Tier 1 Environmental Impact Statement

INVEST Innovative Criteria

Quantm

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Acronyms and Abbreviations

ADOT	Arizona Department of Transportation
ASR	Alternatives Selection Report
EIS	Environmental Impact Statement
FAST	Fixing America's Surface Transportation
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
GIS	Geographic Information System
I-11	Interstate 11
IWCS	I-11 and Intermountain West Corridor Study
MAG	Maricopa Association of Governments
NDOT	Nevada Department of Transportation
NEPA	National Environmental Policy Act
Reclamation	Bureau of Reclamation
ROW	Right-of-Way
RTC	Regional Transportation Commission of Southern Nevada
US	United States

1 INTRODUCTION

1.1 Overview

The Federal Highway Administration (FHWA) and the Arizona Department of Transportation (ADOT) are conducting the environmental review process for the Interstate 11 (I-11) Corridor from Nogales to Wickenburg, Arizona. A Tier 1 Environmental Impact Statement (EIS) is being be prepared as part of this process in accordance with the National Environmental Policy Act (NEPA) and other regulatory requirements. The FHWA is the Federal Lead Agency and the ADOT is the Local Project Sponsor under NEPA.

The environmental review process builds upon the prior *I-11 and Intermountain West Corridor Study* (IWCS) completed in 2014, which was a multimodal planning effort that involved the ADOT, the Nevada Department of Transportation (NDOT), FHWA, Federal Railroad Administration (FRA), Maricopa Association of Governments (MAG), Regional Transportation Commission of Southern Nevada (RTC), and other key stakeholders. The IWCS identified the I-11 Corridor as a critical piece of multimodal infrastructure that would diversify, support, and connect the economies of Arizona and Nevada. The study also concluded that it could be part of a larger north-south transportation corridor, linking Mexico and Canada.

In December 2015, the United States (US) Congress approved the Fixing America's Surface Transportation (FAST) Act, which is a 5-year legislation to improve the Nation's surface transportation infrastructure. The FAST Act formally designates I-11 throughout Arizona, reinforcing the ADOT's overall concept for the I-11 Corridor that emerged from the IWCS study.

The FHWA and ADOT are continuing to study the I-11 Corridor in Arizona for the approximate 280-mile section between Nogales and Wickenburg, as shown on **Figure 1-1** (I-11 Corridor Study Area [Nogales to Wickenburg]).

