Union Pacific Railroad runs parallel to Interstate 19 from Tucson into Mexico. The Nogales International Airport, operated by the County, is located approximately 7 miles northeast of Nogales along State Highway 82.

The topographic characteristics of Santa Cruz County are quite diverse, ranging from the gradually sloping riparian corridor of the Santa Cruz River Valley with its adjoining agricultural areas, to the steeply inclined pine-oak forests located on Mount Wrightson and other parts of the Santa Rita, Tumacácori, and Patagonia mountains, plus numerous other mountain ranges throughout the county. The highest point in the county is Mount Wrightson in the Santa Rita Mountains at 9,453 feet above sea level. The lowest point is Santa Cruz River channel at the Pima County/Santa Cruz County boundary at 3,022. The majority of the County is comprised of high desert plains and foothills that are typical to the Chihuahuan desert.

The primary watercourse within Santa Cruz County is the Santa Cruz River. Other major watercourses within the County include, but are not limited to, the Nogales Wash/Potrero Creek, Peck Canyon, Josephine Canyon and Sonoita Creek. There are also numerous other ephemeral washes and watercourses that primarily convey flood waters. Groundwater extraction is the primary source for both domestic and commercial water consumption.

The geographical characteristics of Santa Cruz County have been mapped into two terrestrial ecoregions[2], which are depicted in Figure 4-3 and described below:

- **Chihuahuan Desert** – this ecoregion is typical of the high altitude deserts and foothills and is found in much of the southeastern portion of Arizona. Elevations in this zone varies between 3,000 to 4,500 feet. The average temperatures for the Chihuahuan Desert tends to be cooler than the Sonoran Desert (see below) due to the elevation differences. However, like its lower elevation cousin, the summers are hot and dry with mild to cool winters.
- **Sierra Madre Occidental Pine-Oak Forest** – this ecoregion is predominant to mountainous regions in southeast Arizona with elevations generally above 5,000 feet. The average temperatures tend to be cool during the summer and cold in winter.

[2] URS, 2004, *State of Arizona All Hazard Mitigation Plan*, GIS shapefiles used to generate Figure 5-2.

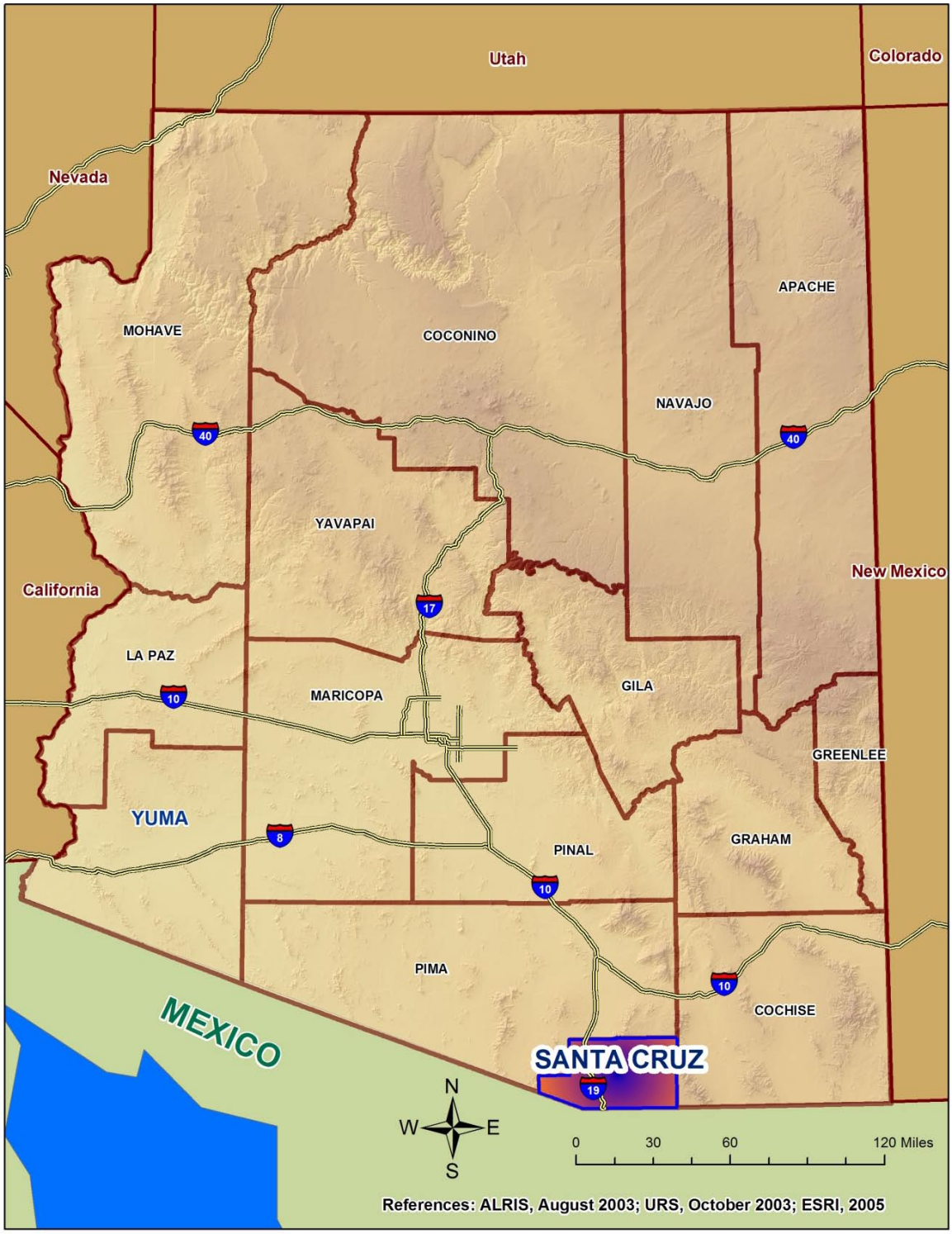


**Figure 4-1**
**Vicinity Map**

**Figure 4-2**
**Transportation Routes Map**

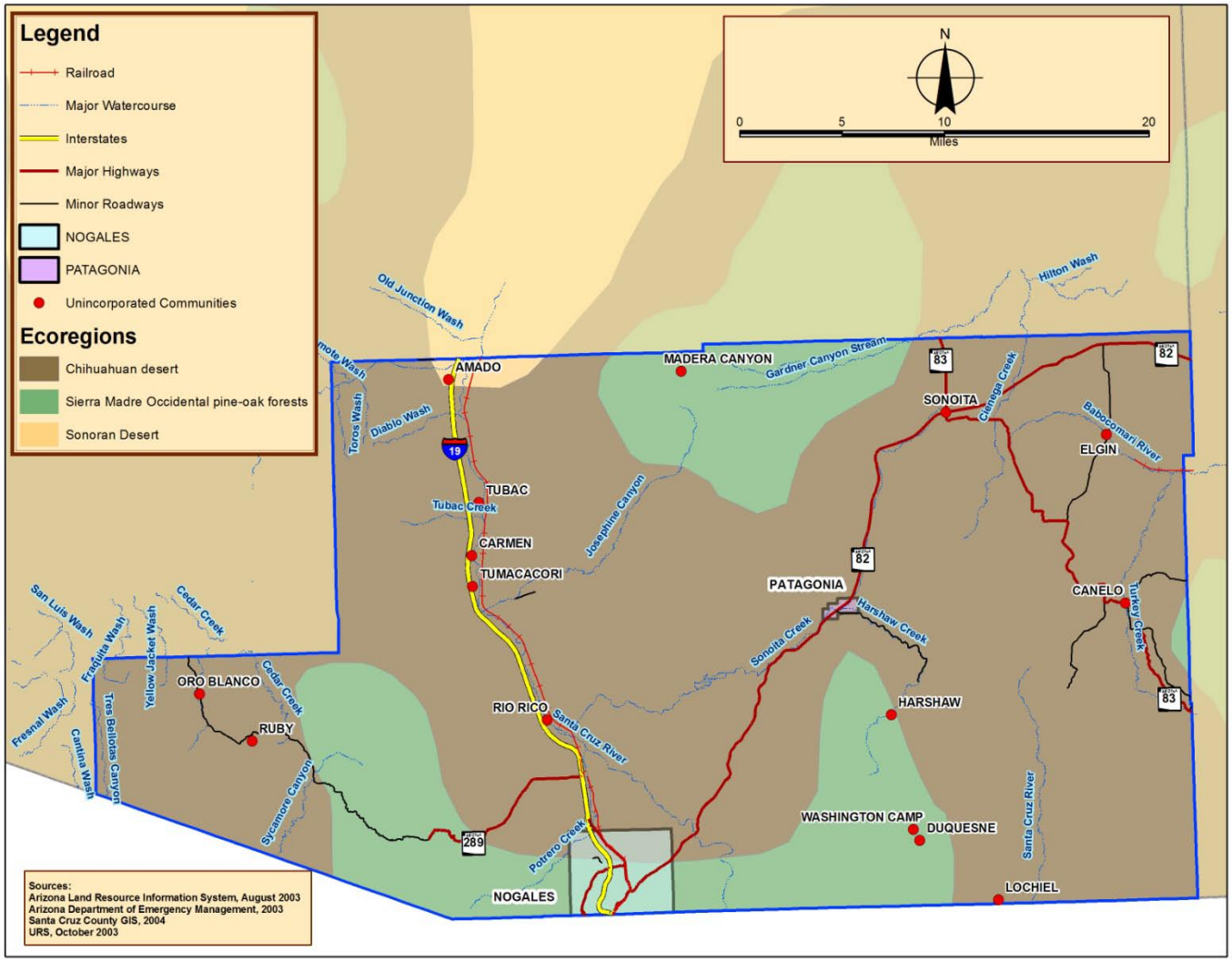


**Figure 4-3**
**Terrestrial Ecoregions Map**

### *4.2.2 Climate*

For the majority of Santa Cruz County, the climate, when compared to other regions in the State of Arizona is relatively moderate. The region is considered to have mild winters and wet summers, with variation within these regions due to the fluctuation in elevation associated with the forests. Climate statistics for weather stations within Santa Cruz County are produced by the Western Region Climate Center[3] and span records dating back to the early 1900's. Locations of reporting stations within or near Santa Cruz County are shown on Figure 4-2.

Average temperatures within Santa Cruz County range from below freezing during the winter months to over 100 degrees Fahrenheit during the hot summer months. The severity of temperatures is highly dependent upon the location, and more importantly the altitude, within the County. For instance, temperature extremes at the top of Mount Wrightson are significantly different from those for the Santa Cruz River Valley. Figure 4-4 presents a graphical depiction of temperature variability and extremes throughout the year for the Nogales 6 N Station, which is situated at an elevation of 3,560 feet in the heart of the Santa Cruz River Valley. Figure 4-5 presents the same temperature variability and extremes throughout the year for the Canelo 1 NW Station, which is situated at an elevation of 5,010 feet in the eastern grassland plain areas of Santa Cruz County.

The Nogales 6 N and Canelo 1 NW Station data are fairly representative of the regions within the County below 5,000 feet in elevation. It is plausible to expect a ten (10) to 20 degree reduction in temperature for areas above 8,000 feet.

Precipitation throughout Santa Cruz County is governed to a great extent by elevation and season of the year. From November through March, storm systems from the Pacific Ocean cross the state as broad winter storms producing mild precipitation events and snowstorms at the higher elevations. Summer rainfall begins early in July and usually lasts until mid-September. Moisture-bearing winds move into Arizona at the surface from the southwest (Gulf of California) and aloft from the southeast (Gulf of Mexico). The shift in wind direction, termed the North American Monsoon, produces summer rains in the form of thunderstorms that result largely from excessive heating of the land surface and the subsequent lifting of moisture-laden air, especially along the primary mountain ranges. Thus, the strongest thunderstorms are usually found in the mountainous regions of the central southeastern portions of Arizona. These thunderstorms are often accompanied by strong winds, blowing dust, and infrequent hail storms.

Figures 4-6 and 4-7 present tabular temperature and precipitation statistics for the Nogales 6 N and Canelo 1 NW Stations.

[3] Most of the data provided and summarized in this plan are taken from the WRCC website beginning at the following URL: http://www.wrcc.dri.edu/CLIMATEDATA.html

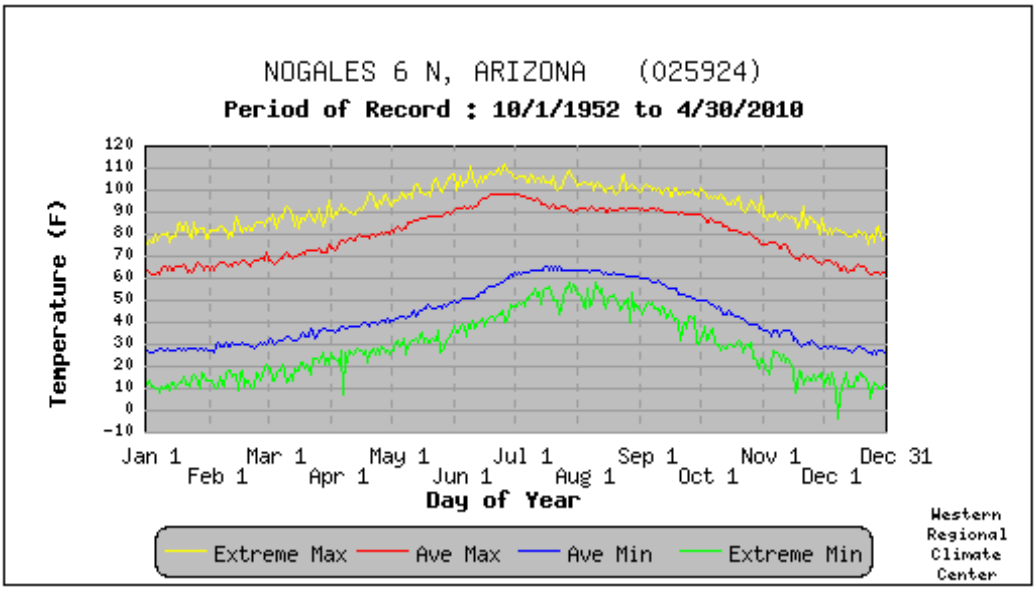


**Figure 4-4**
**Daily Temperatures and Extremes for Nogales 6N, Arizona**

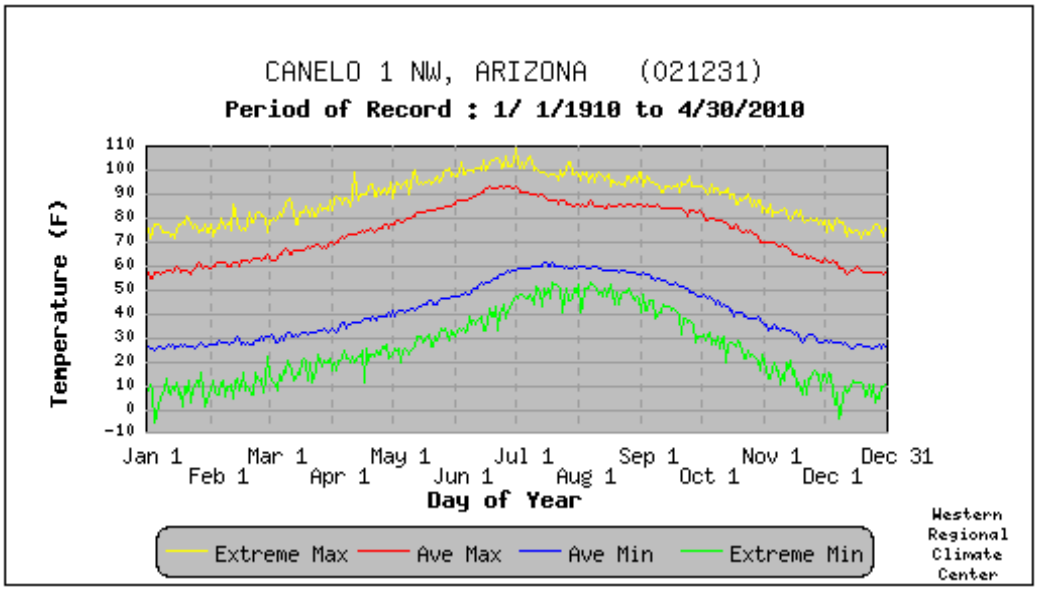


**Figure 4-5**
**Daily Temperatures and Extremes for Canelo 1 NW, Arizona**

# NOGALES 6 N, ARIZONA (025924)

**Period of Record Monthly Climate Summary**

**Period of Record : 10/1/1952 to 4/30/2010**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Max. Temperature (F) | 64.3 | 66.7 | 70.7 | 78.1 | 86.3 | 95.2 | 94.1 | 91.7 | 90.2 | 82.4 | 71.7 | 64.5 | 79.7 |
| Average Min. Temperature (F) | 27.3 | 29.6 | 33.7 | 38.6 | 45.1 | 54.5 | 63.8 | 62.6 | 55.4 | 43.8 | 33.0 | 27.5 | 42.9 |
| Average Total Precipitation (in.) | 1.14 | 0.86 | 0.87 | 0.38 | 0.22 | 0.46 | 4.36 | 4.07 | 1.55 | 1.29 | 0.66 | 1.39 | 17.26 |
| Average Total SnowFall (in.) | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.3 |
| Average Snow Depth (in.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Percent of possible observations for period of record.
Max. Temp.: 98% Min. Temp.: 97.7% Precipitation: 99.3% Snowfall: 98.5% Snow Depth: 97.9%
Check Station Metadata or Metadata graphics for more detail about data completeness.

*Western Regional Climate Center, wrcc@dri.edu*

**Figure 4-6**
**Monthly Climate Summary for Window Rock 4 SW, Arizona**

# CANELO 1 NW, ARIZONA (021231)

**Period of Record Monthly Climate Summary**

**Period of Record : 1/ 1/1910 to 4/30/2010**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Max. Temperature (F) | 57.8 | 61.4 | 66.1 | 73.6 | 81.7 | 90.3 | 88.3 | 85.4 | 83.7 | 76.5 | 65.9 | 58.2 | 74.1 |
| Average Min. Temperature (F) | 26.1 | 28.2 | 31.7 | 36.8 | 43.5 | 52.4 | 59.8 | 58.4 | 52.7 | 42.0 | 31.8 | 26.7 | 40.8 |
| Average Total Precipitation (in.) | 1.29 | 1.16 | 0.93 | 0.45 | 0.20 | 0.73 | 4.41 | 4.04 | 1.70 | 1.03 | 0.84 | 1.39 | 18.18 |
| Average Total SnowFall (in.) | 1.5 | 1.2 | 0.9 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.1 | 5.3 |
| Average Snow Depth (in.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Percent of possible observations for period of record.
Max. Temp.: 78.7% Min. Temp.: 79% Precipitation: 97.3% Snowfall: 96.4% Snow Depth: 95.9%
Check Station Metadata or Metadata graphics for more detail about data completeness.

*Western Regional Climate Center, wrcc@dri.edu*

**Figure 4-7**
**Monthly Climate Summary for Canelo 1 NW, Arizona**

### *4.2.3 Population*

Santa Cruz County is home to 47,420 residents according to 2010 Census, with the international border City of Nogales being the largest community. All of the communities are located within the Santa Cruz River Valley and are located relatively close to each other. There are 13 other towns and communities located throughout the County, with most situated along Interstate 19 and Highway 82 and many being comprised of only one structure or landmark. The largest of these two communities are Tubac and Rio Rico. Table 4-1 summarizes jurisdictional population estimates for Santa Cruz County, the City of Nogales, and the Town of Patagonia, for 10 year cycles beginning in 1990 and projecting through 2020.

The Santa Cruz County labor force in 2010 was 18,792 with an unemployment rate of 15.8 percent[4]. Major industries of the County include transportation, services (i.e., tourism), manufacturing and public administration, and retail and wholesale trade.

Land ownership in Santa Cruz County is divided between the U.S. Forest Service and the Bureau of Land Management (54.6), Arizona State Trust Lands (7.8 percent), Local/State/National Parks (0.1 percent) and private ownership (37.5 percent)[5]. Figure 4-8 provides a visual depiction of the land ownership and town or community locations within the county.

**Table 4-1: Jurisdictional population estimates for Santa Cruz County**

| Jurisdiction | 1990 | 2000 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Santa Cruz County (total) | 29,900 | 40,075 | 47,420 | 56,144 | 61,658 |
| Cities and Towns | | | | | |
| Nogales | 19,595 | 21,810 | 20,837 | 23,858 | 24,783 |
| Patagonia | 890 | 985 | 913 | 1,003 | 1,041 |
| Unincorporated | n/a | n/a | 25,670 | 31,283 | 35,834 |

*Note: Figures for 1990 and 2000(1980 - 2008Historical Estimates: http://www.azcommerce.com/econinfo/demographics/Population+Estimates.html*
*Figures for 2010 from AZ Dept of Commerce's Arizona Workforce Informer, as accessed at: http://www.workforce.az.gov/census-data.aspx*
*Figures for 20150 to 2020: Arizona Department of Economic Security, Research Administration, Population Statistics Unit, 12/01/06. http://www.azcommerce.com/econinfo/demographics/Population+Projections.html*

### *4.2.4 Economy*

The County was formed in 1899 by the 20th Territorial Legislature. The County was named after the Santa Cruz River that flows into Mexico from Arizona before winding back north into Santa Cruz County. Santa Cruz in Spanish means "holy cross", and was given by Father Kino in the 17th century. The primary areas of growth within Santa Cruz County have occurred along the Santa Cruz River and the major transportation corridors within the County. Most residential growth has occurred within or very near the incorporated City of Nogales and the unincorporated community of Rio Rico. Commercial growth has historically been focused along Interstate 19 or State Highway 82, and to a lesser extent State Highway 83. Agricultural growth has occurred mainly along the Santa Cruz River and Sonoita Creek and has remained relatively stable.