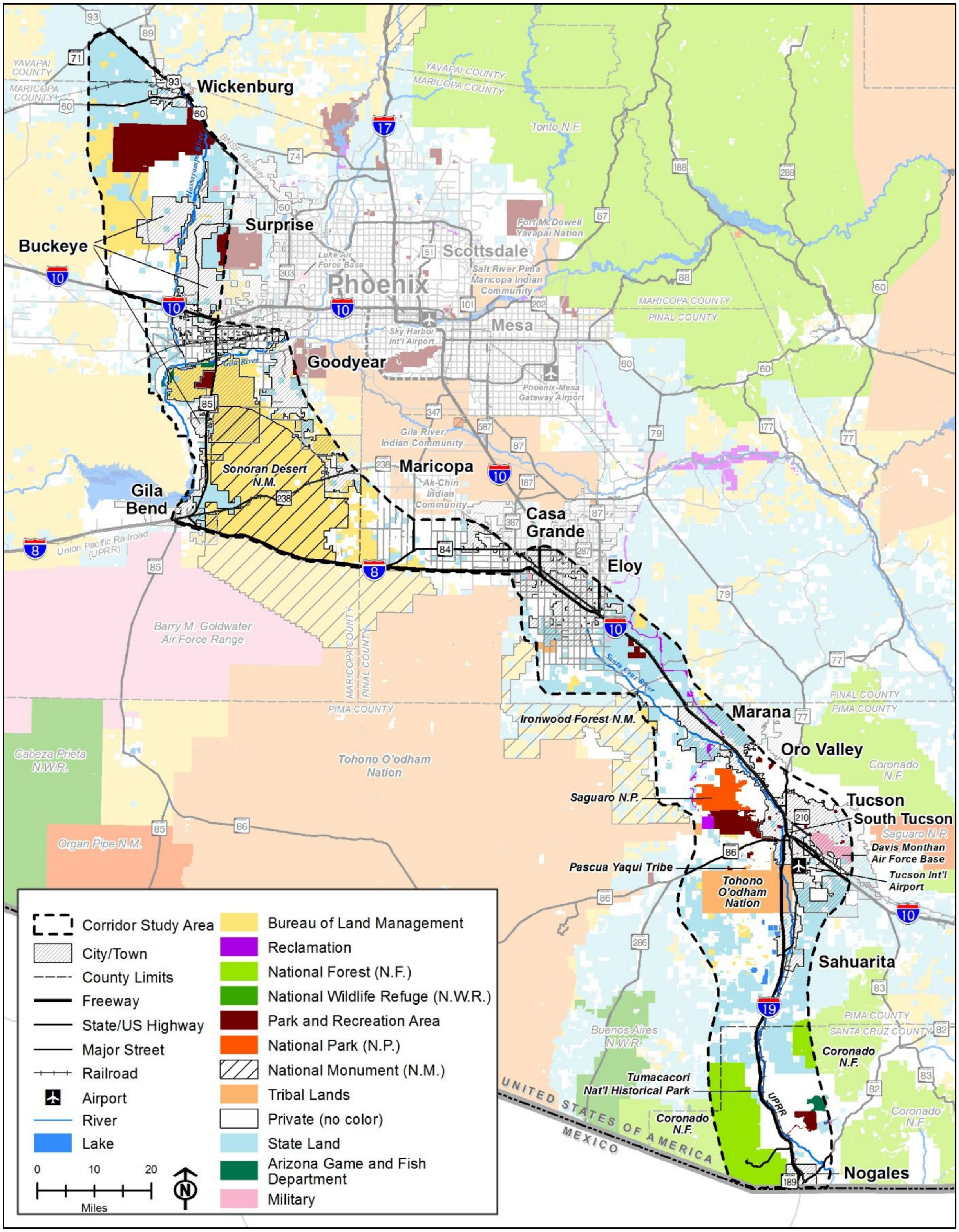


Figure 1-1 I-11 Corridor Study Area (Nogales to Wickenburg)

2 PURPOSE OF REPORT

The purpose of this memorandum is to provide details about the **Technical Analysis** portion of the alternatives development process that utilized the Trimble Software Quantm and demonstrate how it added an innovative spin to the project.

3 ALTERNATIVES DEVELOPMENT

During the alternatives development phase of the I-11 Tier 1 EIS an initial range of corridor alternatives was developed based on the four primary sources listed below.

- **Prior I-11 Study:** The 2014 IWCS performed an alternatives analysis and consensus-building exercise to recommend I-11 corridor alternatives for further analysis in this environmental review process.

- **Agency Scoping Input:** During scoping, agencies and tribal communities provided feedback on potential corridor alternative preferences, considerations, and/or constraint areas, including potential locations for a transportation facility or areas to avoid.

- **Public Scoping Input:** During scoping, the general public also provided feedback on potential corridor alternative preferences, considerations, and/or constraint areas, including potential locations for a transportation facility or areas to avoid.

- **Technical Analysis:** Quantm, a software tool, was used that simultaneously considered engineering factors and avoided sensitive resources to both identify and screen out corridor alternatives that potentially have substantial impacts and other issues.

The fourth input to the development of an initial range of alternatives was the technical analysis component. The technical analysis utilized a software tool (Quantm) that considered both engineering and environmental factors. It mapped out potential routes for a proposed transportation facility based on engineering design criteria and, at the same time, avoided sensitive environmental resources, land uses, and topographical constraints. The intent of adding this step was to identify any reasonable corridor alternatives not already studied or recommended, as well as to validate or optimize previously suggested routes. For analysis purposes, the I-11 Corridor Study Area was divided into three sections – South, Central, and North – due to the large geographical coverage of the overall Corridor Study Area (**Figure 3-1**; I-11 Corridor Study Area Sections).

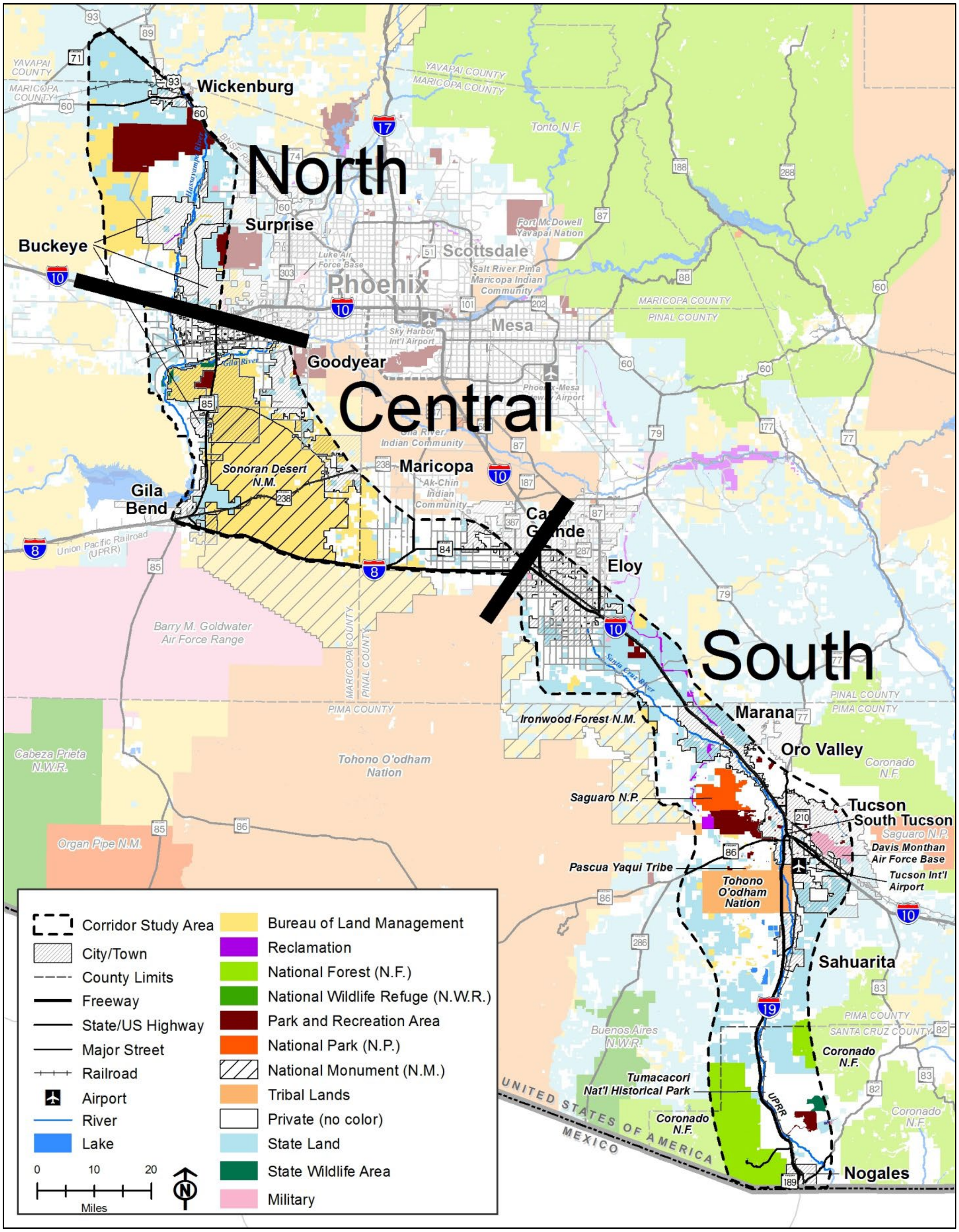


Figure 3-1 I-11 Corridor Study Area Sections

3.1 Technical Analysis

Figure 3-2 (Steps Involved in Technical Analysis) outlines the major technical analysis steps to identify potential corridor alternatives. A summary of those steps is provided below, with a more detailed discussion thereafter:

- Collect and enter **engineering and environmental inputs** into model
- Run model for a **free-to-roam analysis** looking for potential routes within Corridor Study Area
- Evaluate model outputs to identify **route trends** within I-11 Corridor Study Area
- Conduct density analysis of route trends to identify **potential corridor alternatives.**

Engineering and Environmental Inputs

The initial step of the technical analysis involved collecting and entering engineering and environmental inputs into the model. The engineering inputs are based on the design criteria for a proposed interstate freeway facility, with considerations for future multimodal elements (e.g., appropriate grades for rail). The environmental inputs included identified resources, sensitive land uses, and topographical information.

Figure 3-3 (Typical Section for Proposed Interstate Freeway Facility) is an example of the typical cross section of a proposed interstate freeway facility. The engineering input assumptions also addressed minimum turning radii/curves, grade/slope requirements, right-of-way (ROW) needs, etc. for a 4-lane interstate freeway. At this stage of the technical analysis, a 400-foot ROW footprint was used to take into consideration the maximum horizontal width required for a proposed interstate freeway facility. In areas of ROW constraint or where a wider footprint may not be needed (e.g., no need for frontage roads), the I-11 Corridor may be narrower than 400 feet. This was an estimate for planning purposes only during the ASR phase.

As discussed in the Purpose and Need Statement, a specific need for additional rail and utility facilities in the Corridor Study Area has not been identified. However, the engineering inputs for a proposed interstate freeway facility would allow for a multimodal facility (i.e., rail and/or utility) in the future if needed.

Figure 3-4 (Environmentally Sensitive Areas) illustrates the environmental inputs for this stage of the analysis that were collected from various sources. These sensitive areas are considered as potential avoidance areas in the technical analysis. Initial information for sensitive environmental resource and land use information was gathered from the prior IWCS and PEL process. Additional information was provided by agencies, tribal communities, and the public during the scoping period. Tribal lands were avoided unless a tribal government requested or approved otherwise. The I-11 Corridor Study Area was scanned and inventoried for other sensitive land uses not otherwise noted (e.g., schools, landfills, prisons, etc.). **Appendix A** (Environmentally Sensitive Resources by Section) provides a compilation of this information for the South, Central and North sections of the I-11 Corridor Study Area that were used as a basis for the environmental inputs and potential avoidance areas in the technical analysis.