Future growth in the next five years will depend on the region's ability to climb out of the recession, a reduction or cessation of violence along the border and the continued implementation of the North American Free Trade Agreement (NAFTA). The County has been hard-hit by the economic downturn and the stigma that violence across the border has created. When those factors are coupled with the response nationally to actions taken on the State level regarding immigration reform, the region's economy is at an all-time low.

The County has identified seven (7) growth areas in its latest comprehensive plan update[6]. All of these areas are located west of the Santa Rita Mountains in recognition of the interest for limited growth in the east. The following is a brief description of each area:

**Airport** – The Nogales International Airport is located along SR 82, northeast of the City of Nogales. The Airport itself, and the land surrounding it, are ideal locations for industrial and commercial land uses. Development occurring near the airport should be complementary to long-term expansion

[4] Arizona Department of Commerce, 2011, File obtained from ADOC web page at the following URL: *http://www.workforce.az.gov/current-employment-statistics.aspx*

[5] Arizona State Land Department, Arizona Land Resource Information System (ALRIS), *Ownership-Land*, August 2010.

[6] Santa Cruz County, 2004, *Santa Cruz County Comprehensive Plan*

opportunities at the Airport, including restricting noise-sensitive developments. Industrial growth will continue to be limited by the lack of a major road linking SR 82 and I-19.

**Amado** – Amado serves as a gateway to the County along the I-19 corridor. The current zoning intensity should remain in the area. Appropriate development activities are neighborhood retail and services and campus commercial.

**I-19 Corridor (Rio Rico Drive to Nogales)** – The I-19 corridor is a significant residential and commercial area for the County. Warehousing and other industrial and commercial activities occur along both sides of the highway with residential development beyond that. This growth area recognizes the desire of many businesses to be located along a highway to improve their accessibility and visibility.

**Kino Springs Village Center** – The Kino Springs Village Center is a 2,000 acre master planned development area. It will serve the growing residential and tourism activities there with commercial uses.

**Rio Rico Drive East** – The growing residential and tourism market in the Rio Rico area will continue to support an increasing amount of commercial development. Grocery stores, large retail and other smaller development are envisioned to be located along Rio Rico Drive, east of I-19.

**Ruby Road** – Ruby Road is relatively a mid-point between the populations of Nogales and Rio Rico. As growth continues to occur in Rio Rico at a faster rate than in Nogales, the geographic center of the population in the west County will continue to move northward. The area south of Ruby Road is situated to serve both of these population centers. Retail and other commercial activities, including a regional mall or large retail development, would be appropriate uses in this area.

**Tubac** – The Tubac core area is a tourist destination and also provides services for local residents. This area, located along the east side of I-19, is home to a resort and various retail and commercial businesses. Maintaining the identity of this area is critical, so any new development should respect the current activities. There should be no intensification of existing zoning, and new development should support the tourism core that already exists.

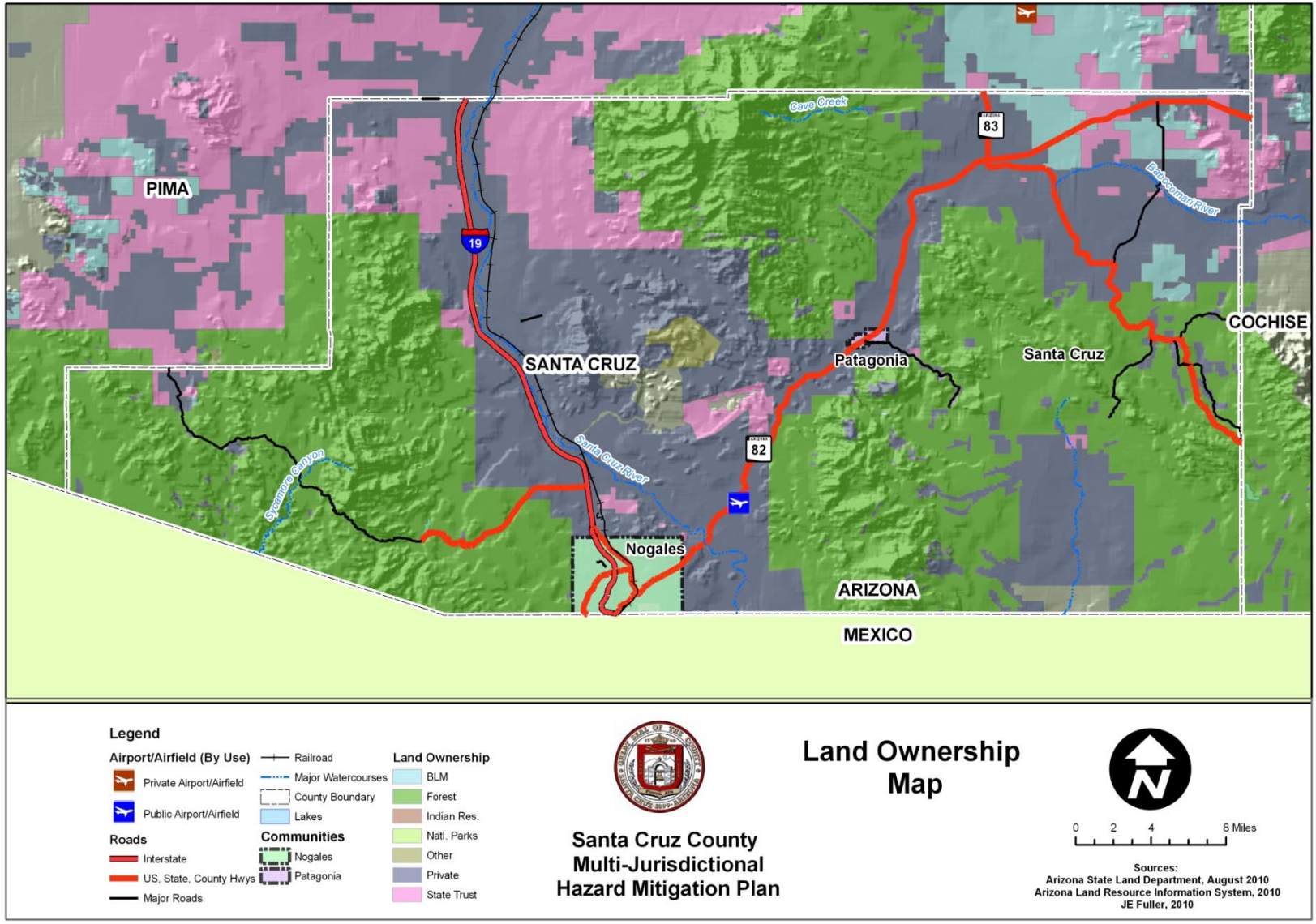


**Figure 4-8: 2010 Land Ownership Map for Santa Cruz County**

## 4.3 Jurisdictional Overviews

The following are brief overviews for each of the participating jurisdictions in the Plan.

### *4.3.1 Nogales*

The City of Nogales is on the international border separating the United States and Mexico as shown in Figure 4-1. The City of Nogales serves as the economic capital and the County seat of Santa Cruz County, the smallest and southernmost of Arizona's counties. Situated at the junction of Interstate 19 and State Road 82(Patagonia Highway) approximately 67 miles south of Tucson and 179 miles from downtown Phoenix. The city lies within a mountainous setting at an elevation of 3,865 feet.

The centroid of the City is generally located at longitude 110.934 degrees west and latitude 31.340 degrees north and the average elevation is 3,865 feet. The Union Pacific Railroad parallels Interstate 19 and passes through the City. Figure 4-9 shows the land ownership and major transportation routes within the vicinity of Nogales.

Thousands of years ago, before European explorers ever dreamed of sailing across the Atlantic, Nogales was part of a migratory path and trade route much later called El Camino Real (The King's Highway). Much later, regiments of armor-clad Conquistadors forayed north along this very valley in quest of precious metals and gems. Today missions built by the Spanish colonists still dot the valley's landscape.

The Santa Cruz River Valley narrows to its narrowest point in Nogales. In the 1700s and 1800s, settlers in the area were besieged by Apaches raiding herds of well-fed cattle. One local rancher, Pete Kitchen, used to say, "Tucson, Tubac, Tumacácori, to hell," when returning to Nogales from a cattle drive from Tucson.

Nogales a far more hospitable place today. Where Pete's ranch once was, is now Soto’s PK Outpost, a restaurant. It's actually one of the original 1853 structures of the old Kitchen homestead. Life on the border would not be complete without the influence of Pancho Villa, whose army occupied Nogales, Mexico in 1914 during the Mexican Revolution. The U.S. military's garrison in Nogales swelled to over 10,000 mostly black soldiers of the highly decorated 25th Regiment mostly detached from Washington, D.C. The military buildup and related business growth attracted many businesses to Nogales, some of which remain today.[7]

Nogales was established in 1880 by Jacob and Isaac Isaacson, who built a trading post along the border. Two years later, Nogales was the site of the first rail connection between Mexico and the United States.

The Census 2010 population for Nogales was 20,837. The civilian labor force in June 2011 was 9,609 with an unemployment rate of 18.9 percent. The major industries significant to the economy of Nogales include: Trade, Transportation, Utilities, Government and Goods Producing.

[7] http://cityofnogales.net/visitors

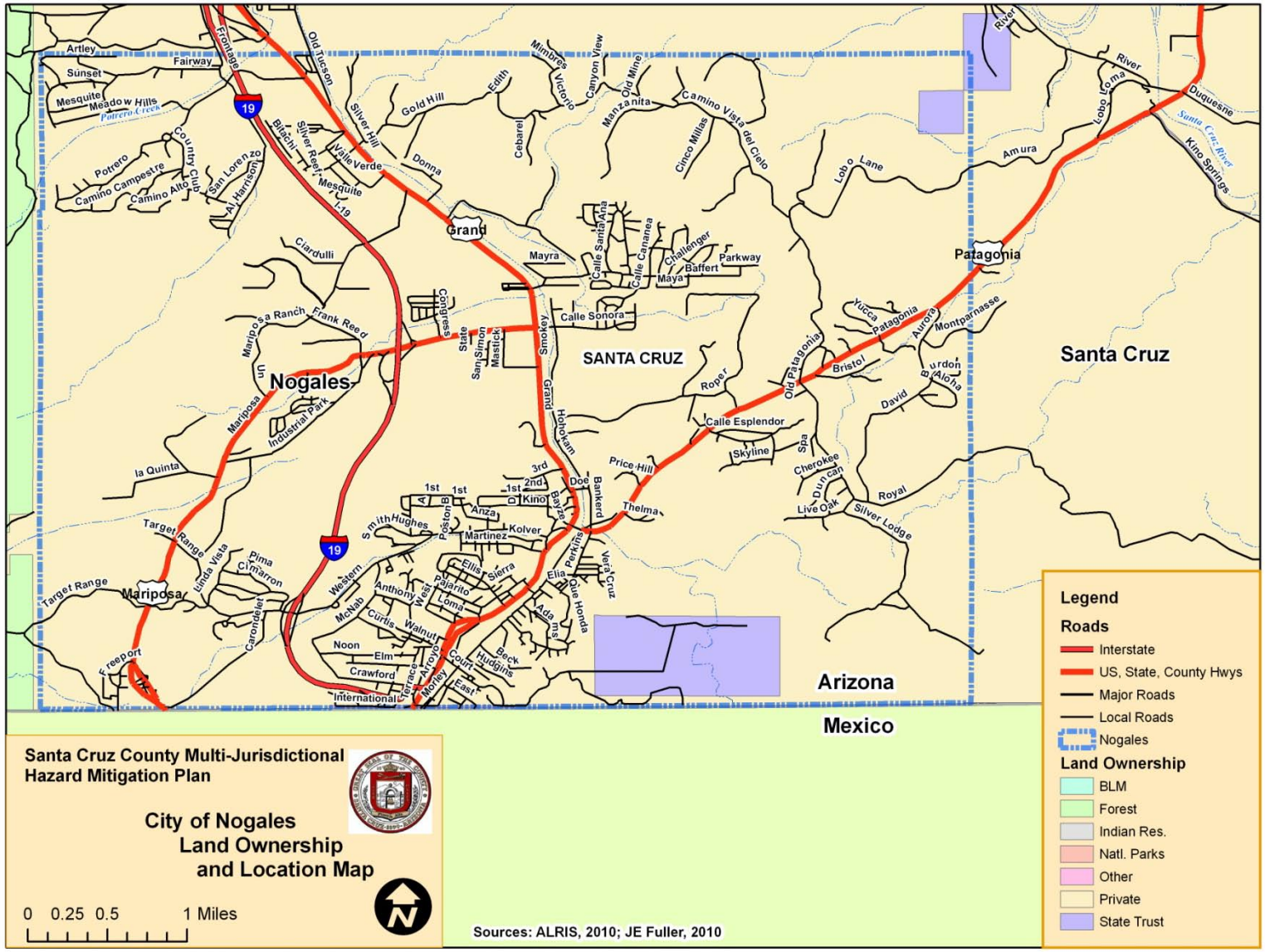


**Figure 4-9: City of Nogales Land Ownership and Location Map**

### *4.3.2 Patagonia*

Patagonia is approximately 14 miles north of the international border separating the United States and Mexico as shown in Figure 4-2. The Town of Patagonia lies in a narrow valley surrounded by the Santa Rita Mountains to the north and the Patagonia Mountains to the south. Both the town and the mountains take their name from the Patagonia Mine. This Town is on State Road 82 (Patagonia Highway) approximately 61 miles south of Tucson and 174 miles from downtown Phoenix.

The centroid of the Town is generally located at longitude 110.756 degrees west and latitude 31.539 degrees north and the average elevation is 4,044 feet. Figure 4-10 shows the land ownership and major transportation routes within the vicinity of Patagonia.

The founder of Patagonia, Rollin Rice Richardson, was a Pennsylvanian who made his money in oil investments. Richardson purchased the San Rafael de la Zanja land grant in 1880 and three years later went into business with the San Rafael Cattle Company. Rollin founded Patagonia in 1896, and named it after himself. Not much later in 1899 the residents petitioned the postmaster general for a post office, and at that time decided to change the Town's name to Patagonia, after the mountain range that towers over the valley.

Mining was the primary industry of Patagonia residents, since rich ore and other minerals were discovered in the Patagonia Mountains and other surrounding mountain ranges. As Patagonia became a busy hub, other mining towns sprung up around its outskirts: Harshaw, Duquesne, Mowry, and Washington Camp were successful settlements located to the east and southeast. Patagonia eventually became connected through the New Mexico and Arizona Railroad that was built through the center of town. But when the mining industry dropped off, so did the Town's boom days. The last ore was shipped in 1960, and in 1962 the rail line was closed down. The rails were removed and railroad right-of-way was dedicated as a park. The old depot became Town Hall.

The Census 2010 population for Nogales was 913. The civilian labor force in June 2011 was 474 with an unemployment rate of 11.6 percent. The major industries significant to the economy of Patagonia include: Trade, Transportation, Tourism, Utilities, Government and other Private Service-Providing.

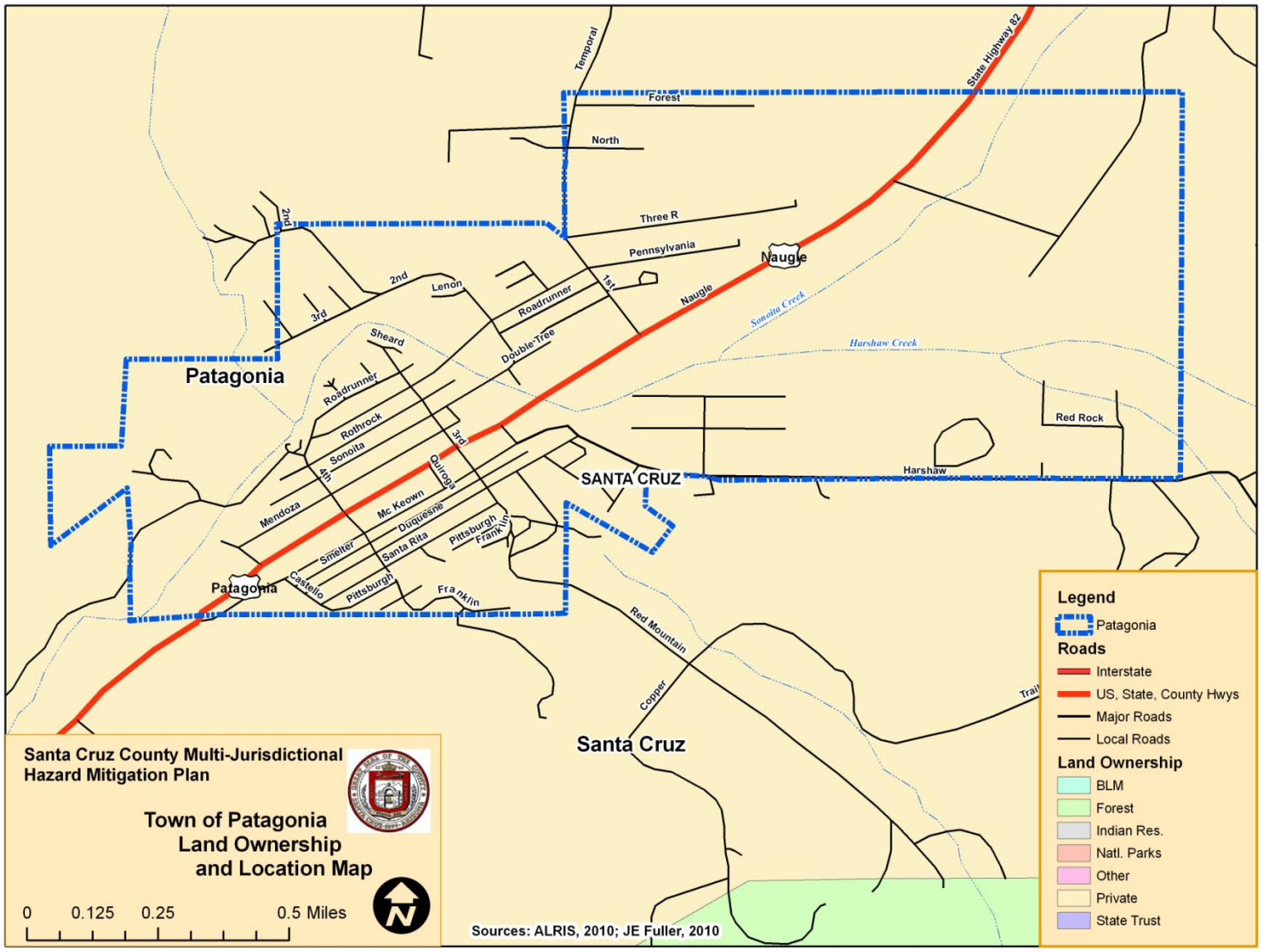


**Figure 4-10: Town of Patagonia Land Ownership and Location Map**

# SECTION 5: RISK ASSESSMENT

> ***§201.6(c)(2):*** *[The plan shall include…] (2) A* ***risk assessment*** *that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:*
> *(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.*
> *(ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of:*
> *(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;*
> *(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate;*
> *(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*
> *(iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.*

One of the key elements to the hazard mitigation planning process is the risk assessment. In performing a risk assessment, a community determines "what" can occur, "when" (how often) it is likely to occur, and "how bad" the effects could be[8]. According to DMA 2000, the primary components of a risk assessment that answer these questions are generally categorized into the following measures:

**Hazard Identification and Screening**

**Hazard Profiling**

**Assessing Vulnerability to Hazards**

The risk assessment for Santa Cruz County and participating jurisdictions was performed using a county-wide, multi-jurisdictional perspective, with much of the information gathering and development being accomplished by the Planning Team. This integrated approach was employed because many hazard events are likely to affect numerous jurisdictions within the County, and are not often relegated to a single jurisdictional boundary. The vulnerability analysis was performed in a way such that the results reflect vulnerability at an individual jurisdictional level, and at a countywide level.

## 5.1 Hazard Identification and Screening

Hazard identification is the process of answering the question; "*What hazards can and do occur in my community or jurisdiction?*" For this Plan, the list of hazards identified in the 2006 Plan were reviewed by the Planning Team with the goal of refining the list to reflect the hazards that pose the greatest risk to the jurisdictions represented by this Plan. The Planning Team also compared and contrasted the 2006 Plan list to the comprehensive hazard list summarized in the 2010 State Plan[9] to ensure compatibility with the State Plan. Table 5-1 summarizes the 2006 Plan and 2010 State Plan hazard lists.

[8] National Fire Protection Association, 2000, *Standard on Disaster/Emergency Management and Business Continuity Programs*, NFPA 1600.