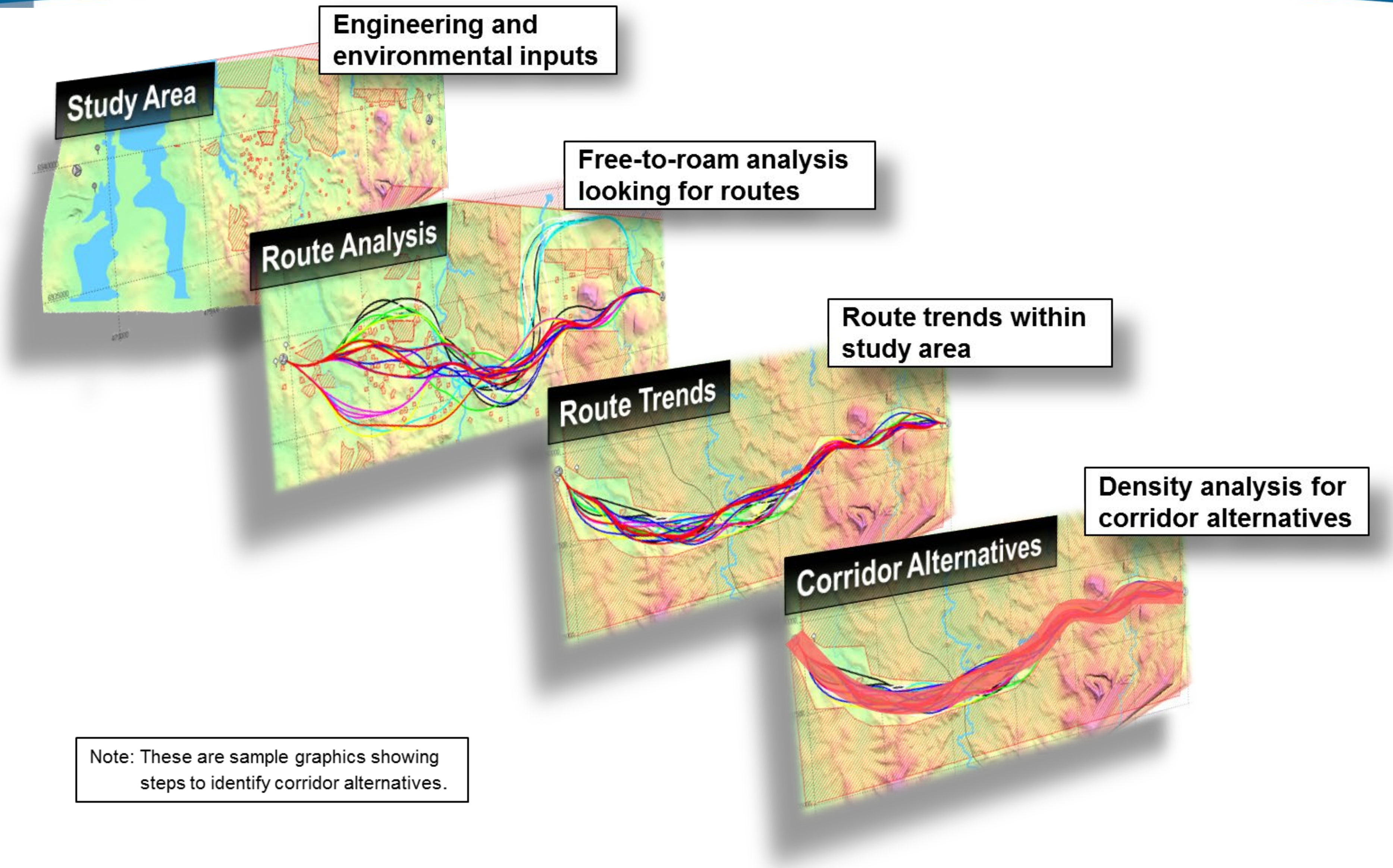
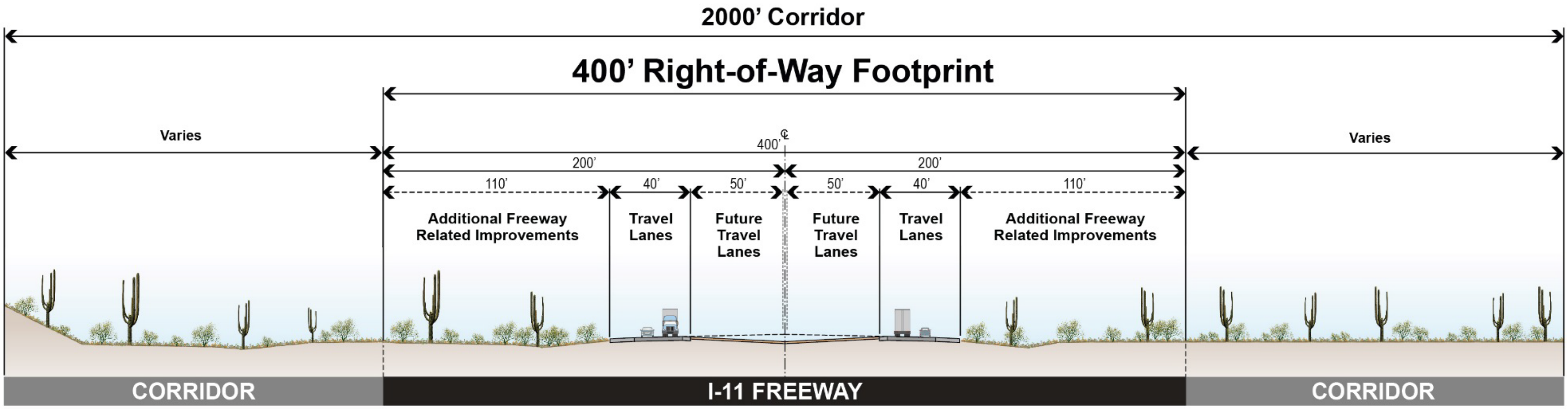


Figure 3-2 Steps Involved in the Technical Analysis



Note: 400' right-of-way footprint for the I-11 Corridor may not be centered in the overall 2000' study corridor but could be located anywhere within the 2000' alternative. Additionally, in areas co-located with existing facilities with lower anticipated traffic volumes or parallel constraints, the footprint may be less than 400' wide. Widths on either side of freeway corridor may vary. Engineering inputs for grade would allow the alternative to integrate other parallel transportation or linear uses in the future, such as freight rail, passenger rail, and/or a utility corridor.

Figure 3-3 Typical Section for Proposed Interstate Freeway Facility (not to scale)

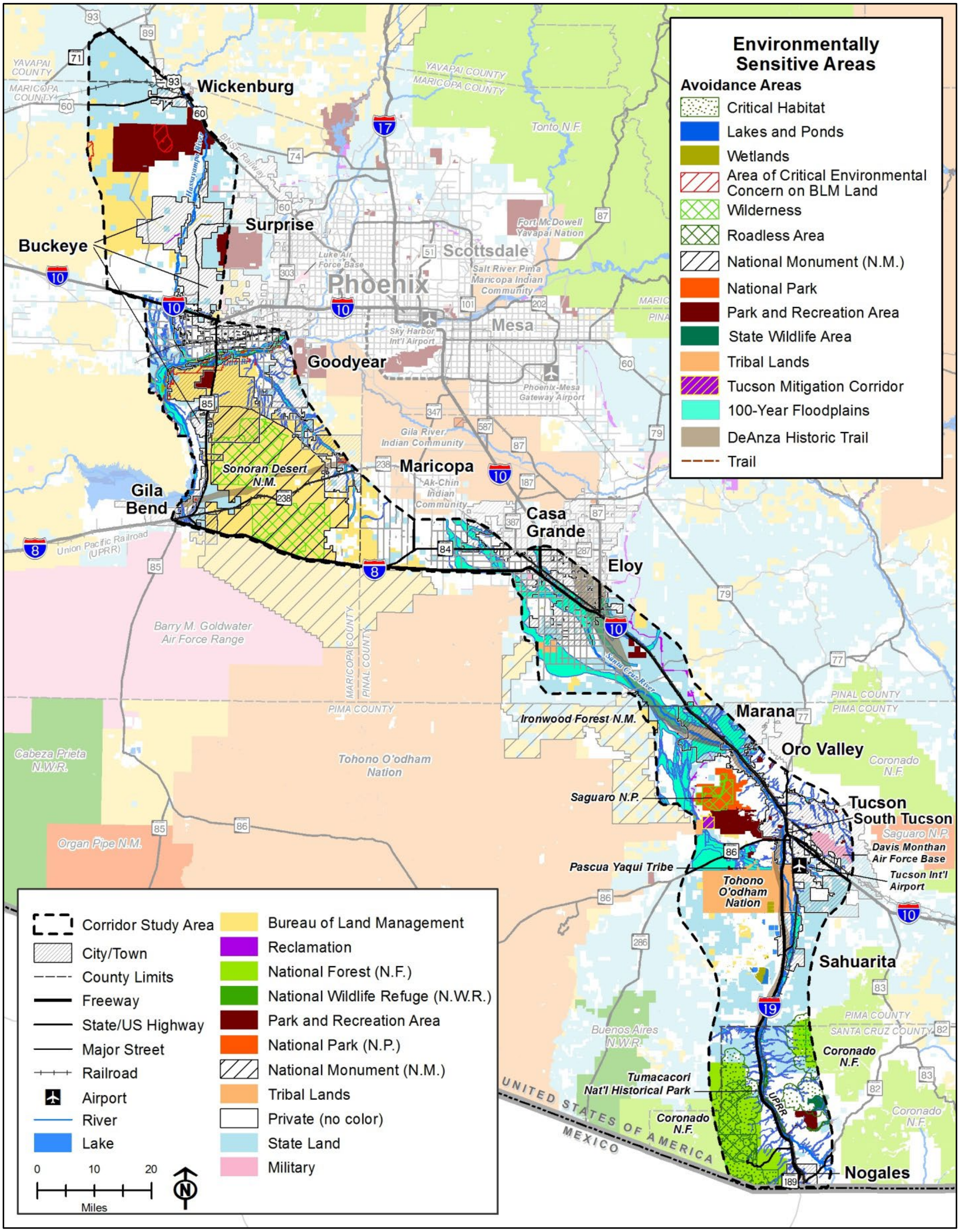


Figure 3-4 Environmentally Sensitive Areas

Free-to-Roam Analysis Looking for Routes

With the engineering design criteria and environmental avoidance areas established, the model was run to determine how potential routes respond to the inputs, conducting a "free-to-roam" analysis. Due to the extent and limits of the I-11 Corridor Study Area and large volumes of information, the South, Central, and North sections are run separately in the model. The model considered the engineering inputs such as slope and curvature requirements when traversing the topographic terrain layers, thereby generating potential routes that meet the design criteria of a proposed interstate freeway facility. Simultaneously, the model avoids, goes around, or minimizes crossings of environmentally sensitive resources when mapping out potential routes. Using these input parameters, this technical analysis screens out potential fatal flaws, while also maximizing corridor options.

Route Trends within Corridor Study Area

The free-to-roam analysis can generate as many as 50 to 100 potential routes for each section to identify the most reasonable options that meet the engineering and environmental inputs. The next step is to identify potential route trends, or groupings of routes, that generally follow a common path. These common path options will be used to identify potential corridor alternatives.

Density Analysis for Potential Corridor Alternatives

To assist in determining the most dominant route trends or groupings, the modeled routes were imported into Geographic Information Systems (GIS) to run through a density analysis to more clearly distinguish the most common paths for the routes. The results of this multi-step process were used to map the routing trends of the software analysis for consideration with the other corridor alternatives derived from previous studies and agency and public scoping input, as previously described.

In addition to the potential corridor alternatives generated as a result of the engineering and environmental inputs, the technical analysis also integrated previously suggested routes (e.g., agency-studied corridors) to optimize or refine these corridors to ensure the same level of avoidance of major environmental features and compliance with base level engineering requirements. At this level of screening, not all obstacles would be avoided. The purpose of this effort is to broadly define a reasonable range of feasible corridors to undergo detailed analysis in the Tier 1 EIS.

3.2 Optimization of Corridor Alternatives

The final step in the alternatives development process incorporated all potential alternative corridors (routes proposed during scoping, those from prior studies, technical analysis outputs) back into the software tool to optimize corridor routing to ensure the alternatives are meeting the minimum engineering and environmental design criteria, to the extent possible. In addition, corridors may be slightly moved to overlay with existing roadways/right-of-way, avoid defined constraints (e.g., tribal land), or better respond to engineering constraints Initial Range of Corridor Alternatives.

3.3 Capital Costs

The elements contained in the capital cost estimates were derived from the quantity outputs from Quantm for the alignment alternatives. These quantities included the major cost elements such as earthwork, pavement, retaining walls, and bridges. Ultimately the estimates also included typical ADOT project-wide and other percentage-based costs as follows:

- 12% for mobilization along new route and 8% along existing routes
- 30% for unidentified items
- 1% for dust and water palliative
- 15% for maintenance and protection of traffic along existing routes and 8% along new routes
- 1% for erosion control
- 1% for contractor quality control
- 1.5% for construction surveying
- 14% for construction engineering
- 5% for construction contingency
- 1% for public relations
- 10% for engineering design
- 1% for post-design services
- 10.14% for indirect cost allocation (ICAP)