[9] ADEM, 2007, *State of Arizona Multi-Hazard Mitigation Plan*

| Table 5-1: Initial hazard identification lists | |
|---|---|
| **2006 Santa Cruz County Plan Hazard List** | **2010 State Plan Hazard List** |
| • Building/Structure Collapse<br>• Drought<br>• Flooding/Flash Flooding<br>• Tropical Storms/Hurricane<br>• Hazardous Material Incidents<br>• Wildfire | • Dam Failure<br>• Drought<br>• Earthquake<br>• Extreme Heat<br>• Fissure<br>• Flooding/Flash Flooding<br>• Landslides/Mudslides<br>• Levee Failure<br>• Severe Wind<br>• Subsidence<br>• Wildfires<br>• Winter Storms |

The review included an initial screening process to evaluate each of the listed hazards based on the following considerations:

- Experiential knowledge on behalf of the Planning Team with regard to the relative risk associated with the hazard
- Documented historic context for damages and losses associated with past events (especially events that have occurred during the last plan cycle)
- The ability/desire of Planning Team to develop effective mitigation for the hazard under current DMA 2000 criteria
- Compatibility with the state hazard mitigation plan hazards
- Duplication of effects attributed to each hazard

One tool used in the initial screening process was the historic hazard database referenced in 2006 Plan. With this update, the 2006 Plan database was reviewed and revised to separately summarize declared disaster events versus non-declared events. Declared event sources included Santa Cruz County Department of Emergency Management (SCCDEM), Arizona Division of Emergency Management (ADEM), Federal Emergency Management Agency (FEMA), and United States Department of Agriculture (USDA). Non-declared sources included Arizona State Land Department (ASLD), National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC), United States Geological Survey (USGS), and United States Forest Service (USFS). Both data sets were updated with additional hazard events that have occurred over the last plan cycle. The declared events represent the period of January 1966 to August 2010. The undeclared events are as of January 2011. Three tables are used in this update to summarize the historic hazard events. Table 5-2 summarizes the federal and state disaster declarations that included Greenlee County with data provided solely from ADEM, Recovery Section. Table 5-3 summarizes federal and state declarations with data provided by many sources that included fatalities, injuries, and property damages. Table 5-4 summarizes all non-declared hazard events that were considered to be a significant event to the jurisdiction(s). These events may have included:

- 1 or more fatalities
- 1 or more injuries
- Any dollar amount in property or crop damages
- Significant event, as expressed in historical records or according to defined criteria above

Only hazards with a reported event or events are shown in each of the three tables.

**Table 5-2: State and Federally Declared Natural Hazard Events That Included Santa Cruz County – January 1966 to August 2010**

| 2010 State Plan Hazard Categories | Arizona Declared Events That Included Santa Cruz County January 1966 to August 2010 | | |
|---|---|---|---|
| | No. of Events | Total Expenditures | |
| | | State | Federal |
| Drought | 5[A] | $211,499 | $0 |
| Flooding / Flash Flooding | 15 | $39,484,704 | $303,670,820 |
| Wildfire | 16 | $5,685,834 | $0 |

ITEM A - 3 of these events are USDA declarations for 1999, 2001, and 2002
GENERAL NOTES:
- Damage Costs are reported as is and no attempt has been made to adjust costs to current dollar values.
- Only a portion of the reported expenditures were spent in the subject county.

Source: ADEM - Recovery Section, October 2010

**Table 5-3: State and Federally Declared Events That Included Santa CruzCounty January 1966 to August 2010**

| Hazard | No. of Declarations | Recorded Losses | | |
|---|---|---|---|---|
| | | Fatalities | Injuries | Damage Costs ($) |
| Drought | 5 | 0 | 0 | $300,000,000 |
| Flooding / Flash Flooding | 15 | 39 | 1087 | $1,291,955,000 |
| Wildfire | 18 | 0 | 0 | $0 |

Notes:
- Damage Costs are reported as is and no attempt has been made to adjust costs to current dollar values. Sources: ADEM, FEMA, USDA, NCDC, NWS,

**Table 5-4: Santa Cruz County Undeclared Historic Hazard Events – September 1960 to January 2011**

| Hazard | No. of Records | Recorded Losses | | |
|---|---|---|---|---|
| | | Fatalities | Injuries | Damage Costs ($) |
| Extreme Temperature | 2 | 21 | 0 | $0 |
| Flooding | 24 | 8 | 6 | $499,000 |
| Hazardous Materials Incident | 31 | 0 | 28 | $256,877 |
| Severe Wind | 16 | 0 | 0 | $10,207,300 |
| Transportation Accident | 4 | 2 | 3 | $0 |
| Wildfire | 22 | 0 | 30 | $650,000 |

**NOTES:** Damage Costs include property and crop/livestock losses and are reported as is with no attempt to adjust costs to current dollar values. Furthermore, wildfire damage cost do not include the cost of suppression which can be quite substantial. Sources: ADEM, NCDC, NWCG, NWS, USFS

Detailed historic hazard records are provided in Appendix D.

The culmination of the review and screening process by the Planning Team resulted in a revised list of hazards that will be carried forward in this Plan. The 2006 Plan hazards selected for removal are listed below and include a brief explanation of the reason for removal:

> ***Building/Structure Collapse*** – After much discussion, the Planning Team concluded that the true hazard is really tied to a potential failure of the Nogales Wash tunnels, which will only be precipitated by flooding of those tunnels as they convey runoff underground from Mexico through downtown Nogales. Instead, this special condition of the flooding hazard will be added to the Flooding/Flash Flooding vulnerability analysis.

Several of the hazards in the 2006 Plan list may be better described as storm events wherein the effects of the storm may pose exposure to multiple hazards. For instance, hazards associated with a ***Thunderstorm*** may include flooding, microburst winds, tornados, and/or hail in a single event. ***Tropical Storms/Hurricane*** is another storm event that may include damaging winds and heavy precipitation resulting in flooding. In both of these examples, the true resulting hazards are generally flooding and damaging severe winds. Accordingly, the Planning Team chose to consolidate or eliminate the following 2006 Plan hazard:

> ***Tropical Storms/Hurricane*** – the damaging elements associated with tropical cyclones are the heavy precipitation that results in flooding and severe winds.

The Planning Team has selected the following list of hazards for profiling and updating based on the above explanations and screening process. Revised and updated definitions for each hazard are provided in Section 5.3 and in Section 8.2:

- **Dam Failure**
- **Drought**
- **Extreme Temperature**
- **Flooding**
- **HAZMAT**
- **Severe Wind**
- **Wildfire**

## 5.2 Vulnerability Analysis Methodology

### *5.2.1 General*

The following sections summarize the methodologies used to perform the vulnerability analysis portion of the risk assessment. For this Plan, the entire vulnerability analysis was either revised or updated to reflect the new hazard categories, the availability of new data, or differing loss estimation methodology. Specific changes are noted below and/or in Section 5.3. A comparison was made between the new vulnerability analysis and the 2006 Plan for Flooding/Flash Flooding, HAZMAT and Wildfire, as noted in Section 5.3.

For the purposes of this vulnerability analysis, hazard profile maps were developed for Dam Failure, Flooding/Flash Flooding, HAZMAT and Wildfire to map the geographic variability of the probability and magnitude risk of the hazards as estimated by the Planning Team. Hazard profile categories of HIGH, MEDIUM, and/or LOW were used and were subjectively assigned based on the factors discussed in the Probability and Magnitude sections below. Within the context of the county limits, the other hazards do not exhibit significant geographic variability and will not be categorized as such.

Unless otherwise specified in this Plan, the general cutoff date for new hazard profile data and jurisdictional corporate limits is the end of April 2010.

### *5.2.2 Calculated Priority Risk Index (CPRI) Evaluation*

The first step in the vulnerability analysis (VA) is to assess the perceived overall risk for each of the plan hazards using a tool developed by the State of Arizona called the Calculated Priority Risk Index[10] (CPRI). The CPRI value is obtained by assigning varying degrees of risk to four (4) categories for each hazard, and then calculating an index value based on a weighting scheme. Table 5-4 summarizes

[10] ADEM, 2003, *Arizona Model Local Hazard Mitigation Plan*, prepared by JE Fuller/ Hydrology & Geomorphology, Inc.

the CPRI risk categories and provides guidance regarding the assignment of values and weighting factors for each category.

As an example, assume that the project team is assessing the hazard of flooding, and has decided that the following assignments best describe the flooding hazard for their community:

- Probability = Likely
- Magnitude/Severity = Critical
- Warning Time = 12 to 24 hours
- Duration = Less than 6 hours

The CPRI for the flooding hazard would then be:

CPRI = [ (3*0.45) + (3*0.30) + (2*0.15) + (1*0.10)]

CPRI = 2.65

### *5.2.3 Asset Inventory*

A detailed asset inventory was performed for the 2006 Plan to establish a fairly accurate baseline data-set for assessing the vulnerability of each jurisdiction's assets to the hazards previously identified. The asset inventory from the 2006 Plan was updated to reflect the current critical and non-critical facilities potentially exposed to hazards. Details of the update are discussed later in this section. The 2010 State Plan defines assets as:

> *Any natural or human-caused feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.*

The 2006 Plan asset inventory database was generally categorized into critical and non-critical categories. The working definition for ***Critical facilities and infrastructure,*** adopted for the 2006 Plan and continuing with this Plan is as follows:

*Systems, structures and infrastructure within a community whose incapacity or destruction would:*

- *Have a debilitating impact on the defense or economic security of that community.*
- *Significantly hinder a community's ability to recover following a disaster.*

**Table 5-5: Calculated Priority Risk Index (CPRI) categories and risk levels**

| CPRI Category | Degree of Risk | | | Assigned Weighting Factor |
|---|---|---|---|---|
| | Level ID | Description | Index Value | |
| Probability | Unlikely | ▪ Extremely rare with no documented history of occurrences or events.<br>▪ Annual probability of less than 0.001. | 1 | 45% |
| | Possible | ▪ Rare occurrences with at least one documented or anecdotal historic event.<br>▪ Annual probability that is between 0.01 and 0.001. | 2 | |
| | Likely | ▪ Occasional occurrences with at least two or more documented historic events.<br>▪ Annual probability that is between 0.1 and 0.01. | 3 | |
| | Highly Likely | ▪ Frequent events with a well documented history of occurrence.<br>▪ Annual probability that is greater than 0.1. | 4 | |
| Magnitude/ Severity | Negligible | ▪ Negligible property damages (less than 5% of critical and non-critical facilities and infrastructure).<br>▪ Injuries or illnesses are treatable with first aid and there are no deaths.<br>▪ Negligible quality of life lost.<br>▪ Shut down of critical facilities for less than 24 hours. | 1 | 30% |
| | Limited | ▪ Slight property damages (greater than 5% and less than 25% of critical and non-critical facilities and infrastructure).<br>▪ Injuries or illnesses do not result in permanent disability and there are no deaths.<br>▪ Moderate quality of life lost.<br>▪ Shut down of critical facilities for more than 1 day and less than 1 week. | 2 | |
| | Critical | ▪ Moderate property damages (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure).<br>▪ Injuries or illnesses result in permanent disability and at least one death.<br>▪ Shut down of critical facilities for more than 1 week and less than 1 month. | 3 | |
| | Catastrophic | ▪ Severe property damages (greater than 50% of critical and non-critical facilities and infrastructure).<br>▪ Injuries or illnesses result in permanent disability and multiple deaths.<br>▪ Shut down of critical facilities for more than 1 month. | 4 | |
| Warning Time | Less than 6 hours | Self explanatory. | 4 | 15% |
| | 6 to 12 hours | Self explanatory. | 3 | |
| | 12 to 24 hours | Self explanatory. | 2 | |
| | More than 24 hours | Self explanatory. | 1 | |
| Duration | Less than 6 hours | Self explanatory. | 1 | 10% |
| | Less than 24 hours | Self explanatory. | 2 | |
| | Less than one week | Self explanatory. | 3 | |
| | More than one week | Self explanatory. | 4 | |

Following the criteria set forth by the Critical Infrastructure Assurance Office (CIAO), the State of Arizona has adopted eight general categories[11] that define critical facilities and infrastructure:

1. **Communications Infrastructure:** Telephone, cell phone, data services, radio towers, and internet communications, which have become essential to continuity of business, industry, government, and military operations.
2. **Electrical Power Systems:** Generation stations and transmission and distribution networks that create and supply electricity to end-users.
3. **Gas and Oil Facilities:** Production and holding facilities for natural gas, crude and refined petroleum, and petroleum-derived fuels, as well as the refining and processing facilities for these fuels.
4. **Banking and Finance Institutions:** Banks, financial service companies, payment systems, investment companies, and securities/commodities exchanges.
5. **Transportation Networks:** Highways, railroads, ports and inland waterways, pipelines, and airports and airways that facilitate the efficient movement of goods and people.
6. **Water Supply Systems:** Sources of water; reservoirs and holding facilities; aqueducts and other transport systems; filtration, cleaning, and treatment systems; pipelines; cooling systems; and other delivery mechanisms that provide for domestic and industrial applications, including systems for dealing with water runoff, wastewater, and firefighting.
7. **Government Services:** Capabilities at the federal, state, and local levels of government required to meet the needs for essential services to the public.
8. **Emergency Services:** Medical, police, fire, and rescue systems.

Other assets such as public libraries, schools, businesses, museums, parks, recreational facilities, historic buildings or sites, churches, residential and/or commercial subdivisions, apartment complexes, and so forth, are typically not classified as critical facilities and infrastructure unless they serve a secondary function to the community during a disaster emergency (e.g. - emergency housing or evacuation centers). As a part of the update process, each community was tasked with determining which of the previously identified "non-critical" assets, if any, were deemed critical by the community. The remaining "non-critical" assets were deleted from the database. New facilities were also added as appropriate and available. Each community was also tasked with making any needed changes to the geographic position, revision of asset names, updating replacement costs, etc. to bring the dataset into a current condition. The updated asset inventory is attributed with a descriptive name, physical address, geospatial position, and an estimated building/structure and contents replacement cost for each entry to the greatest extent possible and entered into a GIS geodatabase.

The 2006 Plan used a combination of the Asset Inventory and HAZUS®-MH[12] data to represent the critical facilities and general building stock and population for Santa Cruz County jurisdictions. Tools used by the Local Planning Team for the update included GIS data sets, on-line mapping utilities, insurance pool information, county assessors data, and manual data acquisition. Table 5-6 summarizes the facility counts provided by each of the participating jurisdictions in this Plan.

It should be noted that the facility counts summarized in Table 5-6 do not represent a comprehensive inventory of all the category facilities that exist within the county. They do represent the facilities inventoried to-date by each jurisdiction and are considered to be a work-in-progress that is to be expanded and augmented with each Plan cycle.

[11] Instituted via Executive Order 13010, which was signed by President Clinton in 1996.

[12] U.S. Department of Homeland Security, Federal Emergency Management Agency, HAZUS®-MH.

**Table 5-6: Asset inventory structure counts by category and jurisdiction as of April 2011**

| | Communications Infrastructure | Electrical Power Systems | Gas and Oil Facilities | Banking and Finance Institutions | Transportation Networks | Water Supply Systems | Government Services | Emergency Services | Educational [a] | Cultural [a] | Business [a] | Flood Control [a] | Residential [a] | Recreational [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **County-Wide Totals** | **11** | **4** | **6** | **10** | **81** | **60** | **36** | **22** | **10** | **0** | **2** | **2** | **0** | **0** |
| Nogales | 2 | 1 | 0 | 7 | 1 | 5 | 14 | 8 | 0 | 0 | 1 | 0 | 0 | 0 |
| Patagonia | 2 | 0 | 1 | 0 | 0 | 4 | 5 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |
| Unincorporated Santa Cruz County | 7 | 3 | 5 | 3 | 80 | 51 | 17 | 12 | 9 | 0 | 0 | 2 | 0 | 0 |

NOTES: a – Assets listed under these categories have been determined to be critical per the definition of this Plan by the corresponding jurisdiction .

### *5.2.4 Loss Estimations*

In the original 2006 Plan, losses were estimated by either quantitative or qualitative methods. Quantitative methods consisted of intersecting hazard map layers with the asset inventory map layer and the HAZUS®-MH map layer. Other quantitative methods included statistical methods based on historic data. The loss estimates for this Plan represent the current hazard map layers and asset databases using the procedures discussed below.

Economic loss and human exposure estimates for each of the final hazards identified in Section 5.1 begins with an assessment of the potential exposure of asset inventory structures and human populations to those hazards. Exposure estimates of asset inventory structures identified by each jurisdiction is accomplished by intersecting the asset inventory with the hazard profiles in Section 5.3. Human or population exposures are estimated by intersecting the same hazards with the 2000 Census Data population statistics that have been re-organized into GIS compatible databases and distributed with HAZUS®-MH (HAZUS).

Additional exposure estimates for general residential, commercial, and industrial building stock not specifically identified with the asset inventory, are also accomplished using the HAZUS database, wherein the developers of the HAZUS database have made attempts to correlate building/structure counts to census block data. *It is duly noted that the HAZUS data population statistics may not exactly equate to the current population statistics provided in Section 4.2 due to actual changes in population counts associated with a particular census block, GIS positioning anomalies and the way HAZUS depicts certain census block data. It is also noted that the residential, commercial and industrial building stock estimates for each census block may severely under-predict the actual buildings present due to the substantial growth in the last decade, the general lack of commercial and industrial data for some of the more rural communities and counties, and the disparity of the HAZUS replacement cost estimates for these categories when compared to current market rates. However, without a detailed, site specific structure inventory of these types of buildings, the HAZUS database is still the best available and the results are representative of a general magnitude of population and residential, commercial and industrial facility exposures to the various hazards discussed.* Combining the exposure results from the asset inventory and the HAZUS database provides a fairly comprehensive

depiction of the overall exposure of building stock and the two datasets are considered complimentary and not redundant.

Economic losses to structures and facilities are estimated by multiplying the exposed facility replacement cost estimates by an assumed loss to exposure ratio for the hazard. The loss to exposure ratios used in this plan update are summarized by hazard in Section 5.3. It is important to note that the loss to exposure ratios are subjective and the estimates are solely intended to provide an understanding of relative risk from the hazards and potential losses. Real uncertainties are inherent in any loss estimation methodology due to:

- Incomplete scientific knowledge concerning hazards and our ability to predict their effects on the built environment;
- Approximations and simplifications that are necessary for a comprehensive analysis; and,
- Lack of detailed data necessary to implement a viable statistical approach to loss estimations.

Several of the hazards profiled in this Plan will not include quantitative exposure and loss estimates. The vulnerability of people and assets associated with some hazards are nearly impossible to evaluate given the uncertainty associated with where these hazards will occur as well as the relatively limited focus and extent of damage. Instead, a qualitative review of vulnerability will be discussed to provide insight to the nature of losses that are associated with the hazard. For subsequent updates of this Plan, the data needed to evaluate these unpredictable hazards may become refined such that comprehensive vulnerability statements and thorough loss estimates can be made.

### *5.2.5 Development Trend Analysis*

The 2006 Plan development trend analysis will require updating to reflect growth and changes in Santa Cruz County and jurisdiction boundaries over the last planning cycle. The updated analysis will focus on the potential risk associated with projected growth patterns and their intersection with the Plan identified hazards.

## 5.3 Hazard Risk Profiles

The following sections summarize the risk profiles for each of the Plan hazards identified in Section 5.1. For each hazard, the following elements are addressed to present the overall risk profile:

- **Description**
- **History**
- **Probability and Magnitude**
- **Vulnerability**
- **Sources**
- **Profile Maps (if applicable)**

Much of the 2006 Plan data has been updated, incorporated and/or revised to reflect current conditions and Planning Team changes, as well as an overall plan format change. County-wide and jurisdiction specific profile maps are provided at the end of the section (if applicable). Also, the maps are not included in the page count.

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### *5.3.1 Dam Failure*

**Description**

The primary risk associated with dam failure in Santa Cruz County is the inundation of downstream facilities and population by the resulting flood wave. Dams within or impacting Santa Cruz County can generally be divided into two groups: (1) storage reservoirs designed to permanently impound water, provide flood protection, and possibly generate power, and (2) single purpose flood retarding structures (FRS) designed to attenuate or reduce flooding by impounding stormwater for relatively short durations of time during flood events. All dams within the county are equipped with an emergency spillway, which provides a designed and protected outlet to convey runoff volumes exceeding the dam's storage capacity during extreme or back-to-back storm events. Dam failures may be caused by a variety of reasons including: seismic events, extreme wave action, leakage and piping, overtopping, material fatigue and spillway erosion.

**History**

Santa Cruz County has no history of dam failure.

**Probability and Magnitude**

The probability and magnitude of dam failure discharges vary greatly with each dam and are directly influenced by the type and age of the dam, its operational purpose, storage capacity and height, downstream conditions, and many other factors. There are two sources of data that publish hazard ratings for dams impacting Santa Cruz County. The first is the Arizona Department of Water Resources (ADWR) and the second is the National Inventory of Dams (NID). Hazard ratings from each source are based on either an assessment of the consequence of failure and/or dam safety considerations, and they are not tied to probability of occurrence.

ADWR has regulatory jurisdiction over the non-federal dams impacting the County and is responsible for regulating the safety of these dams, conducting field investigations, and participating in flood mitigation programs with the goal of minimizing the risk for loss of life and property to the citizens of Arizona. ADWR jurisdictional dams are inspected regularly according to downstream hazard potential classification, which follows the NID classification system. High hazard dams are inspected annually, significant hazard dams every three years, and low hazard dams every five years. Via these inspections, ADWR identifies safety deficiencies requiring correction and assigns each dam one of six safety ratings. Examples of safety deficiencies include: lack of an adequate emergency action plan, inability to safely pass the required Inflow Design Flood (IDF), embankment erosion, dam stability, etc. Further descriptions of each safety classification are summarized in Table 5-7.