APPENDIX A
Environmentally Sensitive Resources by Section

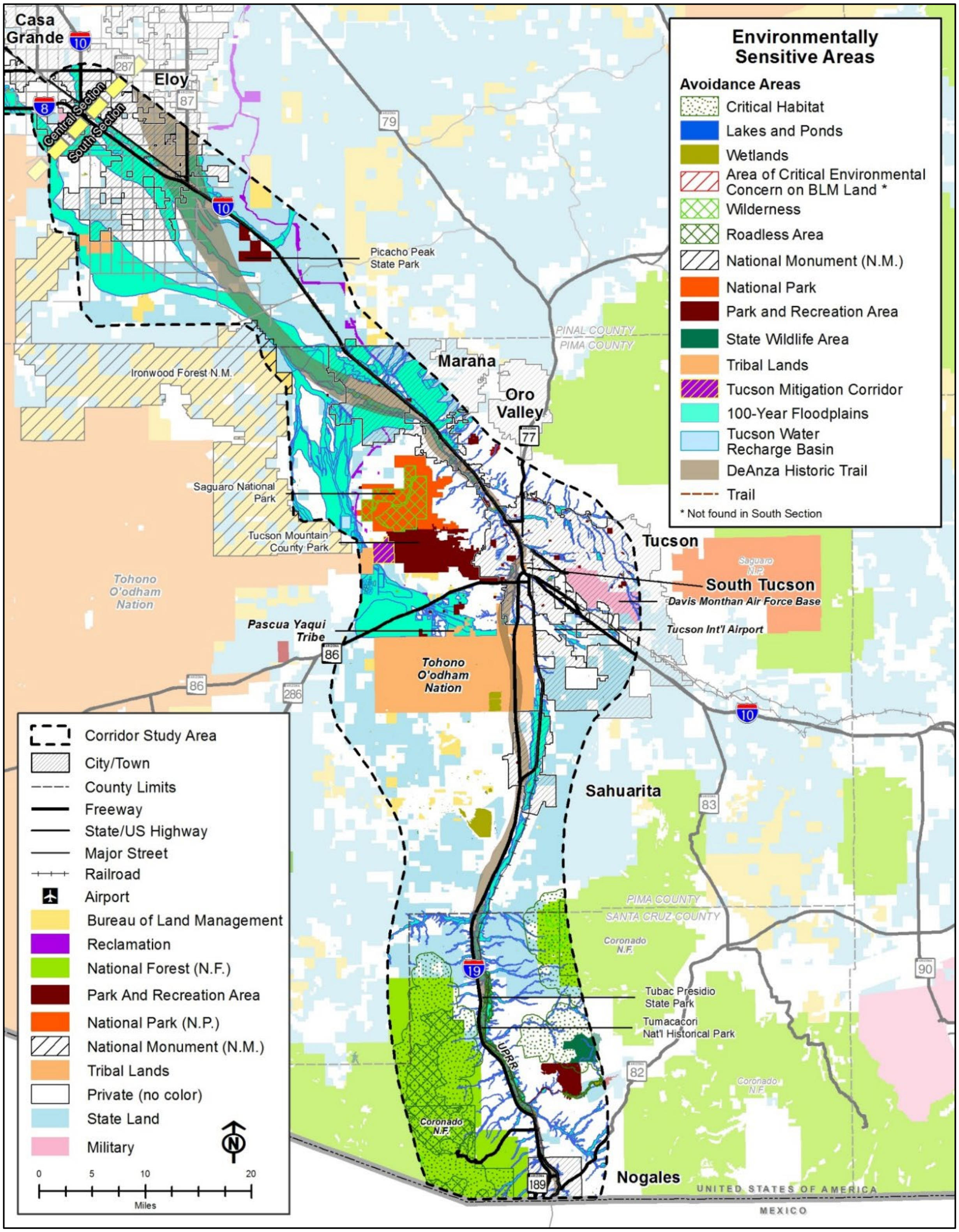


Figure A-1 Environmentally Sensitive Areas (South Section)