The NID database contains information on approximately 77,000 dams in the 50 states and Puerto Rico, with approximately 30 characteristics reported for each dam, such as: name, owner, river, nearest community, length, height, average storage, max storage, hazard rating, Emergency Action Plan (EAP), latitude, and longitude.

The NID and ADWR databases provide useful information on the potential hazard posed by dams. Each dam in the NID is assigned one of the following three hazard potential classes based on the potential for loss of life and damage to property should the dam fail (listed in increasing severity): low, significant, or high. The hazard potential classification is based on an evaluation of the probable present and future incremental adverse consequences that would result from the release of water or stored contents due to failure or improper operation of the dam or appurtenances, regardless of the condition of the dam. The ADWR evaluation includes land-use zoning and development projected for the affected area over the 10-year period following the classification of the dam. It is important to note that the hazard potential classification is an assessment of the consequences of failure, but not an evaluation of the probability of failure or improper operation. Table 5-8 summarizes the hazard potential classifications and criteria for dams regulated by the State of Arizona.

**Table 5-7: ADWR safety categories**

| ADWR Safety Rating | Definition |
|---|---|
| No Deficiency | Not Applicable |
| Safety Deficiency | One or more conditions at the dam that impair or adversely affects the safe operation of the dam. |
| **Unsafe Categories** | |
| Category 1: Unsafe Dams with Elevated Risk of Failure | These dams have confirmed safety deficiencies for which there is concern they could fail during a 100-year or smaller flood event. There is an urgent need to repair or remove these dams. |
| Category 2: Unsafe Dams Requiring Rehabilitation or Removal | These dams have confirmed safety deficiencies and require either repair or removal. These dams are prioritized for repair or removal behind the Category 1 dams. |
| Category 3: Unsafe Dams with Uncertain Stability during Extreme Events (Requiring Study) | Concrete or masonry dams that have been reclassified to high hazard potential because of downstream development (i.e. hazard creep"). The necessary documentation demonstrating that the dams meet or exceed standard stability criteria for high hazard dams during extreme overtopping and seismic events is lacking. The dams are classified as unsafe pending the results of required studies. Upon completion of these studies, the dams are either removed from the list of unsafe dams or moved to Category 2 and prioritized for repair or removal. |
| Category 4: Unsafe Dams Pending Evaluation of Flood-Passing Capacity (Requiring Study) | In 1979, the U.S. Army Corps of Engineers established Federal Guidelines for assessing the safe-flood passing capacity of high hazard potential dams (CFR Vol. 44 No. 188). These guidelines established one-half of the "probable maximum flood" (PMF) as the minimum storm which must be safely passed without overtopping and subsequent failure of the dam. Dams unable to safely pass a storm of this size were classified as being in an "unsafe, non-emergency" condition.<br><br>Prior studies for these earthen dams (mostly performed in the 1980's) predicted they could not safely pass one-half of the PMF. They were predicted to overtop and fail for flood events ranging from 30 to 46 percent of the PMF. Recent studies both statewide and nationwide have indicated that the science of PMF hydrology as practiced in the 1990's commonly overestimates the PMF for a given watershed. The ADWR is leading efforts on a statewide update of probably maximum precipitation (PMP) study scheduled for completion in 2011. These dams should be re-evaluated using updated methods to confirm their safety status. Upon completion of these evaluations, they are either removed from the list of unsafe dams or moved to Category 2 and prioritized for repair or removal. |

Source: ADWR, 2009.

| Table 5-8: Downstream hazard potential classes for state regulated dams | | |
|---|---|---|
| **Hazard Potential Classification** | **Loss of Human Life** | **Economic, Environmental, Lifeline Losses** |
| Low | None expected | Low and generally limited to owner |
| Significant | None expected | Yes |
| High | Probable. One or more expected | Yes (but not necessary for this classification) |
| Note: The hazard potential classification is an assessment of the consequences of failure, but not an evaluation of the probability of failure. | | |
| Source: ADWR and NID 2009 | | |

The NID database includes dams that are either:

- High or Significant hazard potential class dams, or,
- Low hazard potential class dams that exceed 25 feet in height and 15 acre-feet storage, or,
- Low hazard potential class dams that exceed 50 acre-feet storage and 6 feet height.

There are 4 dams in Santa Cruz County based on the two databases. 2 of the dams, Oro Blanco and Kino Springs, are low hazard dams. The other two dams, Pena Blanca and Lake Patagonia are identified as high hazard dams. All four are under ADWR jurisdiction. Table 5-9 provides a summary of the high hazard dams in both the ADWR and NID databases.

**Table 5-9: NID and ADWR dams by hazard classification**

| Hazard Class | SID | NID | Dam Name | ADWR Safety Types | EAP | Inundation Mapping | Nearest Downstream Development | Distance in Miles |
|---|---|---|---|---|---|---|---|---|
| **High** | 12.05 | AZ00028 | Pena Blanca | No Deficiency | Yes | Yes | 1-19 | 8.3 |
| | 12.06 | AZ00029 | Lake Patagoni | No Deficiency | Yes | Yes | Rio Rico, I-40 & Railroad | 8.2 |

Sources: NID, ADWR Dam Safety Database (October 2009)

The magnitude of impacts due to dam failure are usually depicted by mapping the estimated downstream inundation limits based on an assessment of a combination of flow depth and velocity. These limits are typically a critical part of the emergency action plan. Of the 2 dams considered, both have emergency action plans showing downstream dam failure inundation limits were readily available. For inundation resulting from dam failure, the following two classes of hazard risk are depicted:

HIGH Hazard = Inundation limits due to dam failure

LOW Hazard = All other areas outside the inundation limits

Maps 1A is a county-wide map and 1B is more detailed map of the inundation area showing the location and hazard classifications for each dam and the corresponding dam failure inundation limits (if available).

The most populated areas of Santa Cruz county are situated downstream of Nogales, Sonora, Mexico. There are several flood control and water storage dams situated within the Sonoran watershed for Nogales Wash, which if they were to fail, could cause significant flooding at the international border and into Nogales, Arizona. In 2010, the USGS released a report (Norma, L.M., et al, 2010) documenting the impacts of Sonoran detention basins. An excerpt from the report showing a map of the analyzed detention basins is shown in Figure 5-1. No dam safety level evaluations or analyses

were performed, but the report did summarize the potential watershed impacts of with and without dam scenarios for various magnitude storms up to the 100-year event. The Planning Team evaluating the magnitude of runoff and concluded that a failure of one or more of the larger detention structures during a 100-year event would likely increase the impact on downstream areas. Without the benefit of detailed technical analyses, the Planning Team chose to depict a dam failure hazard area through Nogales, Arizona and downstream as the equivalent of the 100-year floodplain plus a 75 foot buffer.

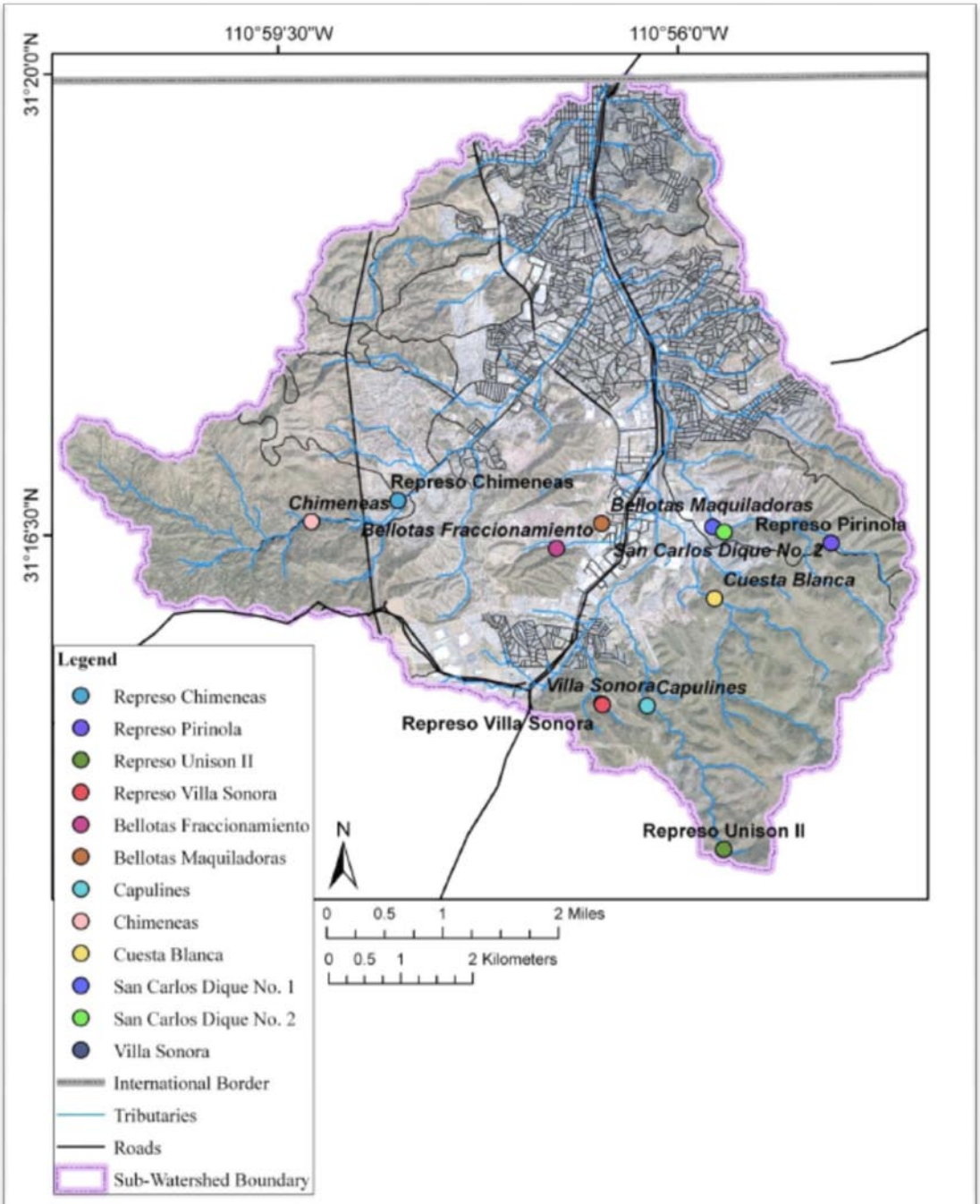



**Figure 3.** Location map depicting detention features (circles shown in various colors), in relationship to tributaries and roads in the Nogales, Sonora, sub-watershed.

**Figure 5-1: Nogales, Sonora dam locations**

**Vulnerability – CPRI Results**

Dam failure CPRI results for each jurisdiction are summarized in Table 5-10.

**Table 5-10: CPRI results by jurisdiction for dam failure**

| Participating Jurisdiction | Probability | Magnitude/ Severity | Warning Time | Duration | CPRI Score |
|---|---|---|---|---|---|
| Nogales | Likely | Catastrophic | < 6 hours | < 6 hours | 3.10 |
| Patagonia | Highly Likely | Critical | < 6 hours | < 6 hours | 3.40 |
| Unincorporated Santa Cruz County | Unlikely | Catastrophic | < 6 hours | < 24 hours | 2.45 |
| | | | | **County-wide average CPRI =** | **2.98** |

**Vulnerability – Loss Estimations**

The estimation of potential losses due to inundation from a dam failure was accomplished by intersecting the human and facility assets with the inundation limits depicted on Maps 1A and 1B. As stated previously, delineated dam failure inundation limits were readily available for both dams. Therefore, the results of this analysis are expected to underestimate the exposure of people and infrastructure within Santa Cruz County.

Since no common methodology is available for obtaining losses from the exposure values, estimates of the loss-to-exposure ratios were assumed based on the perceived potential for damage. Any storm event, or series of storm events of sufficient magnitude to cause a dam failure scenario, would have potentially catastrophic consequences in the inundation area. Floodwaves from these types of events travel very fast and possess tremendous destructive energy. Accordingly, an average event based loss-to-exposure ratio for the inundation areas with a high hazard rating are estimated to be 0.25. Low rated areas are zero.

It should be noted that the Planning Team recognizes that the probability of a dam failure occurring at multiple (or all) locations at the same time is essentially zero. Accordingly, the loss estimates presented below are intended to serve as a collective evaluation of the potential exposure to dam failure inundation events.

Table 5-11 summarizes estimations of losses to Planning Team identified assets for the dam failure inundation hazard. Table 5-12 summarizes the estimated population exposed to the dam failure inundation hazard. Tables 5-13 through 5-16 summarize exposure and loss estimates to the HAZUS residential, commercial, and industrial building stock for the dam failure inundation hazard. Table 5-13 summarizes the HAZUS based exposure and losses for the entirety of Santa Cruz County. Tables 5-14 through 5-16 summarize jurisdiction specific HAZUS data exposure and loss estimates.

In summary, $38 million in asset related losses are estimated for dam failure inundation for all the participating jurisdictions in Santa Cruz County. An additional $132 million in losses to HAZUS defined residential, commercial, and industrial facilities is estimated for all participating Santa Cruz County jurisdictions. Regarding human vulnerability, a total population of 5,048 people, or 13.16% of the total Santa Cruz County population, is potentially exposed to a dam failure inundation event. The potential for deaths and injuries are directly related to the warning time and type of event. Given the magnitude of such an event(s), it is realistic to anticipate at least one death and several injuries. There is also a high probability of population displacement for most of the inhabitants within the inundation limits downstream of the dam(s).

**Vulnerability – Development Trend Analysis**

Of the two high hazard dams within the county, a failure of Patagonia Lake would have the greatest impact on new development and potential growth areas within Rio Rico. Recent improvements to the Patagonia Lake Dam and spillway have are also not reflected in the current inundation mapping available through ADWR. Update of these limits should be evaluated to determine the potential dam failure risk for the populated and expanding areas of Rio Rico.

**Sources**

Arizona Department of Water Resources, 2009, http://www.azwater.gov/AzDWR/SurfaceWater/DamSafety/default.htm

Arizona Division of Emergency Management, 2010, *State of Arizona Multi-Hazard Mitigation Plan, 2010 Update*

Norman, L.M., et al, 2010, *Nogales Flood Detention Study*, USGS Open File Report 2010-1262.

US Army Corps of Engineers, National Inventory of Dams, 2009, https://nid.usace.army.mil/

**Profile Maps**

Maps 1A and 1B – Potential Dam Failure Inundation Hazard Maps-Countywide

Maps 1C – Nogales Dam Failure Inundation Hazard Map

(No Dam Failure Inundation impact Patagonia so no map is provided)

**Table 5-11: Asset inventory losses due to dam failure flooding**

| Community | Total Facilities Reported by Community | Impacted Facilities | Percentage of Total Community Facilities Impacted | Estimated Replacement Cost (x$1000) | Estimated Structure Loss(x$1000) |
|---|---|---|---|---|---|
| **HIGH** | | | | | |
| **County-Wide Totals** | **244** | **57** | **23.36%** | **$152,696** | **$38,174** |
| Nogales | 39 | 21 | 53.85% | $6,558 | $1,639 |
| Patagonia | 16 | 0 | 0.00% | $0 | $0 |
| Unincorporated Santa Cruz | 189 | 36 | 19.05% | $146,138 | $36,534 |

**Table 5-12: Population sectors exposed to dam failure flooding**

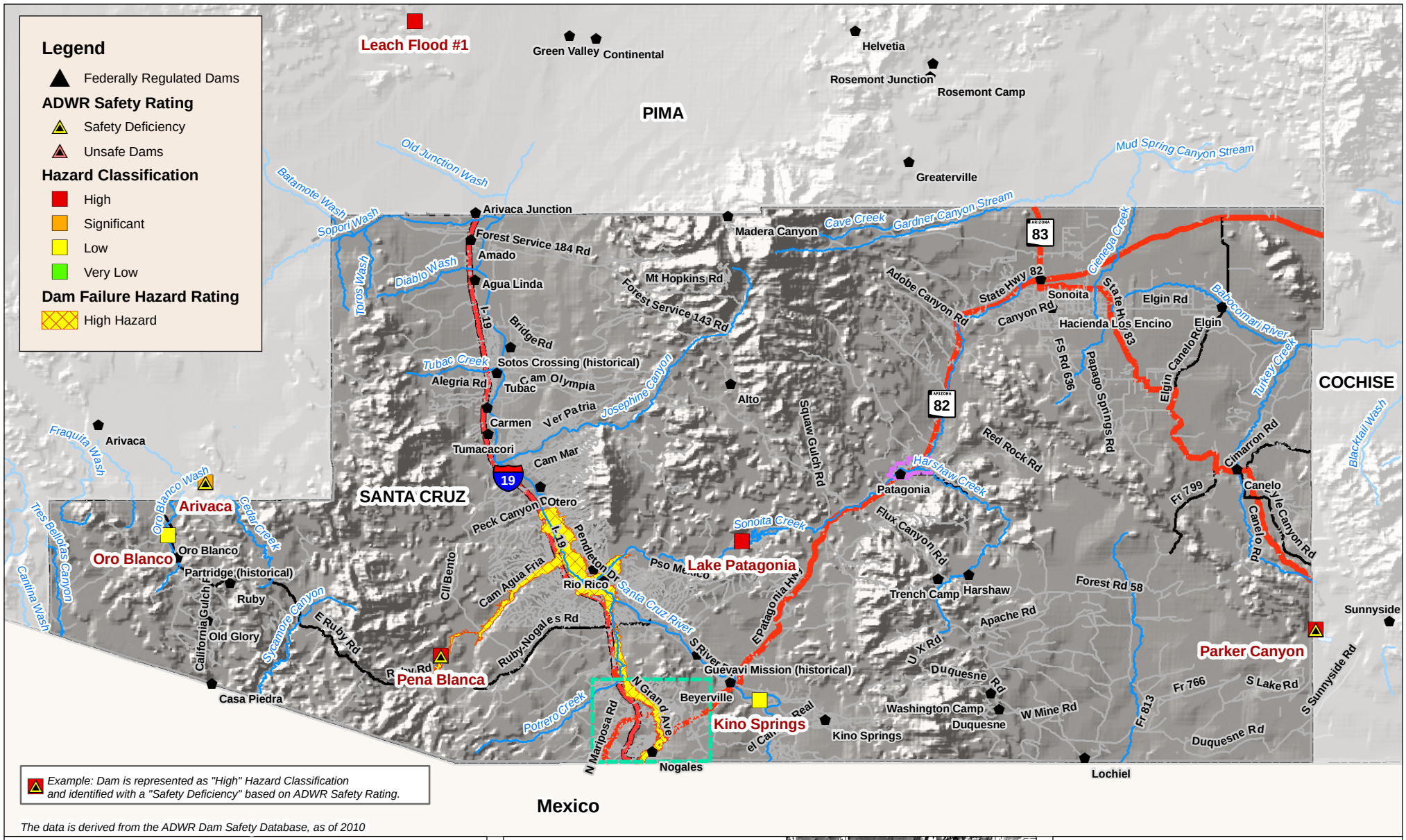
| Community | Total Population | Population Exposed | Percent of Population Exposed | Total Population Over 65 | Population Over 65 Exposed | Percent of Population Over 65 Exposed |
|---|---|---|---|---|---|---|
| **HIGH** | | | | | | |
| **County-Wide Totals** | **38,353** | **5,048** | **13.16%** | **4,047** | **461** | **11.40%** |
| City of Nogales | 20,818 | 3,454 | 16.59% | 2,204 | 376 | 17.05% |
| Town of Patagonia | 827 | 0 | 0.00% | 178 | 0 | 0.00% |
| Unincorporated | 16,708 | 1,594 | 9.54% | 1,665 | 86 | 5.14% |

| Table 5-13: Santa Cruz County HAZUS building exposure to dam failure | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
| Santa Cruz County HAZUS Summary | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Total of All Economic Impact (x$1000) | Loss-to-Exposure Ratio | Total Estimated Loss (x$1000) |
| **County-Wide Totals** | **13,318** | **$2,022,210** | **693** | **$896,552** | **206** | **$179,733** | **$3,098,495** | | |
| High Hazard Exposure | 1,653 | $207,553 | 195 | $291,168 | 31 | $31,443 | $530,164 | 25% | $132,541 |
| Santa Cruz County HAZUS Summary | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | | | |
| High Hazard Exposure | 12.41% | 10.26% | 28.14% | 32.48% | 15.21% | 17.49% | | | |

| Table 5-14: City of Nogales HAZUS building exposure to dam failure | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
| City of Nogales HAZUS Summary | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Total of All Economic Impact (x$1000) | Loss-to-Exposure Ratio | Total Estimated Loss (x$1000) |
| **Community-Wide Totals** | **5,922** | **$856,827** | **372** | **$594,349** | **96** | **$114,768** | **$1,565,944** | | |
| High Hazard Exposure | 1,110 | $139,205 | 148 | $201,644 | 24 | $22,035 | $362,884 | 25% | $90,721 |
| City of Nogales HAZUS Summary | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | | | |
| High Hazard Exposure | 18.75% | 16.25% | 39.78% | 33.93% | 24.68% | 19.20% | | | |

| Table 5-15: Town of Patagonia HAZUS building exposure to dam failure | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
| Town of Patagonia HAZUS Summary | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Total of All Economic Impact (x$1000) | Loss-to-Exposure Ratio | Total Estimated Loss (x$1000) |
| **Community-Wide Totals** | **539** | **$51,820** | **11** | **$7,168** | **5** | **$1,397** | **$60,385** | | |
| High Hazard Exposure | 0 | $0 | 0 | $0 | 0 | $0 | $0 | 25% | $0 |
| Town of Patagonia HAZUS Summary | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | | | |
| High Hazard Exposure | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | | | |

| Table 5-16: Unincorporated Santa Cruz County HAZUS building exposure to dam failure | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
| Unincorporated Santa Cruz County HAZUS Summary | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Building Count | Potential Economic Impact (x$1000) | Total of All Economic Impact (x$1000) | Loss-to-Exposure Ratio | Total Estimated Loss (x$1000) |
| **Community-Wide Totals** | **6,856** | **$1,113,563** | **310** | **$295,035** | **105** | **$63,568** | **$1,472,166** | | |
| High Hazard Exposure | 542 | $68,348 | 47 | $89,524 | 8 | $9,408 | $167,280 | 25% | $41,820 |
| Unincorporated Santa Cruz County HAZUS Summary | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | % Building Count | % Potential Economic Impact | | | |
| High Hazard Exposure | 07.91% | 06.14% | 15.20% | 30.34% | 07.34% | 14.80% | | | |




*The data is derived from the ADWR Dam Safety Database, as of 2010*

**Legend**

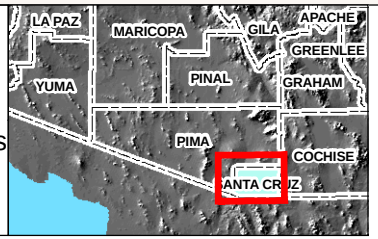
**Communities**
- NOGALES
- PATAGONIA
- County Boundary

- Cities, Towns, Places
- Watercourses
- Lakes

**Roads**
- Interstate
- US, State, County Hwys
- Major Roads
- Local Roads

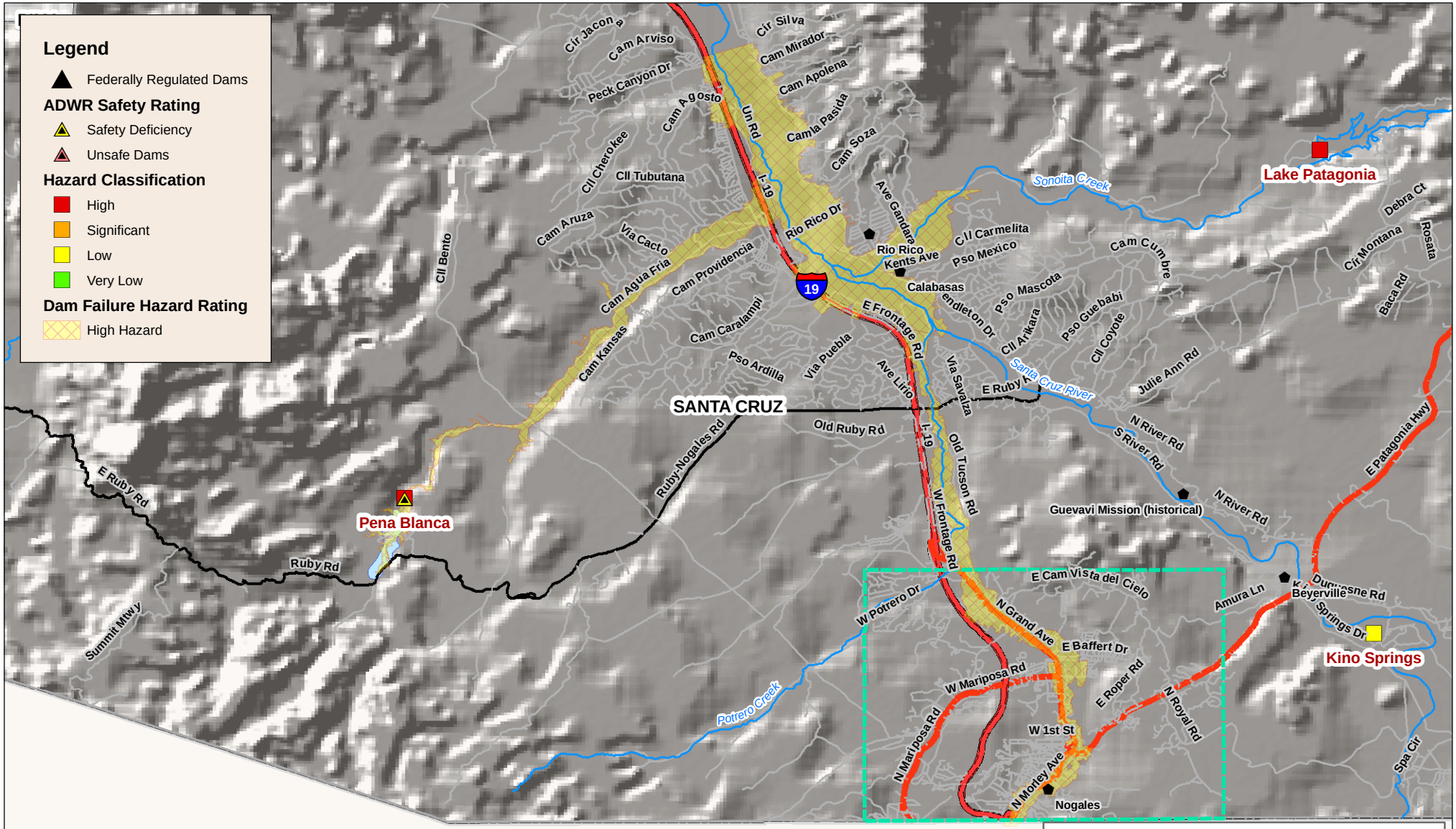
0 2.5 5 10 Miles

*Source: FEMA, 2010; ADWR, 2009; NID, 2009*
*JEF 2011; SCC, 2011; ALRIS, 2010*




**Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan**

**Map 1A**
**Santa Cruz County**
**Dam Failure Hazard Map**
**as of May 2011**




*The data is derived from the ADWR Dam Safety Database, as of 2010*

*Example: Dam is represented as "High" Hazard Classification and identified with a "Safety Deficiency" based on ADWR Safety Rating.*

**Legend**

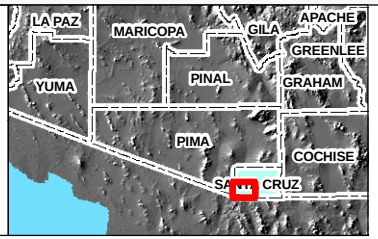
**Communities**
- NOGALES
- PATAGONIA
- County Boundary

- Cities, Towns, Places
- Watercourses
- Lakes

**Roads**
- Interstate
- US, State, County Hwys
- Major Roads
- Local Roads

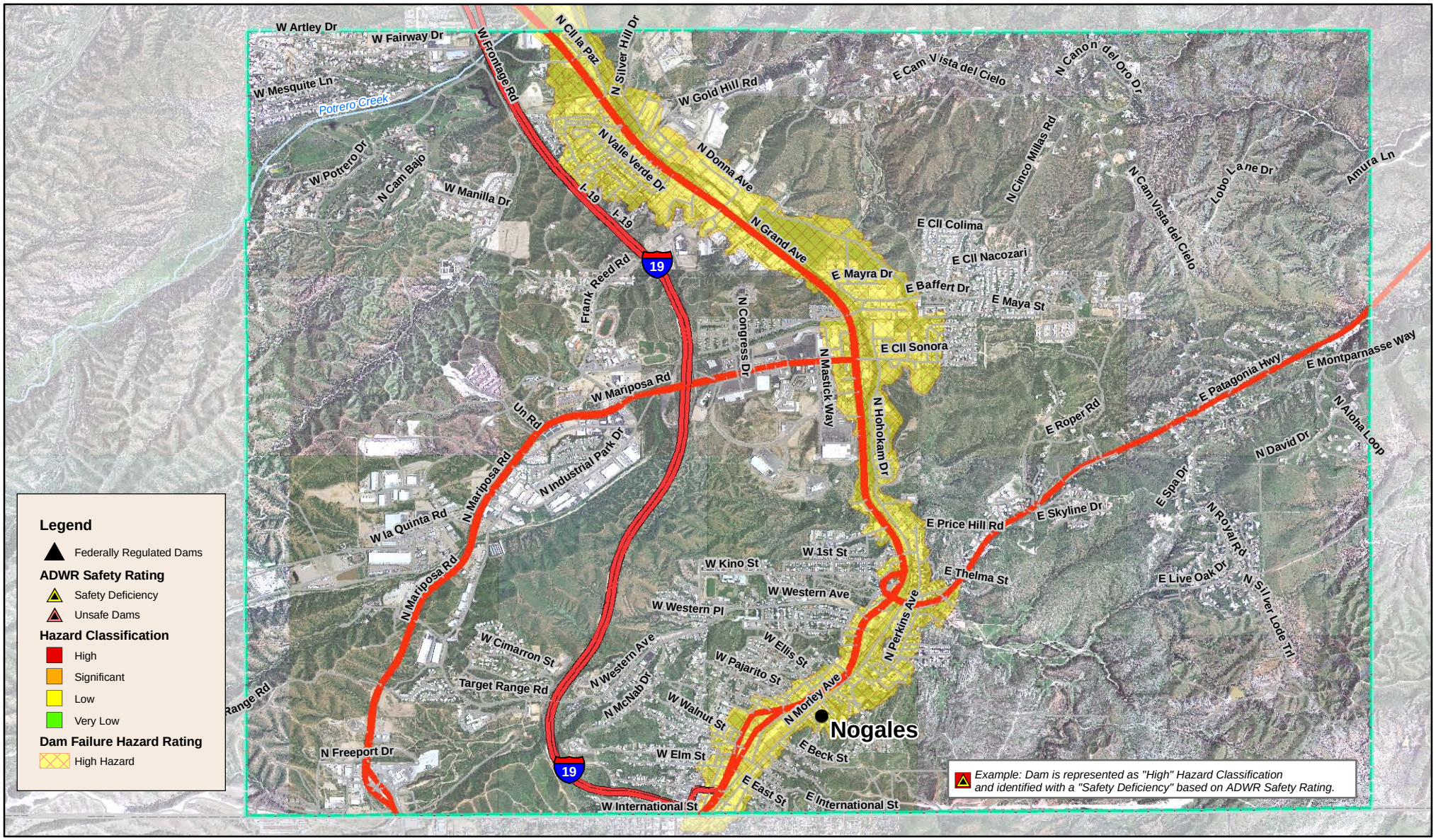
0 1 2 Miles

*Source: ADWR, December 2009; NID, 2009*
*JE FULLER 2010; ALRIS, 2010*




**Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan**

**Map 1B**
**Santa Cruz County**
**Dam Failure Hazard Map**
**as of May 2011**




**Legend**

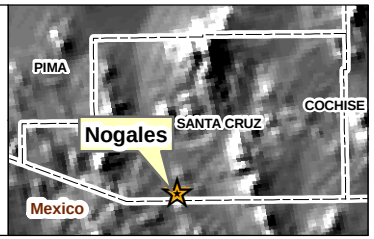
**Communities**
- NOGALES
- PATAGONIA
- County Boundary

- Cities, Towns, Places
- Watercourses
- Lakes

**Roads**
- Interstate
- US, State, County Hwys
- Major Roads
- Local Roads

0 0.5 1 Miles

Sources: FEMA, 2010; ALRIS, 2010; JEF, 2011; SCC, 2011; ASLD, 2010




**Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan**

**Map 1C**
**City of Nogales**
**Dam Failure**
**Hazard Map**
**as of May 2011**

### *5.3.2 Drought*

**Description**

Drought is a normal part of virtually every climate on the planet, including areas of high and low rainfall. It is different from normal aridity, which is a permanent characteristic of the climate in areas of low rainfall. Drought is the result of a natural decline in the expected precipitation over an extended period of time, typically one or more seasons in length. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds and low relative humidity (FEMA, 1997).

Drought is a complex natural hazard which is reflected in the following four definitions commonly used to describe it:

- Meteorological – drought is defined solely on the degree of dryness, expressed as a departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
- Hydrological – drought is related to the effects of precipitation shortfalls on streamflows and reservoir, lake, and groundwater levels.
- Agricultural – drought is defined principally in terms of naturally occurring soil moisture deficiencies relative to water demands of plant life, usually arid crops.
- Socioeconomic – drought associates the supply and demand of economic goods or services with elements of meteorological, hydrologic, and agricultural drought. Socioeconomic drought occurs when the demand for water exceeds the supply as a result of weather-related supply shortfall. It may also be called a water management drought.

A drought's severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. Due to its multi-dimensional nature, drought is difficult to define in exact terms and also poses difficulties in terms of comprehensive risk assessments.

Drought differs from other natural hazards in three ways. First, the onset and end of a drought are difficult to determine due to the slow accumulation and lingering effects of an event after its apparent end. Second, the lack of an exact and universally accepted definition adds to the confusion of its existence and severity. Third, in contrast with other natural hazards, the impact of drought is less obvious and may be spread over a larger geographic area. These characteristics have hindered the preparation of drought contingency or mitigation plans by many governments.

Droughts may cause a shortage of water for human and industrial consumption, hydroelectric power, recreation, and navigation. Water quality may also decline and the number and severity of wildfires may increase. Severe droughts may result in the loss of agricultural crops and forest products, undernourished wildlife and livestock, lower land values, and higher unemployment.

**History**

Arizona has experienced 17 droughts declared as drought disasters/emergencies and 93 drought events (droughts affecting multiple years are recorded as a distinct event for each year affected) since records have been kept. Figures 5-2 and 5-3 depict recent precipitation data from NCDC regarding average statewide precipitation variances from normal. Between 1849 and 1905, the most prolonged period of drought conditions in 300 years occurred in Arizona (Jacobs, 2003). Another prolonged drought occurred during the period of 1941 to 1965. The period from 1979-1983 appears to have been anomalously wet, while the rest of the historical records shows that dry conditions are most likely the normal condition for Arizona. Between 1998 and 2007, there have been more months with below normal precipitation than months with above normal precipitation.

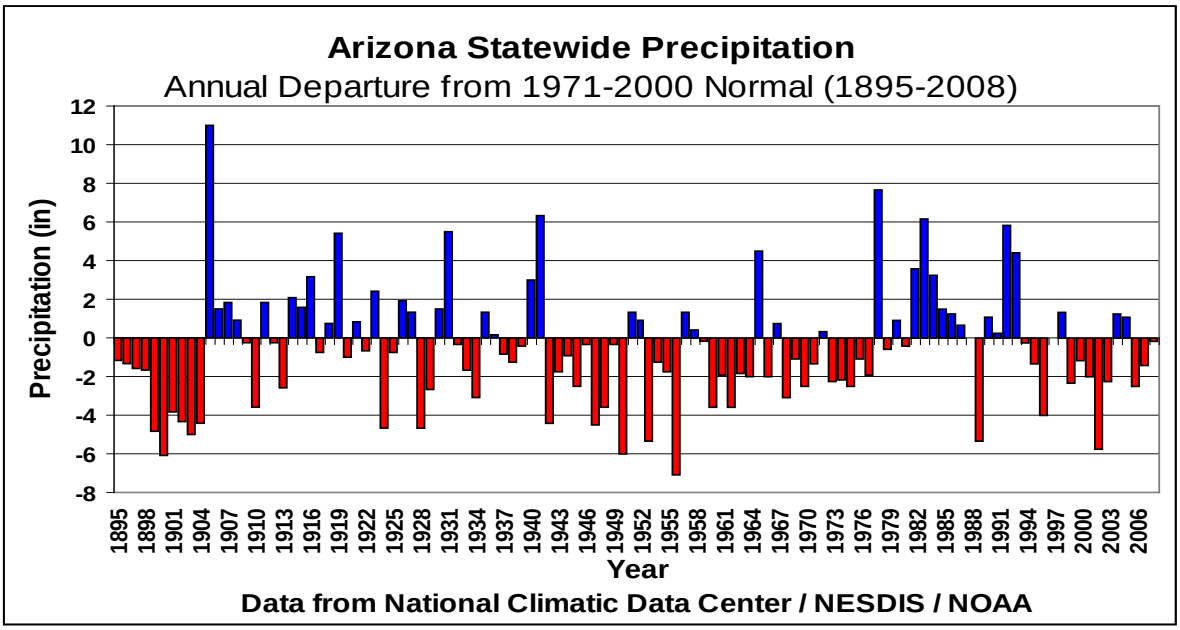



**Figure 5-2: Average statewide precipitation variances from a normal based on 1971-2000 period.**

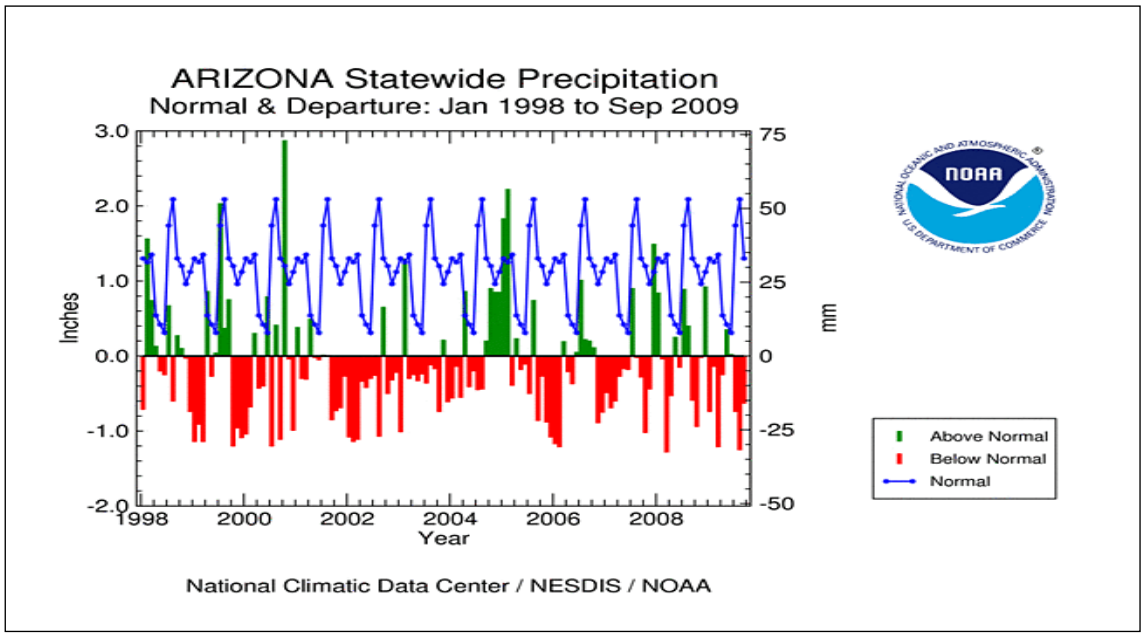
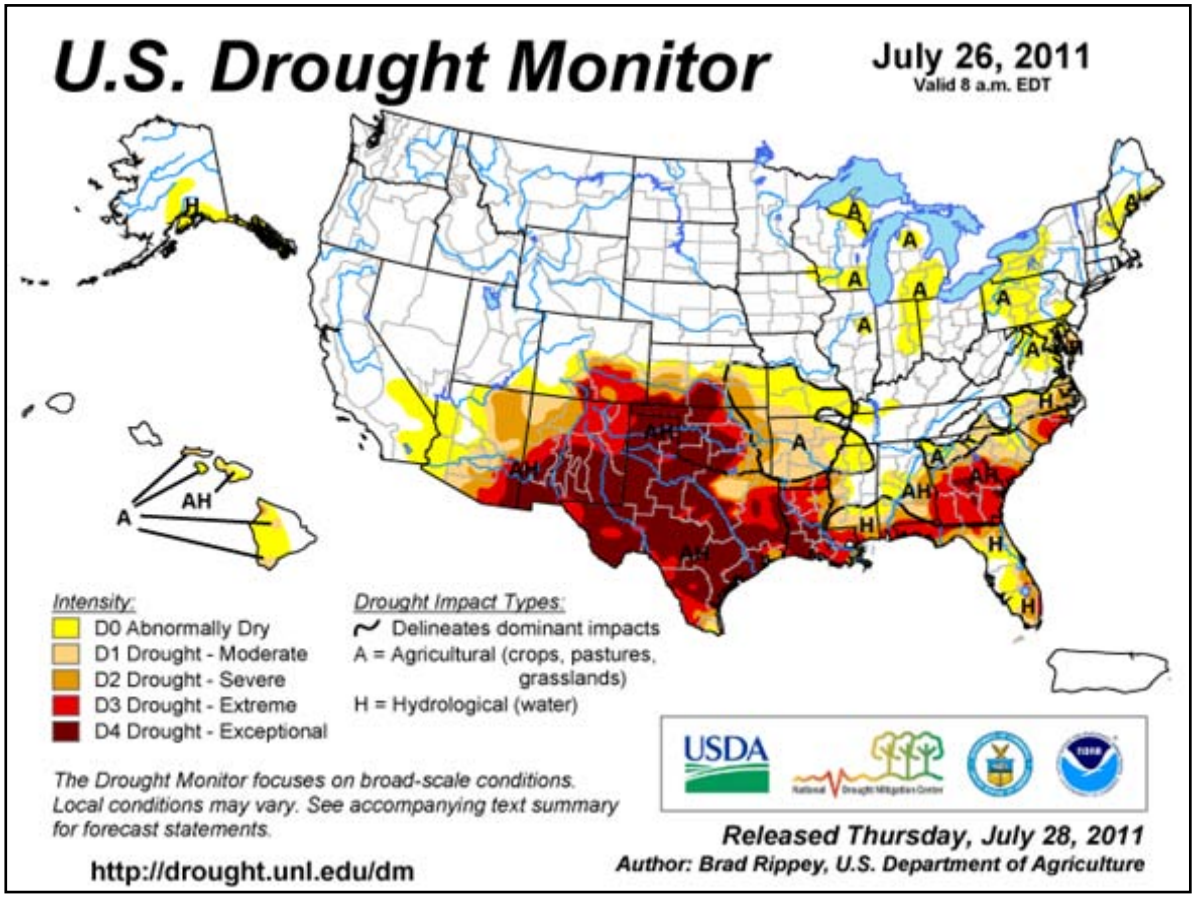



**Figure 5-3: Average statewide precipitation variances from a normal based on 1998-2009 period**

**Probability and Magnitude**

There is no commonly accepted return period or non-exceedance probability for defining the risk from drought (such as the 100-year or 1% annual chance of flood). The magnitude of drought is usually measured in time and the severity of the hydrologic deficit. There are several resources available to evaluate drought status and even project expected conditions for the very near future.