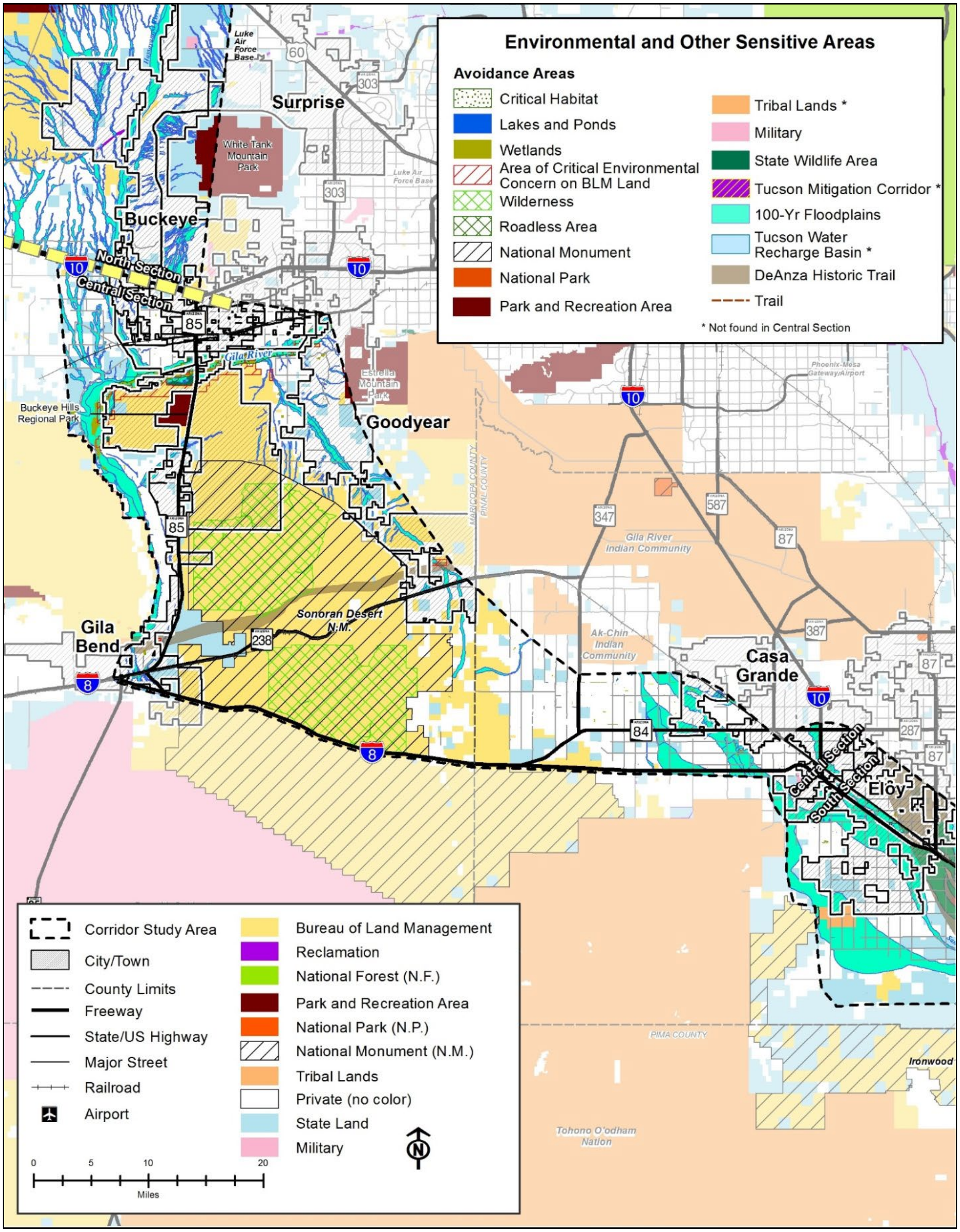


Figure A-2 Environmentally Sensitive Areas (Central Section)