The National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430) prescribes an interagency approach for drought monitoring, forecasting, and early warning (NIDIS, 2007). The NIDIS maintains the U.S. Drought Portal[13] which is a centralized, web-based access point to several drought related resources including the U.S. Drought Monitor (USDM) and the U.S. Seasonal Drought Outlook (USSDO). The USDM, shown in Figure 5-4, is a weekly map depicting the current status of drought and is developed and maintained by the National Drought Mitigation Center. The USSDO, shown in Figure 5-4, is a six month projection of potential drought conditions developed by the National Weather Service's Climate Prediction Center. The primary indicators for these maps for the Western U.S. are the Palmer Hydrologic Drought Index and the 60-month Palmer Z-index. The Palmer Drought Severity Index (PSDI) is a commonly used index that measures the severity of drought for agriculture and water resource management. It is calculated from observed temperature and precipitation values and estimates soil moisture. However, the Palmer Index is not considered to be consistent enough to characterize the risk of drought on a nationwide basis (FEMA, 1997) and neither of the Palmer indices are well suited to the dry, mountainous western United States.



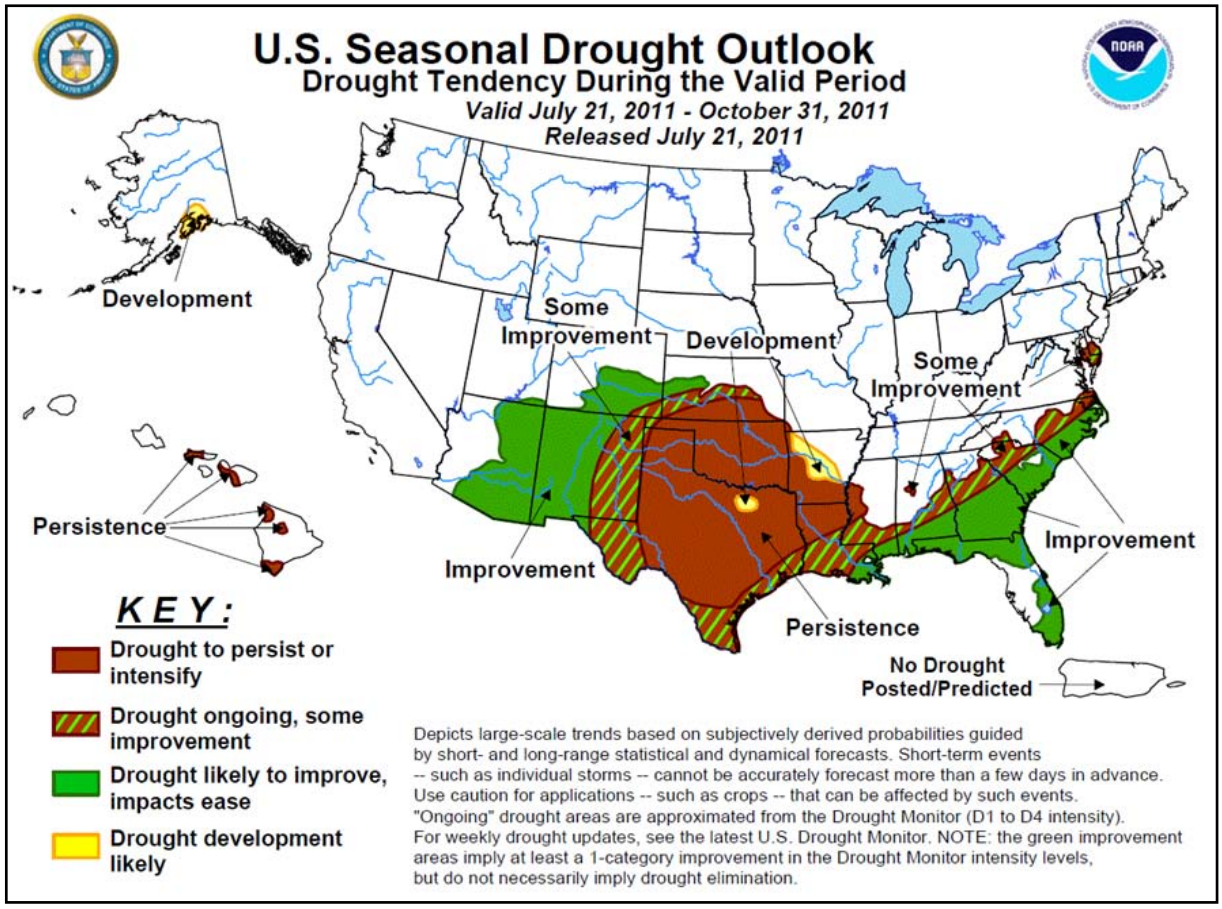

Source: http://drought.unl.edu/dm/monitor.html

**Figure 5-4: U.S. Drought Monitor Map for July 26, 2011**

[13] NIDIS U.S. Drought Portal website is located at: http://www.drought.gov/portal/server.pt/community/drought.gov/202

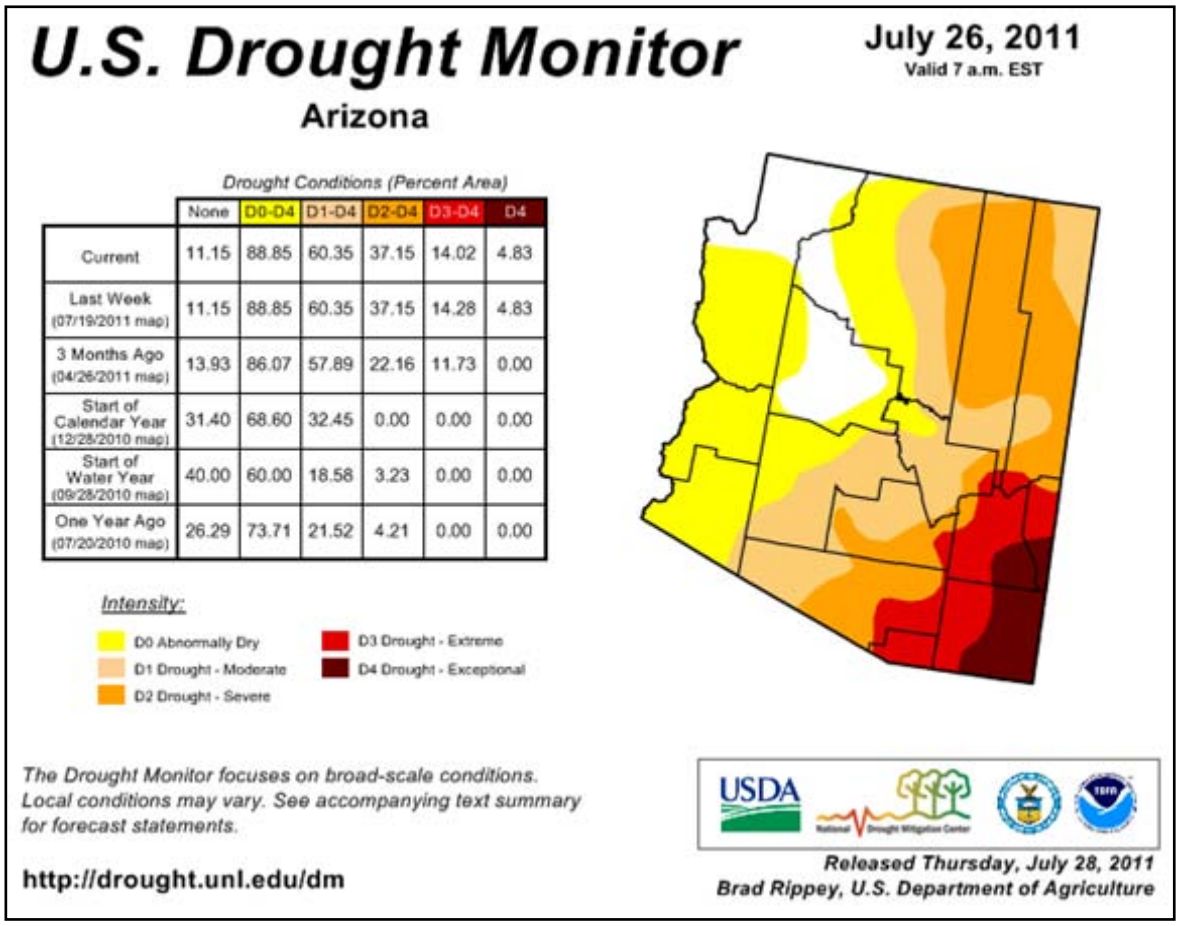
In 2003, Governor Janet Napolitano created the Arizona Drought Task Force (ADTF), led by ADWR, which developed a statewide drought plan. The plan includes criteria for determining both short and long-term drought status for each of the 15 major watersheds in the state using assessments that are based on precipitation and stream flow. The plan also provides the framework for an interagency group which reports to the governor on drought status, in addition to local drought impact groups in each county and the State Drought Monitoring Technical Committee. Twice a year this interagency group reports to the governor on the drought status and the potential need for drought declarations. The counties use the monthly drought status reports to implement drought actions within their drought plans. The State Drought Monitoring Technical Committee defers to the USDM for the short-term drought status and uses a combination of the Standardized Precipitation Index (SPI), evaporation and streamflow for the long-term drought status. Figures 5-6 and 5-7, present the most current short and long term maps available for Arizona as of the writing of this plan.

The current drought maps are in general agreement that Santa Cruz County is currently experiencing a moderate to severe drought condition for the short term and in a moderate drought condition for the long term. Figure 5-5 indicates that the drought conditions are likely to improve and ease the impact for Santa Cruz County over the next few months.




Source: http://www.cpc.ncep.noaa.gov/products/expert_assessment/seasonal_drought.html

**Figure 5-5: U.S. Seasonal Drought Outlook, July to October, 2011**




| | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|---|---|---|---|---|---|
| Current | 11.15 | 88.85 | 60.35 | 37.15 | 14.02 | 4.83 |
| Last Week (07/19/2011 map) | 11.15 | 88.85 | 60.35 | 37.15 | 14.28 | 4.83 |
| 3 Months Ago (04/26/2011 map) | 13.93 | 86.07 | 57.89 | 22.16 | 11.73 | 0.00 |
| Start of Calendar Year (12/28/2010 map) | 31.40 | 68.60 | 32.45 | 0.00 | 0.00 | 0.00 |
| Start of Water Year (09/28/2010 map) | 40.00 | 60.00 | 18.58 | 3.23 | 0.00 | 0.00 |
| One Year Ago (07/20/2010 map) | 26.29 | 73.71 | 21.52 | 4.21 | 0.00 | 0.00 |

Source: http://www.adwr.state.az.us/AzDWR/StatewidePlanning/Drought/DroughtStatusMonitorPU.htm

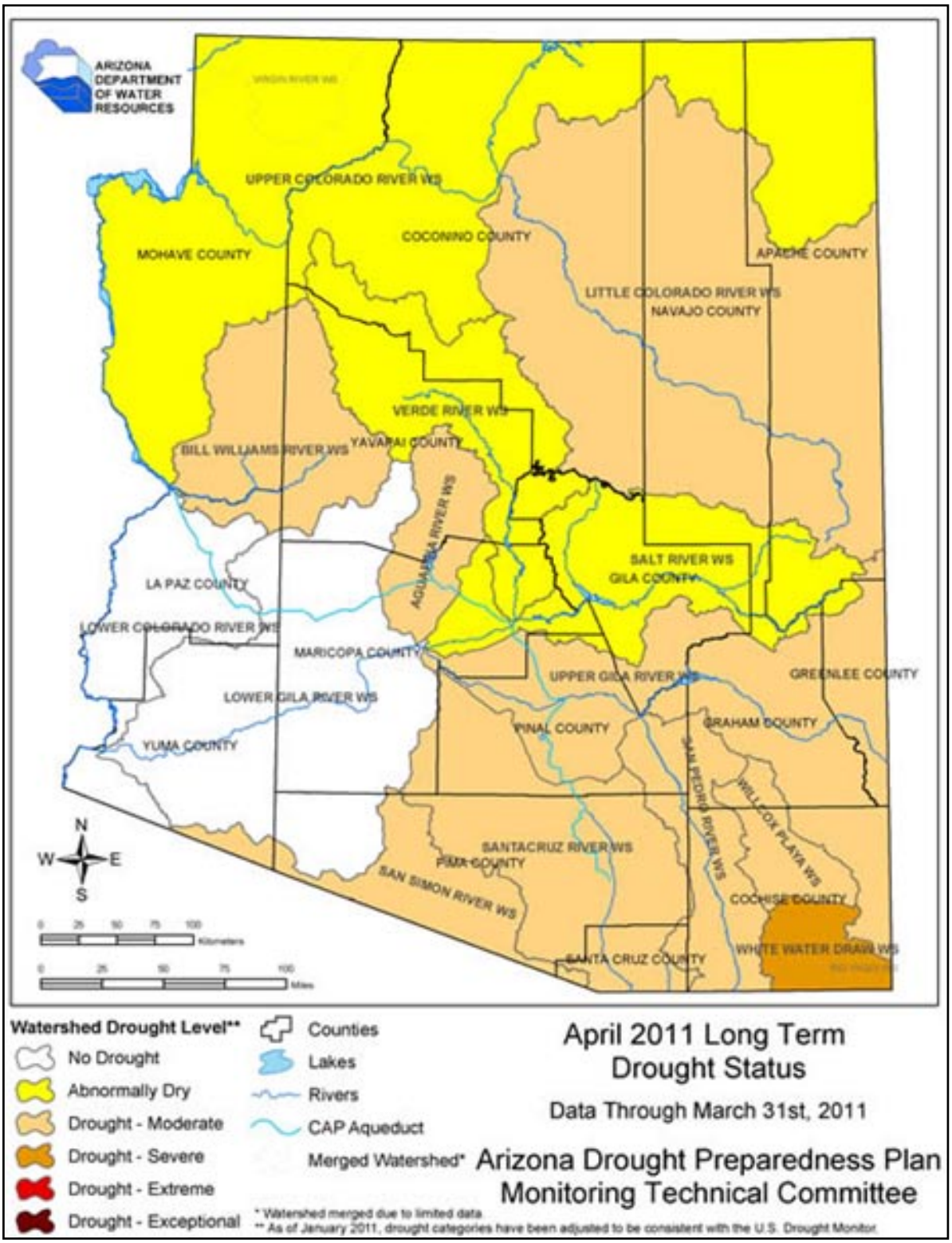
**Figure 5-6: Arizona short term drought status map as of July 26, 2011**

**Vulnerability – CPRI Results**

Drought CPRI results for each community are summarized in Table 5-17 below.

**Table 5-17: CPRI results by jurisdiction for drought**

| Participating Jurisdiction | Probability | Magnitude/ Severity | Warning Time | Duration | CPRI Score |
|---|---|---|---|---|---|
| Nogales | Likely | Critical | < 6 hours | > 1 week | 3.25 |
| Patagonia | Possible | Limited | > 24 hours | > 1 week | 2.05 |
| Unincorporated Santa Cruz County | Highly Likely | Negligible | < 6 hours | > 1 week | 2.65 |
| | | | | **County-wide average CPRI =** | **2.65** |




Source: ADWR, 2011 as accessed at: http://www.azwater.gov/azdwr/StatewidePlanning/Drought/DroughtStatus2.htm

**Figure 5-7: Arizona long term drought status map for April 2011**

**Vulnerability – Loss Estimations**

No standardized methodology exists for estimating losses due to drought and drought does not generally have a direct impact on critical facilities and building stock. A direct correlation to loss of human life due to drought is improbable for Santa Cruz County. Instead, drought vulnerability is primarily measured by its potential impact to certain sectors of the County economy and natural resources including:

- Crop and livestock agriculture
- Municipal and industrial water supply
- Recreation/tourism
- Wildlife and wildlife habitat

The Santa Cruz County farming and ranching industries are directly affected by extended drought conditions. The primary sources of water for irrigated farming are the Santa Cruz River, including groundwater that is sustained by this watercourse along the valley floor. Rangeland ranching is dependent upon groundwater and captured rainfall runoff via stock tanks and rain catchments. Extended drought conditions reduce rangeland grasses and other fodder. Stock tank water levels and replenishment are also significantly reduced. This forces ranchers to feed more hay and to truck in water to sustain their rangeland herds. The expense of these activities forces ranchers to drastically reduce herd sizes, flooding the markets with excess animals and tumbling livestock prices. Then supplies in following years are drastically reduced due to lack of rangeland and water and prices soar. These expenses are translated into the Santa Cruz County economy as a two-fold hardship. First, as an economic hardship for merchants and retailers that provide goods and services to the ranching community. Second, as increased costs due to a reduced supply in ranching commodities.

From 1995 to 2010, Santa Cruz County farmers and ranchers received $666,094 in disaster related assistance funding from the U.S Department of Agriculture (USDA) (EWG, 2011). The majority of those funds were received during the time period of 2000 to 2005 and are associated with livestock assistance and aid. The 2000-2005 time period also corresponds to the most severe period of the recent drought cycle for Santa Cruz County.

Other drought impacts include:

- Increased pumping costs due to lowering of groundwater levels
- Costs to expand water infrastructure to compensate for reduced yields or to develop alternative water sources
- Intangible costs associated with lost tourism revenues, and impacts to wildlife habitat and animals.

Typically, these impacts are translated into the general economy in the form of higher food and agricultural goods prices and increased utility costs.

Sustained drought conditions will also have secondary impacts by increasing risks associated with hazards such as fissures, flooding, subsidence and wildfire. Extended drought may weaken and dry the grasses, shrubs, and trees of wildfire areas, making them more susceptible to ignition. Drought also tends to reduce the vegetative cover in watersheds, and hence decrease the interception of rainfall and increase the flooding hazard. Subsidence and fissure conditions are aggravated when lean surface water supplies force the pumping of more groundwater to supply the demand without the benefit of recharge from normal rainfall.

**Vulnerability – Development Trends**

Growth in Santa Cruz County over the past five years has been very small and is not anticipated to increase significantly over the next five years. Requirements for additional surface and ground water supplies is therefore expected to be minimal. It is also unlikely that significant growth will occur in the ranching and farming sectors given the current constraints on water rights, grazing rights, and

available range land. However, drought planning should be a critical component of any domestic water system expansions or land development planning. The ADTF is also working cooperatively with water providers within the State to develop System Water Plans that are comprised of three components:

- *Water Supply Plan* – describes the service area, transmission facilities, monthly system production data, historic demand for the past five years, and projected demands for the next five, 10 and 20 years.
- *Drought Preparedness Plan* – includes drought and emergency response strategies, a plan of action to respond to water shortage conditions, and provisions to educate and inform the public.
- *Water Conservation Plan* – addresses measures to control lost and unaccounted for water, considers water rate structures that encourage efficient use of water, and plans for public information and education programs on water conservation.

The combination of these requirements will work to ensure that future development in Santa Cruz County will recognize drought as a potential constraint.

**Sources**

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National Integrated Drought Information System, 2007, *National Integrated Drought Information System Implementation Plan*, NOAA.

NIDIS U.S. Drought Portal website is located at: http://www.drought.gov/portal/server.pt/community/drought.gov/202

NOAA, NWS, Climate Prediction Center, 2010, website located at: http://www.cpc.ncep.noaa.gov/products/expert_assessment/seasonal_drought.html

**Profile Maps** - No profile maps are provided.

### *5.3.3 Extreme Temperature*

**Description**

Extreme temperatures on either the cold or hot side of the thermometer can occur within any area and can often have adverse impacts on the health and welfare of a community or region. These extreme temperatures can impact people, pets, plants and infrastructure such as power lines and above and below-ground pipes throughout the area.

Extreme heat is defined as temperatures that hover ten degrees or more above the average high temperature for the region and last for several weeks. Humid conditions may also add to the discomfort of high temperatures. Health risks from extreme heat include heat cramps, heat fainting, heat exhaustion and heat stroke. However, most deaths are attributed to prolonged heat waves in large cities that rarely experience hot weather. The elderly, ill, and poor are most at-risk, along with those who exercise outdoors in hot, humid weather. In Arizona, excessively dry and hot conditions can also induce dust storms and low visibility.

Extreme Heat is the combination of very high temperatures and exceptionally humid conditions that exceed regionally based indices for perceived risk. According to the National Weather Service, heat is the leading weather-related killer in the United States and has killed more people than lightning, tornadoes, floods and hurricanes combined in the last 10 years. The major human risks associated with extreme heat are as follows:

- Heat Cramps: May occur in people unaccustomed to exercising in the heat and generally ceases to be a problem after acclimatization.
- Heat Syncope: This refers to sudden loss of consciousness and is typically associated with people exercising who are not acclimated to warm temperatures. Causes little or no harm to the individual.
- Heat Exhaustion: While much less serious than heatstroke, heat exhaustion victims may complain of dizziness, weakness, or fatigue. Body temperatures may be normal or slightly to moderately elevated. The prognosis is usually good with fluid treatment.
- Heatstroke: Considered a medical emergency, heatstroke is often fatal. It occurs when the body's responses to heat stress are insufficient to prevent a substantial rise in the body's core temperature. While no standard diagnosis exists, a medical heatstroke condition is usually diagnosed when the body's temperature exceeds 105°F due to environmental temperatures. Rapid cooling is necessary to prevent death, with an average fatality rate of 15% even with treatment.

Extreme cold is normally associated with northern climates and regions, but in reality is much like extreme heat in that it is relative to what is considered normal cold temperatures for a region. In Arizona, sustained, below normal temperatures can prove to be dangerous and damaging. For example, economic losses due to frozen crops, downed power lines, or burst pipes can be significant. Frigid, below normal temperatures that continue for lengthy periods can be very dangerous and risk the health and well being of people and their animals.

**History**

Extreme temperature events impacting Santa Cruz County regularly experiences extreme temperature events that effected the southern bordering counties adjacent to Mexico. The following are examples of documented past events:

- According to a report prepared by the Arizona Dept of Health Services (ADHS, 2010), a total of 51 heat related deaths have occurred in Santa Cruz County over the period of 1992-2009, with the majority occurring between 2003 and 2009.
- Deaths of illegal immigrants in the desert areas along the Arizona-Mexico border are also attributed to extreme heat. In 2005, roughly 80 migrants died in the Tucson sector alone from heat exposure, while more than 180 total deaths occurred from heat exposure along the border (Guido, 2008).

- In February 2011, record breaking cold blanketed the southern portion of Arizona. Temperatures in Santa Cruz County ranged from 5 to 15 degrees and with the wind chill factor, the estimates went as low as -10 degrees. Across the county, individual water pipes were either frozen or burst, closing businesses, schools, and government buildings. One elderly resident in Patagonia had to be evacuated to her sister's house after the pipes in her ceiling burst causing drywall to fall in her home. The City of Nogales reported two water main ruptures including a 16-inch pipeline that feeds the city water system from the Santa Cruz River (Nogales International, 2011).

**Probability and Magnitude**

There are no recurrence or non-exceedance probabilities developed for extreme temperature events in Arizona or Santa Cruz County. Figures 4-4 through 4-7 in Section 4 of this Plan, provide example normal and extreme temperature ranges for two weather stations within the county. In general, extreme temperatures vary from normal by 10 to over 30 degrees, with highs that exceed 110 degrees and lows extending into the -10 degrees Fahrenheit.

One indicator of the degree of danger associated with extreme heat is the Heat Index (HI) or the "Apparent Temperature". According the NWS, the HI is an accurate measure of how hot it really feels when the Relative Humidity (RH) is added to the actual air temperature. Figure 5-8 is a quick reference chart published by the NWS that shows the HI based on current temperature and relative humidity, and levels of danger for HI values. It should be noted that the HI values were devised for shady, light wind conditions and that exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

**Vulnerability – CPRI Results**

Extreme Temperature CPRI results for each community are summarized in Table 5-18 below.

**Table 5-18: CPRI results by jurisdiction for extreme temperature**

| Participating Jurisdiction | Probability | Magnitude/ Severity | Warning Time | Duration | CPRI Score |
|---|---|---|---|---|---|
| Nogales | Highly Likely | Critical | 12 - 24 hours | < 1 week | 3.30 |
| Patagonia | Possible | Limited | > 24 hours | < 1 week | 1.95 |
| Unincorporated Santa Cruz County | Possible | Negligible | > 24 hours | < 24 hours | 1.55 |
| | | | | **County-wide average CPRI =** | **2.27** |

**Vulnerability – Loss Estimations**

Losses due to extreme heat or cold primarily occur in the form of death and illness for people and animals, and damaged infrastructure. There are currently no statistical analyses for projecting heat or cold related deaths in the State, however, ADHS does track data and monitor trends and other factors to determine if a statistical significance exists. Past history would indicate that multiple deaths due to extreme heat are highly likely, and especially for illegal immigrants that attempt to cross the Arizona deserts during the summer months. The homeless and low income populations are particularly vulnerable to extreme temperatures due to the increased exposure to the natural elements and decreased ability to compensate.

**Vulnerability – Development Trends**

Growth in Santa Cruz County over the past five years has been very small and is not anticipated to increase significantly over the next five years. The primary intersect of extreme temperature hazards and future development of the county is in the general increase in population that would be exposed. Advanced building codes requiring adequate burial depth of water lines are generally being used and enforced.

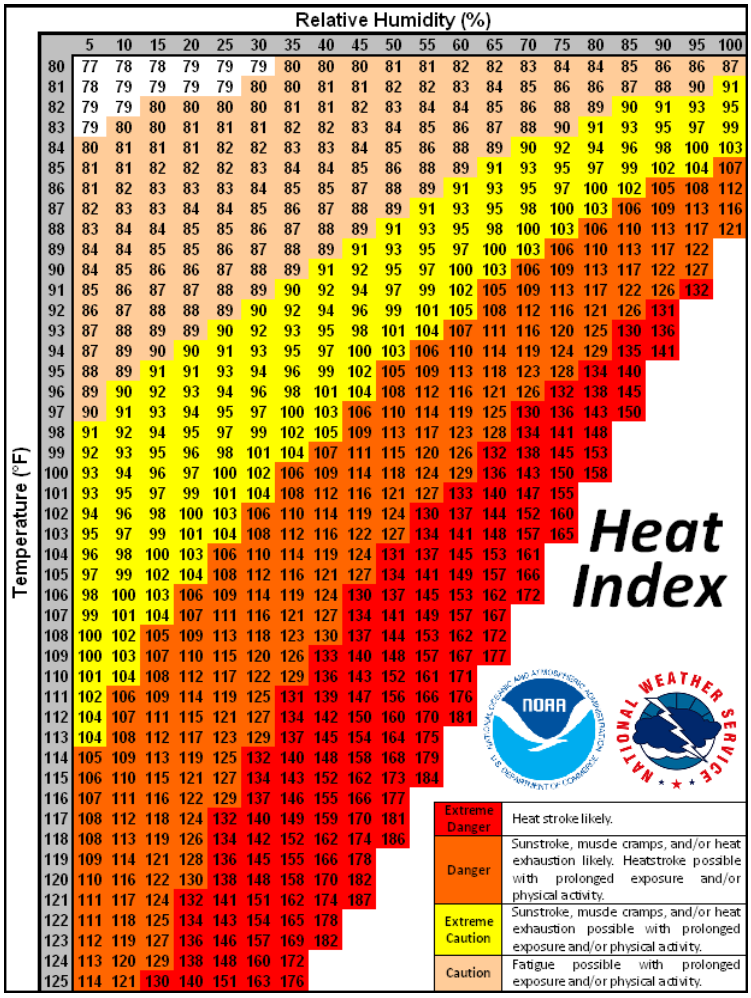


**Figure 5-8: National Weather Service Heat Index Chart**

**Sources**

AZ Dept of Health Services, 2004, Prevention Bulletin, Volume 18, No. 4, http://www.azdhs.gov/diro/pio/preventionbulletin/july04.pdf

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NASA, 2010, *NASA Assets Provide Orbital View to Study Phoenix Heat Waves*, http://www.nasa.gov/centers/johnson/home/phoenix_heatwaves_feature_prt.htm

National Weather Service, Warning and Forecast Office – Phoenix, 2009, http://www.wrh.noaa.gov/psr/general/safety/heat/

University of Arizona Library, *Books of the Southwest website portal is located at:* http://southwest.library.arizona.edu/azso/body.1_div.3.html

**Profile Maps -** No profile maps are provided.

### *5.3.4 Flood / Flash Flood*

**Description**

For the purpose of this Plan, the hazard of flooding addressed in this section will pertain to floods that result from precipitation/runoff related events. Other flooding due to dam or levee failures will not be addressed in this plan. The three seasonal atmospheric events that tend to trigger floods in Santa Cruz County are:

- *Tropical Storm Remnants*: Some of the worst flooding tends to occur when the remnants of a hurricane that has been downgraded to a tropical storm or tropical depression enter the State. These events occur infrequently and mostly in the early autumn, and usually bring heavy and intense precipitation over large regions causing severe flooding.
- *Winter Rains*: Winter brings the threat of low intensity; but long duration rains covering large areas that cause extensive flooding and erosion, particularly when combined with snowmelt.
- *Summer Monsoons*: A third atmospheric condition that brings flooding to Arizona is the annual summer monsoon. In mid to late summer the monsoon winds bring humid subtropical air into the State. Solar heating triggers afternoon and evening thunderstorms that can produce extremely intense, short duration bursts of rainfall. The thunderstorm rains are mostly translated into runoff and in some instances, the accumulation of runoff occurs very quickly resulting in a rapidly moving flood wave referred to as a flash flood. Flash floods tend to be very localized and cause significant flooding of local watercourses.

Damaging floods in the County include riverine, sheet, alluvial fan, and local area flooding. Riverine flooding occurs along established watercourses when the bankfull capacity of a watercourse is exceeded by storm runoff or snowmelt and the overbank areas become inundated. Sheet flooding occurs in regionally low areas with little topographic relief that generate floodplains over a mile wide, Alluvial fan flooding is generally located on piedmont areas near the base of the local mountains and are characterized by multiple, highly unstable flowpaths that can rapidly change during flooding events. Local area flooding is often the result of poorly designed or planned development wherein natural flowpaths are altered, blocked or obliterated, and localized ponding and conveyance problems result. Erosion is also often associated with damages due to flooding.

Another major flood hazard comes as a secondary impact of wildfires in the form of dramatically increased runoff from ordinary rainfall events that occur on newly burned watersheds. Denuding of the vegetative canopy and forest floor vegetation, and development of hydrophobic soils are the primary factors that contribute to the increased runoff. Canopy and floor level brushes and grasses intercept and store a significant volume of rainfall during a storm event. They also add to the overall watershed roughness which generally attenuates the ultimate peak discharges. Soils in a wildfire burn area can be rendered hydrophobic, which according the NRCS is the development of a thin layer of nearly impervious soil at or below the mineral soil surface that is the result of a waxy substance derived from plant material burned during a hot fire. The waxy substance penetrates into the soil as a gas and solidifies after it cools, forming a waxy coating around soil particles. Hydrophobic soils, in combination with a denuded watershed, will significantly increase the runoff potential, turning a routine annual rainfall event into a raging flood with drastically increased potential for soil erosion and mud and debris flows.

**History**

Flooding is clearly a major hazard in Santa Cruz County as shown in Tables 5-2 through 5-4. Santa Cruz County has been part of 15 disaster declarations for flooding, with three of those declarations occurring in the past five years. There have been at least twenty-two other non-declared events of reported flooding incidents that met the thresholds outlined in Section 5.1, two of which occurred in the last five years. The following incidents represent examples of major flooding that has impacted the County:

- During January and February 1993, winter rain flooding damage occurred from winter storms associated with the El Nino phenomenon. These storms flooded watersheds throughout Arizona by dumping excessive rainfall amounts that saturated soils and increased runoff. Warm temperature snowmelt exacerbated the situation over large areas. Erosion caused tremendous damage and some communities along normally dry washes were devastated. Stream flow velocities and runoff volumes exceeded historic highs. Many flood prevention channels and retention reservoirs were filled to capacity and so water was diverted to the emergency spillways or the reservoirs were breached, causing extensive damage in some cases (e.g., Painted Rock Reservoir spillway). Ultimately, the President declared a major federal disaster that freed federal funds for both public and private property losses for all of Arizona's fifteen counties. Damages were widespread and significant, impacting over 100 communities. Statewide total public and private damages exceeded $400 million and eight deaths and 112 injuries were reported to the Red Cross (FEMA, April 1, 1993; ADEM, March, 1998) Santa Cruz County damages were primarily associated with flows and erosion in the Santa Cruz River, Nogales Wash, Peck Canyon Creek, Western Wash and other minor tributaries. Public damages reported through FEMA, FHWA and SBA amounted to approximately $1.4 million. The Tubac Country Club sustained over $100,000 in damages from the Santa Cruz River flooding.
- In August 1994, a devastating severe thunderstorm caused wind damage and flash flooding in both eastern Pima and Santa Cruz counties. Considerable flooding occurred in Santa Cruz County with thunderstorms around Nogales causing extensive flooding and heavy runoff. In some places, at least three inches of rain fell in the afternoon and early evening hours. The Santa Cruz river was reported flowing, and the Nogales Wash was nearly bankfull. A Mexican woman and her two children were drowned when their pickup truck was caught in flood waters on Cinco de Febrero Street in Nogales, Sonora. The bodies were swept downstream, two miles north of the border, where they were found near the Chula Vista subdivision. Many homes and businesses were flooded, but no estimates of damage were made and no evacuations were necessary (Green Valley News and Sun, circ:7,500).
- In August 2007, the Nogales Wash Emergency was declared when portions of downtown Nogales experienced flash flooding. Extensive damage occurred to the concrete lining of Nogales Wash in the City of Nogales. City officials estimated damage at $10 million on the U.S. side of the border. Scattered thunderstorms across Southeast Arizona caused hail and wind damage in Tucson and flash flooding in Nogales. (ADEM, 2008)
- In July 2008, Nogales Wash 2008 Emergency was declared - Heavy rainfall on the Mexican side of the border caused flash flooding in the city of Nogales, Arizona. This was caused by a damaged portion of the underground Nogales Wash. Local emergency management reported that water burst through the underground wash onto the surface just across the International Border. The border wall acted as a dam, keeping most of the flooding on the Mexican side. However, some water did flow through the port of entry into downtown Nogales, Arizona. Several businesses in the downtown business district experienced flooding and two illegal immigrants found two days later in the underground wash are also believed to have drowned due to this flooding. In addition, three illegal immigrants in an underground flood channel beneath the international border were rescued. Slow moving thunderstorms developed in a very moist environment across Southeast Arizona resulting in areas of flash flooding.(ADEM, 2008; NCDC,2010)
- In August 2010, the Monsoon 2010 Flooding Emergency was declared: On July 19, 2010, through July 29, 2010, a series of potent monsoon thunderstorms causing high winds and flash floods damaged many locations in southeastern Arizona. The heavy rains resulted in unusually strong flooding events and caused extreme peril to public health and safety in two primary areas: Wards Canyon in Greenlee County and the Nogales Wash in Santa Cruz County. On July 29, 2010 both the Town of Clifton and Greenlee County declared a state of emergency for this event, followed on July 30, 2010 by Santa Cruz County, stating that this monsoon event has created a situation above and beyond their capabilities and they are

requesting assistance from the State. These water flows caused extensive $500,000 in damages to public infrastructure and threatened resources that provide essential life services to Greenlee and Santa Cruz residents, primarily roads and sewer lines.(ADEM, 2010)

Numerous other flood related incidents are summarized in the historic hazard database provided in Appendix D and on the enclosed CD.

**Probability and Magnitude**

For the purposes of this Plan, the probability and magnitude of flood hazards in Greenlee County jurisdictions are primarily based on the 1% (100-year) and 0.2% (500-year) probability floodplains delineated on FEMA Flood Insurance Rate Maps (FIRMs), plus any provisional floodplain delineations used for in-house purposes by participating jurisdictions or Planning Team delineated areas. FEMA has recently completed a map modification program to update the FIRMs for the County into a digital FIRM (DFIRM) format. The tentative effective date for the new DFIRM maps is December 2011. DFIRM floodplain GIS base files were obtained from FEMA and are the basis for the flood hazard depictions in this Plan. Therefore, the vulnerability analysis results in this plan are likely conservative.

Two designations of flood hazard are used. Any "A" zone is designated as a high hazard area. Medium flood hazard areas are all "Shaded X" zones. All "A" zones (e.g. – A, A1-99, AE, AH, AO, etc.) represent areas with a 1% probability of being flooded at a depth of one-foot or greater in any given year. All "Shaded X" zones represent areas with a 0.2% probability of being flooded at a depth of one-foot or greater in any given year. These two storms are often referred to as the 100-year and 500-year storm, respectively. High and medium hazard designations were also assigned to the non-FEMA areas by the Planning Team based on the anticipated level of flood hazard posed.

Maps 2A show the flood hazard areas for the entire county. Maps 2B and 2C show the flood hazard areas for Nogales and Patagonia, respectively.

**Vulnerability – CPRI Results**

Flooding CPRI results for each community are summarized in Table 5-19 below.

**Table 5-19: CPRI results by jurisdiction for flooding**

| Participating Jurisdiction | Probability | Magnitude/ Severity | Warning Time | Duration | CPRI Score |
|---|---|---|---|---|---|
| Nogales | Highly Likely | Critical | 6 - 12 hours | < 24 hours | 3.65 |
| Patagonia | Highly Likely | Critical | < 6 hours | < 24 hours | 3.50 |
| Unincorporated Santa Cruz County | Highly Likely | Critical | < 6 hours | > 1 week | 3.70 |
| | | | | **County-wide average CPRI =** | **3.62** |

**Vulnerability – Loss Estimations**

The estimation of potential exposure to high and medium flood hazards was accomplished by intersecting the human and critical facility assets with the flood hazard limits depicted on Map 2A. Loss estimates to all facilities located within the high and medium flood hazard areas were made based on loss estimation tables published by FEMA (FEMA, 2001). Most of the assets located within high hazard flood areas will be subject to three feet or less of flooding. Using the FEMA tables, it is assumed that all structural assets located within the high hazard areas will have a loss-to-exposure ratio of 0.20 (or 20%). A loss to exposure ratio of 0.05 (5%) is assumed for assets located in the medium hazard areas. Table 5-20 summarizes the Planning Team identified critical facilities potentially exposed to high and medium flood hazards, and the corresponding estimates of losses. Table 5-21 summarizes population sectors exposed to the high and medium flood hazards. HAZUS residential, commercial and industrial exposures and loss estimates to high and medium flood hazards are summarized in Tables 5-22 through 5-25.

In summary, $73 million and $2.4 million in asset related losses are estimated for high and medium flood hazards, for all the participating jurisdictions in Santa Cruz County. An additional $215 and $1.8 million in high and medium flood losses to HAZUS defined residential, commercial, and industrial

facilities is estimated for all participating Santa Cruz County jurisdictions. Regarding human vulnerability, a total population of 11,587 people, or 30.21% of the total population, is potentially exposed to a high hazard flood event. A total population of 246 people, or .64% of the total population, is potentially exposed to a medium hazard flood event. Based on the historic record, multiple deaths and injuries are plausible and a substantial portion of the exposed population is subject to displacement depending on the event magnitude.

It is duly noted that the loss and exposure numbers presented above represent a comprehensive evaluation of the County as a whole. It is unlikely that a storm event would occur that would flood all of the delineated high and medium flood hazard areas at the same time. Accordingly, actual event based losses and exposure are likely to be only a fraction of those summarized above. Furthermore, it should be noted that any flood event that exposes assets or population to a medium hazard will also expose assets and populations to the high hazard flood zone. That is, the 100-year floodplain would be entirely inundated during a 500-year flood.

**Vulnerability – Repetitive Loss Properties**

Repetitive Loss (RL) properties are those NFIP-insured properties that since 1978, have experienced multiple flood losses. FEMA tracks RL property statistics, and in particular to identify Severe RL (SRL) properties. RL properties demonstrate a track record of repeated flooding for a certain location and are one element of the vulnerability analysis. RL properties are also important to the NFIP, since structures that flood frequently put a strain on the National Flood Insurance Fund. FEMA records dated January 2010 (provided by ADEM) indicate that there are 7 identified RL properties in Santa Cruz County, with a total of over $124,148 in associated building and contents value payments. None of the payments have occurred within the last five years. Table 5-27 summarizes the RL property characteristics by jurisdiction.

**Table 5-27: Repetitive Loss property statistics for Santa Cruz County jurisdictions**

| Jurisdiction | No. of Properties | No. of Properties Mitigated | Total Payments |
|---|---|---|---|
| Nogales | 4 | 0 | $92,978 |
| Patagonia | 0 | 0 | $0 |
| Unincorporated Santa Cruz County | 3 | 3 | $31,169 |

Source: FEMA Region IX, 2010 (data as of January 31, 2010)

It is duly noted that all three of the RL properties listed for Unincorporated Santa Cruz County are disputed by the Santa Cruz County Flood Control District, as the FEMA data cannot be verified. The same is true for a couple of the properties listed for Nogales.