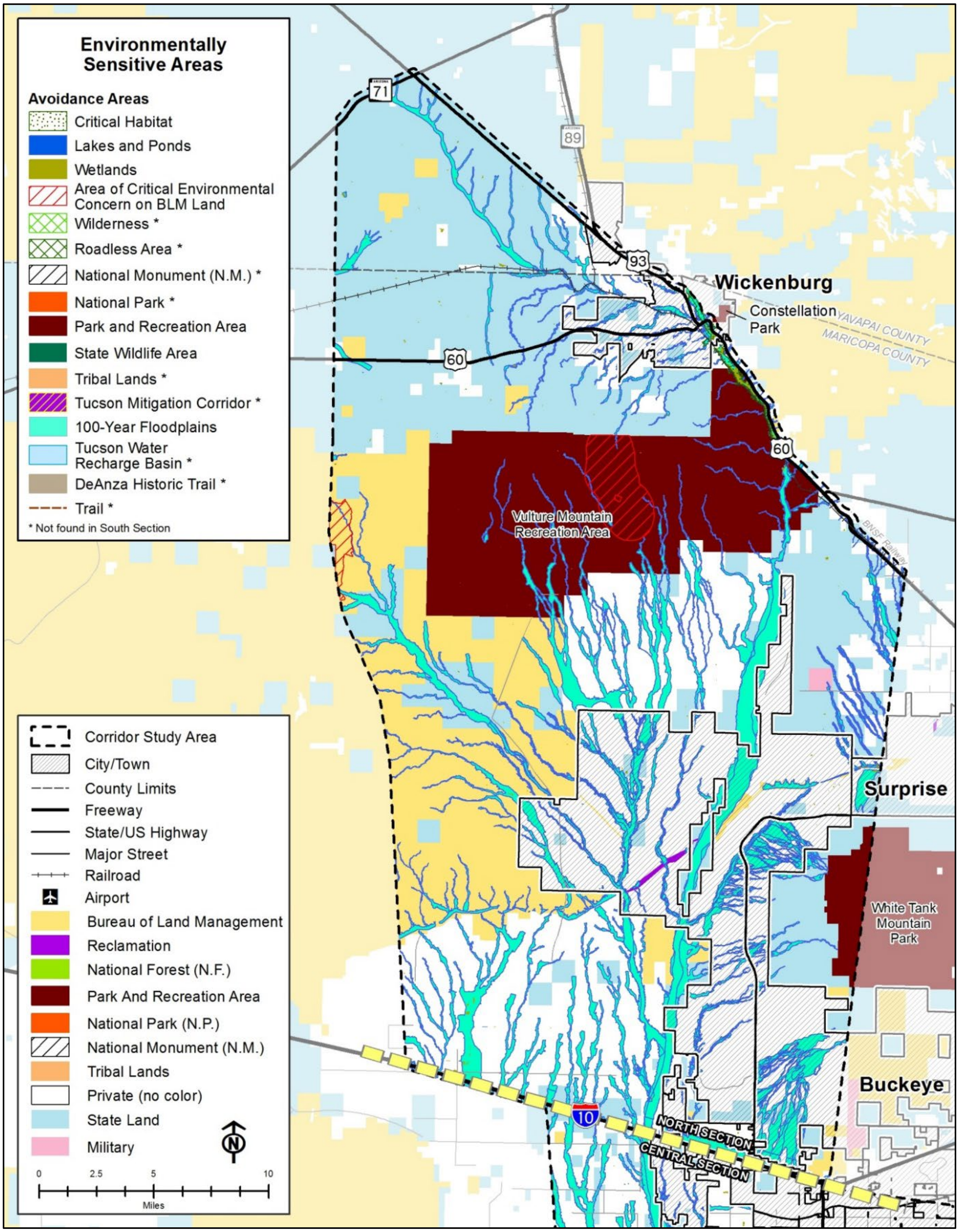


Figure A-3 Environmentally Sensitive Areas (North Section)