**Vulnerability – Development Trends**

Most floodprone properties in Santa Cruz County pre-date the planning jurisdictions' entry into the NFIP and were constructed prior to current floodplain management practices. The development of new properties or substantial re-development of existing structures is now subject to regulatory review procedures implemented by each jurisdiction. New development, adequate planning and regulatory tools are in place to regulate future development. For many areas within the county, challenges for the management of new growth include the need for master drainage planning and additional floodplain delineations to identify and map the flood hazards within the growth areas where no mapping currently exists.

**Table 5-20: Asset inventory exposure to high and medium hazard flooding and corresponding loss estimates**

| Community | Total Facilities Reported by Community | Impacted Facilities | Percentage of Total Community Facilities Impacted | Estimated Replacement Cost (x$1000) | Estimated Structure Loss (x$1000) |
|---|---|---|---|---|---|
| **HIGH** | | | | | |
| **County-Wide Totals** | **244** | **132** | **54.10%** | **$369,623** | **$73,925** |
| Nogales | 39 | 21 | 53.85% | $1,939 | $388 |
| Patagonia | 16 | 12 | 75.00% | $2,573 | $515 |
| Unincorporated Santa Cruz | 189 | 99 | 52.38% | $365,110 | $73,022 |
| **MEDIUM** | | | | | |
| **County-Wide Totals** | **244** | **8** | **3.28%** | **$48,165** | **$2,408** |
| Nogales | 39 | 3 | 7.69% | $6,665 | $333 |
| Patagonia | 16 | 1 | 6.25% | $6,500 | $325 |
| Unincorporated Santa Cruz | 189 | 4 | 2.12% | $35,000 | $1,750 |

**Table 5-21: Population sectors exposed to high and medium hazard flooding**

| Community | Total Population | Population Exposed | Percent of Population Exposed | Total Population Over 65 | Population Over 65 Exposed | Percent of Population Over 65 Exposed |
|---|---|---|---|---|---|---|
| **HIGH** | | | | | | |
| **County-Wide Totals** | **38,353** | **11,587** | **30.21%** | **4,047** | **1,340** | **33.10%** |
| City of Nogales | 20,818 | 6,101 | 29.30% | 2,204 | 653 | 29.61% |
| Town of Patagonia | 827 | 748 | 90.46% | 178 | 161 | 90.60% |
| Unincorporated | 16,708 | 4,738 | 28.36% | 1,665 | 526 | 31.57% |
| **MEDIUM** | | | | | | |
| **County-Wide Totals** | **38,353** | **246** | **0.64%** | **4,047** | **31** | **0.75%** |
| City of Nogales | 20,818 | 166 | 0.80% | 2,204 | 19 | 0.88% |
| Town of Patagonia | 827 | 1 | 0.10% | 178 | 0 | 0.10% |
| Unincorporated | 16,708 | 79 | 0.47% | 1,665 | 11 | 0.66% |

**Table 5-22: Santa Cruz County HAZUS building exposure to flooding**

| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
|---|---|---|---|---|---|---|---|---|---|
| **Santa Cruz County HAZUS Summary** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Total of All Economic Impact (x$1000)** | **Loss-to-Exposure Ratio** | **Total Estimated Loss (x$1000)** |
| **County-Wide Totals** | **13,318** | **$2,022,210** | **693** | **$896,552** | **206** | **$179,733** | **$3,098,495** | | |
| High Hazard Exposure | 4,208 | $594,073 | 308 | $422,175 | 70 | $61,184 | $1,077,432 | 20% | $215,486 |
| Medium Hazard Exposure | 93 | $13,610 | 11 | $19,719 | 2 | $2,463 | $35,792 | 5% | $1,790 |
| **Santa Cruz County HAZUS Summary** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | | | |
| High Hazard Exposure | 31.60% | 29.38% | 44.44% | 47.09% | 34.08% | 34.04% | | | |
| Medium Hazard Exposure | 0.70% | 0.67% | 01.57% | 02.20% | 01.04% | 01.37% | | | |

**Table 5-23: City of Nogales HAZUS building exposure to flooding**

| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
|---|---|---|---|---|---|---|---|---|---|
| **City of Nogales HAZUS Summary** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Total of All Economic Impact (x$1000)** | **Loss-to-Exposure Ratio** | **Total Estimated Loss (x$1000)** |
| **Community-Wide Totals** | **5,922** | **$856,827** | **372** | **$594,349** | **96** | **$114,768** | **$1,565,944** | | |
| High Hazard Exposure | 1,821 | $253,588 | 188 | $287,022 | 36 | $42,464 | $583,074 | 20% | $116,615 |
| Medium Hazard Exposure | 49 | $6,766 | 4 | $6,330 | 1 | $669 | $13,764 | 5% | $688 |
| **City of Nogales HAZUS Summary** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | | | |
| High Hazard Exposure | 30.74% | 29.60% | 50.57% | 48.29% | 37.20% | 37.0% | | | |
| Medium Hazard Exposure | 0.82% | 0.79% | 0.96% | 01.07% | 0.68% | 0.58% | | | |

**Table 5-24: Town of Patagonia HAZUS building exposure to flooding**

| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
|---|---|---|---|---|---|---|---|---|---|
| **Town of Patagonia HAZUS Summary** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Total of All Economic Impact (x$1000)** | **Loss-to-Exposure Ratio** | **Total Estimated Loss (x$1000)** |
| **Community-Wide Totals** | **539** | **$51,820** | **11** | **$7,168** | **5** | **$1,397** | **$60,385** | | |
| High Hazard Exposure | 485 | $47,482 | 12 | $7,432 | 5 | $1,397 | $56,311 | 20% | $11,262 |
| Medium Hazard Exposure | 0 | $42 | 0 | $0 | 0 | $0 | $42 | 5% | $2 |
| **Town of Patagonia HAZUS Summary** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | | | |
| High Hazard Exposure | 90.04% | 91.63% | 108.20% | 103.68% | 100.0% | 100.0% | | | |
| Medium Hazard Exposure | 0.08% | 0.08% | 0.0% | 0.0% | 0.0% | 0.0% | | | |

**Table 5-25: Unincorporated Santa Cruz County HAZUS building exposure to flooding**

| | RESIDENTIAL | | COMMERCIAL | | INDUSTRIAL | | SUMMARY | | |
|---|---|---|---|---|---|---|---|---|---|
| **Unincorporated Santa Cruz County HAZUS Summary** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Building Count** | **Potential Economic Impact (x$1000)** | **Total of All Economic Impact (x$1000)** | **Loss-to-Exposure Ratio** | **Total Estimated Loss (x$1000)** |
| **Community-Wide Totals** | **6,856** | **$1,113,563** | **310** | **$295,035** | **105** | **$63,568** | **$1,472,166** | | |
| High Hazard Exposure | 1,902 | $293,003 | 108 | $127,721 | 30 | $17,323 | $438,047 | 20% | $87,609 |
| Medium Hazard Exposure | 44 | $6,802 | 7 | $13,389 | 1 | $1,794 | $21,985 | 5% | $1,099 |
| **Unincorporated Santa Cruz County HAZUS Summary** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | **% Building Count** | **% Potential Economic Impact** | | | |
| High Hazard Exposure | 27.74% | 26.31% | 34.83% | 43.29% | 28.13% | 27.25% | | | |
| Medium Hazard Exposure | 0.65% | 0.61% | 02.35% | 04.54% | 01.42% | 02.82% | | | |

**Sources**

Arizona Division of Emergency Management, 2010, State of Arizona Multi-Hazard Mitigation Plan.

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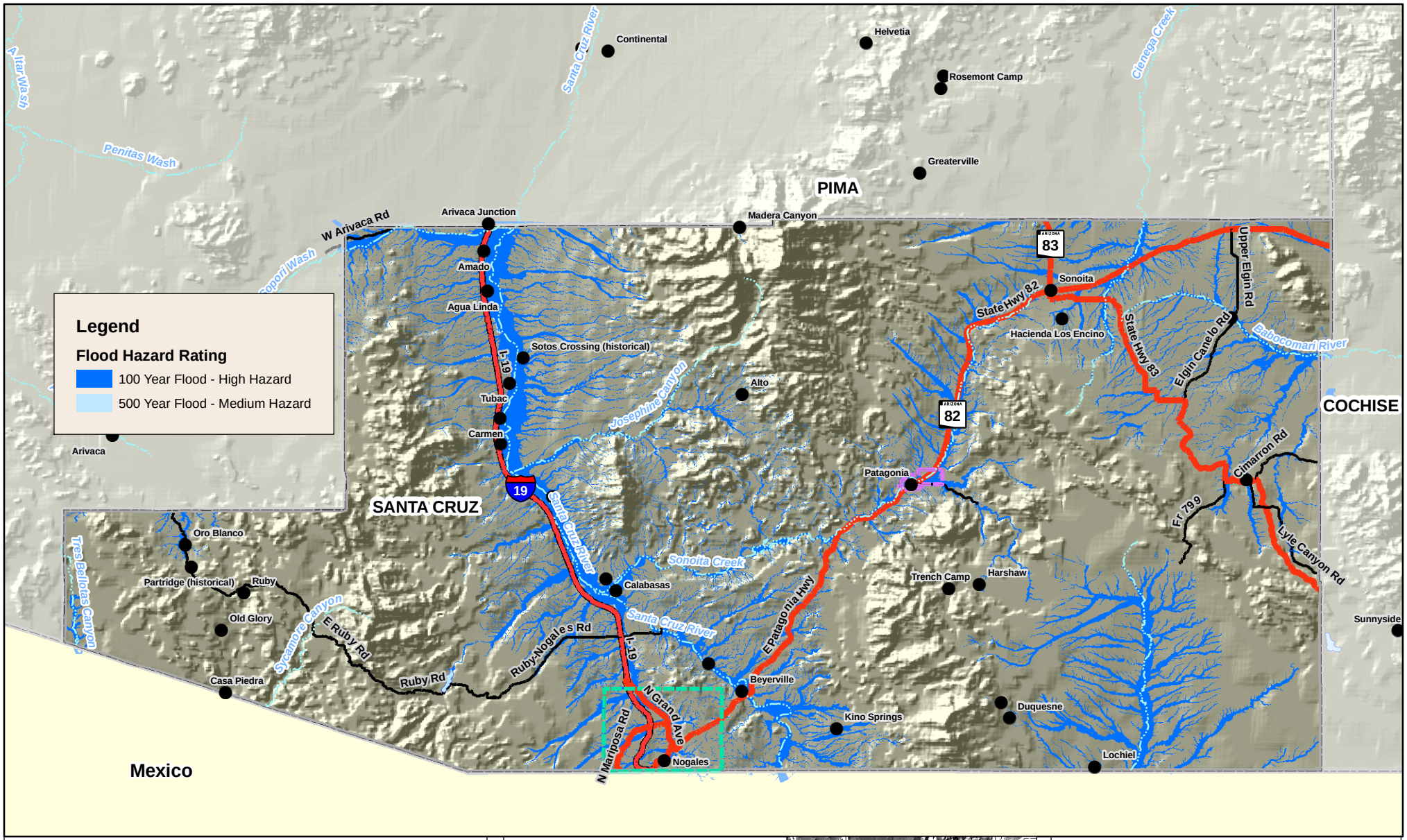
U.S. Dept of Commerce, National Climatic Data Center, 2010, Storm Events Database, accessed via the following URL: http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

U.S. Army Corps of Engineers, Los Angeles District, 1994, Flood Damage Report, State of Arizona, Floods of 1993.

**Profile Maps**

Maps 2A– County-Wide Flood Hazard Map

Maps 2B and 2C – Nogales and Patagonia Flood Hazard Maps




**Legend**

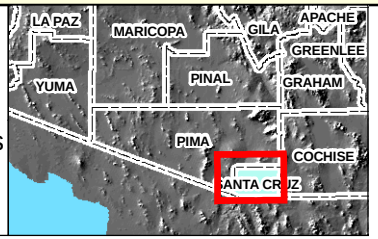
**Communities**
- NOGALES
- PATAGONIA
- County Boundary

- Cities, Towns, Places
- Watercourses
- Lakes

**Roads**
- Interstate
- US, State, County Hwys
- Major Roads

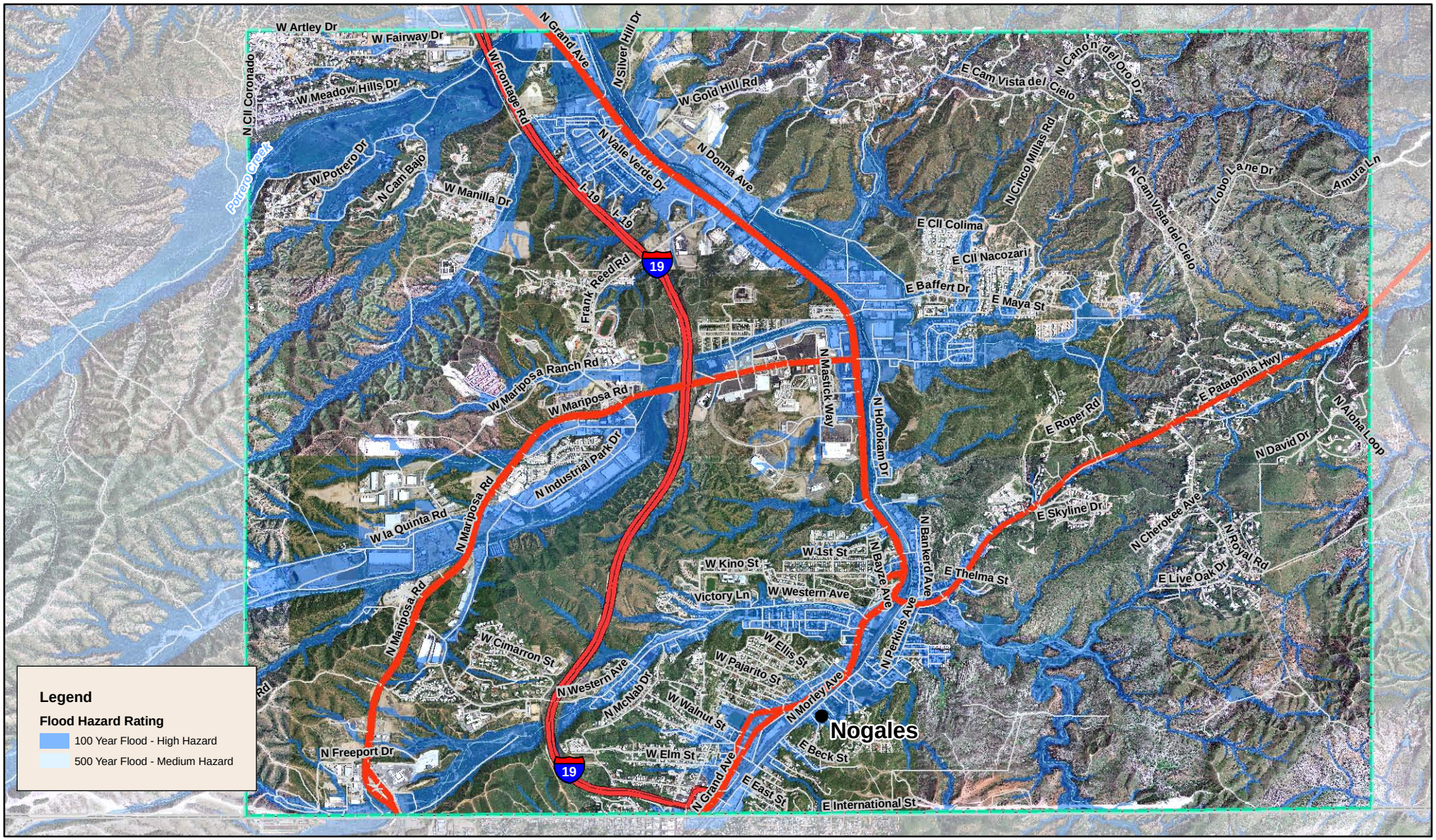
0 2.5 5 10 Miles

Sources: FEMA, 2010; ALRIS, 2010; JEF, 2010; SCC, 2011




**Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan**

**Map 2A**
**Santa Cruz County Flood Hazard Map as of May 2011**




**Legend**

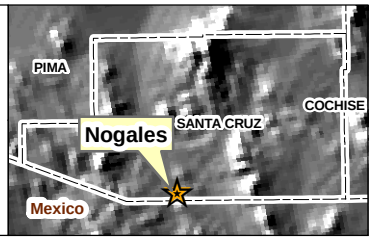
**Communities**
- NOGALES
- PATAGONIA
- County Boundary

- Cities, Towns, Places
- Watercourses
- Lakes

**Roads**
- Interstates
- Highways
- Arterials
- Streets

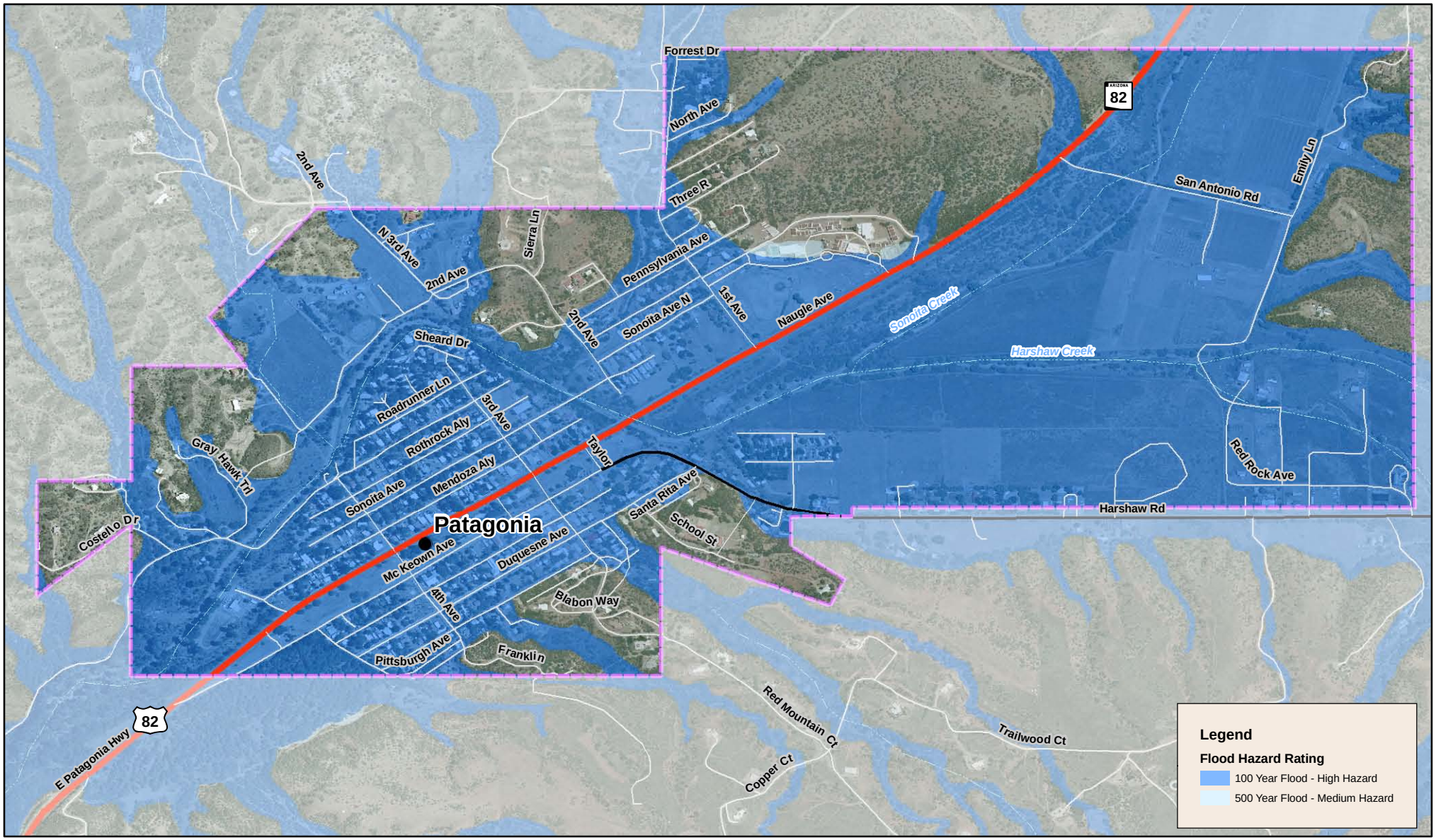
0 0.5 1 Miles

Sources: FEMA, 2010; ALRIS, 2010; JEF, 2010; SCC, 2010; ASLD, 2010




**Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan**

**Map 2B**
**City of Nogales**
**Flood**
**Hazard Map**
**as of December 2010**




**Legend**

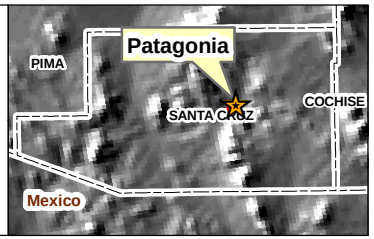
**Communities**
- NOGALES
- PATAGONIA
- County Boundary

- Cities, Towns, Places
- Watercourses
- Lakes

**Roads**
- Interstates
- Highways
- Arterials
- Streets

0 380 760 1,520 Feet

Sources: FEMA, 2010; ALRIS, 2010; JEF, 2010; SCC, 2010; ASLD, 2005




**Santa Cruz County Multi-Jurisdictional Hazard Mitigation Plan**

**Map 2C**
**Town of Patagonia**
**Flood**
**Hazard Map**
**as of December 2010**